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ABSTRACT

A Hazard Model of the Probability of Medical School Dropout in the United Kingdom*

From individual-level longitudinal data for two entire cohorts of medical students in UK universities, we analyse the probability that an individual student will 'drop out' of medical school prior to the successful completion of their studies. We examine the cohort of students enrolling for a medical degree at the start of the academic years 1985 or 1986. We find evidence that medical student completion is influenced by measures of academic preparedness, sex, and age as well as by the characteristics of the medical school itself. On the basis of our results, we also comment on the construction of institutional performance indicators against the criterion of student dropout.

JEL Classification: J24, I2, C41

Keywords: Medical students, student dropout (non-completion) probabilities, discrete time hazard, limited duration model, survival analysis

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1. Introduction

The issue of the determinants of medical student dropout probabilities is important and topical in both the UK and beyond for a variety of reasons. First, there is serious and growing concern in the UK and elsewhere[1] regarding a shortage in the domestic supply of medical doctors. As we describe in more detail below, this has led to Government-supported enquiries into the causes and potential cures for this problem. The most obvious policy initiative is to train more doctors. But an expansion of medical student numbers begs questions regarding both student quality and student retention. This paper attempts to inform our understanding of the latter issue.

A second reason for examining medical student dropout behaviour relates to the UK debate on the desirability of 'widening' access into higher education, in general, and into medical schools in particular. There has been a lively and high-profile debate in the UK concerning the extent of accessibility of medical schools to students regardless of their social or school background (see McManus (1998) and the related discussion). This has led to explicit recommendations to broaden access to undergraduate medical education (see Angel and Johnson, 2000). Predicting the likely impact of such policies on retention and progression is clearly an important issue. A third reason for analysing medical student withdrawal concerns the related debate concerning the extent to which previous educational qualifications affect medical student performance and progression (see, for example, McManus *et al.*, 1999). An issue here concerns whether it should be compulsory for medical students to have studied science subjects prior to enrolment.

[1] The Third Report of the UK's Medical Workforce Standing Advisory Committee (1997) cites indications that there will be a deficit of doctors in Europe early in this century (MWSAC, 1997. p. 30).

Finally, we note that the UK Government has recently introduced a series of Performance Indicators for Higher Education Institutions in the UK, including an indicator that ranks institutions on the basis of completion rates.[2] Other European countries are following the UK government's lead in the publication of official university league tables. We argue that the interpretation of league tables based on completion rates should be carried out against the backdrop of an understanding of which factors influence dropout rates. Furthermore, it is important to assess the statistical significance of rankings represented in such league tables. We offer some discussion of these issues in the current paper.

The rest of this paper is organised as follows. Section 2 presents a discussion of the institutional and policy contexts, which provide the backdrop to our analysis of data on UK medical students. Section 3 describes the data set and Section 4 describes the econometric model along with a discussion of relevant issues regarding our model estimation procedure. Estimates of the determinants of dropout probabilities are presented in Section 5. Some discussion on predicted dropout probabilities from our preferred model is presented in Section 6. Finally, Section 7 closes the paper with conclusions and further remarks.

2. Institutional context and public policy

Labour economics focuses chiefly on the analysis of decentralised labour markets in which equilibrium outcomes emerge from the interplay of the forces of supply and demand, where these forces are governed significantly by the price of labour. In important respects, however, the labour market for medical practitioners in the UK is better described by a planning model than by a model of a purely decentralised free market. Primarily, this is because of the nature of the necessary regulation in the market. In the UK, doctors are trained within medical

[2] For a discussion of performance indicators based on graduate employment outcomes, see Smith, Naylor and McKnight (2000).

schools funded and regulated by the government. In large part, this arrangement follows from the still predominantly public nature of medical provision under the auspices of the National Health Service. Currently in the UK, as in many other countries, there are major concerns regarding a growing shortage of medical doctors. The UK solution to this problem is perceived as requiring more efficient planning of the medical workforce.[3] The Third Report of the Medical Workforce Standing Advisory Committee (MWSAC, 1997) to the Secretary of State for Health bears testimony to this reliance on a planning approach and also makes plain how such an approach – to be effective and efficient – demands a wealth of detailed data and appropriate accompanying analysis. In part, the nature of this information requirement is a consequence of the lengthy training period and the consequent time lags between forecasting future supply and demand and the subsequent 'production' of the medical workforce. Uncertainties in demographic trends – which are themselves endogenously determined with the nature and level of medical provision – and in the evolution of medical technologies themselves compound the difficulties associated with forecasting and planning.

The Third Report of the MWSAC proposed a number of measures to prevent what it describes as 'the current significant imbalance' between demand and the domestic supply of doctors from becoming 'increasingly severe'. A main conclusion of the Report was that there should be a substantial increase in medical student intake (about 1,000 per annum, approximately 20% of the current intake), together with policies to ensure 'minimised levels of wastage from such courses, thereby increasing the proportion of entrants that qualify as doctors.' Of course, a significant incentive to reduce wastage rates lies in the high cost

[3] This is a very different approach from that recently recommended from an analysis of the shortage of postgraduate students of Economics in the UK (see Machin and Oswald, 2000). In that case, the problem was attributed largely to a distortion in the relative price of labour.

associated with medical training. There is no concensus figure on the full cost of a medical training – partly because the costs vary across institutions and are borne by a variety of parties – but a figure of around £50,000 per annum, is often quoted. One element of the proposed package of measures to address the issue of minimising wastage concerns changes in selection procedures of candidates for medical schools in order to 'obtain graduates with a wider range of skills and interests.' The related issue of selection and admission of students into medical schools in the UK has itself been the recent focus of significant debate.

As the MWSAC report has emphasised, the development of strategies to minimise the medical student dropout rate should be conducted in the light of analysis of the determinants of completion and withdrawal behaviour by medical students. This has been rendered difficult in the UK by a lack of reliable data and analysis. The MWSAC Report acknowledges that there is significant uncertainty regarding estimates of medical school qualification rates. Estimates are typically based on the difference between annual intake of students at each medical school and the number qualifying 5 years later. This is imprecise partly because of variations over time and across institutions in the number of students taking intercalated degrees, for example, and hence taking longer to qualify. Thus, it is not surprising that there is so much variation in the estimated drop-out rates, which fluctuated (with no systematic trend) between 8% and 14% during the period 1986/7 and 1991/2 (see MWSAC, 3rd Report, p. 65). So severe is the information problem regarding the drop-out rate that the Third Report of the MWSAC acknowledges that all its analysis and recommendations rest on an estimated student wastage rate which is itself based on 'some anecdotal evidence that drop out is falling' (p. 25). One of the eight recommendations of the Report called for more information and research into medical school wastage rates, *inter alia*.

In the absence of reliable data on medical school dropout rates, different studies have produced widely varying estimates of the average national rate. Parkhouse (1996) uses

University Statistical Record (USR) and Higher Education Funding Council (HEFCE) data on medical school intake and numbers qualifying five years later and estimates an average UK drop-out rate of between 11.7% and 14.1%. McManus (1996) disputes these figures and cites survey evidence that the rate is around 7% or 8%, with about half of the students who drop out doing so for non-academic reasons.

