Educational Returns, ability composition and cohort effects: theory and evidence for cohorts of early-career UK graduates

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Abstract

An increase over time in the proportion of young people obtaining a degree is likely to impact on the relative ability compositions (i) of graduates and non-graduates and (ii) across graduates with different classes of degree award. In a signalling framework, we examine the implications of this on biases across cohorts in estimates of educational returns. In an empirical analysis, we exploit administrative data on whole populations of UK university students for ten graduate cohorts to investigate the extent to which early labour market outcomes vary with class of degree awarded. Consistent with our theoretical model, we find that returns by degree class increased across cohorts during a period of substantial graduate expansion. We also corroborate the empirical findings with evidence from complementary data on graduate sample surveys.

JEL Classification: J31, J24, I21, D82
Keywords: Educational Returns, College Wage Premium, Degree Class, Ability Bias, Statistical Discrimination.

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1. Introduction

One motivation for the current paper is the view that insufficient attention has been paid to the impact of changes across cohorts in ability composition on estimated returns to education. This is an important issue as an understanding of changes in educational returns over time is vital for both policy-makers and for individuals making human capital investment decisions. There is a substantial literature devoted to understanding variations over time in the US college wage premium[1] and to estimating returns to degrees for UK university graduates.[2] Recent work in the UK, partly motivated by the ongoing policy debate on the introduction and extension of top-up fees, has examined variations in graduate returns according to factors such as subject studied, university attended and degree class awarded.[3, 4] Our paper focuses on variations by class of degree.

The US literature has tended to downplay the role of ability composition changes across cohorts in explanations of the behaviour of educational returns over time. This is largely because – as discussed in Blackburn and Neumark (1991, 1993) – expansion in the college graduate population is likely to have reduced the average ability gap between college and high school graduates and hence depressed the college wage premium. As the college wage premium in the US was increasing during the 1980s, the effect of rising college participation on ability composition does not seem to offer a possible explanation for the changing premium.

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[1] See, for example: Katz and Murphy (1992); Blackburn and Neumark (1995); Autor, Katz and Krueger (1998); Cawley *et al*. (2000); Heckman and Vytlacil (2001), and Taber (2001).

[2] See, for example, Blundell, Dearden, Goodman and Reed (2000) and Blundell, Dearden, and Sianesi (2005). For work on changes over time, see Harkness and Machin (1999), Moffitt (2007), and Walker and Zhu (2008).

[3] See Dolton and Makepeace (1990), Greenaway and Haynes (2003), Chevalier and Conlon (2003), and Bratti, Naylor and Smith (2008).

[4] Traditionally, the degree classification system in the UK is an alternative to a transcript system. The main classes of degrees are: first; upper second; lower second; pass and fail. A 'high' degree refers to a first or upper second class honours degree: a 'low' degree class refers to any other degree classification.

In the current paper, we explore the mechanisms linking expansion of the graduate population with behaviour of labour market returns via changes in relative ability composition for different levels of educational attainment. We extend the signalling-based theoretical analysis developed by Blackburn and Neumark (1991, 1993) to capture not only returns to a degree but also returns associated with the classification of the degree award. In this light, we then interpret the observed evidence on the behaviour of graduates' labour market outcomes over time in the UK.

That our main focus concerns returns by class of degree awarded to graduates contrasts with much of the existing literature on educational returns which defines educational attainment either as numbers of years of schooling or by qualification level. In reality, however, employers commonly recruit from shortlists of candidates with common 'amounts' of education. This is inevitable given the finite number of formal qualification levels and the consequent clustering at each. In the UK, for example, the major clusters occur with the general certificate of secondary education at age 16, A-levels at 18, and with an undergraduate degree at *circa* 21. The main problem for the employer is to differentiate between job candidates with a common qualification level: this is likely to lead employers to use information on mark or grade score achieved at each level. There is, however, very little analysis based on grade score. At least at degree level for the UK, this is not surprising: very few data-sets contain information on degree class awarded. One exception to this is the BCS70 data-set, which has been exploited by Bratti, Naylor and Smith (2008), who estimate a positive return to a 'high' degree class relative to a 'low' degree class at age 30.

In the empirical analysis, we exploit administrative data on full populations of successive cohorts of university leavers to produce a comparison over cohorts in labour market returns by class of degree awarded. The period covered by the data is one of a substantial increase in the higher education age participation index (HE API) of 18 year olds. Hence, we are able to examine whether the observed behaviour of returns by degree class during this period of expansion is consistent with theoretical predictions.

Our theoretical approach is consistent with the literature on what Altonji and Pierret (2001) refer to as the 'Employer Learning with Statistical Discrimination', or EL-SD, hypothesis, which states that in the absence of full information about workers' potential productivities at the point of recruitment, firms will distinguish between individuals with different characteristics on the basis of known or perceived statistical regularities: see also Farber and Gibbons (1996) and Lange (2007). An empirical implication of the hypothesis is that initial or early career labour market outcomes will be sensitive to those worker characteristics (such as education level) which are both likely to be correlated with potential productivity and are easily observable at the recruitment stage, even though these same characteristics might have little or no relationship with long run returns, when – at least in competitive labour markets – employers learn through experience and rely less on initial signals. Accordingly, in our empirical analysis, we focus on the early-career outcomes of graduates.

The EL-SD approach offers a framework for integrating signalling and human capital theories, with signalling having diminishing relative influence on educational returns over the course of the individual's working life.[5] We view the acquisition of a

[5] On signalling, see Spence (1973, 1974) and Arrow (1973). On the human capital approach, see Becker (1975).

degree as likely to combine features both of human capital enhancement and of signalling: in contrast, we think of the degree class award as acting more like a pure signal of ability, broadly defined. The theoretical analysis focuses on the importance of changes in the distribution of ability for the behaviour of returns to education. As Lang (1994) has discussed, the relationship between ability and schooling emerges in a signalling model because employers do not observe ability: in a human capital model the source of bias is the econometrician's failure to observe ability. Under either interpretation, our theoretical treatment provides insights into the relationships between ability distribution, cohort size and earnings premia.

The rest of this paper is organized as follows. In Section 2, we describe a model in which we explore how graduate expansion is likely to impact on estimated returns to degrees via its effect on the relative ability composition of groups with different levels of educational attainment. We interpret existing evidence on the college wage premium in the US and in the UK in the light of this model. In Section 3, we then extend the model in order to capture the case of degrees which are differentiated by the class of the award. The model generates predictions regarding the likely impact of graduate expansion on the premium for a high class – relative to a low class – degree award. In Section 4, we present the results of an empirical investigation of a full cohort of UK university graduates, exploring the extent to which early graduate labour market outcomes are related to the class of degree. We find that there is a significant positive statistical relationship, the magnitude being consistent with estimates reported by Bratti *et al.* (2008), for the 1970 birth cohort.[6] The estimates suggest an occupational earnings

[6] Members of this birth cohort would, typically, have graduated at about the same time as the 1993 graduate cohort which we analyse in the current paper.

premium of about 6 percent for the award of a high class, relative to a low class, degree. We replicate the analysis for other cohorts and find that the strength of the relationship between degree class outcome and graduate returns grew across a run of cohorts characterized by expansion in graduate cohort size: consistent with theoretical predictions. We report corroborating results based on earnings collected from graduate surveys for 1985 and 1990. Section 5 concludes with a summary and further remarks.

2. Theoretical Framework

Cawley *et al*. (2000) observe that the increasing wage gap between those with high and those with low education in the US over the last decades of the 20th century has led to a debate on whether the source of the increase is a rise in the return to education or whether it results from an increase in the wage return to ability. Consider a standard empirical approach in which wages are a function of education and ability and where education and ability are positively correlated:

$$w = w(e, a(e)) \tag{1}$$

Suppose that the econometrician observes e but not a – as is often likely to be the case. Then the estimated return to education from an OLS regression based on (1) will be given by:

$$\frac{dw}{de} = r_e + r_a \left[\frac{da}{de} \right], \tag{2}$$

where $r_e = \partial w / \partial e$ is the direct – or human capital – effect of education on wages and $r_a = \partial w / \partial a$ is the wage return to ability. We can think of da / de as a measure of the difference in ability between individuals or groups with different levels of education: for example, the average ability gap between college and high school graduates in the US.

