Using success to measure quality in British Higher Education: which subjects attract the best-qualified students?

by

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Abstract

A method of ranking the quality of applicants and acceptances to UK Higher Education establishments is developed. Quality is measured by a weighted average of qualifications, whereby different qualifications can be compared by their success in generating a Higher Education place. A theory is developed to justify this weighting procedure and is based on the idea that more able applicants will self-select into more difficult subject choices, which offer higher returns. Choices are made prior to examination results being known, so high ability applicants may still be rejected. The relative quality of applicants and acceptances across 170 separate subject groups is then devised and discussed.

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I Introduction

The Universities College Admissions Service (UCAS) processes undergraduate applications for around 300 Higher Education (HE) establishments spread throughout the United Kingdom, ranging from the most prestigious institutions, such as Oxford and Cambridge universities, to the more obscure. Full-time undergraduate applicants do not approach HE colleges directly, rather they are required to apply via UCAS.[1] Around 42,000 separate courses are covered, which are split into 170 broad subject groups. Over the five-year period 1996-2000, there were nearly two million home based (UK domiciled) applicants to HE who went through the UCAS application system. The qualifications of these applicants are also tracked by UCAS. So this provides a huge databank of information about subject choices and the qualifications of applicants. The purpose is to use this information to understand which subjects attract the best qualified students and which subjects attract the less well-qualified.

Such an exercise is not only of interest in itself – comparing the quality of academic establishments and subject groups, either formally or informally, is a popular pastime among educationalists. But there are more substantial reasons other than the `beauty contest' interest factor. Endogenous growth theory has at its core the view that human capital provides an important external benefit generating growth, but this externality is likely to be subject specific (see Romer, 1994). Some subjects (e.g. Engineering and Computer Science) might be better able to generate additional GNP compared with more purely academic subject choices. Elias (1999, p. 7) shows that there are considerable variations in unemployment among recent graduates depending on subject choice. More

applied subjects such as Engineering have less than half the unemployment rate compared with Natural Science graduates. So which subject groups attract the best students? Do the brightest and the best opt for subjects with higher potential positive spillovers?[2] Having comparative information about student quality is an important first step in any policy driven education strategy that seeks to align student choices with social goals.

Each UCAS applicant is recorded with one of 19 separate qualifications (see Table 1). The key issue is how to devise a standard of comparison across these different qualifications, which is objective rather than a ranking based on subjective judgement. It may be reasonable to assert that a 30 point A-level score is a better qualification level than a lower point A-level score, but how can a BTEC Merit qualification be compared with an A-level and so on? A method for making such a comparison is developed and this is then used to devise a scale by which subjects can be ranked in terms of the quality of applicants and the quality of those that are accepted.

The paper is structured as follows. Section 2 outlines the mechanics of the UCAS admissions system and Section 3 describes the UCAS data in more detail. Section 4 explains the theory that underpins the ranking method, which also has a strong intuitive appeal. It is based on the idea qualifications can be ranked according to the success with which they can convert applicants into acceptances. Overall 76.7 % of applicants were successful over the five-year period of this study, but there are large differences across the 19 qualification levels. Section 5 presents and discusses the results based on the ranking method.

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[1] www.ucas.ac.uk is a central resource for detailed information about UCAS. The data used in this study are available from this source.
[2] Blundell *et al.* (1997) surveys UK graduate earnings and employment prospects.

2 The UCAS system

From the mid 1980s, HE in the UK experienced a rapid expansion. Between 1983-84 and 1993-94, there was a 67% growth among full-time undergraduates. After this, growth slowed, with total student numbers increasing by 6% between 1996-97 and 2000-01. The main cause of this expansion was the growth in the number of 18-21 year olds taking university courses. The age participation index rose from 15% in 1983-84 to 30% in 1993-94. HEFCE (2001) suggests a number of reasons for the growth in student numbers. First, the introduction of the General Certificate of Secondary Education (GCSE) in 1988 (normally taken by students at age 16) improved the staying-on rate after compulsory schooling, through an increase in academic attainment at 16 (see also McIntosh, 2001, McVicar and Rice, 2001). In 2001 the government set an ambitious target of 50% participation for the 18-30 age group by 2010.

Against this background of a generally buoyant demand for undergraduate HE, Figure (1) gives a schematic picture of how a typical applicant is processed through the UCAS system. The model described in Section 4 abstracts the essential elements of this complex process. The key point is that applicants do not apply directly to the HE institutions, but must do so via the centralized UCAS system.[3] With the academic term commencing around late September, the first deadline occurs the previous January (exact dates are announced annually). Each applicant is permitted to make up to six applications (except in Medicine, which is restricted to four). Usually these six applications are in a well-defined subject area, but need not be so. In this case the

[3] This refers to full-time undergraduates. Part-time students and postgraduates apply directly to specific institutions. Consequently the Open University, the largest provider of part-time education with no entrance requirements, is excluded from UCAS.

applicant is described as being in `no preferred subject area' and the applicant will be assigned to a specific subject if the application is subsequently successful. Around 20% of applicants are in this category and this is one reason why some subjects will appear to have more acceptances than applicants.

These applications are then reviewed by the institutions and rejections or offers are made. Offers will typically be conditional on the achievement of some prescribed entry standard. The majority of offers are conditional because most applicants will not know the results of exams until around August. The model will seek to describe the choice problem of this typical applicant. Applicants are obliged to choose a maximum of two from these conditional offers – assuming that the applicant is not rejected outright at this stage.

Applicants and their educational establishments have good knowledge about the relative quality of subject/institution choices. There is a well-defined pecking order among the various HE institutions, with correspondingly varying entry standards.[4] Subjects also vary in entry standards, with certain subjects such as Medicine having high entrance standards, whereas combination subjects tend to have lower standards. The typical applicant will tend, therefore, to keep one `high' first choice offer at a better institution and a `low' insurance offer at a less prestigious institution.

So applicants have a fairly sophisticated game to play. It can be safely assumed that they will have a fairly accurate idea of the entry tariff required when they apply for a particular

[4] See Abbott and Leslie (2001), which reviews relative institutional quality among the top 97 institutions, which account for the majority of applications. Some newspapers, for example, the Sunday Times and the

course/institution. What they will not know is the outcome of their exams, but most will have a fair idea of how they are likely to perform. So students who expect to do well will opt for the more difficult choices, which offer higher returns, and students who expect to do less well will opt for lower entry tariff courses at less prestigious institutions. The consequence is that it can easily turn out that one student with a better grade than another will be rejected at this stage and the student with the inferior result will be accepted. It is this somewhat fuzzy success/failure entrance standard that will be at the heart of the method of determining which subjects attract the best qualified students.