Previous data and accompanying analysis have been based, typically, either on aggregated (medical school-level) official data from the USR or HEFCE or on follow-up surveys of particular sub-samples of medical students. This mirrors the situation regarding the analysis of all UK university students across all subject areas. Johnes and Taylor (1990), for example, model student withdrawal rates using university-level data.[4]

Very recently, however, (anonymised) individual student-level administrative data for full population cohorts of students have become available to researchers for the period 1972-1993. These data contain rich information not only on the academic characteristics of students in UK universities (their courses, institutional affiliation, performance, reasons for leaving, accommodation, *inter alia*) but also on their personal, social, and prior educational characteristics. These data offer the prospect of much more precise estimates of dropout rates and of detailed analytical investigation of the factors associated with dropout behaviour. This is of clear interest and relevance to the issue of examining the impact of changing selection procedures on medical students' dropout probabilities (see, for example, Angel and Johnson, 2000).[5] Given the public policy importance of the issue, in the current paper we focus exclusively on a detailed analysis of the determinants of the withdrawal probability of UK medical students.

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[4] Amongst other phenomena such as degree performance and labour market outcomes.

[5] Smith and Naylor (2001b) use individual-level data to examine the student dropout rate across all UK university students, on three or four year degrees (which excludes medical students).

3. The Data

All higher education institutions – including all medical schools – in the UK are required annually to deposit comprehensive longitudinal individual student records data with a central government agency. Our data-set is based on these administrative data from the anonymised individual Universities Student Records (USR) for the full populations of undergraduate students leaving university in the UK in one of the academic years 1985-1993. The full dataset contains information on about 720,000 students – about 90,000 per cohort – across the full range of university degree courses. From information on each of these 'leaving cohorts', we have generated a data-set comprising all those full-time students who entered university at the start of the academic year 1985 or 1986 to study for a medical degree and who had either completed their course by the end of July 1993, or had left their medical degree program prior to completion.

The reason for the choice of starting years 1985 and 1986 is based on data considerations. Data availability restricts us to cohorts leaving university no later than 1993. In general, a medical degree in the UK takes five years to complete and the analysis is therefore conducted on students who enrolled for a five-year degree program. Normally, the first two years are classified as pre-clinical and the latter three as clinical parts of the degree. At the end of the second year of the program, those who perform well are given the opportunity to take an extra year in order to complete a Bachelor of Science degree before continuing with their medical degree. If they are successful, these students will then have taken a minimum of six years to complete their original degree. Students are also allowed to retake any failed examinations during their course of studies. In order to proceed to the next year of the degree program, the student is required to pass the examinations (either at the first attempt or after re-sits). Students who completed their medical degree program in 1993 after 5 years of study would have first enrolled in 1988. However, if we study only these students, we will fail to observe students taking more than 5 years to complete. For this reason, we prefer to consider students who enrolled no later than 1986 as this gives us a minimum of 7 years over which to observe their withdrawal or completion. In order to increase the size of our dataset, we also include the 1985 starting cohort. The two cohorts will have faced very similar labour market and related conditions. This becomes less true if we take additional earlier cohorts.

In the event of non-completion, an administrative leaving date is recorded along with a university-recorded reason for the student's withdrawal. From this information, we find that degree course transfers account for around 26% of all withdrawals, with academic reasons accounting for 36% and other reasons accounting for 32%. This breakdown appears to conflict with that suggested by McManus (1996); however, for a number of reasons, we are not satisfied that the administrative coding of date and reason for leaving are reliable. For example, it is very likely that the first indication that a student has withdrawn will be their absence from examinations or their failure to submit other work. It is not clear whether this is – or should be – coded as academic failure, and in any case practice may vary across institutions. Accordingly, we have not used the actual administrative leaving date and the reason for the withdrawal in our analyses.

In this paper, an individual is assumed to have successfully completed if s/he obtains a medical degree by the end of five to seven years (and 8 years for the 1985 cohort) regardless of whether the individual had to re-sit some examinations. Dropout is defined as withdrawal from the medical degree program for whatever reason. In particular, if a student changes the degree program half-way through then this student is deemed to have withdrawn from the medical program. All those who dropped out of the program after five program years are assumed to have dropped out in the final year of the program. Thus, the standard length of the medical program, which is five years, is used as the duration time in our analysis rather than the actual calendar time taken for completion. Hence, by the end of the fifth year there is assumed to be a forced termination: a successful completion, or a dropout.

Table 1 provides some information about dropout rates. The 1985 cohort consists of 3,889 students, while the 1986 cohort has 3,900 students. The unconditional non-completion rate for all students who started a medical degree in either 1985 or 1986 is 10.7% (and is the same for each of the two years individually). From these two cohorts of medical students 7.9% actually drop-out from university altogether, this non-completion rate compares with a value of 8.9% obtained by Smith and Naylor (2001b) looking at all three and four-year degree courses for students commencing a degree at the start of the academic year in 1989.

Looking at the conditional dropout rates of medical students, we see that conditional dropout is a rare event and is surprisingly similar across the two cohorts. More specifically, as the student progresses through the program, the aggregate figures for conditional dropout decline quite dramatically. About 50% of those who do not complete their medical degree leave prior to the start of their 2^{nd} year. This finding is very similar to that found by Smith and Naylor (2001b), where across all students, the equivalent figure was 55%, and is similar to that found in the U.S. by Porter (1990) across all students. After the first year, the conditional rate of withdrawal declines. In particular, the conditional dropout rate in the final year of the program is only 0.37%. Given these small numbers, we have combined together both the two cohorts and also years four and five of the program.

4. Econometric Model and Issues

In the current paper, our objective is to model the conditional probability that an individual will drop out of a medical degree program during some small time interval, conditional on not having dropped out up to that point: that is, the hazard function. As indicated above, the underlying variable is the time spent on the program rather than calendar time. Unlike in conventional duration models, two specific characteristics of the program need to be accounted for in this case. First, the program duration is limited to five years. Because of this limited duration, the underlying continuous time duration variable will have a distribution that is continuous over the interval (0,5) and a discrete probability mass at the end point of 5 years. Second, the program cannot be completed before the end of five years. That is, the probability of successfully completing the program during the first five years is zero.[6]

We use the Cox's Proportional Hazards Model as a starting assumption. Given the above characterisation of the program of studies, the hazard for individual i, $\theta_i(t)$, is parameterised as

$$\theta_i(t)=\lambda(t)\exp(\mathbf{x_i}'\boldsymbol{\beta}) \qquad (t < 5 \text{ years}) \qquad (1)$$

where $\lambda(t)$ is the baseline hazard at time t, $\mathbf{x}_i$ is the vector of characteristics for individual i (excluding the intercept term) and $\boldsymbol{\beta}$ is the corresponding vector of unknown coefficients. As discussed earlier, because of possible measurement errors in the recording of the date of dropout, for the purpose of the analysis presented here the duration information has been re-coded in terms of whole years completed. A recorded duration of t whole years therefore indicates duration on the continuous time-scale, between t-1 and t years. Hence, the probability of exiting by time t conditional on $\mathbf{x}_i$, given that the student was still on the program at time t-1 is given by

$$h_{1i}(t \mid \mathbf{x}_i) = Prob\left[T_i < t \mid t-1 \le T_i\right] = 1 - exp\left\{-\int_{t-1}^{t}\theta_i(\tau)d\tau\right.$$