The term $r_a\left[da/de\right]$ measures the indirect effect of a change or difference in education on wages: in an OLS regression of wages on education, it is the omitted variable bias in the estimate of r_e.

Our interest focuses on the behaviour of estimated returns to education over time as the cohort of university graduates rises as a proportion of the age cohort. From (2), it is clear that the estimated return to education will increase over cohorts if:

(i) the direct effect of education on wages, r_e, increases;

(ii) the wage return to ability, r_a, increases, and/or;

(iii) there is an increased difference in ability by educational level – that is, da/de increases.

We note that the relation $a(e)$ in (1) might be generated either by a signalling-type model or within a human capital approach, or by a combination of the two. Under a human capital model, the omitted variable bias arises simply because the econometrician does not observe a variable, ability, which is observed and rewarded by employers and which is correlated with education through, for example, a higher marginal return to education for the more able. The induced bias is the econometrician's problem. In a pure signalling model, it is the employer who has the problem of not observing ability directly and whose pay or recruitment strategy is 'biased' towards those with more education, who are perceived to have – and, in equilibrium, do have – higher ability. The EL-SD literature suggests that signalling might characterize the early career relationship between labour market outcomes, education and ability while, in the long run, bias will be a potential problem solely for the econometrician. Either way, changes over cohorts in da/de are likely to have implications for the behaviour over time of early career labour market outcomes. Hence, even though our exploration of the $a(e)$ relationship in sections 2 and 3 is based on a signalling model, it is – as we discuss in more detail below – likely to be of relevance also under a human capital approach.

2.1 The college wage premium in the US

The existing literature has focused on the relative importance of changes in r_e and r_a in explaining increases in the college wage premium in the US. Cawley *et al.* (2000) report a " . . . consensus view that much of the increase in the return to education is attributable to an increase in the return to ability." They then show how different approaches to the identification problem lead to varying estimates of the relative importance of r_a. Taber (2001) explicitly acknowledges a potential role for changes in ability differentials between workers of different educational levels – 'da/de' in (2) – but argues that these cannot be a major influence on changes he observes in the college wage premium as there were no major changes in college matriculation rates across cohorts in the data he considers. Taber (2001) also remarks that Chay and Lee (1999) adopt the assumption that the ability differential between college and high school graduates is constant over time, thereby explicitly ruling out the mechanism on which we focus in the current paper.

Blackburn and Neumark (1991, 1993), in a signalling framework, point out that an increase in the size of the college graduate cohort is likely to *reduce* the ability differential for graduates relative to non-graduates – that is, reduces da/de – and hence exerts a *downward* force on the omitted variable bias. This is supported by their empirical results, which reject the hypothesis that a change in the relationship between ability and education contributed to the observed rise in returns to schooling (see also Blackburn, Bloom and Freeman, 1990).

We now describe a simplified version of the Blackburn and Neumark (1991) model as it provides the basis for the approach we adopt in Section 3. Assume that individuals make a choice between and a high and a low level of education: specifically, consider the dichotomy between (i) graduating from college/university and (ii) quitting education without attending college/university. There is a cost, $c(a)$, associated with matriculating and graduating, decreasing in individual ability: $c'(a) < 0$. Initially, we consider the case in which ability is uniformly distributed across the population. Subsequently, we discuss alternative specific forms as well as a more general specification. Ability is assumed to be private information to the individual: it is unobservable by prospective employers, who know only the distribution and hence can compute the expected ability of workers at each educational level. Employers are assumed to pay a wage to each individual equal to the expected ability of the worker: we treat ability and productivity as synonymous. In equilibrium, workers sort by ability such that $a_i \geq a*$ for graduates and $a_i < a*$ for non-graduates.

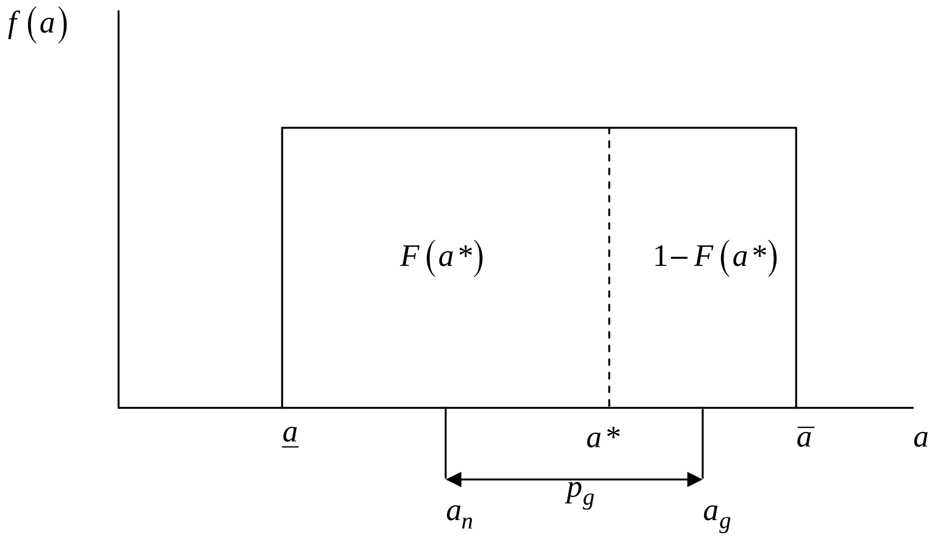


Figure 1: The college wage premium, p_g, under a uniform ability distribution.

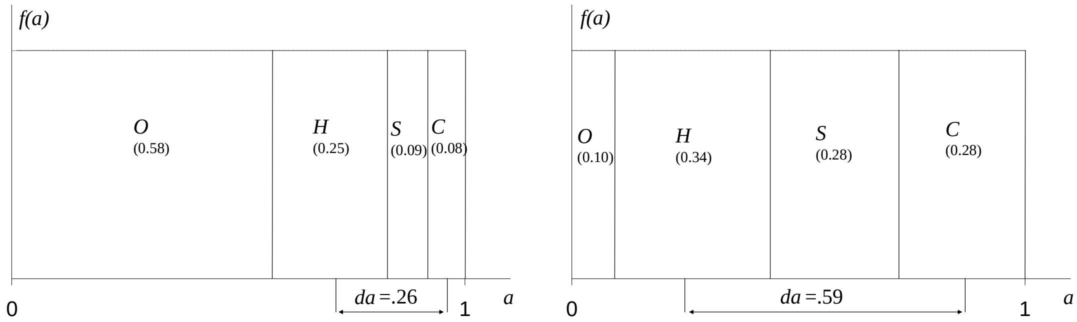
We depict the equilibrium in Figure 1, where ability is assumed to be distributed uniformly on the support $(\underline{a}, \overline{a})$.[7]

In this pure signalling model, the wage premium associated with graduating is given by $p_g = a_g - a_n$, where a_g is the average ability of graduates and a_n that of non-graduates. For the marginal investor, indifferent about investing in higher education, $a_g - a_n = c(a^*)$ in equilibrium. As p_g is the difference in average ability between graduates and non-graduates, we have $p_g = da/de$, where we abstract from human capital returns to education and from returns to ability. For the specific case of the uniform distribution, $dp_g / da^* = 0$: that is, graduate expansion – represented by a reduction in a^* – has no effect on the return to education and thus changes in the ability-education relationship resulting from graduate expansion cannot explain increases in the college wage premium over time.

Blackburn and Neumark (1991) consider single-peaked symmetric densities, the standard normal distribution and a triangular distribution, and show that, so long as more educated workers are a minority, $\int_{a^*}^{\overline{a}} f(a)\,da < 1/2$, then $dp_g / da^* > 0$. Hence, the omitted variable bias should decrease with graduate expansion and therefore cannot account for the observed rise in the college wage premium. For asymmetric triangular distributions, Naylor and Smith (2008) show that $dp_g / da^* > 0$ is more likely the more positively-skewed the distribution.

[7] The support for ability, a, is to be thought of as calibrated along a scale which yields equivalence with the measure of productivity and, hence, wages. We assume that this scalar is fixed – that is, we abstract from changes in the rate of return to ability, r_a.