For applicants rejected at this stage, all is not lost. A process known as clearing then comes into to play (and a small number of late registrants who do not enter the initial stage of the annual round can come in at the clearing stage).[5] Clearing operates from around the end of August until courses commence, although in practice the majority of clearing takes place in a brief two week window from the point that results are announced.

Among the 42,000 courses offered many would not have filled their target numbers from applicants in the first stage. These will then advertise vacancies (this information is widely disseminated in newspapers and the Web). Students can then directly contact these institutions to see if their exam grades meet the entry tariff for that course. UCAS will then record the applicant as accepted if he or she is successful at this late stage. 20.5% of acceptances came through clearing and late registrations during 1996-2000 admission rounds.

Financial Times publish annual rankings and these results are widely disseminated. The FT ranking can be found at http://specials.ft.com/universities2001/index.html.

One would think that clearing should `mop up' all the better-qualified applicants but this turns out not to be the case. A significant proportion of very well-qualified applicants will turn out not to be accepted. The reason is that such applicants may well feel that the less prestigious courses on offer at clearing are simply not good enough, given their qualifications and prefer to sit out for another year or not bother at all. Or they may simply become disheartened and give up. Clearing has an associated stigma with students and institutions alike keen to avoid it if possible. Less well-qualified applicants might be grateful for any opportunity at HE. The process of clearing is another reason why some subjects (these are usually among the least prestigious) will appear to have more acceptances than applications. Those accepted through clearing may have to settle for an alternative subject choice. It also means that some subjects might turn out to have a lower quality of acceptances compared with its applicants, which is not what one would expect.

There is one fairly sophisticated strategy that the really determined applicant can make to avoid the restrictions of the UCAS system, which fig. (1) describes. This is to be released from a conditional offer once results are known. This practice, if it became widespread, would undermine the model somewhat. Fortunately, it is rare but the practice has increased in recent times. Expansion of HE means that far more courses are entered into clearing and the associated institutions will drop their entry tariff in order to fill places. Students who meet the standard of at least one of their conditional offers now observe that they could actually be accepted into what they believe to be a more prestigious course/institution, if only they could only enter clearing! So some smart students request

[5] Late registrants are at a disadvantage, because popular courses will be full at this stage. There is,

to be released from the offer. Such is the competition among HE institutions for good students nowadays, they will encourage students to break these contracts in order to fulfill their student quotas. Fair play among British academics is declining, it has to be said.

In summary, therefore, the whole UCAS process is complicated and the wide diversity of outcomes among qualification levels is unsurprising. It is not a simple matter of pass and fail – with those above the line entering HE and the rest rejected.

3 The UCAS data.

The ranking is based on an analysis of home-based applicants over a five-year period from 1996-2000, giving 1,930,582 individual observations.[6] The data cover 21 broad subject areas, which are then further divided into 170 specific subject groups. It should be emphasized that individual subjects will be offered at many HE establishments with the entry tariff varying according to the prestige of the institution offering the course. So the aim is to devise an average quality measure of applicants and acceptances by subject, which is not institution specific.

A second important distinction needs to be made. Although HE represents the upper tier of post compulsory education in the UK, two broad types of education are offered in the HE sector. The first type is degree level courses and the second broad type is Higher National Diploma (HND) courses. These are less academic, normally taking one year less to complete, and are more vocational in nature. Around 8.6 % of admissions are to HND level courses and these are generally of a less demanding standard than degree level

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therefore, an incentive to enter the competition at the earliest stage, which is what most applicants do.

courses.[7] The entrance requirements are accordingly less demanding and a more limited range of subjects is covered – for example, Medicine and Dentistry can only be undertaken at degree level. The quality measures will, therefore, distinguish two types of courses. The top institutions do not offer HND level courses.

Table 1 gives some key information about qualifications and success rates. The overall acceptance rate for the five years covered can be seen from the last row to be 76.7%, but there is considerable variation around this depending on the type of qualification achieved. The percentage of applicants with a particular qualification and that qualification's success rate in generating an acceptance (this includes both degree level and HND level acceptances) are shown. This ranges from a high of 94.4% for those with 6 or more Highers and a low of 48.7% for those with 3 or fewer Highers.

A-levels, shown in the first six rows, are the core qualification taken by 54.7% of applicants. These are given a point score, with 30 representing the highest possible score. The typical applicant sits 3 A-levels. There are five passing A-level grades, from A (highest) to E (lowest). Grade A earns 10 points; B earns 8 down to E, which scores 2.

It can be seen that success is very much linked to the point score, ranging from a below average 66% for those with 0-5 points to a very high 91.5% for 26-30 points. Since a higher point score means a better qualification, this provides informal support for the view that the percentage success rate can be used as a means of comparing qualification quality. The next four rows refer to `Highers'. These are the Scottish equivalent of A-

[6] These datasets can be found at www.ucas.ac.uk
[7] 11.3 % of Britain's ethnic minority communities in HE enter HND level courses, compared with 7.5% of whites. The differences between whites and the ethnic minority communities are explored in Leslie (2001).

levels because Scotland has always had a considerable degree of independence in the organization of its education.[8] As with the traditional A-level, it can be seen that the acceptance rate works in the expected way; a greater number of Highers means a greater chance of acceptance. Notice, however, that there is far from a 100% acceptance rate, even for those with the best qualifications among A-levels and Highers.

Access/Foundation course are a miscellaneous group of qualifications usually taken by mature students in the FE sector without formal qualifications looking to enter the HE sector. The Baccalaureate is an international qualification taken by 6185 of applicants over this data period. BTEC and its Scottish equivalent SCOTVEC are vocational qualifications, usually offered within the Further Education sector and by employers. The three grades (distinction, merit, pass) of GNVQ (General National Vocational Qualifications) are distinguished – once again the better the GNVQ score, the better are the chances of success. These are mainly vocation-related qualifications. `Other' refers to qualifications, which do not readily fit into any of the listed categories.[9]

The final qualification is the `none' category. At first sight an apparent success rate of 70.6% seems somewhat implausible. The reason is that the none category includes a lot of missing information, not only failures. For example, late registrants do not always record the qualification actually achieved – only a minimal return is sent to UCAS for the purpose of record keeping.[10] Subsequent analysis will include the none category as a qualification level in its own right.

