To be or not to be a scientist?

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Preliminary: please do not quote

Version 1.2 : 13 July 2015

Abstract:
Employers regularly complain of a shortage of qualified scientists and policy makers advocate that to remain competitive more scientists need to be trained. However, using a newly available survey of recent graduates from Higher Education, linked to administrative data on HE participation, we report that less than 50% of graduates from science subjects are working in a scientific occupation three years after graduation.
We investigate some potential explanations for this large "wastage" of qualified scientists and tentatively hypothesise whether science graduates are pushed or pulled to non-scientific occupations.

Keywords: science, graduate, labour market
JEL Codes: I21, J24, J44

Acknowledgement:
This paper was drafted during a placement at the Department for Innovation, Universities and Skills. The views represented in this manuscripts are the author's and do not represent the view of the DIUS. Financial support from the ESRC for their placement scheme is also gratefully acknowledged. I also want to thank Stijn Broecke, Tarja Viitanen and participants at the DWPEG meeting (Sheffield) for their helpful comments.

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I Introduction

Despite a doubling in the number of graduates since the early Nineties some sectors of the UK economy, especially those related to science and engineering, still report difficulties in the recruitment of graduates (see Roberts (2002), DIUS (2008) and references therein or ACE (2008) for specific evidence in the construction engineering sector). The lack of workers in the scientific occupation is not a recent issue and in the previous decade Mason (1999) already reported that 43% of research and development (R&D) positions had been difficult to fulfil. These skills shortages are severe enough to reduce investments in R&D and have long-term consequences on productivity (Forth and Mason, 2006; Nickell and Nicolitsas, 2000). Consistent with the idea of a shortage of science graduates and a relatively high demand for their skills, earnings for science graduates tend to be greater than for other graduates (Chevalier et al., 2002; Walker and Zhu, 2005).

Moreover, there is a widespread belief that science graduates are lured to non-scientific occupations like finance which value their numerical skills and offer higher wages. Roberts (2002), for example, reveals that 6 months after graduations almost half of the new science graduates work outside manufacturing and R&D. Clearly there is a large "wastage"[1] of science graduates in the labour market. The answer to any shortage of scientists may thus be more in increasing the conversion from scientific studies to scientific occupations rather than training more scientists; especially when considering that due to curriculum choices in secondary schools, the potential for expending the number of science graduates may be limited (Royal Society, 2006). Additionally science graduates cost more to train than other graduates, so it may be more efficient to improve the retention of science graduates

[1] Throughout the paper we will use wastage in the very specific of science graduates not working in a scientific occupation; these graduates may nonetheless be using their scientific skills, especially those who teach science, and have large public returns. More generally, "the wider societal benefits of having people with a science or math background in areas such as journalism, law, politics, […], and more generally, as citizens , are increasingly well understood" (Royal Society, 2006, p55).

into scientific occupations rather than expand the number of science graduates altogether[2].

Despite the advantageous prospective labour market outcomes, statistics from the Higher Education Statistical Agency (HESA) over the period 2002/03-2006/07 suggest that students' intake in science subjects has grown at a slower pace than non-scientific ones (11% vs. 15%), so any shortages in the supply of scientists on the labour market are unlikely to be eliminated soon. More worryingly most of the growth in science originates from Sports Science (+69%) and Psychology (31%), as well as Medicine (34%) while more traditional scientific subjects have grown at a below average pace or even shrank (see Table 1 for details)[3]. Concomitantly the supply of science in higher education has been reduced by the closures of physics and chemistry departments including some high profile ones (House of Common, 2005, for details).

The shortage of scientists in the labour force has been a concern amongst stakeholders. The emphasis on science originates from the view that the UK productivity would be hampered by a relative lack of R&D investment compared to other countries, which would negatively impact on economic growth (see among others HMT (2004), or the Sainsbury review (2007)). A flurry of reports has thus been commissioned by recent governments to identify the determinants of the supply of science graduates (Roberts, 2002; Lambert, 2003; Royal Society, 2006; Sainsbury, 2007). This debate is not unique to the UK and a similar angst about a country's readiness for the knowledge economy and competitiveness also exists in the US (Freeman, 2005, Adams, 2009) and Europe (European Commission, 2003).

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[2] The Higher Education Funding Council for England (HEFCE) provides universities with block grants for funding. The formula used to calculate these grants accounts for four categories of subject costs. For an undergraduate full time student the HEFCE notional grant rate in 2008 varies from £5,484 for science (non medical) subjects and £2,709 for non-science subjects.

[3] Roberts (2002) also reports that the number of students in Engineering, Mathematics and Physics declined between 1995 and 2000. A reclassification of degree subjects in Higher Education Statistic Agency (HESA) statistics in 2001 make it problematic to build a longer time series.

This paper focuses on the labour market outcomes of recent science graduates. We rely on evidence from the Longitudinal Destination of Leavers of Higher Education (LDLHE) which pertains to a sample of UK graduates from the 2003 cohort observed in November 2006. As well as being the most up to date, this survey has the advantage of representing the universe of higher education institutions and includes covariates on academic attainment (from pre-university to post-graduate qualification) and family background.

We replicate most of the findings from previous studies but in a common framework and after controlling for a large array of confounding factors. We also expand the literature in three directions. First, we estimate the returns to science degrees by occupation. Second, we use quantile regression so that we allow the wage differential to vary depending on unobservable characteristics of graduates. Third, we use additional information to assess whether the wastage is due to science graduates being pushed or pulling themselves out of scientific occupation.

Using various definitions of science degrees - we find that on average science graduates employed full time earn between 6 % and 13% more than non-science graduates. However there is a substantial amount of heterogeneity: Medicine and dentistry graduates earn up to twice as much as psychology graduates (£39,190 vs £19,290). After accounting for differences in the characteristics of science and non-science students, the wage gap is reduced to 5%. For all but those with the best unobservable characteristics, the gap disappears when controlling for occupation and should thus be considered an occupational premium rather than a premium to being a science graduate. Contrary to the assumption that science graduates are lured to high-paying occupation, they do not command earning premiums relative to non-science graduates in non-scientific occupations.

As in the previous literature, despite using different definitions to Roberts (2002) and Royal Society (2006) we find that just under 50% of science graduates are in a scientific occupation. The wastage could indicate that work conditions in scientific occupations are worse than in other occupations. Alternatively, the wastage could be due to a mismatch between the skills learnt at university and the demand of employers, or some other form of dissatisfactions from science graduates that push them towards non-scientific occupations. We attempt to distinguish between these hypotheses consistent with a large proportion of science graduates not working in scientific occupations, a shortage of scientists and relatively high wages in scientific occupations. Occupational choice is not random and is correlated with academic attainment and university quality, so that science graduates in scientific occupations and finance have the best credentials. Using additional information on satisfaction and reasons for taking up jobs we conjecture that science graduates may be pushed out of scientific occupations.

II Literature review and data description

Several studies have documented the large differences in earnings between graduates from different subjects in the UK (see amongst others Dolton and Makepeace (1992), Chevalier et al. (2002), Naylor et al. (2002), Lissenburgh and Bryson (1996), Blundell et al. (2000), Harkness and Machin (1999) or Walker and Zhu (2005)) have also been used. Graduate studies have usually limited data on earnings while non-graduate datasets contain little information on academic achievement or institution attended. Despite the disparities of survey used, the general conclusion is that there is large heterogeneity in the returns to higher education by subject with the wage premium to science degree reaching 10% compared to humanities graduates. These large differences in the returns to higher education are not specific to Britain, and are reasonably similar in France, Germany and the US (Machin and Puhani (2006), Grogger and Eide (1995)).

Borghans et al. (2000) report that workers working in field unrelated to their studies have lower earnings than subject-matched workers. Research on the labour market of scientists is rather limited. An example is Bender and Heywood (2006) who use a survey of US doctoral recipients in science and social sciences to investigate labour market mismatch. They show that science doctorates are 5% to 7% less likely to have a job closely related to their education than economists resulting in lower job satisfaction and greater turnover. Freeman (2005) also points out that in the U.S. the labour market conditions have worsened in science and engineering compared to other occupations thus reducing the supply of science graduates. Roberts (2002) and Sainsbury (2007) also highlights that in the UK part of the supply difficulties originate from teaching quality in secondary and tertiary education as well as inadequacies between curriculum and employers desired skills.