Rosenbaum (2003), in contrast to much of the previous literature, finds that for native white US males accounting for changes in ability composition across educational groups can explain about half of the increase in the college wage premium between 1969 and 1989. Rosenbaum (2003) distinguishes between (i) college graduates, C, (ii) high school graduates, H, and (iii) an intermediate group with some college education, S. In Figure 2, Panel A shows a calibration based on Rosenbaum's population shares for C, S, H and O (Other) for 1950 of 8%, 9%, 25% and 42%, respectively: Panel B is calibrated for 1996 with shares of 28%, 28%, 34% and 10%, respectively.[8]



Panel A: 1950 calibration *Panel B: 1996 calibration*

Figure 2: The average ability gap between US college and high school graduates, da, under a uniform ability distribution in the presence of an intermediate educational group.

In the figure, da represents the absolute ability gap for the difference in educational level, de, between college and high school graduates. The gap has clearly increased substantially between 1950 and 1996: partly because of the reduction in the size of the O group and partly because of the increase in the proportion, S, with some college education. This provides a possible explanation for the rise in the college wage

[8] Ability is calibrated on the (0,1) support.

premium based on the effects of changing participation on the ability-education relationship. The calibration implies that the extent of the omitted variable bias represented by da/de more than doubles. Rosenbaum (2003) observes that most of the papers in the literature on ability bias focus on changes in *returns* to ability in single cohorts, ignoring changes in the *distribution* of ability by education level across cohorts.

2.2 Returns to a degree in the UK

For the UK, there is no consensus on the behaviour of graduate returns over time. The literature has focused on the fact that there has been a huge expansion in the size of the graduating cohort. Walker and Zhu (2008) cite OECD (2007) evidence that between 1988 and 1996 higher education participation rose by 15% in the US but by 93% in the UK. The HE API for 18 year olds in the UK had been 10% in 1970, increased to 15% by 1985, and reached approximately 30% by 1993.

There are two longitudinal birth cohort studies, for 1958 and 1970, for which returns to degrees have been estimated.[9] Graduates from the first of these cohorts would have tended to leave university in about 1980; and from the second in about 1992. Between these 2 cohorts, there have been two changes which are likely to have had potential effects on the average ability gap between university graduates and those with just A-levels (the highest secondary education qualification). First – tending to increase the gap – the proportion staying on at 16 to take A-levels increased from about 35% for the 1958 birth cohort to 45% for that of 1970.[10] Second, there was a disproportionate growth of university graduates relative to those with just A-levels. Under the uniform

[9] The National Child Development Study (NCDS) is a continuing longitudinal survey based on all the children born in a particular week in March 1958 in Great Britain: the Birth Cohort Survey (BCS70) is the equivalent for all the children born in a particular week in April 1970.
[10] See DfES (2003) for data on proportions staying on at age 16 and the HE API.

distribution, this relative change has no effect on the difference in average ability; just as in Figure 1, p_g is independent of a^*. However, if we calibrate these 2 changes under a single-peaked ability distribution – such as for the symmetric triangular distribution – then we have the Blackburn and Neumark (1991) result that $dp_g / da^* > 0$: details are provided in Naylor and Smith (2008).

With regard to empirical evidence on graduate returns in the UK, Walker and Zhu (2008) find that the premium for a degree was constant for men and rose only weakly for women during the expansion of 1988 to 1996. This contrasts with evidence for the longer 1974-1995 interval analysed by Harkness and Machin (1999), who reported rising returns to a degree despite the relative increase in supply. Both pieces of evidence are consistent with demand-side forces offsetting supply-side shifts – including those channeled through effects on the ability-education relationship – in higher education participation.

Heckman *et al*. (2006), observe that comparisons over time in returns to education should use cohort-based estimates as cross-section estimates respond only slowly to cohort changes, being diluted by absorption into the stock of earlier cohorts. Blundell *et al*. (2000) use NCDS data for the 1958 birth cohort to estimate returns to a degree, reporting estimated wage premia of 17% for men and 37% for women, relative to individuals with A-levels only. Bratti *et al*. (2008), using BCS70 data, estimate that the return to a degree for men was no different to that reported by Blundell *et al*. (2000) for the earlier birth cohort, while the degree return for women fell markedly.

The result for men is consistent with the interpretation that demand-side forces – captured by increases in r_e and in r_a – have been matched by an offsetting reduction in the ability gap between graduates and non-graduates (and hence da / de) as the relative proportion of graduates has risen. For women, the increase in the proportion participating in higher education has been much more dramatic that that for men, consistent with the explanation that the ability-composition dynamic has dominated demand-side changes, causing graduate returns to diminish. It is sometimes argued that comparison is invalidated by changes in ability composition across the two cohorts: but that is precisely the issue which this analysis addresses.

3. Theoretical model with degree class premia

In this section, we extend the basic model described in Section 2 to the case of classified degrees. Initially, we set out the model for the simplest case of a uniform ability distribution before discussing other specific distributions as well as a more general specification. Other assumptions remain the same as for the basic model with the additional assumption that, unlike employers, the university is able to observe individual ability – or, at least, rank it – and in making degree awards distinguishes between those qualifying with a high and those with a low class award. The university awards a high class degree to a fixed proportion, λ, of graduates. Each worker receives a wage which reflects the average ability of the group to which they belong. Were the university to reveal more finely graded information about graduates' abilities, each graduate would receive a wage closer to their actual ability while non-graduates would command a wage related to their group average ability. This would be similar to the analysis presented by Arcidiacono *et al*. (2008) who find evidence to support the hypothesis that a US college education reveals ability, in contrast to those with a high school education for whom ability is merely signalled.[11] In terms of our model, the full revelation of ability of university graduates implies that any premium for a high class degree would reflect purely the econometrician's failure to observe graduates' ability.

Figure 3 is a depiction which modifies that described in Figure 1 to reflect the additional assumption of a distinction between high and low class degree awards, with the proportion of high class awards given by $\lambda = \left[1 - F\left(\hat{a}\right)\right] / \left[1 - F\left(a^*\right)\right]$. In the figure, a^* pertains to the marginal investor, $\hat{a}$ to the marginal recipient of a high class degree award, a_p is the average ability of those awarded a low class and a_d is the average ability of those awarded a high class degree.

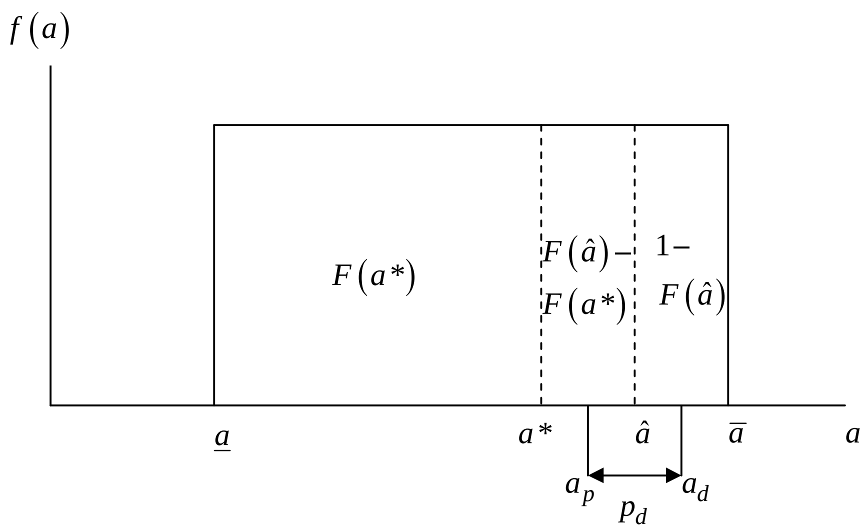


Figure 3: The premium, p_d, for a high class degree award under a uniform ability distribution.