[8] Scottish education goes for breadth rather than the traditional depth of the A-level. Students sit a larger number of Highers. A Scottish degree lasts four years, rather than the typical English three-year scheme.
[9] Details of specific qualifications are in *UK Qualifications for Entry to Higher Education*, published annually by UCAS. See UCAS (2001),
[10] Subsequently confirmed in conversations with Jim Wilkins of UCAS.

From 2002 onwards the traditional A-level will be replaced and UCAS is developing a method to compare all qualifications. See UCAS (2000), where part of the purpose of the exercise is to widen access for those with less familiar (non A-level type) qualifications. A comparability scale is thought to make admissions tutors keener to offer places on the basis of a common tariff rather than relying on qualifications that are familiar and trusted. The UCAS method is, however, subjective, unlike the method of comparison developed here. Here it is behaviour that measures quality – qualifications are ranked in quality according to their acceptance rate. So, in effect, it is the behaviour of admissions tutors that is the acid test of a qualification's worth. It respects the collective judgment of individual HE institutions to determine the relative worth of qualifications.

4 Using qualification success rates as a measure of quality

The idea that a particular qualification with a higher success rate (as measured by the proportion with that qualification obtaining an HE place, as shown in Table 1) is a better qualification compared with one with a lower success rate has a strong intuitive appeal. Nevertheless, a formal analysis is useful to see precisely how such a method can be justified in a situation where the entrance requirements of courses offer vary, as is the case in HE. If qualifications were uni-dimensional (with marks arranged along a cardinal scale of 1-100 say) then the measurement problem to be addressed here would not arise. Qualifications could easily be ranked in this instance – where one would expect a positive monotonic relationship with acceptances. The issue here is to devise a method of

comparing disparate qualifications, which cannot be easily compared. Thus it may to reasonable to state that 26-30 A-level points is better than 5-10 points, but how can A-levels be compared with BTEC as an example?

The institutional structure of the UCAS system has already been described. It is not a case of there being one single standard that applicants must achieve to gain an acceptance. The 42,000 courses on offer all differ in the `tariff', i.e. the minimum standard to gain acceptance. For example, in Cambridge University entrants achieve an average A-level grade of 29.8 points, whereas entrants to Anglia Polytechnic University (also located in Cambridge) achieved an average grade of 11.2 points.[11]

Suppose that the various courses on offer across the various institutions can be arranged along an entry standard scale denoted as *c*, where higher values of *c* indicate a higher standard. An applicant's utility will be described by *U(c, tastes)*, where *U* is a Von Neumann Morgenstern utility function. *Tastes* are exogenous and would reflect the applicant's subject preferences. So an applicant, who wants to study French, is unlikely to gain a high utility from Business Studies, even though *c* levels may be comparable. The assumption is that with 42,000 different courses on offer *tastes* are not so specific as to rule a wide range of possible choice options along the *c* scale. Some applicants might additionally really want to study Medicine as an example, but have sufficient insight about their underlying ability that they opt for a more realistic choice such as a Nursing degree.

[11] Note this differs from the entry tariff, but it gives a fair indication of the large range in entry standards.

It is assumed that $\frac{dU}{dc} = U' > 0;$ thus a `tougher' course (as measured by the entry standard *c)* provides greater utility (more prestige, higher potential earnings, better teaching etc). $U'' < 0$ indicates risk aversion and $U'' > 0$ indicates risk loving behaviour in the usual way.[12] An applicant will aim to choose a value for *c* that will maximize expected utility. To reflect the institutional UCAS setting, applicants must choose *c* prior to the realization of their qualification level.

It is clear that applicants do not make choices in a random way; rather, there is a considerable degree of self-selection in the application process. No hopers do not bother to apply to Cambridge and those with little prospect of good A-levels will bother to apply for Medicine or other tough courses. It will be seen later that there is a considerable correlation between applicant quality and acceptance quality, which largely (but not entirely) reflects this self-selection process.

Assume that the i^{th} applicant's realized qualification level is composed of two parts

$$z_i = q_i + v_i \qquad \textbf{(1)}$$

where $q_{i\,\text{is}}$ the applicant's private information (or expectation) about his or her likely qualification level, which reflect factors such inherent ability, motivation and so on. The actual grade z_i is this part plus a random component with $E(v_i) = 0$. The point is that z_i is unobservable; the aim is to infer something about this cardinal scale from knowledge of the success rate of particular qualifications for which the comparison scale z_i is a latent unobserved variable.

[12] An accessible account of the Von Neumann Morgernstern approach is given in Hey (1979, Chap. 4).

It follows that

$$E(z_i) = q_i \quad \textbf{(2)}$$

The applicant is required to choose a course (i.e. make a choice of *c*) prior to the realization of v_i. To highlight the key issues involved, it is initially assumed that the applicant can only make one choice. Suppose that the entry standard for a particular course is c_0. The applicant's expected grade, if successful, will be the mean of the truncated distribution

$$Ez_i \mid z_i \geq c_0 \quad \textbf{(3)}$$

For an applicant with a given q_i, the probability of acceptance across the range of course choices will be decreasing in *c*. Similarly for courses with the same entrance standard the probability of acceptance will be increasing in q_i. This probability relationship can be described by (dropping subscripts):

$$p = p(q, c) \quad \textbf{(4)}$$

where $\frac{\partial p}{\partial q} > 0$ *and* $\frac{\partial p}{\partial c} < 0$. The actual outcome will then be determined by the realization of v_i. Thus *c* in eq.(4) refers to the entry standard and should be distinguished from eq.(3). The average grades achieved by successful applicants to a particular course would be expected to exceed the minimum entrance standard. There are no tournament issues involved in the applicant's choice strategy because only rarely would an HEI renege on an offer if the applicant meets the required standard. Thus *p* is independent of the number of applicants to a particular course. Popular courses will ration by setting a high value for *c*.