Compared to previously used data the LDLHE has some advantages – it is larger than the previous graduate datasets and can be linked to administrative data recording information when the student entered and left university – it has thus precise information on academic achievement and family background. Moreover, we include measures of institution quality based on the "good University Guide"[4]. The score includes various dimensions of university quality including research (RAE score), teaching quality (pupil/teacher ratio, expenditure on students, completion rate) and quality of the student body (average entry score). The first component account for 71% of the variation and a higher value of the score indicates a greater quality of the institution.

[4]The Good University Guide is one of the providers of ranking of universities. Rather than using its ranking, we only use the raw variables which can be obtained from: http://www.thegooduniversityguide.org.uk. The variables pertain to data collected for the academic year 2003/04 and the 2001 Research Assessment Exercise.

The LDLHE was conducted in November 2006 amongst a random sample of higher education leavers[5] who typically graduated between June and July 2003. The sampled population are leavers from higher education who responded to a questionnaire administered by the Higher Education Statistic Agency (HESA) six months after graduation. The response rate in the Destination of Leavers of Higher Education reaches 75%. A sample of 55,900 of these original respondents is contacted three years after graduation by HESA to take part in the LDLHE. 24,823 responded to either a postal, phone or online questionnaires. Finally, accounting for item non-response on the earning question leaves us with 19,979 observations. We then select first degree holders only, aged 18 to 25 on graduation, non-special entry students and who are currently observed in employment. This leads to a sample of 9,296 observations (See Table A1 for details on the sample selection). Tipping and Taylor (2007) provide evidence in favour of the representativeness of the survey.

As mentioned above, stakeholders are concerned that the lack of scientists will slow economic growth. The two main questions are first, whether the relative lack of demand in higher education for science stems from low financial returns to science degrees as predicted by Willis and Rosen (1979). Expected wages are difficult to compute as they may be affected by selection; i.e. graduates have some unobservable characteristics that make them choose a given subject but are also correlated with earnings. Berger (1988) using the NLSY relies on functional form to identify the selection term and reports that the present value of future earnings affects subject choice positively. For the UK, Bratti and Mancini (2003) estimate jointly the subject choice (four broad categories) and earning equations. However their estimates of the returns to subject become unstable, often jumping from one year to the next by 10 to 30 percentage points, casting doubts on the identifying strategy. Due to the lack of

[5] The survey only includes individuals who were UK domiciled prior to attaining higher education.

credible identification variables we will rely on the richness of the dataset to limit the endogeneity bias of subject choice. Using differences in business cycles to identify the selection effect, Beffy et al. (2009) estimate that the elasticity of expected wages on subject choice is small in France. A 10% increase in expected wages increases participation in a science subject by 2 percentage points. While Arcidiacono (2004) uses the National Longitudinal Study of the Class of 1972 to estimate a dynamic model of major and college choice and reports that future monetary returns do not drive the major choice. In the absence of credible identifying restrictions, this study will assume no selection effects.

The second question is assessing why science graduates work in non-scientific occupations. The first difficulty is to define a science degree. We use four alternative definitions. The first definition is the most inclusive and includes all individuals graduating from Medicine, Subject allied to Medicine, Biological Science, Veterinary/Agriculture related subject, Physical science, Mathematical and Computer science, Engineering/Technologies, and Architecture. Individual with mixed subjects in science are also classified as science undergraduates (*Science 1*). The second definition excludes Sport science, Psychology, Forensic and Archaeology from the science group (*Science 2*) as these subjects are often viewed as less rigorous scientifically. The third definition focuses on hard sciences: Physics/Chemistry, Mathematics and Engineering and exclude Medicine graduates from the analysis (*Science 3*). The fourth definition is identical to *science 2* but also exclude medical graduates from the analysis.

Regularly, employers claim a shortage of qualified workforce (Learning and Skills Council, 2008) especially in scientific occupations (Roberts, 2002; DIUS, 2008). It is thus advocated that universities should increase the number of science graduates. This has proven difficult in the recent past. Table 1 reports the number of graduates by subjects in the last five years. Overall, there has been an increase of 13%, but only 11% for Science subjects. Moreover, out of the extra 12,600 students graduating from science between 2002 and 2007 half originated from Psychology (+ 2,800), Sport Science (+ 2,600) and forensic (+1,000). The other science subjects that had a large increase in the number of graduates are health subjects: Medicine (+ 2,000) and Associated to medicine (+6,800). If restricting science to hard sciences (science 3) then there has been no change in the number of graduates over the last five years and a large drop in the number of computer scientists.

Moreover, the production of science graduates suffers from important wastage upon reaching the labour market, in the sense that scientific graduates are likely to be able to occupy non-scientific occupations, where they may even have a comparative advantage while non-scientific graduates will, in general, find it difficult to obtain a job in a scientific occupation. We thus define scientific occupations (using the 5-digit SOC2000 codes). This definition suffers from some arbitrariness (see note under Table 2), however it delivers sensible results: only 5% of non-scientific graduates work in such occupations. Like in Roberts (2002) who uses an alternative definition based on industry, just under half of the scientific graduates work in a scientific occupation. A career that is often thought to compete for science graduates is finance where the analytical skills of science graduates are in high demand. Overall, 5% of graduates work in finance. This proportion is 4% for science graduates. However, when focusing on hard science only, we find some evidence that these graduates are indeed more likely to be working in finance (7%).We also investigate the choice to follow a career in teaching where science graduates are in high demand and which accounts for 10% of science graduates employment three years after graduation.

The top panel of Table 2 reports occupational choice by subjects. In general more vocational scientific graduates (health, engineering, IT, architecture) have a higher probability to remain in a scientific occupation than graduates from more theoretical scientific subjects (Biology, Physics and Math). Subjects with a lower science content like sport sciences and psychology have the lowest proportion of graduates in scientific occupations. Financial occupations are an alternative only for graduates from math and combined science; for other subjects less than 5% of graduates work in finance. Thus it is unlikely that competing salaries in finance are an important factor in the general shortage of scientists in the labour force. Teaching is a popular occupational choice – attracting between 14%-18% of graduates in hard sciences as these subjects form an important component of the curriculum. Psychology and Sport science graduates also have a high probability of graduates becoming teachers (between 20% and 30%)[6].

III.1: Descriptive statistics

The descriptive analysis focus on two characteristics of graduates: A-level score and quality of the attended institution, which may be confounding factors in the relationships between subject of degree, occupational choice and earnings (see Tables 3). The data includes the score of the best 3 A-levels (or equivalent) for 90% of the selected sample[7].

Scientists have a marginally higher average A-level score than non-scientists however this difference disappears when excluding medics (*science 4*) who have the

[6] To assess the robustness of these findings we also use the Labour Force Survey (1994-2007) reducing the sample to male employees. The LFS also offers statistics over the life time of graduates not only over their early careers. It broadly confirms that just over half of science graduates are found in a scientific occupation and that graduates from more vocational disciplines are more likely to be in a scientific occupation. The lowest retention rate is for math with only 29% of employed graduates working in such occupation. Five percents of science graduates work in finance but, like in DHLE it only attracts substantial numbers from math and, to a lower extent, physics. Teaching accounts for 10% of science graduates employment but substantially more in hard sciences and in psychology. One third of science graduates are working in other occupations but, as in DHLE, this proportion is higher for graduates from biology, physics and psychology.

[7] A, B, C, D and E grades are worth 10, 8, 6 ,4, and 2 points respectively. A-levels are not compulsory to attend higher education, so the missing are a mix on non-response and no A-levels. In more recent cohorts the tariff score which takes account of all qualifications has been computed, but this is not available for this cohort. No information on the subject of the A-level is available for this cohort.

highest average test score (28.12 out of 30). The average A-level score in this cohort is 19.50, only math is clearly above average and half of the science subjects have an average entry grade below the cohort average; so in general science does not recruit the most able students. Since occupations are not randomly allocated it is of interest to assess whether graduates' characteristics differ by occupation. Overall, the average A-level score is the highest for graduates working in finance – this is true for science and non-science students. For science students the gap between those in a scientific occupation and those in finance is at least 2.5 point. Graduates teaching (not if restricting to hard-science) and those in other occupations have the lowest A-level score, and in these occupations there is less evidence that science graduates have higher A-levels than non-science graduates. A similar pattern is also observed at the subject level; hence these findings are not due to some composition effects at the occupational level. There are clearly some selections of students to occupation; those in finance and scientific occupations tend to be higher achievers.