In a pure signalling model, the premium, p_d, associated with the award of a high class relative to a low class degree is given by:

[11] It is plausible that the US college system reveals more information to prospective employers and other recruiters than does the more 'lumpy' UK system based on degree classification without, traditionally, a more detailed provision of resumés, transcripts or in-class ranking information.

$$p_d = a_d - a_n. \tag{3}$$

It is straightforward to show that, for given λ:

$$\frac{dp_d}{da*} < 0 \tag{4}$$

Hence, graduate expansion generates an increase in the pay premium, p_d, for a high class degree through the implied change in the ability-education relationship – da/de in equation (2). The property that $dp_d / da* < 0$ holds both for triangular distributions – independently of skewness and of $a*$ – and for the normal distribution.[12] The result is not completely general, however, as we demonstrate in an Appendix. Nonetheless, quite extreme assumptions are necessary for the sign of $dp_d / da*$ to be non-negative: after considering various linear approximations, we find $dp_d / da*$ to be positively-signed only when the ability distribution is multi-peaked, (locally) highly negatively-skewed, and with implausibly high values for λ.

In the next section, we produce estimates of the labour market returns by degree class and consider results in the context of the hypothesis that the premium for a high class of degree is likely to be increasing with graduate expansion across cohorts.

4. Empirical analysis

Bratti *et al*. (2008) report a wage premium of 6.4% for the award of a high relative to a low degree class for the 1970 birth cohort.[13] Unfortunately, changes relative to the 1958 cohort cannot be observed directly as degree class information is not available in the

[12] Results cited but not demonstrated here are available in a longer working paper version of this section: see Naylor and Smith (2008).
[13] The estimate is based on individuals' earnings at age 30. A high class degree is defined as a first or upper second class honours degree: a low degree class is any award below a lower second.

NCDS data. However, previously unexploited information on graduates' early labour market outcomes can give us insights into this question.

The data we exploit are based on administrative records for full populations of UK university students for the leaving cohorts of 1985 through 1993 and of 1998. We are interested in how the transition of these students into the post-university labour market is influenced by their class of degree, among other characteristics, and how any such influence has changed across cohorts. From the EL-SD literature, we expect that signalling is more relevant in early careers, which motivates our use of data on the post-university destinations of university leavers one year after graduation.

Our principal aim is to examine whether class of degree awarded is associated with the quality of the new graduate's labour market outcome and whether this association has changed over cohorts. Were we to measure the quality of the outcome by the graduate's personal earnings – which are not recorded in the first destination survey – we would risk conflating any 'structural' change in the effects of degree class on outcomes with potential 'inequality-inflation' effects arising from the general widening of pay differentials over time. Potentially, this problem can be overcome by using a measure of outcome quality based on the occupation in which the graduate is employed. Various quality measures might be used. Smith *et al*. (2000) and Bratti *et al*. (2004) draw the binary distinction between jobs which draw on graduate skills and those which do not.

Instead, we attribute to each graduate the average gender-specific earnings of the occupation in which they are employed.[14] For each cohort, we match current occupational

[14] We know the graduates' occupation at the 4-digit SOC level, but match to this occupational earnings information from the New Earnings Survey at the 3-digit level: cell sizes are too sparse at the 4-digit level.

earnings data for each year: in the empirical analysis, we consider both results based on contemporaneous occupational earnings and results based on averaging earnings for each occupation over all years. An additional advantage of the earnings variable we use over an earnings measure based on the graduates' personal first-destination earnings is that they are a better measure of lifetime earnings in occupations.

Given that we attribute to each individual their median occupational earnings, we do not capture intra-occupational differences in earnings across graduates. These differences are unlikely to be randomly assigned and hence there is the potential that estimated effects on occupational earnings are biased estimates of effects on actual earnings. As any correlation between intra-occupational earnings and degree class is likely to be positive, we interpret our results as lower-bound estimates of the effects of degree class on graduates' earnings. To corroborate this, we also conduct analysis based on actual earnings of a sample of graduates for the 1985 and 1990 cohorts.

4.1 Data description

All UK universities maintain detailed administrative records on all of their students, including information on: parental occupational background; previous school attended; prior qualifications (with grades per subject); degree course; study details (eg., full/part-time status, duration of study); and degree class awarded. These data are collected and archived at a national depository: until 1994, this was managed by the Universities Statistical Records (USR); since 1994, the responsible agent has been the Higher Education Statistics Agency (HESA). In the year following graduation, all university leavers from all universities are sent a first destination survey (FDS). We exploit data from the FDS data, linked to the USR administrative records of the entire cohort of UK university graduates for each of the leaving cohorts of 1985 through 1993; separate consideration is also given to the 1998 cohort using matched HESA records.

Initially, we focus on the 1993 cohort in estimating the effect of degree class on graduates' early post-university outcomes. Subsequently, we consider each of the earlier cohorts, establishing the time-path of the estimated effects. We select 1993 because there is a break in the series of accurate and informative student record data for succeeding cohorts. We have produced estimates based on data we have obtained for the 1998 leaving cohort, but are not as confident of the comparability over time in these data as we are for the main series we exploit. By considering the period 1985-93, we are selecting an interval similar to that period of graduate expansion covered by Walker and Zhu (2008) in their analysis of the college wage premium in the UK. An additional advantage of using the 1993 cohort data is that they provide a potential source of comparison for related work on the BCS70 birth cohort, graduates from which would typically have obtained their degrees alongside or close to the 1993 graduate cohort.

4.2 Summary statistics

Our analysis is based on university students who were registered for a degree-level course.[15] Initially, our analysis examines data for 1993 graduates and their first destinations in 1994. Of the 47,388 male graduates in 1993, 71% responded to the First Destination Survey. Of these, approximately 20% were unemployed or inactive six months after graduation, 22% were in further study and 58% were in employment. Of the 38,381 female graduates in 1993, 76% responded to the FDS. Of these respondents, 15%

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[15] We include all courses which typically lead to a classified degree. We exclude overseas students for two reasons: first, to be consistent with our theoretical approach; second, as only a small and unrepresentative sample of overseas students respond to the FDS.

were unemployed or inactive, 16% were in further study, and 68% were employed. A total of 39,454 graduates in employment identified their particular occupation.

Table 1 presents summary statistics for the main explanatory variables used in our analysis of the 1993 cohort. We note that of those in employment, 7% (10%) of female (male) students graduated with a first class degree, 55% (45%) with an upper second class, 32% (33%) with a lower second class and 3% (7%) with a third class degree. Table 2 shows the mean and standard deviation of occupational earnings, disaggregated both by gender and by degree class, based on matching the individual's reported occupation at the 3-digit SOC level to the corresponding gender-specific median occupational earnings from the New Earnings Survey (1994). For the whole sample, mean earnings of males were £450.28 per week, with mean earnings of females at £333.10. For male graduates, the raw differential for a first relative to an upper second degree class is 3.2%, while that for a lower second (third) is -7.0% (-12.2%). For female graduates, relative to an upper second degree class, the raw differential for a first is 3.8%; that for a lower second (third) is -4.7% (-5.7%).[16]

With respect to changes across the cohorts between 1985 and 1993, we note from Table 2 that there was a growth in the overall number of students leaving university from 74,953 to 93,613 an overall growth rate of 25%. The growth rate was not constant, but tended to increase after 1989. Overall, the number of female students leaving university rose by 37% and the number of male students by 16%. The proportion of males (females) awarded an upper second or first class degree was 39% (41%) in 1985, compared with

[16] In the theoretical discussion, we distinguish between high and low class degrees. Similarly, in our work on BCS70, we draw the simple dichotomy between two class groups. The USR/HESA data provide much larger cell sizes, however, and hence in our empirical analysis we are able to distinguish between individual degree classes.

46% (54%) in 1993. Thus, we note that despite the rise in the size of the graduate population, there was an increase in the proportion of graduates awarded high degree classes. The raw occupational earnings premium for a first over an upper second degree was zero (2.9%) for male (female) students in 1985 compared to 3.2% (3.8%) in 1993. The raw premia were mostly greater in 1993 than in 1985 for each of the degree classes.

4.3 Empirical estimates

Estimates for the 1993 cohort

Initially, we estimated a multinomial logit model of the first destination outcomes of the students in the 1993 cohort based on: (i) employment; (ii) further study; (iii) unemployment (or inactivity) or (iv) non-response. Correcting the occupational earnings equation for possible self-selection (see Lee, 1983), we note that the p-values on the correlation term are not significant at even the 10% level. Hence, reported results are based on OLS regressions.