The objective is to establish the relationship between p and q. From eq.(4) it can be seen that this is composed of two parts

$$\frac{dp}{dq} = p_q + p_c * \frac{dc}{dq} \quad \textbf{(5)}$$

If it can be shown that $\frac{dp}{dq} > 0$ this will help establish the idea that the success rate of a particular qualification is a measure of its relative value. The first task is to demonstrate that $\frac{dc}{dq} > 0$, that is that people who expect a high grade select into harder courses.

Expected utility (V) is given by

$$V = p(q,c)U(c,tastes) + (1 - p(q,c))U_0(q) \quad \textbf{(6)}$$

Lack of success implies a utility level of $U_0(q)$. The idea here is that the no success utility may be increasing in q with $\frac{d(U_0)}{dq} \geq 0$. A person with top A-levels who is not successful (and Table 1 shows some of these exist) is probably better off with more options than someone with a set of much poorer qualifications who is also unsuccessful. However, this assumption is not critical to the analysis.

The individual with a given q and a set of tastes , which are both known information to the applicant, will choose a course (i.e. a value of c) to maximise V. This will satisfy:

$$\frac{dV}{dc} = p_c(U - U_0) + pU' = 0 \quad \textbf{(7)}$$

The second-order condition requires that:

$$\frac{d^2V}{dc^2} = p_{cc}(U - U_0) + 2p_cU' + pU'' = G < 0 \quad \textbf{(8)}$$

Notice that this condition does not require the assumption of risk aversion, nor is $p_{cc} < 0$ a requirement. Equations (7) and (8) can be used to establish that:

$$\frac{dc}{dq} = \frac{-p_q U' + p_c U_0'}{G} > 0 \qquad \textbf{(9)}$$

where it has been assumed that $p_{qc} = 0$ – there seems no overwhelming reason that this cross-partial should exert any influence. This then establishes the common-sense result (for which the empirical evidence is overwhelming – see the next section) that people with higher q apply courses with higher entrance standards.

However, the key question is how high q people trade-off the desire for a better course against the fact that this might mean a lower probability of acceptance. The commonsense view would be that individuals do a bit of both. Thus if an applicant has a high innate q he or she will opt for a higher c but not choose c to be so high that it lessens the probability of acceptance. However, it should also be commonsense that some individuals might not behave in this typical way and the model should not be so restrictive as to rule out idiosyncratic behaviour.

Equation (5) is the starting point. The relationship between the acceptance probability and q is composed of a direct part p_q which is > 0. The second part is the indirect influence of q through the fact that it alters the choice of c. This indirect effect works in the opposite direction (paradoxically if $\frac{dc}{dq}$ had a perverse sign, then higher q would unambiguously be associated with a higher probability of acceptance). So which effect is likely to dominate, the direct or the indirect? It can be seen that:

$$\frac{dp}{dq} = \frac{\overset{-}{p_q p_c U'} + \overset{\pm}{p_q p_{cc}(U - U_0)} + \overset{\pm}{p_q p(q,c)U''} + \overset{+}{p_c{}^2 U_0'}}{G} \qquad (10)$$

where the possible signs of the four terms on the numerator are indicated above each term. An overall positive effect requires the numerator to be negative. It is not possible to sign eq.(10) unambiguously – so the formal analysis does not rule out the possibility that some among the more able seek out courses, which offer a lower acceptance probability. Not surprisingly, risk aversion ($U'' < 0$) would make $\frac{dp}{dq} > 0$ a more likely outcome.

The sign of p_{cc} is ambiguous, but the following consideration suggests that this reinforces risk averse behaviour. Think of the density function of z_i in eq.(1). This would be unimodal with a peak value at q. With $c < q$, then $p_{cc} < 0$ and when c > q then $p_{cc} > 0$. With $c < q$, the probability of acceptance is greater than 50%. Given that the overall acceptance rate far exceeds 50%, the typical applicant appears to set $c < q$.

The final term works against $\frac{dp}{dq} > 0$. It reflects the fact that higher ability people face a lower failure penalty, which would encourage the choice of more difficult courses. So the theory does not always rule out that some high ability applicants will have a lower probability of acceptance because of unusual preferences. Empirical evidence, however, supports the idea that $\frac{dp}{dq}$ is positive for the typical applicant. A 26-30 point range in A-levels is a better score than 21-25 points and so on. Table 1 shows that the acceptance proportion is monotonically increasing in the A-level point score, which supports the idea

that $\frac{dp}{dq} > 0$ for the typical applicant. Other self-contained qualification groupings (Highers and GNVQs) also behave in the same way. Consequently, $\frac{dp}{dq} > 0$ is the most realistic behavioural assumption for the majority of applicants.

So, if the joint distribution of grades and the probability of acceptance across the whole population of applicants is considered in the light of the individual behavioural predictions of the model, looking at eq.(2) it can see that there is a positive association between *E(z)* and *q*, which is positively associated with *p*.[13] The joint distribution of expected grades of all applicants and acceptance probabilities can be described by:

$$\frac{dE(z) \mid p}{dp} > 0 \qquad \textbf{(11)}$$

However, the concern is the expected probability of acceptance for any given z. Equation (11) says that a high z means a higher q is more likely, which in turn means a higher probability of acceptance. Hence eq.(11) can be re-expressed as:

$$\frac{dE(p) \mid z}{dz} > 0 \qquad \textbf{(12)}$$

Given that there is comprehensive data over a five year period, then to a very good approximation *E(p)* can be measured by the sample proportion of those successful for any given *z* value.[14] The sample proportion acceptance rate for particular qualifications will be used as the indirect measure of *z*.

[13] Qualification data refer to all applicants, not just successful applicants. However, it is easily seen from eq. (3) that E(z) for successful applicants will also be positively associated with q, given that c and q are positively correlated.

Each subject group (of which there are 170) is composed of many different courses across many institutions, each of which has its own entrance standard *c*. Each subject will typically have a range of qualifications associated with its successful applicants. Recall also eq.(3), which shows that even if there was a common entrance standard across each subject, there would be a distribution of *realized* grades across each subject based on the truncated distribution.

The quality measure is the weighted average of the qualification success rates. Thus the quality measure for the *j*th subject is:

$$Z_j = \sum_{i=1}^{19} \alpha_i \bar{p}_i \qquad \textbf{(13)}$$

where α_i is the relevant proportion among the 19 possible qualifications and $\bar{p}_i$ is the proportion who successfully gain an acceptance with the *i*th qualification level. In effect, this weighting scheme assumes that there is a linear relationship between *E(p)* and z in eq.(12).