[6] Mealli, *et al.* (1996) consider a duration-limited competing risks model in the context of Youth Training Programs. Booth and Satchell (1995), and van Ours and Ridder (2000) look at a related model for PhD completion rates.

$$= 1- \, exp\left[-\int_{t-1}^{t} \lambda(\tau) \, exp\{\, \mathbf{x}_i{}'\boldsymbol{\beta} \} \, d\,\tau \right]$$

$$= 1- \, exp \, \left[-exp\left\{ \mathbf{x}_i{}'\boldsymbol{\beta} + \delta\left(t\right) \right\} \right] \qquad (2)$$

where $$\delta(t) = ln\left\{ \int_{t-1}^{t} \lambda(\tau) \, d\,\tau \right\} \qquad (3)$$

We thus have an Extreme-value form for the hazard model in discrete time.[7]

As seen earlier, the degree program finishes at the end of year 5.[8] There is thus a forced termination at this point. In order to account for this, it is assumed that these limit point probabilities take the same Extreme-value form as before but with a different set of coefficients. This is specified as

$$h_{2\mathrm{i}}\left(t = 5 \,|\, \mathbf{x}_{\mathrm{i}}\right) = Prob[\text{dropping out in year 5 | survival up to year 5, } \mathbf{x_i}]$$

$$= 1 - exp\left[-exp\left\{ \mathbf{x}_i{}'\boldsymbol{\alpha} + \eta \right\} \right] \qquad (4)$$

where $\boldsymbol{\alpha}$ is the vector of unknown coefficients and η is the intercept term.

A useful way of looking at the above specifications is in terms of a binary model since each individual in the sample can be thought of as contributing a maximum of five observations to the likelihood function. The binary variable will take the value of one if the individual drops out during the year and zero otherwise. To be more specific, let T_i be the recorded duration in years for individual i. Define a set of indicator variables, c and f such that, $f_i = 1$ if the individual drops out of the program in the first four years, and $f_i = 0$ otherwise; $c_i = 1$ if the individual successfully completes the program, and $c_i = 0$ if he/she

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[7] See Narendranathan and Stewart (1993a, 1993b) for a model of unemployment duration in discrete time.
[8] Because of possible endogeneity, no distinction is made between those who had an intercalated year to complete a science degree and those who did not.

drops out in the final year. Then the log-likelihood contribution by individual i with a recorded duration of T_i is given by

$$ln\, L_i = f_i\, ln[h_{1i}(T_i)] + (1-f_i)(1-c_i)\, ln[h_{2i}] - \Big(\sum_{t=2}^{\min(T_i,4)} ln[1-h_{1i}(t-1)]\Big) - c_i\, ln[1-h_{2i}] \qquad (5)$$

As there is no unobserved heterogeneity in the above model, the likelihood function (5) factors into two parts, where the parameters of the first and the second hazards can be estimated separately.[9]

The main advantage of working within the binary variable framework is that we are then able to relax the extreme value assumption and use standard models such as probit and logit. Unlike the extreme value distribution, probit and logit distributions are symmetric with respect to their means, although they do differ in the tail behaviour.

Unobserved heterogeneity

It is well known that failure to control for any unobserved individual-specific effects that may affect the hazard function will result in misleading inference due to inconsistent parameter estimators (Lancaster, 1990). The previous model can be extended for this purpose by including a random error term along with the vector of characteristics **x**. This requires an assumption regarding the distribution of this unobservable individual-specific error term.[10] In none of the models we estimated could we find any evidence of unobservables. The models

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[9] The above model also can be thought of in a competing-risks framework where the two risks faced by the individuals are completion and dropping out. Since the degree program lasts for a minimum of five years, the completion specific hazard has to be set equal to zero for the periods up to the 5 years. This model then collapses to the one specified above.

[10] In addition to the assumption regarding the actual distribution of the unobservables, we also require the assumption of independence of the unobservables and the included regressors in order to marginalise with respect to these unobservables. The models for the unobservables that were tried were: normally distributed unobservables, normally distributed unobservables with allowance for different masses at the end points, and a two mass point discrete distribution.

with unobservables always converged to the same point as the models without unobservables. Therefore, we report results only from models without unobservables.

5. Empirical Results

Analysis of student dropout behaviour has received much attention in the US, where one of the most influential theoretical explanations of student attrition is the path analyses model of Tinto (1975, 1987). This model and related analyses suggest that the major determinants of completion are likely to be the student's (i) academic preparedness, and (ii) social and academic integration into the educational institution. The analysis identifies a number of key influences on the withdrawal probability, including: the student's previous schooling, prior academic performance, family background and personal characteristics, as well as institutional characteristics. In our model of student dropout probabilities, we therefore include control variables reflecting the student's prior academic preparedness, their social background and personal characteristics.[11] Previous schooling includes both prior qualifications of students and the type of school attended prior to university. Part of the motivation for the latter comes from the general issue of the impact of school quality and school type on later outcomes (see Moffit (1996)). In one of our models, we include dummy variables for the medical institution attended.[12] In a second model, we replace the medical school dummy variables with a set of variables measuring characteristics of the medical school attended by the student.

In order to obtain data on a satisfactory number of dropouts in each year of the program, the models have been estimated by combining the two cohorts, with a year dummy

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[11] In an analysis of the dropout behaviour of all UK University students matriculating in 1989, Smith and Naylor (2001b) find evidence in support of a role for both academic preparedness and social integration. They use a simple probit model based on the incidence of a student dropping out of university.

[12] Due to small cell sizes and the amalgamation of some London medical schools over our sample period, the University of London medical schools were treated as a single medical school.

included to account for any aggregate macro effect. The dependent variable takes the value of one in a year if the individual drops out of the program in that year and zero otherwise. Because of the very small number of withdrawals after year four, the final hazard refers to year four onwards. We thus have one hazard specification for years 1 to 3 (see h_1 in equation (2)) which models the dropout/continuation process, and another hazard specification for the rest of the period (h_2 in equation (4)) which models the dropout/completion process.

Prior to the discussion of the results, we consider the testing procedure used to discriminate between various models. The maximised log likelihood values for a set of estimated models are presented in Table 2. When the three types of model – Extreme value, logit and probit – are estimated without any covariates, the maximised values are exactly the same. The differences caused by the distributional assumptions become apparent when covariates are included in the model. The log likelihood values in the second panel of Table 2 refer to a model that includes the full set of covariates. Among the symmetric distributions (logit and probit), probit performs very poorly. But there is essentially no difference between the extreme value model derived from the proportionality assumption for the underlying continuous time hazard and the logit model that does not impose this restriction.[13] The restriction that the effects of the covariates are the same in both the hazards in the logit specification is easily rejected by the data (see bottom panel of Table 2) with a $\chi^2(50)$ value of 194.8 and p-value of [0.00]. On the basis of this, we choose the logit model with unrestricted coefficients across the two hazards as our preferred model. This model does not impose the proportionality assumption like the extreme value model. The definitions and summary statistics for the variables used in the analyses are provided in Table 3.

[13]The estimated marginal effects were very similar across the extreme value and the logit models.