Table 3 presents results from the occupational earnings regressions for both males and females. Focusing on the main variable of interest, the table reports the estimated coefficients on the dummy variables for class of degree awarded.[17] The benchmark is a student graduating with an upper second class honours degree. Each of the coefficients is significant at 1%. In our descriptions below, estimated coefficients are translated into proportional earnings premia using the formula $p = e^{\beta} - 1$. For male graduates, the premium associated with a first class honours degree is 3.9%, relative to the case of a student with an upper second class degree. There are (negative) earnings premia of –5.5%

[17] The patterns we uncover in the behaviour of degree class premia across cohorts are unchanged when we aggregate over classes and re-estimate our models using the dichotomous distinction of high versus lower class degrees.

for a lower second and of –9.9% for a third class degree. Hence, for male graduates, there is an occupational earnings span of about 14% between a first and a third class degree. There is a smaller overall span for females, with a premium of 3.8% for a first and premia of –4.3% for a lower second and of –5.4% for a third class degree, relative to an upper second. Thus, for females there is an occupational earnings span of about 9% between a first and a third class degree. We note that the estimated coefficients on the miscellaneous Other degree class category is similar to those for thirds.

When we aggregate over the individual degree classes and re-estimate our model, distinguishing only between high and low class degrees, we obtain an average premium of 6.0% for men and women – very close to the estimated log wage differential of 6.4% reported by Bratti *et al*. (2008), despite the differences in the construction of the earnings variable.

There are other candidates for variables which might be associated with statistical discrimination, including: pre-university qualifications; type of previous schooling and family background. Table 3 shows that for males, an increase in the A-level score is associated with higher occupational earnings. There are no significant effects of A-level scores for women. There is a strong effect of having studied Mathematics at A-level for both men and women: graduates with A-level Mathematics have over 1% higher occupational earnings, *ceteris paribus*, consistent with Dolton and Vignoles (1999).[18]

Table 3 shows that relative to a graduate who had attended a state (LEA) school prior to university, earnings are 4.5% (2.4%) higher for male (female) graduates who had previously attended a private 'Independent' school, *ceteris paribus*. Dolton and

[18] Prior study of mathematics also has an indirect effect through its impact on degree performance: see Smith and Naylor (2001).

Makepeace (1990) report a similar finding. There is also a clear pattern of the effects of Social Class background on male graduates' occupational earnings. Compared to an otherwise equivalent male graduate from a Social Class II (technical or intermediate managerial occupational) background, a graduate Social Class IIINM (skilled non-manual), IIIM (skilled manual), IV (semi-skilled) or V (unskilled) has graduate earnings which are around 2% less. For females, we find that graduate occupational earnings are around 3% lower for graduates from Social Class IV relative to II.

Time trends in earnings premia by degree class: estimates for cohorts 1985-1993

We replicate our analysis separately for each of the cohorts of students graduating between 1985 and 1992.[19] As for the 1993 estimations, the p-values on the correlation term, correcting for possible self-selection, are not significant and hence the reported results are based on OLS regressions.

Table 4 reports the estimated degree class earnings premia relative to an upper second class degree, for men and women respectively. The results are also represented graphically in Figures 4a and 4b, and reveal the increasing spread in the returns associated with the graduate's class of degree, at least since 1989. While for both 1990 and 1991 the estimates indicate a premium for males of about 3% for a first relative to an upper second, rising to about 4% in 1992 and 1993, there was no statistically significant premium from 1985 to 1989. For females, a broadly similar – though rather less stable – pattern emerges, with the estimated premium rising from 1.2% in 1985 to around 4% in 1993. The penalty associated with a lower second class degree is statistically significant

[19] For each cohort year we use the appropriate 3-digit gender-specific data on median occupational earnings from the contemporaneous New Earnings Survey. In the section on robustness, we re-estimate using earnings averaged over all cohorts.

in all years for both men and women, rising from 1.8% in 1985 to 5.5% in 1993 for men and from 3% in 1985 to 4.3% in 1993 for women. For males (females) the span between a first and a third class degree rose from 4.4% (5.0%) in 1985 to 13.1% (11.9%) in 1993, with the span becoming increasingly more pronounced from 1990, and hence coinciding with accelerating expansion in the HE API – as is shown in the final row of Table 4.

Pooling together the 1985 to 1993 cohorts but allowing for individual cohort effects and for interactions between degree classes and cohorts, we find no evidence of variation in the premia by degree class over the sub-period 1985-1989: an F-test of parameter constancy is accepted at the 13% level for males and at 25% for females. Similarly, the hypotheses of parameter constancy between 1990 and 1991 and between 1992 and 1993 are accepted – at 47% (21%) for males (females) and at 6% (26%), respectively. Parameter estimates for 1992 and 1993 are significantly different from those for 1990 and 1991 which, in turn, are significantly different from those for 1985-1989. Importantly, estimated parameters on other variables were largely constant, exhibiting no such clear tendency to increase. We also note that the time trend we observe in degree class effects holds across subjects: it is not driven by specific occupation-subject effects.

Estimates based on the 1998 cohort

The most recent leaving cohort for which the USR data are in the public domain is the 1993 cohort. Subsequent data are held by HESA and have not been generally available. We have, however, been able to obtain data for the 1998 leaving cohort and report estimates based on these data in the final two columns of Table 4. The period 1993-98 saw the number of students entering university continuing to expand, as did the proportion of students with good degrees. The HESA data are not entirely compatible with the earlier USR data. For example, the HESA data do not include information on either the school attended or the A-level subjects of the students, although they do include information on each graduate's overall A-level score in their best three subjects.

Based on the 1998 HESA data, we estimate the gap between a first and a lower second class degree to be 9.4% (11.2%) for males (females). The estimates of the premia by degree class for 1998 are similar to those for 1992 and 1993 for males: for females there is evidence of further substantial growth in the premium associated with the award of a first class degree. The data used for the regressions reported under the 1998 (All) column cover all Higher Education Institutions in the UK, including all of the former Polytechnics. However, restricting the analysis to solely pre-1992 (i.e., the 'old') universities – those on which the 1985-1993 results are based – makes very little difference to these estimates, as reported under the 1998 (Old) column. To examine the sensitivity of the results for the 1993 cohort to the set of control variables included, we re-estimate the model using only variables available in the HESA data set: the estimated effects of degree class remain essentially unchanged.

Robustness 1: current versus time-averaged occupational earnings

The widening span in occupational earnings by degree class could indicate either a growing tendency over time for a first class degree to enhance graduates' first destination employment outcomes or could reflect simply a widening inequality in the underlying distribution of median occupational earnings within the merged NES data. In Figure 5, we present the estimated coefficients on degree class for each year from 1985 to 1993, attributing to each 3-digit occupation the gender-specific earnings averaged over all 9 years.

Comparison of Figure 5 with Figure 4 shows that the results are remarkably similar, indicating that the increase in degree class premia over time is not due simply to a general trend for earnings differentials across occupations to become inflated. Looking at the distributions of occupational earnings for the graduate cohorts 1985 through 1993, we note that they are quite stable, with a mean which is largely constant and a standard deviation which shows only a slight increase. We also note that the ranking of occupations was very stable over the 9 cohorts: the correlation coefficient for occupational earnings between 1985 and 1993 is 0.87 for men and 0.82 for women.

Robustness 2: occupational versus individual earnings

A main advantage of the data-set we use is that it provides administrative data on the full population of each of the graduating cohorts. We have argued that the linked data on first destination occupational outcomes fits our focus on early post-university graduate labour market outcomes and that there are also advantages in using average occupational rather than personal earnings. It is useful, nonetheless, to attempt to corroborate our findings with complementary data on samples of graduates for whom there is information on personal earnings one year after graduation.