The model has not captured all the complex institutional detail. This is a one-shot experiment, whereas the UCAS system allows for several chances. (see fig.(1) once more). However, it does capture the essential elements of the process. With two chances, the first part of eq.(6) now has two parts, where the applicant must choose a c_1 and a c_2. Intuition would suggest that c_1 would be set somewhat higher than c and c_2 (the insurance choice) would be pitched somewhat below c. This is what the model predicts and can be demonstrated as follows. With two chances V is modified to:

[14] Actually a slightly more sophisticated empirical measure can also be used, but this turns out to be fairly close to the sample proportions.

$$V = p(c_1,q)U(c_1) + [h(c_2,q) - p(c_1,q)]U(c_2) + (1 - h(c_2,q))U_0(q) \quad \textbf{(14)}$$

Think of c_1 as the higher tariff choice and c_2 ($c_1 \geq c_2$) as the lower tariff (insurance choice) and where h is the probability that the realized grade is $\geq c_2$. Hence $[h(c_2,q) - p(c_1,q)]$ is the probability that the second choice outcome occurs. The applicant chooses a c_1 and a c_2 to maximise V. The signs on h are exactly the same as in the single choice problem.

With two choices, one option is to choose two courses of equal difficulty, in which case $h(c_2,q) - p(c_1,q)$ now becomes zero, and the original problem shown by eq.(6) emerges once more. But it is clear that the applicant can do better than this. Keep c_2 at the original choice of c, when only one choice can be made. The overall probability of acceptance cannot decline. Now choose any c_1 above c. This is bound to offer a higher level of V since there is a finite probability that the realization of z will exceed c_1.

Pari Passu, a similar argument can be made about moves in the opposite direction. Keep c_1 at the original level c. Clearly, setting c_2 at any level below c must lead to an improvement in V. So it has been seen that at the margin with the addition of one extra choice, the applicant gains by raising c_1 above c and lowering c_2 below c. A wider choice means more optimistic bidding at the upper end (c_1) and insurance behaviour at the lower end (c_2). Once more this result does not depend on risk aversion.

In terms of establishing a relationship equivalent to eq.(10), the key probability is h. What matters is if either c_1 or c_2 occurs, not which. Consequently, substitute h for p in eq.(5) and proceed as before. An equation similar to eq.(10) emerges, where once more the sign is ambiguous for all the same reasons as in the single choice problem. However,

for exactly the same reasons there is a strong presumption that the relationship is a positive one. In summary, the two choice case adds some interesting detail, but the fundamental issues are similar to the single subject choice model.

5 Ranking subjects

Table 2 gives the ranking using the measure described by eq.(13) for 21 broad based subject groups. For convenience the Z measure of quality has been scaled between one (highest possible value) and zero. A subject would be given a Z score of one if everyone had the top ranked qualification and zero if everyone had the bottom ranked qualification. The first column shows the ranking based on the average success rate of each qualification and the second column shows the ranking derived using an alternative method, which will be described shortly.

The next column shows the subject group, and the letters associated with these broad subject groups are helpful to track the finer subject classifications of Table 3. As an example one subject group in Table 3 is "NN Combinations". This refers to combination subjects within the "N Business and administrative studies" broad subject group. The first column after the subject group shows the qualification quality of those accepted onto degree level courses. The next column shows the applicant quality. The striking feature is the confirmation of the self-selection process at work as alluded to in Section 3. There is a strong association with acceptance quality. The correlation coefficient is 0.93. If applicants did not self-select, a much more equal distribution in the quality of applicants across subjects would be expected, but this does not happen. Some applicants will have known grades at the time of application and these would be expected to tailor their

applications accordingly. So some association between application quality and acceptance quality would be expected.

The next column shows the quality of HND acceptances (Medicine/Dentistry is not offered at HND level). It demonstrates the much lower quality of HND acceptances and confirms that the ranking method developed in Section 3 works in the expected way. The highest rank HND group lies below the lowest ranked degree subject.

The final column gives the application to acceptance ratio (recall that each applicant can make up to six applications, except Medicine which is restricted to four). This provides further indirect support for the self-selection that goes on among applicants. Suppose it was just a question of numbers. Subjects that attracted the largest numbers of applications would be expected to have the highest acceptance quality, as they could be the most selective in rejection. It is true that the top ranked subject group (Medicine/Dentistry) attracts the highest number of applications by far, but the correlation between acceptance quality and application/acceptance ratio is not particularly strong. This is 0.43, and when Medicine/Dentistry is excluded, this falls to 0.08. The large number of applications to Medicine allows it to have the largest improvement in the quality of acceptances, relative to applications, but it also has the highest applicant quality, despite the larger number of applications. So applicant quality is not a matter of numbers.

The logit method of ranking is shown in column 2 and offers a different method for ranking subject quality. It enables a finer method of isolating the effect of qualifications on acceptances. It may be that particular qualifications are correlated with certain other

characteristics, which the simple proportions method does not take into account. For example, people who do well in examinations tend to come from `better' schools. So it may be that it is the school effect rather than the qualification that generates success and applicants from better schools but with less good qualifications have a corresponding better chance of success. To overcome this a logit model that estimates the probability of acceptance is fitted where the controlling characteristics include social class, ethnicity, school background and time effects in addition to qualifications. To isolate the qualification effect, the average probability of acceptance for each of the 19 qualification levels is calculated (this is just the sample proportions of acceptances in the case of a logit model). The next stage is to predict the average probability of acceptance on the assumption that the qualification had no impact on the chance of acceptance – in other words it is the other characteristics alone that determine the probability of acceptance rate. This value is then subtracted from the previous base run calculations, thus isolating the qualification effect.[15] These numbers (again scaled to lie between zero and one) are then used in place of $\bar{p}_i$ in eq.(13).

There is, as it turns out, little difference in the two methods. The correlation between columns 1 and 2 is 0.98. What this demonstrates is that the admissions procedure to HE in the UK is a merit based system, where qualifications, not other characteristics, are the key determinant of success. The logit model isolates the pure qualification effect from other characteristics, but other characteristics do not in fact exert much influence relative to qualifications.