In the UK, the usual age of entry into a university medical school is 18. Looking at Table 3 we see that 67% of our sample members are aged 18 or less on entry, with a slightly lower proportion found among the dropouts compared to those who successfully complete. Although our sample contains an approximately equal split of male and female students, males are found to dominate among the dropouts. A very small proportion of students were married when they entered the program.

In the two cohorts used in the analysis, 94% of the students were of UK nationality. Fees charged by universities depend on the nationality as well as on some residency conditions. In general, UK students are liable for a UK fee which is much smaller than the overseas student's fees. In any case, for the cohorts we are analysing in the present paper, all fees facing UK students were paid for by the student's local education authority. A European Union student would be liable for paying the UK level of fees. Currently, this is just over £1,000 per annum. The overseas fee varies across universities, but is currently around £9,000 per annum for the 2 pre-clinical years and £17,000 per annum for the 3 clinical years. Overseas fee-paying students account for only 4% of the population but 6% among the dropouts.

Prior to entering university, most UK students study in secondary school towards qualifications which will determine the success of their applications to higher education. Broadly, we can distinguish between two types of school: those which are in the private sector (henceforth, 'Independent' schools) and those which are in the broadly-defined state sector. The latter consists of various sub-categories of school, including local education authority (LEA) comprehensive schools, grammar schools (to which admission is selective and subject to educational tests) and colleges of further education. In the school population of the UK as a whole, about 7% of pupils attend an Independent school. In contrast, around 34%

of medical students went to an Independent school. This is markedly higher even than the 27% observed for the group of all (non-medical) students used in Smith and Naylor (2001b).

The pre-university secondary school qualifications which form the basis for offers of places at medical schools are, typically, 'A-levels' for English and Welsh school pupils, and 'Highers' for school pupils from Scotland and Northern Ireland. Offers of university places are typically conditional on the candidate's performance in their best three A-levels (or best five Highers).[14] In addition, a number of medical schools interview candidates prior to making an offer of a place on the course. The average A-level (Higher) score from the best three (five) subjects was 25.5 (13.7) points (equivalent to grades of around ABB), with some 27% of the cohort having the maximum 30 (15) points.[15] Some 2% of students had no prior qualification recorded and 4% already had a prior qualification obtained from a university in the UK.[16] Approximately 50% of students arriving for a medical degree had either A-levels or Scottish/Irish Highers in Chemistry, Physics and Biology.

The social class background of students entering a medical degree program shows that around 35% come from Social Class I (Professional) (with 39% of these actually coming from a background in which one of the parents or the guardian is a medical practitioner) and 38% for Social Class II (Intermediate professions). This compares with only 19% of all students starting a 3 or 4-year degree in 1989 coming from a Professional background and 62% from either Professional or Intermediate.

Summarising with respect to the characteristics of those among the dropout sample,

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[14] A-levels are classified as A through to E. These grades can be converted into a points score: A=10 points, B=8 points, C=6 points, D=4 points, and E=2 points. Highers are classified as A through to C: A=3 points, B=2 points and C=1 point.

[15] This compares to an average A-level score of 23.7 for non-medical students. On average, then, medical students have better A-level qualifications than other students.

[16] An analysis excluding the 2% of individuals who had no qualifications did not change the results.

compared to those who successfully complete the degree program, there is a slightly larger proportion of individuals, (i) aged more than 19, (ii) who are men, (iii) paying non-UK fees, (iv) who have an average A-Level score which is much lower than ABB, and (v) who have more than the standard 3 A-Levels.

The derived marginal effects on the rates of withdrawal and the corresponding p-values for the estimated logit models are reported in Table 4 (see footnote 2 to Table 4 for an explanation of how these marginal effects are calculated). Model 1 includes a set of university dummies among the covariates. The results from Model 1 are presented in columns [1] and [2]. In order to investigate further the *ceteris paribus* effects of universities, we also experimented by replacing the dummies with some variables that reflected the nature of the medical faculty in that particular university. These were: number of undergraduates, number of postgraduates on taught degrees, number of postgraduates on research degrees, expenditure on salaries per medical student, expenditure per medical student from research grants, percentage of professors among the staff in the faculty, percentage of senior staff, percentage of research staff, separate binary indicators for Scottish, Welsh and Irish universities. Results from substituting the university dummies with university characteristics, called Model 2, are presented in columns [3] and [4]. Columns [1] and [3] refer to the drop-out/continuation hazard (h_1), and [2] and [4] to the drop-out/completion hazard (h_2). As seen earlier (in Table 2), the restriction that the covariate effects are the same is easily rejected.

The estimated pattern of age effects suggests that students aged 20 or 21 at the enrolment time are less likely to drop out compared to someone aged l8 or less. But, these effects are reversed when we consider successful completion. Conditional on progressing to the final years of the program, an individual who was 21 or more at the start of the program has an increased probability of withdrawal at the last stages of the program. More specifically, relative to someone who is 18 at the time of enrolment, this individual is estimated to have an increased withdrawal rate of 4.8 percentage points, *ceteris paribus*. Males are found to be significantly more likely to withdraw than females, but only in the latter parts of the program.

Nationality and the fees status of students are found to play a significant role in the first few years of the program. UK students and those who pay non-UK (non-EU) fees are less likely to withdraw in the first few years of the program, *ceteris paribus*.

There are very strong and well-determined coefficients on prior qualifications. These effects are picked up by various binary indicator variables on the type of prior qualifications as well as by the actual scores obtained for students who had taken either A-Level or Higher qualifications.

With respect to performance at A-Level or in Highers, we note that although it is customary in UK Medical Schools to require a student to obtain three (five) A-Level (Higher) passes prior to entry, some students do more subjects than the required number. In order to allow for this, we include the actual scores they obtained in their best three (five) A-Level (Higher) examinations and also the scores from the rest, if they had more than the required number. As expected, the effect from A-levels (and Highers) on the dropout rates during the entire degree program period is estimated to be negative and declining towards the final years of the program. An extra two points on the A-Level average (equivalent to an extra A-Level grade) reduces the dropout probability by about 0.6 percentage points, *ceteris paribus.* A similar negative effect is also found for Highers. These negative effects are somewhat reduced if the individual had come from a church school and also has more than the customarily required three (five) A-Level (Higher) subjects. The finding that the student's level of performance at A-level (Highers) has statistically significant effects on the dropout probability is in line with the hypothesis that academic preparedness for a medical degree is an important factor determining continuation and completion.

Looking at A-level (Higher) subjects, assuming that a strong background in Biology, Chemistry and Physics is likely to be appropriate for medical students, we include three dummy variables for those students who have one, two, or three of these subjects.[17] Relative to those with only two of the three of these subjects, all the other students are found to be slightly less likely to withdraw, *ceteris paribus*. This non-monotonic result is somewhat counter-intuitive. One possible explanation is that students with three pre-university science subjects are likely to be best prepared and this is reflected in their lower drop-out probability. Students with only one science subject prior to university medical school are in a relative minority and are potentially under-prepared. However, such students are likely to be disproportionately highly motivated to study medicine: indeed, they are likely to have had to demonstrate possession of appropriate characteristics (unobserved in our data-set) to convince admissions selectors to offer them places notwithstanding their subject portfolio. We are, however, unable to test this hypothesis directly within our data-set.