We use the Graduate Cohort Surveys (GCSs) for 1985 and 1990 which followed samples of graduates from 22 UK universities and which provide earnings data, for each cohort, both 1 and 6 years after graduation. The data have been used to investigate variation in graduate returns by university attended (see Chevalier and Conlon, 2003, and Hussain, McNally and Telhaj, 2009). For the 1985 and 1990 cohorts, we regress log wages on as similar a set of variables as possible to those included in our regressions based on USR/HESA data.[20] For the 1985 GCS cohort, there are no significant effects associated with the class of degree awarded. In contrast, for the 1990 GCS cohort, relative to an upper second award, there is an average premium of 6.6% for a first and a penalty of 3.0% for a lower second degree; overall the span between a first and a third is 9.3% and the premium for a high relative to a low class degree is 5%. These results are consistent with those we have reported for occupational earnings based on the USR data, which also yield no premium for a first in 1985 and, for 1990, a span between a first and a third of 8.4% and a premium for a high relative to a low class degree of 4%. The only clear difference in the estimates is that, for 1985 graduates, the USR data reveal a significant penalty of 2.3% (4.2%) for a lower second (third) class degree in contrast to the GCS data which show no significant effects: this could reflect small cell sizes for this group. The time-series trend is consistent across the two data-sets, with increasing effects of degree class from the 1985 to the 1990 cohorts.

Robustness 3: earnings after one year versus earnings after 6 years

Our analysis focuses on early career outcomes of graduates just one year out of university. From the GCS data, we can also examine the change between the 1985 and 1990 cohorts in the extent of degree class effects six years after graduation. For 1985 graduates, we estimate an average premium of 3.6% for a high relative to a low degree class based on earnings in 1991; for 1990 graduates, the average premium is 7.4% in 1996: the results are consistent with degree class effects strengthening for later cohorts. The estimate of a 7.4% premium is similar to the estimate of 6.5% obtained by Bratti *et al*. (2008) based on BCS70 data for a similar cohort at a similar interval after graduation.

[20] The data cannot be linked to the full population USR data. Full sets of results are available on request.

The estimates suggest that, within a cohort, degree class effects are stronger after 6 years than after 1 year post university: we address time effects within cohorts in more detail in related work.

Calibration: theory and evidence compared

The theoretical framework of Section 3 can be used as a basis for calibration in order to generate a numerical prediction for the likely effect on the premium for a high class degree implied by observed changes in the proportion of the population graduating. In Table 5, we compare predictions with our empirical estimates and with those reported by Bratti *et al*. (2008) for the 1970 birth cohort. For this exercise, we aggregate over gender and over individual degree classes and estimate the average premium for a high class degree to be 6.0% for 1993 graduates, close to that reported by Bratti *et al*. (2008). From the table, we see the estimated log wage differential for 1985 is 2.9%, implying that the premium more than doubled over the nine year interval.

We obtain predictions of the log wage differential between a high and a low class degree for various assumptions regarding the underlying distribution of ability.[21] Note that the theoretical model abstracts from roles for returns to ability and for the direct (human capital) effect of education. Hence, the predictions are best interpreted as indicating the extent to which changes in da/de are likely to have contributed to observed changes in the premium for a high class degree, holding constant r_e and r_a. The table shows that, for all the distributions considered, the theoretical model predicts an increase in the premium for a high class award. The proportion of the estimated increase

[21] For each distribution, calibration is based on standardising to the estimated differential for 1985 (this procedure follows Blackburn and Neumark, 1991).

accounted for by changes in da / de vary with the distributional assumptions and are: 94% for the uniform distribution; 52% for the symmetric triangular distribution; and 19% for the normal distribution.

5. Conclusions

The conventional wisdom in the US is that changes in the ability-education relationship brought about by graduate expansion cannot contribute to the explanation of the growth in the college wage premium as the predicted effects are in the wrong direction. For the UK, some estimates suggest that graduate returns have risen over time, but the evidence is consistent with the view that demand-side pressures have been mitigated by the counterveiling effect of expansion on ability gaps between graduates and non-graduates.

The focus of the current paper concerns variations in returns to degrees by class of degree awarded across cohorts as the proportion of the cohort graduating has increased. To address this from a theoretical perspective, we develop a model in the tradition of the signalling framework associated with Blackburn and Neumark and predict that graduate expansion is likely to raise the average ability gap – and hence the estimated wage premium – between those awarded a high class and those a low class degree. The analysis is still relevant in the event that ability is unobserved only by the econometrician: in this case, the increased ability gap associated with graduate expansion implies a greater omitted variable bias in the estimated returns by class of degree.

We address empirically the issue of whether estimated returns by degree class have changed over time in a manner consistent with the theoretical predictions concerning the ability-education relationship. We base our main measure of labour market returns on average occupational earnings as this enables us to isolate real ‘structural’ effects of degree class on post-university outcomes from the effects of general inequality inflation. We focus on early career outcomes as these are where signalling is most likely to occur, as underlined by the employer learning/statistical discrimination literature. Consistent with theoretical predictions, we find evidence of a substantial increase between 1985 and 1993 in the *ceteris paribus* span of occupational earnings between a first and a third for both male and female graduates. Results for the 1998 cohort confirm the conclusion that the premia for high degree classes has risen over time. We note that the timing of the increases in the premia coincides with periods of fastest expansion in the graduating cohort.

We also find corroborating support for our results in evidence based on analysis of complementary data from graduate surveys for the 1985 and 1990 cohorts. In future work, we aim to exploit further the available data – both from graduate cohort surveys and from the birth cohort data – on the evolution of degree class effects over the life-cycle. The intention will be to examine whether degree class effects are significant in later careers and how any such persistence varies across cohorts. If the effects we have identified purely reflect early career signalling, then it is not obvious that the pattern we have uncovered in the current paper – an increasing span in degree class premia as graduate cohorts increase in size – will also characterize later career premia. If, on the other hand, the bias stems from the econometrician’s failure to observe ability – and not from the employers’ – then it is more likely that the pattern will hold at all career stages.

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Table 1: First destination outcomes and summary statistics for those in employment based on the 1993 cohort

Variable	Males Mean	Males SD	Females Mean	Females SD
FDS outcomes				
Out of labour force/Unemployed (OLFU)	0.14	0.35	0.11	0.32
Further study	0.16	0.36	0.13	0.33
Employment	0.41	0.49	0.52	0.50
Non-response	0.29	0.45	0.24	0.43
Sample size (n)	47388		38381	
Previous qualifications				
A-levels	0.80	0.40	0.79	0.41
Scottish Highers	0.07	0.26	0.07	0.26
Other qualifications	0.08	0.28	0.07	0.26
No formal qualification	0.05	0.21	0.06	0.24
A-level information				
A-level score	25.7	8.9	24.1	7.8
A-level subjects				
Chemistry	0.33	0.47	0.24	0.42
English	0.21	0.41	0.45	0.50
Maths	0.59	0.49	0.34	0.48
Physics	0.44	0.50	0.15	0.36
Scottish Higher information				
Higher score	12.94	4.79	12.64	4.26
School type				
LEA school	0.47	0.50	0.47	0.50
Grammar school	0.11	0.31	0.12	0.33
Independent school	0.25	0.44	0.22	0.41
FE college	0.09	0.29	0.10	0.30
Other school	0.07	0.26	0.09	0.29
Part-time	0.02	0.15	0.02	0.15
Age groups				
<24	0.87	0.34	0.86	0.34
24-27	0.08	0.27	0.06	0.23
28-33	0.03	0.18	0.03	0.17
33+	0.02	0.15	0.05	0.22
Married	0.03	0.17	0.05	0.22
Social class				
SC I	0.18	0.38	0.17	0.38
SC II	0.41	0.49	0.42	0.49
SC IIINM	0.12	0.32	0.11	0.31
SC IIIM	0.10	0.31	0.10	0.29
SC IV	0.06	0.24	0.05	0.23
SC V	0.01	0.09	0.01	0.09
Unemployed	0.08	0.27	0.10	0.30
Degree class				
I	0.10	0.30	0.07	0.25
II.1	0.45	0.50	0.55	0.50
II.2	0.33	0.47	0.32	0.47
III	0.07	0.25	0.03	0.18
Other	0.05	0.22	0.03	0.18
Sample size (n)	19476		19978	

Table 2: Average occupational earnings by degree class: 1985 and 1993 cohorts

1993	MALES			FEMALES		
	Mean	Std. Dev	n	Mean	Std. Dev	n
Full Cohort	-	-	47388			38381
Selected Sample	450.28	115.91	19476	333.10	96.27	19978
Degree Class			%			%
I	480.14	102.37	9.80	351.31	87.89	6.55
II.1	465.25	115.34	45.14	338.44	97.47	54.97
II.2	432.62	116.50	33.23	322.58	94.93	31.94
III	408.41	110.02	6.90	319.06	92.21	3.21
Other	431.57	113.13	4.93	323.36	95.95	3.32