[15] The logit results are not reported, but can be viewed at www.mmu.ac.uk/h-ss/eco/ppdl.htm

A further confirmation that the ranking method measures quality is to track degree results. People with better qualifications ought to achieve better results in their final degrees. This quality effect is present, but the issue is complicated by subject specific `custom and practice' in the awarding of degrees. The UK system ranks degrees according to the following five-point scale – first; upper second; lower second; third; pass; fail. By convention a `good degree' is regarded as achieving an upper second or first class honours. Tables 2 and 3 have established that subjects definitely vary by the quality of their intake, so one might expect that subjects with better qualified entrants would reveal more people with good degrees. In fact this turns out not to be the case.[16] There is a fairly wide variation in the proportion that achieve good degrees in particular subjects but this is not associated with the underlying quality of entrants. So individual subjects tend to set their own benchmarks as to what constitutes a good degree. What turns out to be the case is that within subject groups there is an association between the quality of entrants and the class of degree obtained. This supports the view that admissions officers are reasonable discriminators of quality.

So much then for the general issues raised by Table 2. The final row shows the overall average scores, thus subject groups ranked below 9 are the under-performers. Combined sciences has an above average applicant quality, but below average acceptance quality, possibly a consequence of the small application to acceptance ratio. The general pattern revealed at the broad subject level is somewhat reassuring in that it is not dominated by either Arts or Sciences – contrary to a certain `folk wisdom' that the young are less interested in Science based subjects. Leslie (2001), however, has shown that there different patterns across the ethnic communities in this respect. The ethnic communities,

[16] See Leslie (2001) for a full discussion.

who comprise around 15% of entrants to HE, are more strongly attracted to non- Arts based subjects such as Medicine, Business Studies and Mathematics.

Education emerges with a low score; it is perhaps disappointing that those entrusted with the production of new human capital should be relatively poorly endowed relative to other participants in HE. However, this excludes PGCE students, which are those who undertake a teaching qualification after an undergraduate degree. Finally, note that the `No preferred subject group' attracts the lowest qualified applicants. This result makes good sense. It can be imagined that the least able will have the least commitment to HE and are unable to formulate a clear view as to a subject choice.

Table 3 provides more detail for 170 separate subject groups.[17] Among the general points to emerge are

- Single subject and combination degrees seem to attract roughly the same quality of student, contrary to the view that single subject degrees are more popular choices. The average rank for combination subjects (30 groups are distinguished overall) is 83.7. This is good news for universities such as Keele and Sussex who espouse a philosophy of the combination approach. However, there is an uneven performance among the combination subjects. `Language Combinations' is ranked 14. Physical Science alongside Mathematics and Social Science combinations also do well.
- By contrast, specific subject choices attract the more able applicant within the various subject groups. General Engineering ranks 148, whereas Chemical

[17] Note that some subjects, notably Archaeology, Geography and Psychology appear twice depending on whether the degree is Arts or Science orientated.

Engineering ranks 16. In many subject groups it is the `Other' non-specific categories that attract the least able students.

- Medicine, Dentistry and Veterinary Science attract some of the most able students. These might be broadly described as part of the `caring for' professions. Other similar subjects fare less well – the low performance of Education has already been noted. Nursing is ranked 157 and Social Work is the lowest ranked of all subjects. Unlike these other professions, Social Work is not regarded as a particularly prestigious job.
- Within the broad subject groups, it is pure subjects rather than the applied subjects that emerge best. For example, Physics ranks 12, whereas Environmental Sciences ranks 115. Mathematics ranks 8, whereas Computer Science ranks 129 and so on.
- Contrary to conventional wisdom that Law attracts some of the most able students, its ranking is 45. Economics (within the same broad subject group) ranks 22 and Sociology manages only a lowly 122. Economics attracts far more able students compared with Business Studies. The highest ranked among that group is Financial Management at 68.

6 Concluding comments

UCAS splits applicants into 170 separate subject groups. By exploring the qualifications of applicants and acceptances, these subject groups were ranked according to the quality of qualifications. The method was based on an expected utility maximisation model, whereby applicants self-select into various course options. Better students will choose courses with higher entrance standards, and this was combined with the behavioural assumption that better students will additionally seek courses with a higher probability of

acceptance. From this it followed that qualifications could be ranked according to the proportion accepted into HE. The ranking method gave plausible results, with applicants having a lower quality than acceptances, and non-degree level HE courses a much lower rank than degree level courses.

So what are the overall lessons from this ranking exercise? What emerges most strongly is diversity. Good students appear to spread themselves a wide range of subjects, with no obvious bias towards the Arts or Sciences. Perhaps, in the final analysis, this diversity is symptomatic of the generally robust health of the British Higher Education system.

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Table 1

Qualifications among applicants (1996-2000)

Qualification	% of applicants with this qualification	% accepted with this qualification
0 to 5 A level pts	1.1	66.0
10 to 6 A level pts	9.2	74.7
15 to 11 A level pts	9.1	81.9
20 to 16 A level pts	14.1	87.0
25 to 21 A level pts	8.9	89.6
30 to 26 A level pts	12.3	91.5
3 or fewer Highers	1.2	48.7
4 Highers	1.1	79.2
5 Highers	1.5	88.1
6 or more Highers	1.6	94.4
Access/Foundation	6.3	67.8
BTEC/SCOTVEC	9.9	67.5
Baccalaureate	0.3	74.1
Deg/Partial Degree	1.4	53.0
GNVQ Pass	3.8	53.4
GNVQ Merit	2.5	78.4
GNVQ Distinction	1.7	83.6
Other Qualification	7.6	53.5
None	6.5	70.6
All Qualifications	100	76.7