Subject choice may also be correlated to the quality of the institution. For example, experimental sciences are expensive to teach and may be more likely to be taught in more prestigious institutions. From Table 3B, we note that science graduates tend to have graduated from higher quality institutions, especially for those in the core subject of mathematics, physics and engineering (*science 3*) where the gap reaches 0.85 points – or almost half of a standard deviation - compared to non-scientific graduates. Graduates working in finance come from substantially higher quality institutions, especially if scientists. Note also that hard science graduates working as teachers originate from good institutions while this is not true in general. Science graduates working in "other occupation" originate from worse institutions than those who made alternative occupational choice.

At the individual subject level, variations in average institution quality are also marked. Medicine, math and combined sciences are taught at the highest quality institutions, while graduates from sport sciences, IT, and to a lower extent architecture and subject allied to medicine tend to come from lower quality institutions. The gaps in quality score by subject are extremely large, reaching two standard deviations, which highlights the potential bias in estimates of return to subject that do not control for institution quality. For all subjects graduates in scientific occupation come from higher quality institutions than those working in other occupations.

III.2 Earnings description

The descriptive analysis suggests a large level of heterogeneity in previous educational attainment – proxied by the A-levels score - and the quality of the institution attended by subject of study. These characteristics are likely to also influence the pay of graduates. The LDLHE reports annual gross pay. We recode 36 observations with an unusually high salary – compared to their occupation average earning - which were due to coding errors (additional zero) and drop 149 individuals who claim to earn less than the national minimum wage (assuming they worked 52 weeks a year). The descriptive statistics are calculated for full time individuals only. The distribution of earnings for science and other graduates in October 2006 is reported in Figure 1. The two distributions differ; for scientists (*science 4*) the distribution is bell shaped with a long right-hand tail. The distribution for non-scientists is bi-modal with a larger share of graduates earning less than £20,000. The right-hand tail is marginally thinner than the one observed for scientists.

In Figure 2, we analyse in more details the earnings of science graduates only by breaking it down by occupation. The distributions have very different shapes. For teachers, the distribution is narrow with a mode around £23,000. The distribution of earnings in science occupation is more bell-shaped with a similar mode and a long right tail. For scientists working in finance, the distribution of earnings is rather flat with a substantial mass between £30,000 and £40,000. The earning distribution in other occupations is bimodal, with modes at £17,000 and £24,000, as well as a long right tail. There is a large heterogeneity in the earnings of science graduates which is also related to occupational choice. Table 3C reports the average annual earnings for full-time workers earning less than £60,000 per year. For all definitions of a science degree, science graduates always earn more than non-scientists; the gap ranges from £1,500 to £3,200. However, it is important to note that this wage differential exists only for scientists working either in a scientific occupation. Also for scientists, the mean earnings in a scientific occupation is comparable to the mean earnings in finance, so the pulling effect of financial occupation is likely to be more limited than previously thought.

The description by subjects reveals the large heterogeneity in earnings within the science and the non-science groups. Medics are the clear outliers with average earnings of £39,000. The next best paid subjects have earnings around the £25,000 mark, and include subject allied to medicine, mathematics, engineering and architecture. At the other end of the pay distribution, psychology is the only scientific subjects with an average pay below £20,000. For subjects with enough graduates working in different occupations there is also a tendency for those working in scientific occupation and finance to earn more than those in teaching or “other occupation”. Hence, the gap that was observed at the aggregate level is not solely due to differences in the subject mix by occupations.

IV Earnings by subject

The descriptive evidences have highlighted that earnings differ by subject group. However, since the characteristics of students also differ this is not concluding evidence that science graduates have higher wages. To conduct the analysis we first rely on Ordinary Least Square estimates of the following model:

$$\ln Y = \beta_0 + \sum_j \gamma_j S_j + \beta_1 X_1 + \beta_2 X_2 + \varepsilon \qquad (1)$$

Where *lnY* is the log annual wage, S_j is a set of dummy variables indicating graduation from subject *j*, so that γ_j is the estimated return to graduating from subject *j*. In some specification we also collapse the model to a single indicator of graduating from a science degree. X_1 and X_2 are controls for pre- and post- university characteristics respectively. Since X_2 may be correlated with subject *j*, the estimated coefficients on X_2 can be considered endogenous and part of the returns from graduating from subject *j* in which case γ_j would be under-estimated. We thus estimate the reduced form of (1) excluding X_2 as well as the full model. ε is a random component assumed randomly distributed.

Results from these regressions are reported in Table 4 where the base category represents all the non-science subjects. The first column reports the raw wage differential between science and non-science subjects after accounting for local labour market characteristics (postcode level). Medics earn 68% more than non-science graduates. Another four subjects enjoy earning premium over non-science that are greater than 10%: subjects allied to medicine, Architecture and planning, Engineering and Math. Only one subject offers significantly lower returns than non-science: psychology. Adding controls for socio-economic characteristics and schooling background (model (2)) mostly reduces these wage differentials but increases the returns to sport sciences by 50%. Model (3) adds class of degree as well as measures of the institution quality which marginally reduces the premium to science degrees. This is our favoured model as it captures all the characteristics of students as they entered the labour market. Model (4) includes job market controls: full time indicator, job tenure, permanent contract, employer's size, additional qualification, number of jobs and length of unemployment since graduation. These variables are thus potentially endogenous as they may be correlated both with having graduated from a specific degree and with income. Their inclusion is nonetheless of interest as they would indicate how much of the degree premium is due to labour market conditions. We thus expect the estimated returns to be reduced. Indeed the inclusion of these variables reduces substantially the returns to Architecture and Engineering. In model (5) we replace the measure of institution quality with a set of dummies for the institution attended. This affects the returns to engineering, sport sciences and psychology – maybe reflecting the large variation in the quality of institutions delivering these degrees. Even accounting for a large array of covariates, there is still some substantial differences in the returns by subjects; excluding health graduates, the gap in returns still reaches 15.5 percentage points between biology and architect graduates.

As mentioned in the descriptive analysis, it also appears that the scientific premium is driven by occupational choice rather than having a science degree. To test this hypothesis formally, (1) is altered to include dummies for occupation (O_k) and their interaction with subject dummies.

$$\ln Y = \beta_0 + \sum_j \gamma_{1j} S_j + \sum_k \gamma_{2k} O_k + \sum_{jk} \gamma_{3jk} (S_j * O_k) + \beta_1 X_1 + \beta_2 X_2 + \varepsilon \qquad (2)$$

We consider the returns to a science degree in general accounting for occupation choice. Table 5 reports the estimate of a science degree on earnings for various specifications. The models (1) to (4) have the same specifications than those presented in Table 4. Adding the full set of controls more than halve the science premium from 11% to 5%[8].

In the descriptive statistics we observed that earnings of scientists are similar in scientific and financial occupation and higher than in teaching and "other occupation" This is puzzling since one reason for the wastage of science students; everything else being constant, would be that other occupations which value the skills of these graduates offer higher wages than science occupation. Specification (5) adds dummies indicating whether working in a scientific, finance or teaching occupation rather than in another occupation while specification (6) also includes interactions between these dummies and having graduated with a degree in science, as expressed in equation (2). These models confirm the descriptive analysis results. The science premium is only an occupational premium and in no occupation there is an additional premium for having a science degree.

Additionally equation (2) is also estimated by quantile regression which estimates the returns at a specified quantile *(θ)* of the conditional wage distribution rather than the mean (Koenker and Bassett, 1978). The advantage of quantile regressions is that the effect of a given covariate is not assumed to be fixed across the distribution. The conditional quantile can be seen as representing unobservable characteristics of the individuals associated with earnings. The second panel of Table 5 reports estimates from quantile regressions to assess whether the previous findings are observed at all part of the conditional earning distribution. In the first part of this panel, we report estimates from specification (3) which includes only covariates observed when leaving university and adds the occupation dummies. A significant premium to science is observed only for the highest quartile. So for the most able individuals there is a premium to have studies science over and above the occupation.