We find that students who have 'other' UK university qualifications or 'other' overseas qualifications are much less likely to drop out before completion relative to those students who have only the standard A-Level/Higher scores, *ceteris paribus*. The 'other' qualification variable may refer to a degree or a diploma. Prior qualification data includes information only on the individual's highest academic qualifications – not their full profile of previous attainment. Therefore, the very strong negative direct effect of one percentage point is additional to any indirect effect associated with A-Level and Higher scores. However, the effect of this variable is not significant in the final year except when the qualification is an overseas one. Because of their previous successful academic experiences, these students with

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[17] An original specification had dummies for whether the student had A-levels (Highers) in Physics, Chemistry or Biology or some combination of these. Results in Table 4 are arrived at having tested the implied restrictions.

a previous university qualification are hypothesised to be more able to persevere with the very strenuous and lengthy medical program: in a sense, they have already signalled themselves as such. Students with no recorded qualification or with qualifications that could not be categorised are also less likely to dropout. These are in addition to those effects coming via any unobserved A-Level and Higher scores.

In terms of the debate about widening access into medical schools, it is interesting to examine whether the effect on the dropout probability associated with the level of performance in pre-university examinations differs by school background. One hypothesis would be that the A-level performance of students from the non-Independent school sector might be an under-estimate of their underlying ability and hence the negative effect of A-level performance, say, might be lower for ex-pupils of state-schools compared to Independent schools.[18] There would then be less concern about the possible adverse effects of reducing A-level entry standards if this were targeted at applicants from the state school sector. In order to test for these kinds of effects, we included binary indicators for school type and also interactions of these with the actual scores obtained in the main entry qualification. The only significant effect on withdrawal probabilities associated with the type of school attended was for someone who had gone to a church school. This significant negative effect was only present in the first few years of the program. Relative to someone who had been to a Local Education Authority school, someone coming from a church school, is 6.3% less likely to dropout in the first years of the program, *ceteris paribus*. Thus, we found no evidence in support of the hypothesis concerning the possible difference in the effects of prior qualifications between (non-church) Independent and state-educated students.

[18] See Smith and Naylor (2001a) for evidence consistent with this hypothesis.

The social class effects are found to be weak in general and show little effect. An exception is the significant negative effect for individuals from Social Class category 'Intermediate' on the withdrawal rate in the latter parts of the program for students. We note that a student whose parent is a medical practitioner is less likely to withdraw, although the effect is not well determined. We also interacted prior academic performance with social class background, but found no significant effects.

In summary, we have found that academic preparedness, as measured by prior qualifications, is a statistically significant determinant of the medical student's probability of dropping out of the medical program. This would indicate that any policy of relaxing entry standards in order to increase the number of medical students would run the risk of raising medical school wastage rates. A similar risk arises if a policy of widening access is implemented simply through reducing entry standards for certain groups. Indeed, we found no evidence that the drop-out probabilities of students from particular school or social backgrounds which might be favoured by wider access policies were less sensitive to previous academic performance. Nor, however, did we find strong evidence that school and family background exerted an influence on the drop-out probability.

We now turn to the results for Model 2 where the university dummies are replaced by a set of university characteristics (see note 3 of Table 4 for a list of these variables). The results are reported in Columns [3] and [4] of Table 4. The estimated marginal effects are broadly similar across the two models. Of the university characteristics only two variables are significant at the 10% level: universities with a higher proportion of the staff as Professors have a lower probability of drop-out in the first period hazard, and universities with higher levels of expenditure on salaries tend to have higher probabilities of students dropping-out.

6. Predicted Probabilities

As we saw earlier the average raw unconditional probability of withdrawal was 10.7% (Table 1). This figure does not control for characteristics of the individual. The estimated models were for the conditional probability of withdrawal from the program conditioned on not having withdrawn up to that point. The discussion in the previous section was in terms of how the estimated conditional probability changes because of a *ceteris paribus* change of a characteristic for an 'average' individual (i.e. marginal effects). In this section we translate these estimated conditional withdrawal probabilities into unconditional probabilities of withdrawal from the program for individuals with some chosen characteristics. These are presented in Table 5.

We start with a reference individual who dominates in terms of the characteristics used in the analysis. This individual, labelled 'Man 1', is a UK male aged 18, who had attended a Local Education Authority (state) school, came from a professional social class background, had the three 'favoured' science-related subjects among his A-Level qualifications, with a score of 26 points for his best three A-Level subjects, and a score of 8 points for a fourth A-Level subject. The dropout probability for this individual is predicted to be 6.37% under Model 1. We note that for an otherwise identical female student (Woman 1), the predicted drop-out probability is slightly less at 6.22%. The rest of the table illustrates how the drop-out probability changes with one-at-a-time changes in the male individual's base characteristics.

First, we observe how a reduction in the number of favoured prior qualification subjects (from 3 to 2) raises the predicted drop-out probability to almost 9% (compare Man 2 with Man 1). Second, we observe that the student (Man 3) who has specialised in just 3 A-levels, choosing not to take optional courses (and therefore has a zero score for 'other' A-levels), has a predicted drop-out probability of less than 3%. Comparing Man 3, Man 4 and Man 6, we see how raising the best-3-subject A-level score from 26 to the maximum of 30 points reduces the predicted drop-out probability to just 1.03%, for the student with just 3 A-levels. A comparison on Man 6 and Man 9 shows that the drop-out of a student who had attended an Independent school is, *ceteris paribus,* greater than that of a student from a local education authority school: though we know from Table 4 that this difference is not statistically significant. Comparisons of Man 11 through Man 15 demonstrates how the predicted dropout probability becomes very high for a student with a relatively poor performance at A-level, especially when that student took more than 3 A-level subjects but with fewer than three in favoured science disciplines, and when the student previously studied at a further education college. We conclude that any attempt at increasing the number of medical students by lowering A-level requirements would potentially increase the overall wastage rate from medical schools. To avoid this, compensating policies such as better admissions targeting or increased academic support and mentoring might be necessary.

Figure 1 reports the estimated coefficients and the 95% confidence interval around these coefficients for each of the medical schools, relative to the median school (the reference category), from the drop-out/continuation hazard for Model 1. As can be clearly seen only 4 schools perform significantly differently from the median medical school: 1 performing significantly better and 3 performing significantly worse. On the basis of these estimated medical schools coefficients, we calculate the unconditional probability that a weighted average of 'Man 1' and 'Woman 1' will drop-out at each medical school.[19] We call this the adjusted medical school effect. We can compare this with the unadjusted medical school

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[19] The dropout probability varies markedly according to the medical school attended. For the composite individual 'Man 1'/'Woman 1' the predicted range is 2.7%-11.5%.

effect, which is simply the average dropout rate for each school. Figure 2 plots the adjusted against the unadjusted medical school effects. We notice that the correlation between the two is almost zero. This leads us to the conclusion that league tables of medical school performance against the criterion of institutional drop-out rates are likely to be potentially misleading indicators of performance if they do not take into account differences across schools in relevant attributes.

7. Summary and Conclusion

The results show that the decision to withdraw from medical school is not random and is strongly determined by both personal characteristics and, in particular, by the level of performance in prior qualifications. Students with high A-level (Higher) grades are markedly less likely to withdraw from their medical degree. Surprisingly, this effect persists over the entire period of the degree. Similarly, the choice of A-level subjects taken is important in preparing students for their degree. For example, it is better to have all science subjects compared to just having 2 sciences. The dropout probability is also lower for students who have specialised in just three subjects rather than taking additional optional subjects at A-level. There are few social class effects, but gender is statistically significant, with male students more likely to dropout. Age is also an important determinant, although its effect is not linear.