Table 2

Ranking of broad subject groups

Rank	Logit Rank	Broad Subject Group	Degree Acceptance Quality	Applicant Quality	HND (sub degree) Quality	Total number of Applicants	Applications to acceptances ratio (degrees)
1	1	A Medicine/Dentistry	0.868	0.778	n/a	53816	9.33
2	2	Q/R/T Languages and related disciplines	0.786	0.772	0.542	96040	6.13
3	3	V Humanities	0.759	0.747	0.452	56115	5.69
4	4	F Physical sciences	0.755	0.736	0.320	68486	5.44
5	5	C Biological sciences	0.749	0.695	0.298	100931	6.67
6	6	Y Social studies combined with arts	0.722	0.696	0.383	33459	6.42
7	8	Y Combined social studies	0.714	0.692	0.305	7033	6.43
8	7	Y Combined arts	0.711	0.717	0.422	30329	5.91
9	9	L/M Social studies	0.705	0.662	0.348	202682	6.16
10	10	D Agriculture and related subjects	0.676	0.603	0.383	22080	6.37
11	11	H/J Engineering and technology	0.669	0.625	0.364	88495	5.27
12	15	Y Combined sciences	0.664	0.648	0.359	11204	4.23
13	12	N Business and administrative studies	0.662	0.572	0.374	225521	6.68
14	14	B Subjects allied to medicine	0.661	0.577	0.354	145197	7.59
15	13	G Mathematical sciences and informatics	0.658	0.573	0.347	128515	5.63
16	16	Y Science combined with social studies or arts	0.641	0.606	0.376	29060	5.59
17	18	K Architecture, building and planning	0.637	0.587	0.309	26747	5.06
18	17	P Mass communications and documentation	0.635	0.576	0.400	49936	7.07
19	20	X Education	0.618	0.535	0.369	111924	7.73
20	19	W Creative arts	0.616	0.567	0.441	185580	6.09
21	21	Z Other general and combined studies	0.598	0.521	0.416	16651	4.08
		No preferred subject group (applicants only)	n/a	0.516	n/a	240781	n/a
		OVERALL SCORES	0.687	0.614	0.374	1930582	6.21

Table 3

Ranking of all subject groups (degree level)

Rank	Logit Rank	Subject	Degree Accept Quality	Application Quality	Numbers accepted
1	2	A2 Pre-clinical dentistry	0.880	0.772	4039
2	1	Q8 Classics	0.868	0.856	3481
3	5	A1 Pre-clinical medicine	0.865	0.779	23831
4	3	Q9 Other ancient languages	0.856	0.512	161
5	4	T9 Other or unspecified modern languages	0.853	0.810	4729
6	6	Q6 Latin	0.842	0.784	74
7	12	D1 Veterinary science	0.840	0.803	2645
8	7	G1 Mathematics	0.827	0.822	19196
9	13	C4 Genetics	0.823	0.761	2244
10	14	B3 Pharmacy	0.823	0.692	8071
11	8	L8 Geography (see also F8)	0.816	0.811	13248
12	16	F3 Physics	0.813	0.811	13481
13	9	R1 French	0.812	0.781	4210
14	10	QRT Combinations	0.812	0.813	19178
15	17	C7 Biochemistry	0.806	0.766	8541
16	28	H8 Chemical engineering	0.804	0.788	4320
17	11	R5 Portuguese	0.802	0.445	6
18	15	V3 Economic and social history	0.800	0.791	1201
19	18	F8 Geography (see also L8)	0.798	0.775	12131
20	20	R2 German	0.796	0.769	1519
21	29	Y1- Combs of groups F and G	0.795	0.807	2411
22	19	L1 Economics	0.794	0.777	18998
23	21	R4 Spanish	0.792	0.766	1188
24	22	V1 History	0.788	0.779	27863
25	23	V5 History and philosophy of science	0.786	0.658	106
26	32	B5 Ophthalmics/Audiology	0.782	0.652	3233
27	27	V7 Philosophy	0.778	0.755	4728
28	25	Q3 English	0.776	0.767	35315
29	24	J2 Metallurgy	0.775	0.576	117
30	26	Q4 American studies	0.774	0.752	3814
31	34	F1 Chemistry	0.768	0.746	18087
32	37	Y Combs of groups L/M or N and Q/R/T	0.767	0.754	14943
33	30	T3 Chinese	0.766	0.748	392
34	40	C3 Zoology	0.764	0.707	4453
35	35	Y3- Combs of groups Q/R/T and P,V,W or X	0.760	0.759	22423
36	36	F6 Geology	0.757	0.731	6856
37	31	F7 Oceanography	0.756	0.668	837
38	33	G4 Statistics	0.756	0.722	1174
39	48	F5 Astronomy	0.754	0.669	873
40	38	R3 Italian	0.753	0.702	547
41	47	FF Combinations	0.752	0.715	2780
42	43	H4 Aeronautical engineering	0.751	0.695	5353

43	42	T4 Japanese	0.749	0.693	382
44	39	M1 Politics	0.748	0.747	12196
45	44	M3 Law	0.748	0.698	52552
46	41	C8 Psychology (see also L7)	0.747	0.691	30909
47	46	C5 Microbiology	0.745	0.692	2273
48	45	VV Combinations	0.743	0.730	3686
49	53	B1 Anatomy/Physiology	0.743	0.704	5884
50	49	D8 Agricultural sciences	0.738	0.353	214
51	50	C1 Biology	0.737	0.687	24260
52	51	P6 Journalism	0.735	0.637	3041
53	58	K1 Architecture	0.731	0.690	8350
54	52	V4 History of art	0.729	0.740	4378
55	59	Y2- Combs of groups L/M and N	0.724	0.702	12687
56	64	CC Combinations	0.723	0.665	2406
57	54	Q1 Linguistics	0.721	0.708	1775
58	57	Q5 Celtic languages	0.719	0.680	758
59	61	C6 Molecular Biology/Biophysics	0.718	0.707	779
60	56	T2 Other European languages	0.718	0.712	3460
61	67	H3 Mechanical engineering	0.716	0.671	16486
62	55	F2 Materials science	0.713	0.582	75
63	65	V6 Archaeology (see also F4)	0.709	0.694	2886
64	70	H2 Civil engineering	0.709	0.646	9207
65	60	L6 Anthropology	0.708	0.715	3606
66	62	F4 Archaeology (see also V6)	0.707	0.553	1535
67	66	LM Combinations	0.707	0.701	18372
68	63	N3 Financial management	0.706	0.644	4045
69	68	R8 Russian	0.704	0.689	382
70	73	Y1- Combs of groups B,C and D	0.700	0.607	4826
71	69	Y Combs of groups L/M or N and P,V,W or X	0.697	0.673	26662
72	78	Y1- Combs of groups B,C,D,F or G and H/J or K	0.695	0.618	5478
73	77	NN Combinations	0.693	0.577	8127
74	79	GG Combinations	0.693	0.727	7413
75	72	P3 Communication studies	0.693	0.662	8103
76	81	H5 Electrical engineering	0.690	0.546	562
77	71	G8 Artificial intelligence (see also C8 and H6)	0.689	0.668	579
78	87	B2 Pharmacology	0.683	0.611	3430
79	74	T7 African languages	0.683	0.562	115
80	76	W3 Music	0.681	0.613	14297
81	86	N4 Accountancy	0.681	0.624	21143
82	75	J5 Other materials technology	0.681	0.659	1333
83	80	J8 Biotechnology	0.676	0.620	551
84	82	C2 Botany	0.674	0.631	238
85	84	N1 Business management	0.672	0.577	78249
86	83	Y2 Combined Social Studies	0.667	0.569	2618
87	96	K4 Town and country planning	0.667	0.651	4617
88	85	Y3- Combs of groups P,V,W and X	0.665	0.602	5874
89	93	H7 Production and/or Manufacturing engineering	0.665	0.636	6067
90	89	Y1- Combs of groups B,C or D and F or G	0.664	0.666	5458
91	92	V8 Theology and religious studies	0.661	0.645	6207
92	97	Y Combs of groups F or G and L/M or N	0.661	0.662	14496
93	99	BB Combinations	0.659	0.560	2727
94	88	X4 Junior only (upper primary)	0.654	0.574	4688
95	90	W4 Drama	0.653	0.585	17875
96	91	Q2 Comparative literature	0.652	0.546	1033