[8] Additionally we estimate the science premium by propensity score matching and also find a premium ranging between 4% and 5% depending on the definition of science

Note, the premium to scientific and teaching occupations falls for greater quantiles while it increases slightly for finance, which suggests that financial occupations are good at selecting the most able graduates. Even for the top quartile the premium to science (3%) is small compared to the occupational returns. (9% to 19%). These conclusions remain the same when the interaction between subjects and occupations are added. The interactions are significant only for science graduates in scientific occupations at the lowest quartile and at the median. So again there is no evidence that science graduates are poached by non-scientific occupation.

We now assess whether these conclusions of the returns to science being driven by occupational premium are true for each specific science subject. Figure 3 plots the expected earnings of graduates by subject and occupation. The estimates are based on model (4) in Table 4 but add a set of dummies for occupation and their interactions with subjects. Darker shades are used to highlight significant interactions. In general, in a given occupation, there is no significant difference between the earnings of a graduate from a science subject and those of a non-science graduate. The exceptions are for medics working in a science occupation or teaching, graduates from subjects allied to medicine who earn less in finance and in teaching. Similarly engineers and psychologists earn less in teaching and science occupations respectively. These results confirm that in general science graduates do not earn more than non-science graduates when controlling for occupational choice[9].

V Occupational Choice

[9] We assess the robustness of these results on a nationally representative sample. The LFS provides weekly earnings for employees only but has no information on ability, social background or institution. We predict earnings by subject for each occupation. Finance jobs pay the most – independently of being a scientist. For science graduates, wages in scientific occupations are 15% greater than in teaching or other occupation. The main difference with the results from the DHLE is that wages in teaching are much lower in the LFS – reflecting that the teaching wage profile is relatively flat. A small premium for being a science graduates exits only in scientific occupation.

To summarise our findings so far: employers claim that there is a shortage of scientists, and consistently we observe a wage premium of about 5% for scientists. However, this premium is due to occupational choice rather than being a scientist. The puzzle is that a large proportion of qualified scientists work in other occupations that have lower earnings. We conjecture three hypotheses that are consistent with these facts. First, we have defined science broadly, so it is possible that there is a mismatch between the type of scientists produced and their demand; for example if biologists are produced when physicists are needed in the economy. Indeed we do observe large differences in wastage by subject or even within subject by specialisation (ACE, 2008). Second, heterogeneity in the quality of the science graduates could lead to some graduates not having the appropriate skills to obtain a scientific job. This is consistent with the observation that those working in scientific occupations have better credentials than science graduates working in other sectors. Finally, scientific occupations may have some dis-amenities that are not compensated appropriately at the current wage level to attract more science graduates. While we cannot formally test these three assumptions, we can bring further evidence.

To assess whether graduates are pushed or pulled to non-scientific occupation, we first assess the evolution of career choices over the first three years since graduating. Table 6 reports the occupational choice of science graduates in the DHLE 6 months and 3 years after graduation. At this broad level of occupation the majority of graduates remains in their original choice; for example, 84% of graduates in a scientific occupation 6 months after graduation are in a similar type of occupation 30 months later. This proportion is the smallest for those working in finance at 53%, so there is a large churning in financial occupation. However, it is also important to account for the 27% of graduates who where not working six months after graduation. This could be because they were unemployed, not looking for jobs or in further studies at the time. Table 6 thus also reports the origin of graduates who are currently observed in a given occupation. Graduates who were not in employment six months after graduation are disproportionally more likely not to be in a scientific occupation and more likely to be teaching or in an “other occupation”. Only 30% of them are in a scientific occupation 3 years after graduation when overall this proportion is 43%. To summarise, only a small proportion of graduates who started in a scientific occupation leaves it within 3 years but graduates are also less likely to move to a scientific occupations than to any other occupations. Thus the decision to not work in a scientific occupation happens in the early stage of the labour market integration.

As previously reported, earnings tend to be greater in scientific occupation than in the “other occupation” category, thus earnings (three years after graduation) are unlikely to explain that science graduates choose to work in non-scientific occupation. To test this relationship we estimate the following model. First, we split the sample between occupations and estimate the determinant of wages in each occupational group, we calculate the expected wage differential for working in a scientific occupation compare to each of the other occupation. Restricting the sample to science graduates, we estimate for each subject a probit model on the decision to work in a scientific occupation including occupational wage differentials. Formally, the estimated model is thus:

$$\ln Y^k = \beta_0^k + \sum_j \gamma_j^k S_j + \beta_1^k X_1 + \varepsilon^k \qquad k = Sc, Fi, Te, Oth$$

$$E(d \ln Y_k) = E(Y^{Sc}) - E(Y^k)$$
$$\Pr(k = Sc) = \Phi\left(\alpha_0 + \alpha_3 X_3 + \lambda \sum_k E(d \ln Y_k) + \mu\right) \text{ if } S = j \qquad (3)$$

Where Φ is the cumulative distribution function of the normal distribution, *k* is an indicator of occupation: *Sc, Fi, Te* and *Oth* represents respectively scientific, finance, teaching and other occupations and $E(d\ ln\ Y_a)$ is the predicted wage differential between a scientific and occupation *a*. X_3 is a vector of covariates which includes all the determinants of earnings as well as an indicator of whether the father of the graduate works in a scientific occupation. μ is a random term capturing the influence of variables not specified in the model on the decision to work in a scientific occupation. This probit model is estimated separately for each subject. The standard errors are estimated by bootstrap with 500 replications since occupational wage differentials are predicted.

Estimates of the marginal effects of predicted wage differentials are reported in Table 7. The earnings differentials are calculated with respect to finance, teaching and "other occupation". A positive sign of the coefficients indicate that if wages in scientific occupation increase relatively to the other occupation then graduates are more likely to work in a scientific occupation. In general wage differentials do not explain much of the occupational choice decisions – this may be because we are using wage differential at an early career stage while graduates base their decision on life-long earnings. Only graduates from Biology and Architecture are sensitive to the wages in finance when deciding whether to work in a scientific occupation, but these subjects provide less than 1% of the graduates working in finance. Increasing the relative wage of science compare to teaching would lead to a 10 and 24 percentage points increase in the probability of graduates from mixed sciences and architecture, respectively working in a scientific occupation. A Chi^2 test of the joint significance of the three wage differentials coefficients rejects non-significance only for Biology and Architecture, so wage differential early on do not appear to affect occupational choice. A caveat of this analysis is that we rely on wages three years after graduation while graduates may base their occupational choice decision on life-long income.

To further differentiate between the hypotheses that have been put forwards to explain the choice of occupation, Table 8 reports various measures of early career development and satisfaction. The top panel reports the effect of being a science graduate (*science 1*)[10] compared to having studied other subjects while the second panel explores the differences along the occupation divide for scientific graduates. The first column reports the coefficients of a Tobit model on months of unemployment since graduation, as a proxy for the employers' demand for the skills of the graduates. Only 27% of graduates currently employed have experienced some unemployment and conditional on having some unemployment the duration was less than five months, so clearly the skills of graduates are in demand. The estimated model controls for socio-economic characteristics before going to university, A-level score, degree class and dummies for the quality of the institution attended. Science graduates have experienced just over one month less of unemployment than other graduates. Among science graduates the integration to the labour market also varies by current occupation. Science graduates currently working in a scientific occupation or teaching have experienced less unemployment than other science graduates which is consistent with the difficulties in finding graduates with the appropriate skills in these occupations. Note, that this is not the case for graduates working in finance.

Using a similar specification, we model the quality of the labour market match, relying on the definition of over-education provided by Purcell and Elias (2004). This classification is based on the proportions of graduates of different age groups in a given occupation and defines five categories of jobs: traditional, modern, new, niche and non-graduate. We define a dummy variable for not working in a graduate job and estimate a probit model. Overall, 22% of graduates are not in an occupation that requires graduate skills, which is substantially higher than for the 1999 cohort four years after graduation (17%) (Purcell et al. 2005). Science graduates are 7% less likely to be over-educated. We cannot estimate this model for science students in

[10] The results are not sensitive to the definition of science used.

different occupation since over-education status would not vary for some of the occupation groups. As expected science graduates are in high demand in the labour market, not only do they spend less time unemployed they are also more likely not to be in a job for which they are over-educated.