We have found that academic preparedness is a statistically significant determinant of the student's probability of dropping out of medical school. This indicates that any relaxing of entry standards in order to increase medical student numbers – or to widen access – would run the risk of raising medical school wastage rates. On the issue of widening access, however, we found no strong evidence that school and family background exert an influence on the dropout probability. Our conclusion is that any policies to widen access to medical school need to be targeted specifically on students whose prior qualification levels of achievement are likely to underestimate their true potential for a medical degree. In the absence of such targeting, a policy of reducing entry standards is likely to lead to higher wastage rates. Furthermore, it is likely that other aspects of medical student performance are similarly sensitive to prior levels of educational attainment. We leave testing this hypothesis to further work.

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Table 1

Unconditional Overall Dropout Rate (%)	10.70
Number of Students (initial)	
1985 entry cohort	3889
1986 entry cohort	3900
Conditional dropout rates	
1985 entry cohort – %	
Year 1	5.32
Year 2	3.04
Year 3	1.01
Year 4	1.33
Year 5	0.37
Unconditional dropout rate %	10.70
Conditional dropout rates	
1986 entry cohort - %	
Year 1	5.54
Year 2	2.39
Year 3	1.39
Year 4	1.47
Year 5	0.37
Unconditional dropout rate %	10.70

Table 2

Maximised Log-Likelihood Values

Model	Maximised Log Likelihood Value
Intercept only models[1]	
1. Discrete time hazard is Extreme Value	-3656.38
2. Discrete time hazard is Logit	-3656.38
3. Discrete time hazard is Probit	-3656.38
Models with full set of covariates including university dummies	
1. Discrete time hazard is Extreme Value	-2637.26
2. Discrete time hazard is Logit	-2640.32
3. Discrete time hazard is Probit	-2690.72
4. Logit Model ($\beta=\alpha$ from equations (2) and (4))	-2737.74
$\chi^2(50)$ [p-value]	194.8 [0.000]

Notes:

1. Model has parameters δ and η.

Table 3 - Definitions and Descriptive Statistics of Variables – Mean (Std. Deviation)

Variable Name	Definition	Overall sample	Dropout sample	Completion sample
Individual Attributes				
Binary Age indicators	Reference category – aged 18 or less in September of entry year	0.670	0.607	0.677
Aged 19 on entry	Aged 19 in September	0.217	0.215	0.218
Aged 20 on entry	Aged 20 in September	0.039	0.044	0.038
Aged 21 on entry	Aged 21 in September	0.015	0.019	0.014
Aged > 21 on entry	Aged more than 21 in September	0.059	0.115	0.053
Sex – male	=1 if the student is male	0.543	0.586	0.538
Marital Status	=1 if the student is married	0.020	0.028	0.019
Nationality	=1 if the student has British Nationality	0.942	0.926	0.944
Non UK fee	=1 if the student pays non-UK fee	0.042	0.058	0.040
Type of School Attended binary indicators	Type of school attended prior to entry into the medical program. Reference category – Local Education Authority School which is non-selective	0.381	0.382	0.381
Grammar School	=1 if Grammar School which is state-funded but selection to which is typically based on ability.	0.135	0.101	0.139
Independent School	=1 if Independent School which is fee paying and also selective	0.343	0.333	0.344
College of Further Education	=1 if College of Further Education	0.080	0.076	0.080
Other	Residual category which includes Church Schools	0.061	0.108	0.056
Entry Qualifications	Type of qualifications the individual had on entry into the program.			
A-Level scores – Best of 3 - total	Best of three total A-Level scores (average among those with these qualifications). This is a university entrance-level qualification, which is typically taken at about age 18. The scores are recorded in steps of two and goes from 2 to 10. It is normal for a student to be doing three of these.	25.5 (4.9)	18.9 (7.6)	26.3 (3.9)
'H' scores – best of 5 - total	Best of five total Scottish/Irish Higher scores (average among those with these qualifications). This is also a university entrance-level qualification, which is typically taken at about age 18. The scores are recorded in steps of one and goes from 1 to 3. It is normal for a student to be doing five of these.	13.7 (1.9)	13.5 (1.9)	13.7 (1.9)

Table 3 Continued

Variable Name	Definition	Overall sample	Dropout sample	Completion sample
Percentage of students having more than 3 AL		42.9	61.4	40.7
Other A-Level scores		8.9 (4.9)	13.3 (6.1)	8.1 (4.2)
Percentage of students having more than 5 'H'		7.2	7.7	7.1
Other 'H' scores		2.8 (1.3)	2.7 (1.3)	2.8 (1.3)
Top Score	=1 if the total score was the highest achievable (out of three for A-Level subjects, and out of five for 'H' level subjects	0.272	0.139	0.288
One favoured subject (Chemistry/Physics/Biology)	=1 if subjects taken included one from (Chemistry, Physics, Biology) among the 'A', 'H' subjects	0.013	0.016	0.012
Two favoured subjects (Chemistry/Physics/Biology)	=1 if subjects taken included two from (Chemistry, Physics, Biology) among the 'A' 'H' subjects	0.439	0.474	0.435
Three favoured subjects (Chemistry/Physics/Biology)	=1 if subjects taken included Chemistry, Physics, and Biology among the 'A', 'H' subjects	0.503	0.416	0.513
Other Entry Qualifcations				
Base category – A-Levels or Highers only		0.919	0.867	0.926
UK university qualifications		0.038	0.053	0.036
Overseas qualifications		0.015	0.023	0.014
BTEC and other		0.006	0.011	0.005
No qualifications		0.022	0.046	0.019
Parental Social Class	Binary indicators for the social class of the head of household. Reference category is professional.	0.343	0.331	0.345
Intermediate		0.383	0.342	0.388
Skilled Non-manual		0.080	0.094	0.078
Manual		0.126	0.136	0.125
Other workers		0.035	0.037	0.034
Non-workers		0.033	0.060	0.030
Father is a Doctor	=1 if the parent/guardian was a medical practitioner	0.137	0.126	0.139
Number of Students		7789	834	6955

Table 4
Derived Marginal Effects (percentage) [p-values] on the Conditional Exit rate of Withdrawal from the Medical Degree Program
Logit Hazard Models