1985	MALES			FEMALES		
	Mean	Std. Dev	n	Mean	Std. Dev	n
Full Cohort	-	-	41749	-	-	28831
Selected Sample	262.22	45.78	21480	181.00	41.28	17297
Degree Class			%			%
I	267.79	39.89	7.38	189.81	38.72	4.30
II.1	267.10	46.52	37.86	184.85	40.91	41.71
II.2	259.48	46.59	37.37	177.35	41.17	40.95
III	255.04	44.10	9.13	175.66	42.62	4.75
Other	255.27	42.33	8.26	178.18	41.71	8.30

Table 3: Results of occupational earnings equation for the 1993 cohort

Variable	MALES Coeff	FEMALES Coeff
Degree class		
I	0.038***	0.037***
II.1 (default)		
II.2	-0.054***	-0.042***
III	-0.094***	-0.053***
Pre-university schooling		
A-level score	0.001***	0.000
A-level subjects		
Biology	-0.010	0.002
Chemistry	0.001	0.005
English	-0.003	-0.002
Maths	0.012**	0.011*
Physics	-0.002	0.010
Higher score	0.001	0.003*
School type		
LEA (default)		
Grammar	0.017**	-0.001
Independent	0.045***	0.024***
FE	-0.013*	0.015**
Other	0.036***	0.047***
Social Class		
SC I	0.001	0.011*
SC II (default)		
SC IIINM	-0.023***	0.009
SC IIIM	-0.022***	0.009
SC IV	-0.024***	-0.033***
SC V	-0.024	-0.038
Unemployed	-0.012	-0.009

*** significant at the 1% level, ** significant at the 5% level and * significant at the 10% level. Regressions also include controls for: university attended, subject studied, personal characteristics of age and marital status and study characteristics, such as full-time/part-time status.

Table 4: Degree class coefficient estimates for the 1985-1993 and 1998 cohorts

		1985	1986	1987	1988	1989	1990	1991	1992	1993	1998 (All)	1998 (Old)
	I	0.005	0.006	-0.007	-0.006	0.001	0.027***	0.027***	0.042***	0.038***	0.046***	0.046***
Males	II.1 (default)											
	II.2	-0.018***	-0.011***	-0.015***	-0.025***	-0.020***	-0.031***	-0.035***	-0.052***	-0.054***	-0.050***	-0.049***
	III	-0.032***	-0.029***	-0.032***	-0.056***	-0.038***	-0.058***	-0.071***	-0.092***	-0.094***	-0.094***	-0.096***
	I	0.012***	0.012	0.018**	0.028***	0.026***	0.033***	0.025***	0.053***	0.037***	0.066***	0.067***
Females	II.1 (default)											
	II.2	-0.030***	-0.032***	-0.028***	-0.026***	-0.030***	-0.023***	-0.038***	-0.039***	-0.042***	-0.046***	-0.046***
	III	-0.062***	-0.052***	-0.040***	-0.059***	-0.049***	-0.045***	-0.065***	-0.072***	-0.053***	-0.087***	-0.065***
HE API 1985=100		100	100	107	107	107	114	114	129	143	242	

*** significant at the 1% level, ** significant at the 5% level and * significant at the 10% level. Regression results for each cohort are based on the same specification as that reported in Table 3 for the 1993 cohort, with controls for: pre-university schooling qualifications, school type, family background, university attended, subject studied, personal characteristics of age and marital status and study characteristics, including full-time/part-time status. HE API indicates the Higher Education age participation index for the respective graduating cohort (source: DfES, 2003): note that there is typically a 3-year interval between matriculation and graduation.

Table 5: Log wage differentials: predictions and estimations compared

	Predicted						**Estimated**		
Distribution	Uniform 1985	Uniform 1993	Symmetric triangular 1985	Symmetric triangular 1993	Normal 1985	Normal 1993	USR/FDS 1985	USR/FDS 1993	*BCS70 ca. 1993*
Log wage differential for high class degree (%)	2.9	5.8	2.9	4.5	2.9	3.5	2.9	6.0	*6.4*
Δ log wage differential		2.9		1.6		0.6		3.1	
% of estimated change		94%		52%		19%		100%	

Figure 4a: Coefficients on degree class variables over time (current earnings) - Males

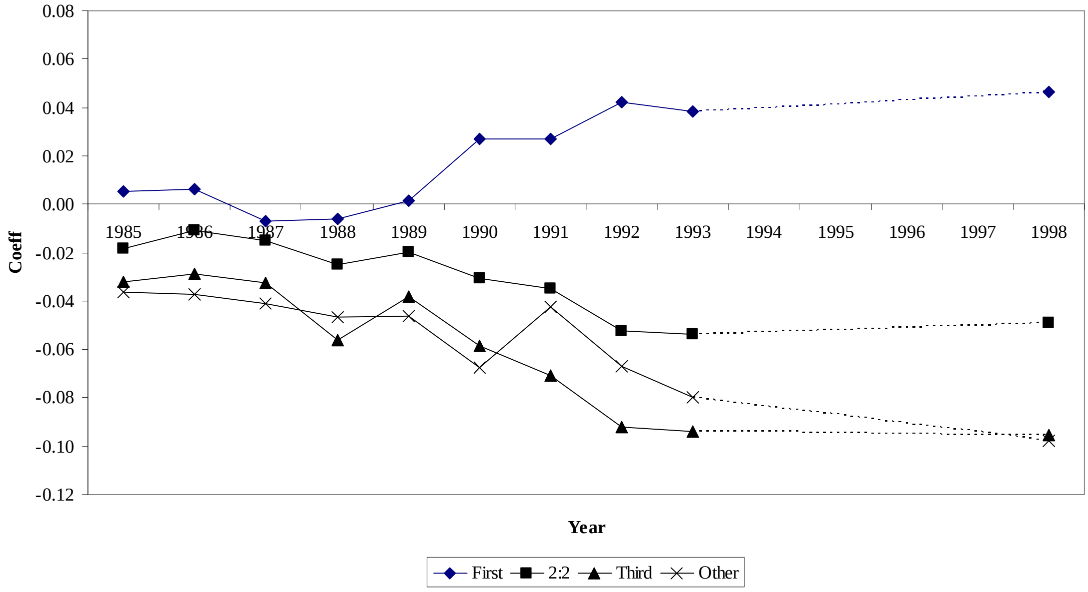
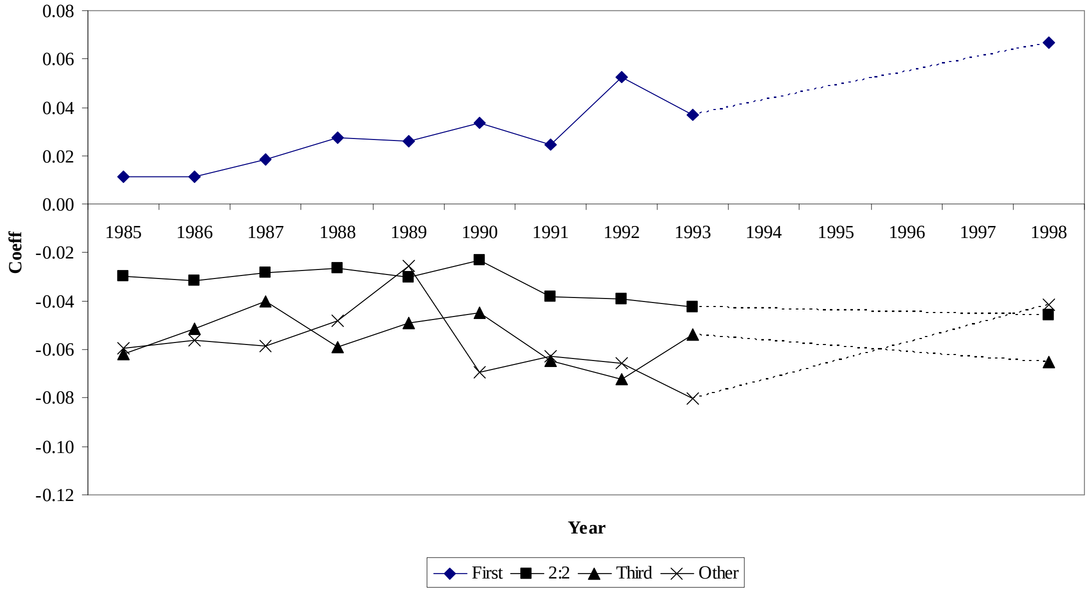


Figure 4b: Coefficients on degree class variables over time (current earnings) - Females



Estimated coefficients are as reported in Table 4, derived from Regression results for each cohort are based on the same specification as that reported in Table 3 for the 1993 cohort, with controls for: pre-university schooling qualifications, school type, family background, university attended, subject studied, personal characteristics of age and marital status and study characteristics of full-time/part-time status.