To indicate whether science graduates are pushed or pulled out of scientific occupation, we investigate the reasons to have accepted the current job. More specifically we report three non-exhaustive reasons: the job is exactly the job I wanted, this was the only job offer, the job allows to pay off debt. The first reason is a positive choice of the graduate while the other two indicates that the graduate may have been pushed into the current occupation. Only 52% of graduates report being in exactly the job they wanted but this proportion is 3 percentage points larger for science graduates even after controlling for current income and all covariates including job characteristics. More interestingly, those working in a scientific occupation and teachers are much more likely to answer this question by the affirmative.

Eighteen percents of graduates report to have accepted a job as it was the only offer and there is no difference by subject. Science graduates in a scientific occupation are however 6 percentage points more likely to be in such situation. The lack of alternative offers could also indicate that science graduates in a scientific occupation were looking for a specific job and had thus a narrow search. Finally, 26% of graduates report being in their current occupation to pay off their debts but science graduates are 6% less likely to have been pushed into such a job. There is no difference in this factor between science graduates in different occupations. Overall, science graduates are less likely to have been pushed into jobs that are not exactly what they wanted, especially if they work in a scientific occupation or in teaching. It thus does not seem that finance is such an attractive career prospect for science graduates. These results also hold when not controlling for current wage.

Science graduates in general are not more satisfied with their career so far. However, those in scientific or finance occupation are more satisfied but surprisingly those who teach – despite being the most likely to report being in the job they wanted are not significantly more satisfied – maybe due to unexpected job conditions in teaching. In the last column, we report estimates of whether graduates would study the same subject again. There is no difference between science graduates and other graduates but there are some clear gaps by occupation for science graduates similar to those observed for being exactly in their occupation of choice. Science graduates outside science or teaching occupation are less satisfied with their choice of studies.

To summarise, there is no evidence that science graduates lack skills compared to non-science graduates; on the contrary, they are less likely to be found in a non-graduate occupation and have spend less time unemployed. Those working in a scientific occupation have an even shorter duration of unemployment. Assuming that all science graduates first search for a scientific occupation and if not successful search for a non-scientific job, one would expect those in a scientific job to have lower unemployment duration. The shorter unemployment of scientists in general would also suggest that scientists have skills that are in need in all occupations. Science graduates working in scientific occupations are more satisfied with their career even after controlling for income, which is inconsistent with the hypothesis of negative uncompensated characteristics of science occupation. Those not working in science are also less likely to report that they would choose the same subject, which could indicate that they have not studied the appropriate (science) subjects and also less likely to report being in their occupation of choice.

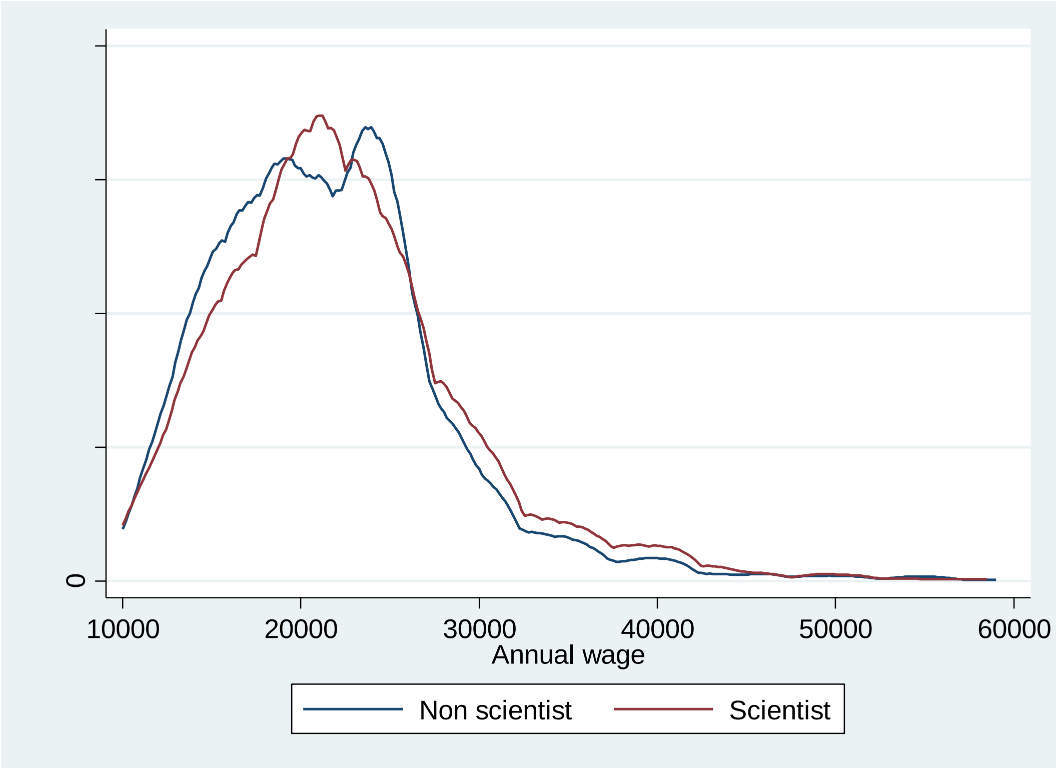
It is thus unclear that the wastage of scientists is due to the appeal of other occupations – graduates not working in scientific occupations are less likely to report being in exactly the job they wanted and are less satisfied with career development so far, which could indicate that they have been pushed into non-scientific careers. This may be due to a lack of scientific skills from these graduates or a mis-match between degree programmes and employers' needs, since they are less likely to report that they would study the same subject again. The lack of skills of some science graduates was indeed mentioned as the main difficulties in research and development recruiting (Mason, 1999; Lambert, 2003).

VI: Conclusions and comments

While there is a general view that there is a shortage of science graduates, this is mostly due to a large number of science graduates not working in scientific occupations rather than a lack of qualified science graduates. Despite higher average returns to a science degree, less than 50% of science graduates work in a scientific occupation three years after graduation. Science graduates are more expensive to teach so even if science skills are needed in non-scientific occupations, the current provision is surely inefficient.

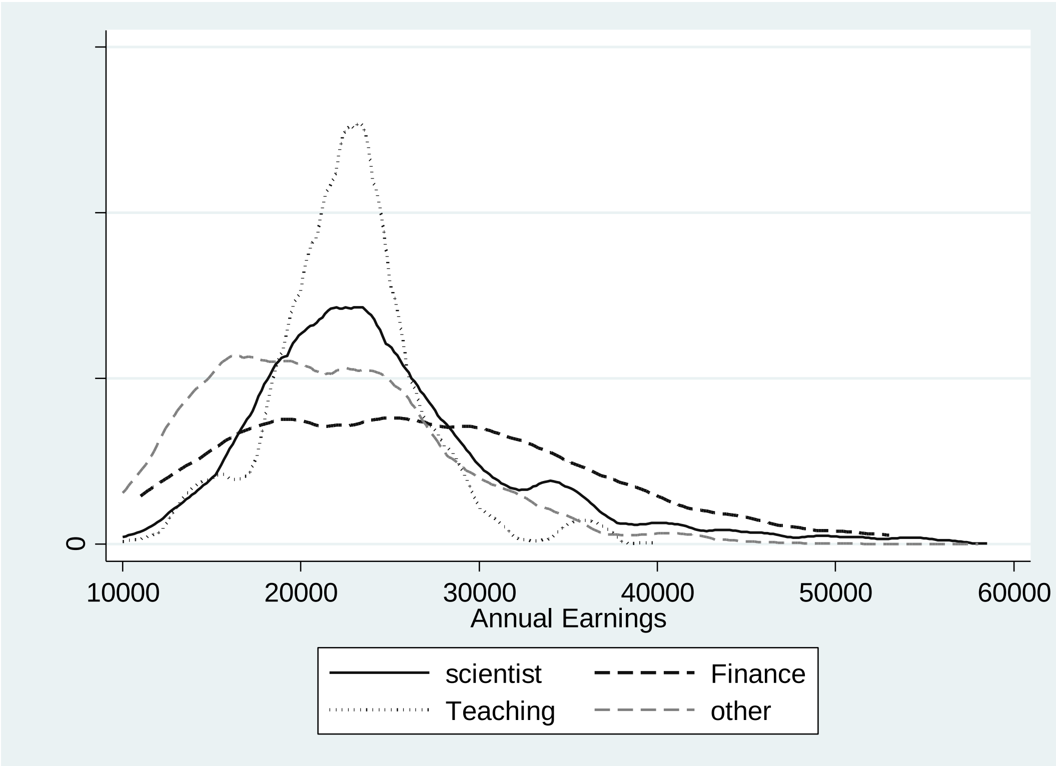
The reasons of this wastage at a period of high demand in scientific occupations remain unclear. We provide some tentative evidence that rejects hypotheses based on uncompensated wage differential. It could then be that there is a lack of scientific skills or a mismatch between the scientists produced and the scientific employers' needs. The Lambert and Roberts reports indeed recommended a greater coordination between higher education institutions and scientific employers. Also the sorting between occupations is not random and those not working in a science occupation (or finance) tend to have lower academic credentials and graduated from less prestigious institutions. The shortage of scientists can currently be covered by migrants but as developing economies are rapidly expanding their demands for this type of labour, this may be only a short-term expedient.