Variable	With university dummies - MODEL 1		With university characteristics[3] - MODEL 2	
	Dropout vs Continuation hazard (h_1)	**Dropout vs Completion hazard (h_2)**	**Dropout vs Continuation hazard (h_1)**	**Dropout vs Completion hazard (h_2)**
Intercept	2.662 [0.00]**	-3.437 [0.00]**	4.069 [0.00]**	-3.097 [0.03]**
Year 2 dummy	-0.350 [0.00]**		-0.378 [0.00]**	
Year 3 dummy	-0.799 [0.00]**		-0.852 [0.00]**	
1986 Year Dummy	0.288 [0.00]**	0.107 [0.62]	-0.153 [0.37]	-0.166 [0.59]
Entry Age binary indicators – Base 18 or less				
19	-0.044 [0.71]	0.598 [0.16]	-0.068 [0.57]	0.646 [0.15]
20	-0.307 [0.08]*	1.509 [0.16]	-0.286 [0.14]	1.553 [0.15]
21	-0.526 [0.02]**	4.845 [0.06]*	-0.604 [0.01]**	4.982 [0.06]*
22 or more	0.175 [0.52]	4.771 [0.03]**	0.191 [0.50]	5.256 [0.02]**
Sex - male	0.023 [0.81]	0.969 [0.01]**	0.022 [0.82]	0.945 [0.01]**
Married	0.282 [0.44]	-0.215 [0.61]	0.281 [0.46]	-0.111 [0.82]
British National	-0.665 [0.02]**	1.633 [0.14]	-0.750 [0.02]**	1.273 [0.19]
Non UK fee student	-0.353 [0.08]*	1.128 [0.24]	-0.470 [0.01]**	1.158 [0.24]
Type of School Attended – binary indicators [base Local Education Authority]				
Grammar School	-0.257 [0.55]	1.893 [0.56]	-0.272 [0.55]	2.375 [0.52]
Independent School	-0.122 [0.61]	-0.143 [0.81]	-0.070 [0.78]	-0.357 [0.49]
College of Further Education	1.600 [0.27]	3.078 [0.78]	1.469 [0.29]	7.545 [0.71]
Other (Church Schools and other)	-0.638 [0.00]**	0.433 [0.73]	-0.680 [0.00]**	0.222 [0.84]
Main Entry Qualifications				
A-Level scores – best of 3 (max30)	-0.266 [0.00]**	-0.187 [0.00]**	-0.274 [0.00]**	-0.199 [0.00]**
'H' Level scores - best of 5 (max 15)	-0.394 [0.00]**	-0.309 [0.00]**	-0.397 [0.00]**	-0.323 [0.00]**
Main Entry Qualifications and School Type interactions				
A-Level scores – best of 3 (max30)				
and Grammar School	0.015 [0.51]	-0.061 [0.23]	0.014 [0.57]	-0.067 [0.20]
and Independent School	0.017 [0.16]	0.004 [0.89]	0.014 [0.25]	-0.014 [0.63]
and College of Further Education	-0.031 [0.24]	-0.085 [0.47]	-0.029 [0.29]	-0.120 [0.30]
and Other (Church Schools and other)	0.061 [0.01]**	0.014 [0.71]	0.065 [0.00]**	0.015 [0.71]

Table 4– Continued

Variable	With university dummies - MODEL 1		With university characteristics - MODEL 2	
	Dropout vs Continuation hazard (h_1)	**Dropout vs Completion hazard (h_2)**	**Dropout vs Continuation hazard (h_1)**	**Dropout vs Completion hazard (h_2)**
'A'/'AS' Level scores – excl. the best 3	0.103 [0.00]**	0.089 [0.00]**	0.109 [0.00]**	0.079 [0.00]**
'H' Level scores – excl. best 5	0.002 [0.98]	0.155 [0.37]	0.011 [0.89]	0.096 [0.61]
Achieved Top Score – binary indicator	0.131 [0.44]	0.568 [0.25]	0.086 [0.63]	0.399 [0.38]
No favoured subject (Chemistry/Physics/Biology)	-0.752 [0.00]**	-1.004 [0.00]**	-0.758 [0.00]**	-1.064 [0.00]**
One favoured subjects (Chemistry/Physics/Biology)	-0.690 [0.00]**	-0.818 [0.00]**	-0.719 [0.00]**	-0.838 [0.00]**
Three favoured subjects (Chemistry/Physics/Biology)	-0.344 [0.00]**	-0.528 [0.00]**	-0.379 [0.00]**	-0.589 [0.00]**
Other Entry Qualifications (binary indicators)				
Has other UK university qualifications	-0.881 [0.00]**	-0.378 [0.20]	-0.909 [0.00]**	-0.431 [0.13]
Has other overseas qualifications	-1.010 [0.00]**	-0.869 [0.00]**	-1.060 [0.00]**	-0.872 [0.00]**
Has BTEC qualifications	-0.983 [0.00]**	-0.362 [0.60]	-1.033 [0.00]**	-0.131 [0.88]
Has no formal qualifications	-1.000 [0.00]**	-0.337 [0.68]	-1.033 [0.00]**	-0.288 [0.75]
Parental Social Class – binary indicators				
[Base is Professional]				
Intermediate	-0.083 [0.50]	-0.511 [0.00]**	-0.065 [0.62]	-0.540 [0.00]**
Skilled Non-manual	0.169 [0.42]	-0.242 [0.46]	0.162 [0.46]	-0.329 [0.28]
Manual	0.015 [0.93]	-0.325 [0.21]	0.029 [0.87]	-0.329 [0.23]
Other workers	-0.158 [0.48]	-0.443 [0.23]	-0.152 [0.52]	-0.503 [0.17]
Non-workers	-0.315 [0.28]	-0.248 [0.64]	-0.377 [0.19]	-0.297 [0.57]
Father/Guardian is a Doctor	-0.122 [0.41]	-0.286 [0.28]	-0.123 [0.42]	-0.304 [0.26]
Maximised log likelihood value	-2640.32		-2671.92	
P-value for the additional university variables	($\chi^2(25) = 134.4$) [0.00]		($\chi^2(14) = 71.2$) [0.00]	
Number of observations	7789		7789	

Notes:

1. Since the probabilities are small, the marginal effects are reported in terms of percentage effects on the conditional withdrawal rates.
2. Marginal effects are calculated as the first derivatives evaluated at the mean of the characteristics for continuous variables, and as the difference in withdrawal probabilities when the binary indicator changes from 0 to 1 for the binary variables.
3. The university characteristics that are included all relate to the medical faculty and are, Number of undergraduates, Number of postgraduates on taught degree programs, Number of postgraduates on research programs, Expenditure on Salaries per medical student, Expenditure on grants and other per medical student, Professors (% of all staff), Senior Staff (% of all staff), Research (% of all staff), a dummy for Scottish universities, a dummy for the Welsh university, and a dummy for the Irish university.

Table 5
Predicted unconditional probability of withdrawal from Model 1

The following calculations refer to a British National, paying UK fee, not married, only has A-Level qualifications and comes from a university which is ranked 10 (the reference university in the model) out of 19 universities in terms of the marginal effect estimates.

Individual	Age	School type	Best 3 A-Level scores	Other A-Level scores	Number of favoured subjects	Social Class	Predicted Probability (%)
Man 1	18	Local Education Authority (LEA)	26 (ABB)	8 (B)	3	Professional (Parent not a medical practitioner) (SC I)	6.37
Woman 1	18	LEA	26	8	3	SC I	6.22
Man 2	18	LEA	26	8	2	SC I	8.91
Man 3	18	LEA	26	0	3	SC I	2.90
Man 4	18	LEA	28 (AAB)	0	3	SC I	1.73
Man 5	18	LEA	28	8	3	SC I	3.83
Man 6	18	LEA	30 (AAA)	0	3	SC I	1.03
Man 7	18	LEA	30	0	3	Intermediate	0.94
Man 8	18	LEA	30	0	3	Skilled Manual	1.19
Man 9	18	Independent School (Ind)	30	0	3	SC I	1.49
Man 10	18	Ind	30	0	3	Skilled Manual	1.73
Man 11	22	Further Education College (FE)	30	0	3	SC I	1.09
Man 12	22	FE	30	10 (A)	3	SC I	2.97
Man 13	22	FE	30	10	2	SC I	4.19
Man 14	22	FE	24 (BBB)	6 (C)	2	SC I	17.52
Man 15	22	FE	22 (BBC)	6	2	SC I	28.65
Man 16	18	LEA	22	6	2	SC I	19.18

Notes:

1. A-levels are classified as A through to E. These grades can be converted into a points score: A=10 points, B=8 points, C=6 points, D=4 points, and E=2 points. Highers are classified as A through to C: A=3 points, B=2 points and C=1 point.