Figure 5a: Coefficients on degree class variables over time (constant earnings) - Males

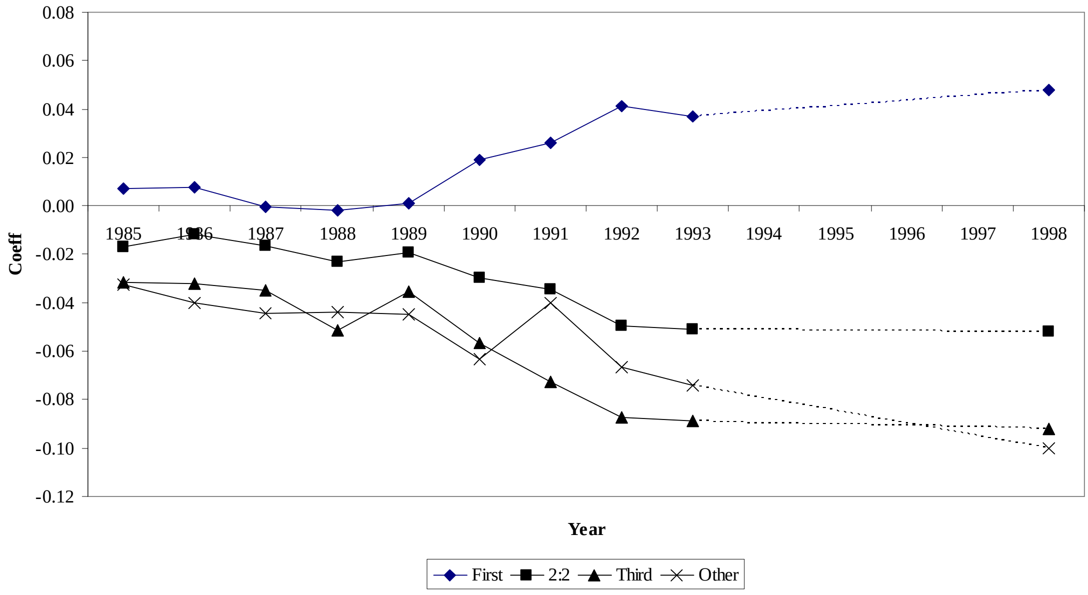
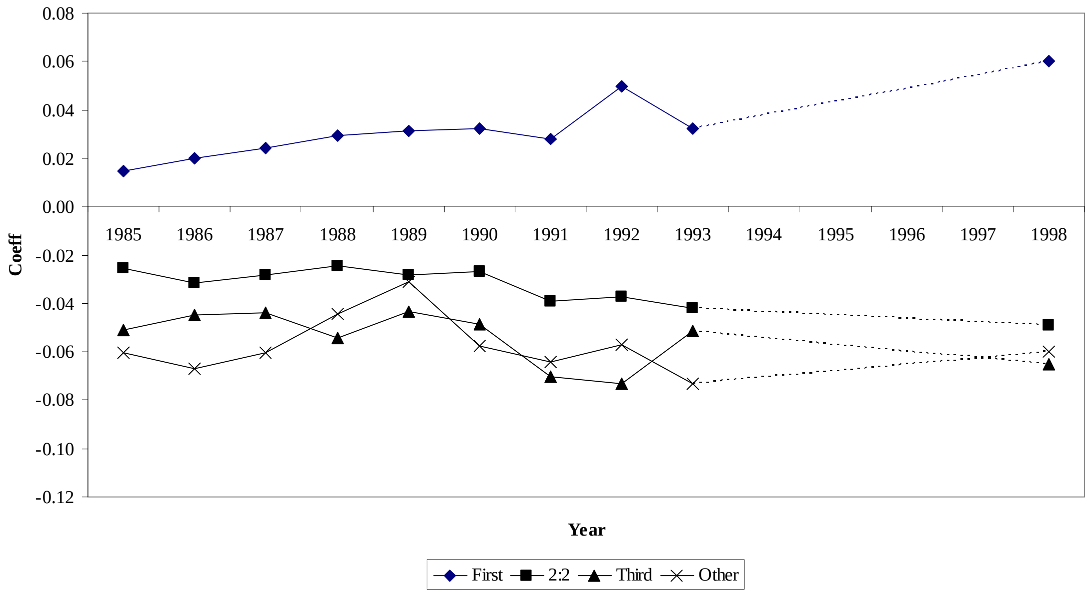


Figure 5b: Coefficients on degree class variables over time (constant earnings) - Females



Estimated coefficients are as reported in Table 4, derived from Regression results for each cohort are based on the same specification as that reported in Table 3 for the 1993 cohort, with controls for: pre-university schooling qualifications, school type, family background, university attended, subject studied, personal characteristics of age and marital status and study characteristics of full-time/part-time status. The dependent variable is based on gender-specific 3-digit SOC mean occupational earnings averaged over the cohorts 1985-1993.

Appendix

We assume that there is some distribution of ability, a, where $f(a)$ represents the density function, which is continuous and differentiable between upper and lower limits given by $\bar{a}$ and $\underline{a}$, respectively. $F(a)$ represents the cumulative distribution function. The cost associated with graduating is given by the continuous, differentiable function $c(a)$, where $c'(a) < 0$. Firms will pay non-graduates a wage, w^N, which is equal to the mean ability of the group of non-graduates:

$$w^N = \int_{\underline{a}}^{a^*} \frac{af(a)}{F(a^*)}\, da\,, \tag{A1}$$

where a^* denotes the ability of the marginal individual who is just indifferent between investing and not. We denote by a^H (a^L) the ability of the marginal recipient of the high (low) class award. The wage of graduates with low class awards is given by:

$$w^L = \int_{a^*}^{a^H} \frac{af(a)}{F(a^H) - F(a^*)}\, da\,. \tag{A2}$$

The wage of graduates with high class awards is:

$$w^H = \int_{a^H}^{\bar{a}} \frac{af(a)}{1 - F(a^H)}\, da\,. \tag{A3}$$

The university awards high class degrees to a proportion, λ, of all graduates, where:

$$F\left(a^H\right) - F\left(a^*\right) = \left[\frac{1-\lambda}{\lambda}\right]\left[1 - F\left(a^H\right)\right]. \tag{A4}$$

We focus on the effect of an increase in the size of the graduate population – a reduction in a^* – on the premium, p^H, associated with the award of a high class degree, where:

$$p^H = w^H - w^L\,. \tag{A5}$$

A decrease in a^* will produce a fall in a^H as λ is exogenous. From (A4), differentiation of the underlying definite integrals yields:

$$\frac{da^H}{da^*} = \lambda \frac{f\left(a^*\right)}{f\left(a^H\right)}\,. \tag{A6}$$

Hence, a change in a^* will have both direct and indirect effects – via the change in a^H – on p^H:

$$\frac{dp^H}{da^*} = \frac{\partial p^H}{\partial a^*} + \frac{\partial p^H}{\partial a^H}\frac{da^H}{da^*} \tag{A7}$$

Using Leibnitz's rule, the solution yields:

$$\frac{dp^H}{da^*} = \frac{\lambda}{1-\lambda}\frac{f\left(a^*\right)}{1-F\left(a^H\right)}\left[(1-\lambda)\left(w^H - w^L\right) - \left(a^H - a^L\right)\right] \tag{A8}$$

From (A8), it follows that the direction of the effect of a change in a^* – and hence in the size of the graduating population – on the extent of the premium for a high class degree award is, in general, ambiguous.