Figure 1: Distribution of annual earning in October 2006 by Science status – excluding medics



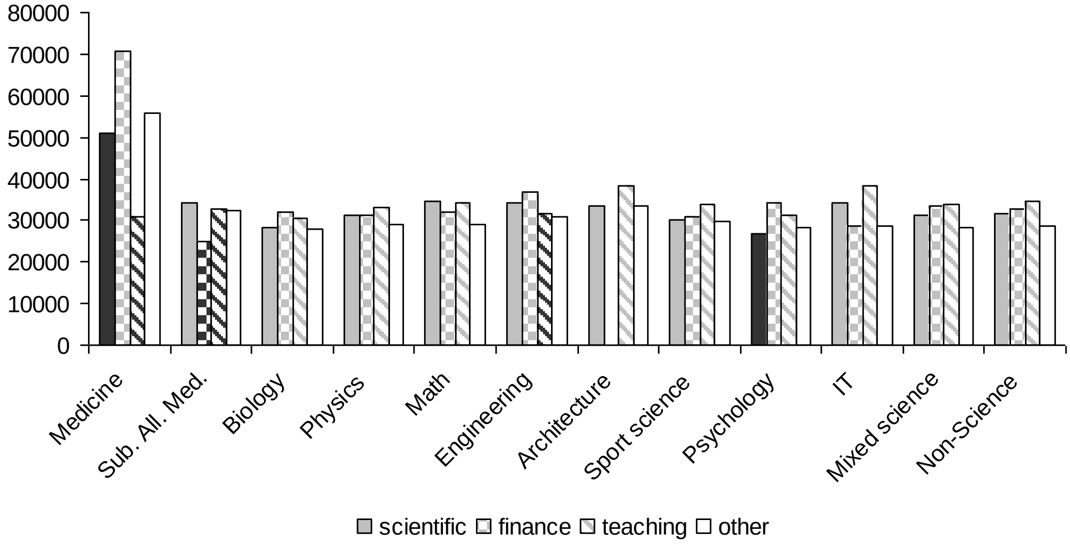
Note: Full time employees only- maximum annual earnings trimmed at £60,000

Figure 2: Distribution of annual earning in October 2006 for science graduates by occupation type



Note: Full time employees only- maximum annual earnings trimmed at £60,000

Figure 3: Predicted ln earnings by subjects and occupation



Note: Predictions are based on a specification similar to Model (4) in Table 4 but which also includes interactions between subject and occupation. Darker shades indicate the interaction between subject and occupation was statistically significant at the 5% level.

Table 1: First Degree Qualifiers from UK Higher Education Institutions

Subject of Study	2002/03	2003/04	2004/05	2005/06	2006/07	Growth
Medicine and Dentistry	6176	7003	7446	7700	8258	34%
Subject allied to Medicine	23666	24707	27866	29774	30460	29%
Biological Sciences	23723	24923	26375	26975	28137	19%
Biology	*4428*	*4480*	*4582*	*4444*	*4670*	5%
Sports Science	*3744*	*4973*	*5629*	*6208*	*6324*	69%
Psychology	*8898*	*9680*	*10616*	*11343*	*11656*	31%
Veterinary science	562	661	692	682	643	14%
Agriculture and related	2149	2413	2223	2139	2183	2%
Physical sciences	12477	11980	12198	12528	12270	-2%
Chemistry	*2954*	*2735*	*2703*	*2520*	*2663*	-10%
Physics	*2205*	*2179*	*2226*	*2346*	*2254*	2%
Forensic and Archaeological science	*385*	*518*	*746*	*1193*	*1447*	276%
Mathematical sciences	5101	5151	4989	5262	5387	6%
Computer science	18240	20008	19777	18493	16255	-11%
Engineering and Technology	19457	19586	19341	19535	19497	0%
Engineering	*17519*	*17559*	*17299*	*17346*	*17119*	-2%
Technology	*1938*	*2028*	*2042*	*2188*	*2378*	23%
Architecture and planning	6554	6736	6567	7363	7616	16%
Total STEM	118105	123166	127475	130450	130706	11%
Total non STEM	156341	161825	169542	175460	179961	15%
Total	274446	284992	297017	305910	310667	13%
% STEM	43%	43%	43%	43%	42%	

Source: Higher Education Statistics Agency (HESA) Student Record.
Note: Figures exclude those qualifying from the Open University due to inconsistencies in their method of recording subject of study over the time period.

Table 2 Proportion of graduates working in specific occupational group

Subject	Scientific occupation	Financial occupation	Teaching	Other	Obs.
Science subject:					
Medicine and Dentistry	0.95	0.01	0.00	0.04	28
Sub. allied to Medicine	0.80	0.01	0.03	0.16	61
Biology, vet, agriculture	0.30	0.01	0.14	0.55	46
Physical science	0.30	0.04	0.14	0.52	43
Mathematics	0.25	0.20	0.18	0.37	23
Engineering and Tech.	0.59	0.03	0.03	0.35	63
Architecture & Planning	0.53	0.00	0.00	0.47	17
Sport science	0.01	0.04	0.31	0.64	15
Psychology	0.23	0.02	0.20	0.55	30
IT	0.47	0.04	0.06	0.43	59
Mixed 100% science	0.43	0.14	0.06	0.37	12
Aggregated subjects					
Non-science 1	0.05	0.07	0.17	0.71	47
Science 1	0.43^{+}	0.04^{+}	0.11^{+}	0.42	45
Science 2	0.46^{+}	0.04^{+}	0.10^{+}	0.40	41
Science 3	0.49^{+}	0.07	0.09^{+}	0.35	96
Science 4	0.43^{+}	0.04^{+}	0.11^{+}	0.42	38
Total	0.26	0.05	0.14	0.55	93

$^{+}$ denotes that the mean is statistically different from the mean for the non-scientific graduates

Science occupations are defined as the following SOC2000 codes: Managers in construction (1122), mining and energy (1123), IT (1136), R&D (1137), Health services (1181), Pharmacy (1182) Healthcare practise (1183), Farm (1211), Natural environment (1212), Chemist (2111), Biologist (2112), Physicists/mathematicians (2113), Engineer (2121. 2122, 2123, 2124. 2125, 2126, 2127, 2128, 2129), IT professional (2131), software professional (2132), medical occupation (2211), other medical professionals (2212), Pharmacist (2213), Optician (2214), Dentist (2215), Veterinarian (2216), Scientific researcher (2321), statisticians (24234), Actuaries (24235), Architects (24310), Technician (3111, 3112, 3113, 3114, 3115, 3119, 3121), draughtsperson (3122), building inspector (3123), IT technician (3131), Nurse (3211), Midwife (3212), Paramedic (3213), other medical associate professional (3214,3215, 3216, 3217,3218, 3221, 3222, 3223, 32290, 32291, 32292, 32293).

Financial occupations are defined as: Financial institution manager (1151), Chartered and certified accountant (2421), Management accountant (2422), Management consultants, actuaries, economists and statisticians (2423), finance and investment analyst (3534), taxation expert (3535), financial and accounting technicians (3537).