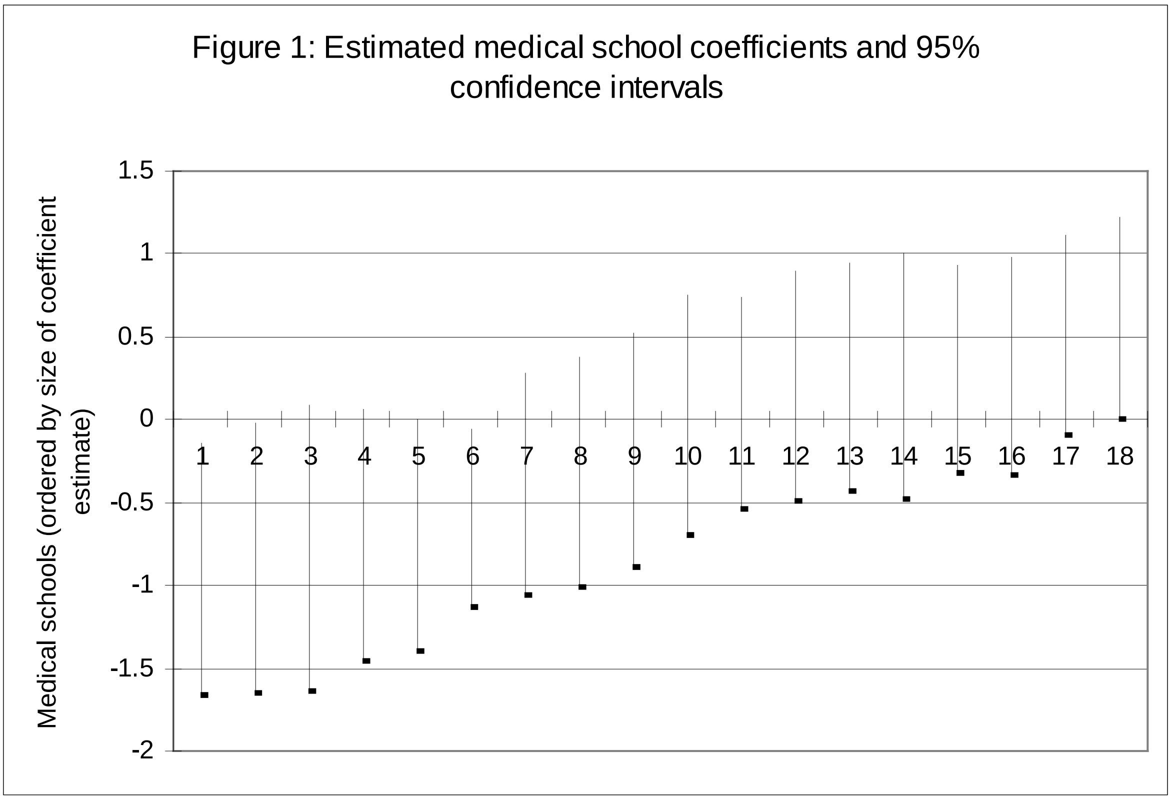
Figure 1: Estimated medical school coefficients and 95% confidence intervals
Medical schools (ordered by size of coefficient estimate)
1.5
1
0.5
0
-0.5
-1
-1.5
-2
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18

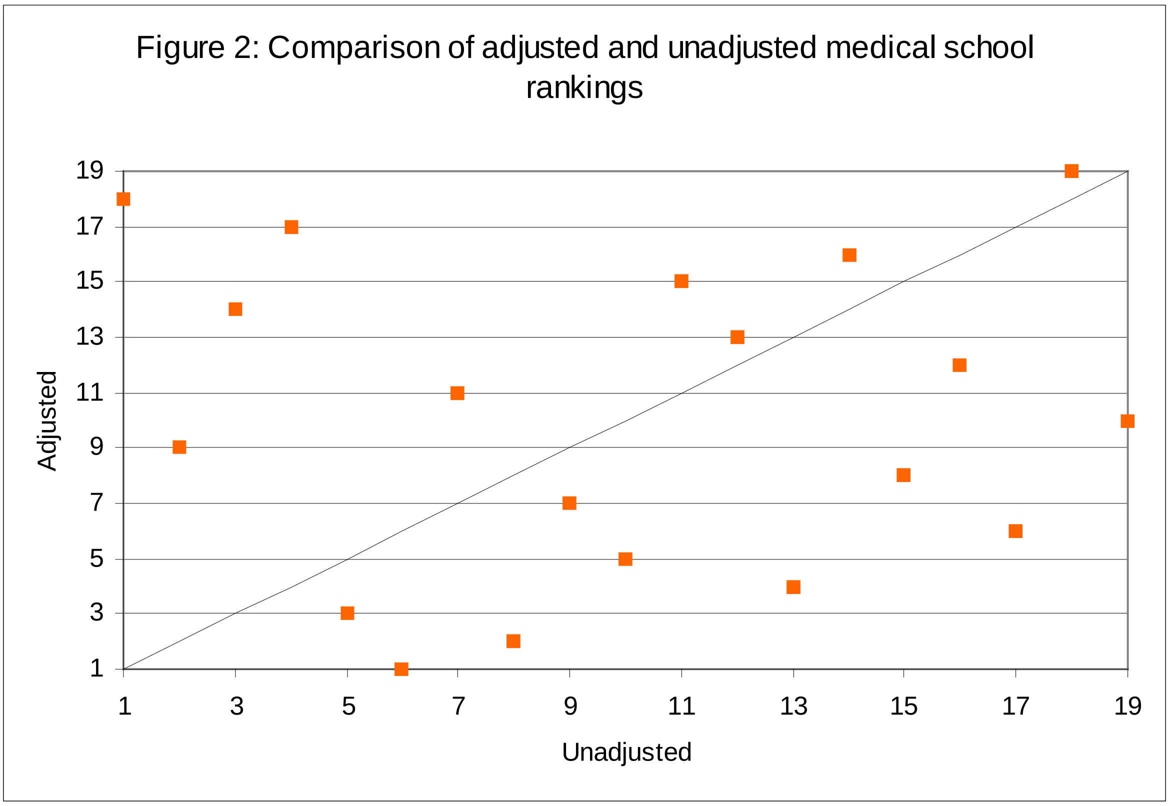
Figure 2: Comparison of adjusted and unadjusted medical school rankings
Adjusted
19
17
15
13
11
9
7
5
3
1
1 3 5 7 9 11 13 15 17 19
Unadjusted

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