97	95	B6 Sports Science	0.652	0.580	16704
98	106	C9 Other biological sciences	0.652	0.602	2586
99	94	X6 Junior/middle (upper primary and middle)	0.649	0.450	1059
100	103	L7 Psychology (see also C8)	0.649	0.572	10305
101	98	N5 Marketing and market research	0.647	0.602	10168
102	117	HJ Combinations	0.647	0.580	9363
103	101	R6 Latin American studies	0.646	0.613	265
104	102	KK Combinations	0.645	0.432	424
105	115	B4 Nutrition	0.644	0.576	2073
106	100	X8 Physical education	0.641	0.521	4800
107	104	Y Combs of groups F or G with P,Q/R/T,V,W or X	0.639	0.637	6907
108	105	N2 Operational research	0.635	0.570	254
109	111	D2 Agriculture	0.634	0.508	7141
110	116	Y Combs of groups B,C,D,H/J or K and L/M or N	0.632	0.572	17910
111	123	B9 Other subjects related to medicine-based sciences	0.632	0.573	31138
112	110	Y Combs of groups B,C,D or H/J or K with P,Q/R/T,V,W or X	0.631	0.584	11576
113	113	K9 Other architectural studies	0.631	0.606	7
114	127	K3 Environmental technologies	0.630	0.586	1163
115	109	F9 Environmental and other physical sciences	0.630	0.603	11591
116	108	XX Combinations	0.630	0.550	23782
117	130	J6 Maritime technology	0.630	0.580	1046
118	122	B8 Radiography	0.630	0.536	4033
119	128	X5 Primary all ages (upper and lower primary)	0.628	0.537	18040
120	114	L3 Sociology	0.627	0.601	24788
121	121	T6 Modern Middle-Eastern languages	0.625	0.563	367
122	119	PP Combinations	0.624	0.575	3330
123	107	X2 Nursery and infants (nursery and lower primary)	0.623	0.515	3540
124	118	D4 Food science	0.623	0.550	1611
125	131	J9 Other engineering and technologies	0.623	0.540	1489
126	112	W5 Cinematics	0.620	0.553	8559
127	125	Y3 Combined Arts	0.618	0.538	8673
128	126	P4 Media studies	0.616	0.574	9593
129	129	G5 Computer science	0.615	0.522	58271
130	139	V9 Other humanities	0.615	0.493	131
131	132	H6 Electronic engineering	0.612	0.562	12528
132	120	W1 Fine arts	0.609	0.597	14566
133	124	X3 Infants only (lower primary)	0.609	0.513	4595
134	143	Y1 Combined Sciences	0.608	0.573	11806
135	134	R7 Scandinavian languages	0.608	0.587	166
136	137	N8 Land and property management	0.605	0.601	3081
137	133	M9 Other social sciences	0.605	0.541	1589
138	144	Y4,Y6; Combs of group A with anything; H/J with K	0.601	0.526	37892
139	138	P2 Information science	0.599	0.509	1382
140	142	J4 Polymers and textiles	0.597	0.496	2407
141	141	T5 Asian languages	0.596	0.535	198
142	140	WW Combinations	0.593	0.536	4969
143	135	N6 Industrial relations	0.592	0.482	902
144	136	W2 Design studies	0.589	0.547	42246
145	149	Q7 Classical Greek	0.588	0.479	8
146	145	G9 Other mathematical and informatics sciences	0.587	0.492	713
147	151	T1 Slavonic and East-European languages	0.585	0.494	145
148	156	H1 General engineering	0.580	0.518	10387
149	150	G7 Software engineering	0.580	0.491	8683
150	155	D9 Other agricultural subjects	0.579	0.404	142

151	147	J1 Minerals technology	0.579	0.482	467
152	153	N9 Other business and administrative studies	0.578	0.529	2148
153	148	L4 Social policy and administration	0.578	0.545	6474
154	146	W6 Craft	0.578	0.509	1317
155	152	N7 Institutional management	0.577	0.460	12903
156	157	B7 Nursing	0.576	0.485	12033
157	161	D3 Forestry	0.574	0.509	452
158	165	DD Combinations	0.570	0.432	81
159	154	P7 Tourism	0.566	0.482	6790
160	166	P5 Publishing	0.563	0.485	492
161	158	W9 Other creative arts	0.556	0.500	3407
162	160	X7 Secondary	0.550	0.457	2972
163	159	W8 Creative therapies	0.550	0.386	256
164	164	K2 Building/Construction	0.547	0.480	10222
165	162	Z unknown other general and combined studies	0.542	0.452	1985
166	163	G6 Computer systems engineering	0.538	0.468	3919
167	167	X9 Other topics in education	0.528	0.426	5944
168	168	J3 Ceramics and glass	0.494	0.360	27
169	169	P1 Librarianship	0.488	0.396	57
170	170	L5 Social work	0.433	0.396	9310

Figure 1

How UCAS works