Teaching professionals are defined as all occupation in the group teaching professionals (231)

Table 3A: A-level score (or equivalent) by subject of study and occupation

Subject	Mean A-level score	Mean A-level and works in Science	Mean A-level and works in Finance	Mean A-level and works in Teaching	Mean A-level and other occupations
Science subjects					
Medicine and Dentistry	28.12	28.19			
Sub. allied to Medicine	20.29	20.97			17.34
Biology, vet, agriculture	18.58	18.71		19.73	18.17
Physical science	19.17	18.62		19.73	18.94
Mathematics	24.06	24.69	24.58	23.70	23.86
Engineering and Tech.	19.18	20.47			17.17
Architecture and Planning	16.58	16.33			16.96
Sport science	17.64			17.54	17.66
Psychology	20.28	22.35		19.84	19.26
IT	16.76	18.12	17.16	13.59	15.51
Mixed 100% science	21.66	22.41			19.88
Aggregated subjects					
Non science 1	19.04	18.77	22.10	17.96	19.00
Science1	19.98*	21.34*	24.04*	18.61	18.65
Science2	20.04*	21.31*	23.90	18.53	18.62
Science3	21.15*	21.31*	24.60*	21.36*	20.45*
Science4	19.38*	20.02	23.85	18.50	18.57
Total	19.50	21.08	22.80	18.22	18.87

Note: Source LDLHE 02/03. Sample restricted to individuals with positive value of the score.
The score is obtained by taking the best three A-levels, grades A, B C, D and E are equivalent to 10, 8, 6, 4, 2 points respectively. – means for cells with less than 25 observations are not reported.
* denotes that the mean is statistically different from the mean for the non-scientific graduates

Table 3B: Institution quality by subject of study and occupation

Subject	Mean Institution quality	Mean Institution quality and works in Science	Mean Institution quality and works in Finance	Mean Institution quality and works in Teaching	Mean Institution quality and other occupations
Science subject					
Medicine and Dentistry	2.42	2.43			
Sub. allied to Medicine	-0.04	-0.04			-0.12
Biology, vet, agriculture	0.48	0.59		-0.24	0.57
Physical science	0.71	0.66		1.37	0.49
Mathematics	1.71	2.14	2.27	1.52	1.40
Engineering and Tech.	0.57	0.70			0.23
Architecture and Planning	-0.40	-0.25			-0.56
Sport science	-1.08			-1.32	-0.96
Psychology	0.20	0.42		-0.13	0.18
IT	-0.32	-0.07	-0.27	-0.80	-0.53
Mixed 100% science	1.67	1.96	-		1.30
Aggregated subjects					
Non science 1	0.11	0.17	0.88	0.00	0.07
Science1	0.43*	0.67*	1.76*	-0.03	0.19
Science2	0.50*	0.68*	1.88*	0.16	0.26*
Science3	0.96*	0.91*	2.64*	1.23*	0.75*
Science4	0.37*	0.40*	1.87*	0.15	0.25*
Total	0.27	0.62	1.21	-0.01	0.11

Note: Source LDLHE 02/03. Sample restricted to individuals with positive value of the score.
– means for cells with less than 25 observations are not reported.
* denotes that the mean is statistically different from the mean for the non-scientific graduates

Table 3C: Average Annual Earnings by subject of study and occupation

Subject	Mean Earning	Mean Earning and works in Science	Mean Earning and works in Finance	Mean Earning and works in Teaching	Mean earning and other occupations
Science Subjects					
Medicine and Dentistry	39,133	38,909			
Sub. allied to Medicine	24,580	25,074			22,948
Biology, vet, agriculture	20,294	20,217		20,821	20,178
Physical science	21,612	22,167		23,226	20,649
Mathematics	24,693	31,581	27,334	22,802	22,162
Engineering and Tech.	24,934	26,127			22,592
Architecture and Planning	24,476	25,150			23,812
Sport science	20,552			20,938	20,207
Psychology	19,285	18,950		19,310	19,355
IT	22,792	24,629	22,761	23,248	20,712
Mixed 45-55 science	22,417	26,416	28,430	23,355	20,776
Mixed 100% science	22,436	23,043			20,825
Aggregated Subjects					
Non science 1	21,600	22,856	25,854	22,577	20,939
Science1	23,757*	26,481*	26,583	22,038	21,197
Science2	24,199*	26,783*	26,866	22,603	21,420
Science3	24,805*	26,660*	28,666	22,353	22,588*
Science4	23,108*	24,829*	26,609	22,602	21,267
Total	22,677	26,126	26,125	22,352	21,032

Note: Source LDLHE 02/03. Sample restricted to Full time employees with annual salaries lower than £60,000. – means for cells with less than 50 observations are not reported.
* denotes that the mean is statistically different from the mean for the non-scientific graduates

Table 4: OLS Estimates on the effect of subject of graduation on annual earnings for science subjects

	(1)	(2)	(3)	(4)	(5)
Medicine	0.677	0.544	0.513	0.548	0.537
	[28.64]	[16.82]	[11.31]	[11.05]	[10.79]
Subject allied to Medicine	0.161	0.150	0.148	0.123	0.123
	[9.08]	[9.13]	[8.95]	[7.40]	[6.21]
Biology, Veterinary	-0.045	-0.049	-0.047	-0.063	-0.056
	[1.58]	[1.98]	[1.93]	[2.85]	[2.59]
Physical science	0.039	0.016	0.014	0.009	0.011
	[1.58]	[0.66]	[0.60]	[0.38]	[0.47]
Mathematics	0.104	0.072	0.061	0.047	0.050
	[3.19]	[2.29]	[1.93]	[1.54]	[1.60]
Engineering and Techno.	0.164	0.130	0.120	0.090	0.077
	[6.46]	[5.55]	[4.95]	[3.83]	[3.29]
Architecture and Planning	0.162	0.155	0.143	0.103	0.101
	[3.24]	[3.26]	[3.24]	[2.70]	[2.55]
Sport sciences	0.023	0.039	0.046	0.023	0.000
	[0.58]	[1.00]	[1.12]	[0.60]	[0.33]
Psychology	-0.062	-0.063	-0.072	-0.060	-0.039
	[3.12]	[3.17]	[3.49]	[2.77]	[1.83]
IT	0.068	0.069	0.069	0.053	0.054
	[2.91]	[3.16]	[3.15]	[2.58]	[2.58]
Mixed 100% science	0.052	0.024	0.021	0.017	0.001
	[1.28]	[0.70]	[0.63]	[0.60]	[0.01]
Socio-economic		Yes	Yes	Yes	Yes
University controls			Yes	Yes	Yes
Job controls				Yes	Yes
HE institutions					Yes
R^2	0.23	0.28	0.29	0.39	0.42

The analysis is conducted on the weighted sample. P-statistics accounting for clustering at the institution level are reported in brackets. Observation 8280. The omitted subject category is all non-science degree.
(1) includes a set of dummies for postcode of employer (3 digit)
(2): (1) + controls for A-levels score, a dummy for missing A-levels score, a dummy for female, a set of dummy for parental social class, ethnicity, age on graduation, fee status, living arrangement while in HE, disability status, and type of previous institution attended.
(3): (2) + dummies for class of degree and dummies for institutional quality (in Quarters).
(4): (3) + FT/PT work, whether work in the UK, Current job tenure, whether contract longer than 12 months, employer's size, highest qualification obtained, number of jobs, length of unemployment.
(5) same as (4) but replace institution quality by a set of dummy for each institution.

Table 5: Estimates on the effect of STEM degrees and occupation on annual earnings

	(1)	(2)	(3)	(4)	(5)	(6)
OLS						
Science	0.114	0.079	0.065	0.052	0.017	0.018
	[9.03]	[7.22]	[6.09]	[5.44]	[1.69]	[1.30]
Scientific occupation					0.135	0.092
					[11.28]	[3.01]
Finance occupation					0.117	0.120
					[5.27]	[4.16]
Teaching occupation					0.166	0.180
					[8.80]	[7.01]
Science * Scientific occupation						0.048
						[1.45]
Science * Finance occupation						-0.006
						[0.14]
Science * Teaching occupation						-0.033
						[0.99]
Background controls		yes	yes	yes	yes	yes
University controls			yes	yes	yes	yes
Job controls				yes	yes	yes
HE institution dummies						yes
R^2	0.13	0.22	0.27	0.34	0.37	0.37

Quantile regression

	Model (3)			Model (3)		
Quantile	.25	.50	.75	.25	.50	.75
Science	0.013	0.009	0.030	0.011	0.008	0.041
	[1.09]	[1.09]	[2.37]	[1.18]	[0.83]	[2.97]
Scientific occupation	0.179	0.133	0.088	0.134	0.082	0.037
	[12.83]	[13.31]	[5.81]	[6.22]	[3.56]	[1.07]
Finance occupation	0.166	0.175	0.191	0.170	0.177	0.184
	[6.97]	[10.33]	[7.23]	[9.20]	[8.99]	[6.23]
Teaching occupation	0.203	0.147	0.088	0.220	0.161	0.113
	[13.08]	[13.86]	[5.66]	[17.92]	[12.80]	[6.45]
Sc * Scient.				0.056	0.060	0.047
				[2.37]	[2.39]	[1.28]
Sc * Finance				-0.014	0.006	-0.018
				[0.47]	[0.19]	[0.405]
Sc * Teach				-0.036	-0.037	-0.054
				[1.87]	[1.92]	[1.95]

Note: The analysis is based on the science 1 definition (8280 observations); The analysis is conducted on the weighted sample and controls for current location (postcode) where also included in all specifications. P-statistics, adjusting for clustering at the institution level are reported in brackets.
Model 2 – controls for A-levels score, a dummy for missing A-levels score, a dummy for female, and a set of dummy for parental social class, dummies for ethnicity, age on graduation, fee status, living arrangement while in HE, disability status, type of previous institution attended.
Model 3: same as (2) + dummies for class of degree and dummies for institutional quality (in Quarters).
Model 4: same as (3) + FT/PT work, whether work in the UK, Current job tenure, whether contract longer than 12 months, employer's size, highest qualification obtained, number of jobs, length of unemployment

Table 6: Occupational choice of science graduates 6 months and 3 years after graduation.

		Occupation: 3 years after graduation					
		Scientific	Finance	Teaching	Other	Total	Obs.
Occupation: 6 months after graduation	Scientific	[84%] (63%) 1,322	[1%] (9%) 14	[1%] (2%) 12	[14%] (11%) 222	(32%)	1,570
	Finance	[8%] (0%) 8	[53%] (30%) 50	[7%] (1%) 6	[32%] (1%) 30	(2%)	94
	Teaching	[7%] (1%) 12	[0%] (1%) 1	[73%] (24%) 129	[19%] (2%) 34	(4%)	176
	Other	[22%] (18%) 373	[3%] (32%) 53	[9%] (29%) 155	[66%] (55%) 1,130	(35%)	1,711
	Not working	[30%] (19%) 391	[4%] (28%) 46	[18%] (44%) 241	[48%] (31%) 622	(27%)	1,300
	Total Observation	[43%] 2,106	[3%] 164	[11%] 543	[42%] 2,038		4,851

Note: In each cell the percentage in brackets pertains to the row percentage, the percentage in parentheses reports the column's percentage, the last row is the number of observations in the cell.
The calculations are based on science graduates only (*science 1*).

Table 7: Choice of scientific occupation by subject and predicted wage differentials – Marginal effects from Probit model

Expected wage differential	Science-finance	Science - teaching	Science - other	$Chi^2(3)$ [P>chi^2]
Medicine	-0.029	-0.016	0.039	0.78
	[0.54]	[0.31]	[0.61]	[0.85]
Subject allied to Medicine	0.027	0.074	-0.012	1.07
	[0.49]	[0.77]	[0.14]	[0.78]
Biology, Veterinary	0.363	0.045	-0.274	11.62
	[3.14]	[0.26]	[1.33]	[0.01]
Physical science	-0.190	0.118	0.213	1.90
	[1.33]	[0.44]	[0.46]	[0.59]
Mathematics	0.219	0.213	-0.017	4.95
	[1.59]	[0.97]	[0.06]	[0.18]
Engineering and Techno.	-0.162	0.220	0.285	2.58
	[1.07]	[1.17]	[0.92]	[0.46]
Architecture and Planning	0.847	2.392	-1.405	43.84
	[2.72]	[5.88]	[2.15]	[0.00]
Sport sciences	n.a.	n.a.	n.a.	n.a.
Psychology	0.031	-0.140	-0.308	1.91
	[0.25]	[0.53]	[0.89]	[0.59]
IT	0.037	0.153	-0.331	1.30
	[0.25]	[0.73]	[1.06]	[0.73]
Mixed 100% science	0.182	1.007	-0.579	6.10
	[0.47]	[2.25]	[0.87]	[0.10]
All science subjects	0.021	0.340	-0.328	43.82
	[0.55]	[3.05]	[2.53]	[0.00]

Note: Science graduates only (4851 observations)
The reported coefficients are marginal effects from a probit model of the decision to work in a scientific occupation – each line represents a different model – one for each subject. The model also includes gender, age,ethnicity, A-level score, socio-economic group, class of degree, fee and disability status, previous school attended, university quality, and an indicator whether the father worked in a scientific occupation. The z statistics are based on bootstrapped standard errors (500 replications).
Wage differentials are based on predicted earnings. Predicted earnings are estimated for each occupation separately using specification (3) in Table 4.
n.a. indicates that the model could not be estimated for the given subject due to small sample sizes

Table 8: Other outcomes:

	Month of unemploy-ment	Not graduate job	Exactly job I wanted.	Only job offer	Job to pay off debts	Career satisfac-tion	Would study same subject?
	Tobit	Probit	Probit	Probit	Probit	Probit	ordered logit
Science definition 1 – all graduates							
Science	-1.227	-0.068	0.030	-0.009	-0.056	0.000	-0.024
	[5.88]	[7.72]	[2.58]	[1.07]	[5.54]	[0.01]	[0.57]
Ln income	--	--	0.226	-0.088	-0.029	0.246	0.789
			[11.93]	[6.35]	[1.85]	[20.61]	[11.27]
Scientific occupation – science 1 graduates only							
Scientific occupation	-1.911	--	0.155	0.056	0.016	0.033	0.414
	[5.53]		[8.42]	[4.14]	[1.08]	[3.21]	[6.04]
Finance occupation	0.884	--	0.021	0.001	-0.004	0.046	-0.174
	[1.10]		[0.49]	[0.03]	[0.10]	[2.09]	[1.12]
Teaching occupation	-3.748	--	0.221	-0.028	-0.042	0.028	0.473
	[6.46]		[7.23]]	[0.12]	[1.62]	[1.65]	[3.93]
Ln income	--	--	0.203	-0.114	-0.029	0.207	0.932
			[7.19]	[5.58]	[1.30]	[12.69]	[8.94]

Note: p statistics are reported in parentheses. Nbr of observations are 9376 in regression not including income and 8280 if income is included. The second panel is based on 4851 observations who are classified as science degree (science 1)

The analysis on career satisfaction and whether would study the same subject is base on specification (4) details of which can be found in the note under Table 4. The specification for over-education and month of unemployment only includes variables up to leaving university as detailed in specification (3) under Table 4.

Over-education is defined using Elias and Purcell (2004) which defines 5 categories of graduate jobs 1 Traditional occupation (20%), 2 Modern occupation (17%), 3 New occupation (19%), 4 Niche occupation (22%), 5 Non-graduate job (22%).

Exactly job I wanted is a dichotomous variable reporting the reason for accepting the current job. It is coded as 0 if answer no (48%) and 1 for yes (52%)

Only job offer is a dichotomous variable reporting the reason for accepting the current job. It is coded as 0 if answer no (82%) and 1 if yes (18%)

Job pay off debts is a dichotomous variable reporting the reason for accepting the current job. It is coded as 0 if answer no (74%) and 1 if yes (26%)

Career satisfaction is coded as 1 satisfied (85%), 0 dissatisfied (15%).

Would study the same subject include 4 categories: 1 very likely different (16%), 2 likely different (19%), 3 not likely different (26%), 4 not likely at all different (39%).

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Appendix:

Table A1: Sample Selection:

Selection criteria	Number of observations
Original sample	19,979
First degree only	11,866
Age on graduation [19,25]	9,850
Not special entry student	9,738
Employed FT or PT	9,296