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Entrance Quotas and Admission to Medical Schools: A Sequential Probit Model*

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Résumé / Abstract

In this paper, we use a data set on admissions and enrolments for entry into the medical school of the Université de Montréal to test the hypothesis that the admission process is meritocratic and free from discrimination and arbitrary decisions. The paper analyses the difficulty of choosing among different categories of applicants in the context of entrance quotas pertaining to the level of higher education (college, university) from which one applies to medical school. We use a sequential probit model to show that the performance variables, as ,measured or observed by the admissions committee through a variety of tests, only partially explain the committee's decisions. The school did not admit all the best in terms of performance, and among the best admitted, almost one out of three did not enrol. We explore some socioeconomic determinants of admissions and enrolments, and suggest an alternative approach to the admissions procedure.

Dans ce texte, nous utilisons les données sur les admissions ;a la Faculté de médecine de l'Université de Montréal pour tester l'hypothèse que les procédures d'admission sont basées sur le mérite et exemptes de décisions discriminatoires ou arbitraires. Cette étude analyse les difficultés à choisir parmi différentes catégories de candidats dans le contexte où des quotas ;a l'entrée, selon la catégorie d'étudiants (collégial, universitaire et autres), s'appliquent ;a la Faculté de médecine. Nous utilisons un modèle probit séquentiel pour montrer que les variables de performance académique individuelle, telles qu'observées et mesurées par le Comité d'admission via une batterie de tests, expliquent partiellement les décisions du Comité. Par ailleurs, il demeure que la Faculté de médecine n'admet pas nécessairement les plus performants. Et parmi les meilleurs admis, un étudiant sur trois décide de ne pas accepter l'offre de l'Université. Nous proposons une approche alternative à la procédure d'admission retenue par l'Université.

Key words: sequential probit model, medical schools, entrance quotas.

Mots-clés : probit séquentiel, Faculté de médecine, quotas à l'entrée.

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1. INTRODUCTION

The most remunerative professions require that entrants secure a specialized education. Typically, the demand for this specialized education exceeds the supply because only a certain proportion of the population has the ability, either innate or acquired, to meet the exact training and performance requirements of the profession. In many cases, the corporate bodies that govern the medical profession restrict entry into medical schools. Such a restrictive practice guarantees a superior quality of medical services to the general public and a high rate of return to a medical degree [see Brown (1989) on the determinants of physician incomes]. The allocation of the scarce educational slots therefore requires an admissions process that selects applicants on the basis of capability to acquire professional qualifications. An efficient admissions process should allocate educational slots only on the basis of attributes of applicants that do not affect their capability to be trained and, ultimately, to perform in the profession of their choice.

In this paper, we use a data set on acceptances and rejections for entry into the medical school of the Université de Montréal to test the hypothesis that the admissions process is meritocratic. The alternative hypotheses are that the admissions process discriminates on the basis of non-meritocratic attributes of the applicants or that it manifests subjective valuations by the members of the admissions committee that we can only interpret as arbitrary. A priori, one would hope that the admissions process to medical schools would not rely on arbitrary decisions because of the specialized training required and the importance of achieving eminent standards of job performance. We would also hope that the admissions process will be free of decisions that can be construed as discriminatory. Medical schools are highly selective in admitting students, and scrutinize applications carefully and according to well-established and closely monitored procedures. As noted in Chiplin (1981), the existence of a clear-cut set of admissions procedures and guidelines permits the identification of the hedonic offer curve of decision-makers on the admissions committee to determine whether there is any evidence of discrimination or arbitrary decisions.

For example, we can conclude that discrimination exists if, for the same qualifications, the admissions committee systematically accepts men rather than women.[1] Evidence of arbitrary decisions is somewhat more difficult to evaluate. An arbitrary decision does not need to be negative with respect to the selection of the "best" students to attend medical school. Socioeconomic variables, such as income or parent's education, might represent another dimension of the meritocratic component of the

[1] Cole (1986) has analyzed this particular issue of sex discrimination in admission to medical schools in the U.S. He concluded that as far back as 1929, the low representation of women in medicine was primarly a result of differences in socialization-based occupational choice, not discrimination.

admissions process not entirely captured by objective tests. Arbitrary decisions, however, lack the transparency of objective tests and may be prejudicial to specific types of students.

The admissions procedures employed at the Université de Montréal are similar to those employed at other Canadian or American medical schools with some variants, particulary with respect to the interview component which is not used by all medical schools. Medical schools specify their conditions for the selection and admission of applicants in their student guide. They also inform the various category of applicants of their probability of being accepted. These admissions criteria are tested in this paper with a formal statistical model and by the means of additional descriptive statistics. What all medical schools share is the difficulty of having to choose among different categories of applicants and to evaluate the "merits" of one type of applicant with respect to the others. A comparison among the various categories is not a trivial issue whenever entrance quotas are present. The common entrance quota maintained by medical schools, at least in Canada, is to admit a variety of applicants including college students, students with or without university degrees. The purpose of these quotas is to encourage especially bright students to enter medical school early, while at the same time ensuring that not too many "immature" candidates populate any particular medical class. The increasing diversity in the ethnic, socioeconomic, and educational backgrounds of applicants poses a major challenge for admissions committees in all disciplines with entrance quotas.[2] Final enrollment results from a process of mutual selection.[3] Admitting the best does not necessarily mean enrolling the best. This dimension of a mutual selection process must also be considered as a part of the admissions process.

The data consist of 1,647 applicants[4] to medical school for the fall of 1987. We have broken down these applicants into three categories : the college students,[5] the university students without a degree and the university students with a first degree.

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[2] This discussion also sheds light on the inevitable trade-offs between affirmative action programs and a meritocratic basis of selection process. Interestingly, in the U.S., the Bakke decision has generally been interpreted as meaning that medical (and law) schools cannot use quotas but can practice affirmative action, i.e., could use race as a positive factor in admissions decisions. Gruhl and Welch (1990) have shown that the Bakke decision had relatively little impact on black and hispanic enrollments.

[3] See Kohn, Manski and Mundel (1976).

[4] Initially, there were 1,993 new applicants. The other applicant categories have missing values on some key variables (mainly for applicants outside Québec) and represent a very heterogenous group that is mostly treated case by case by the admissions committee. Those excluded represent about 14 % of the enrollment at the medical school.

[5] In Québec, students go to "college" after having completed high school and before beginning university.

Of these applicants, 13 % gained admission[6] and of those admitted, 72 % enrolled. Information was collected on the sex, age, native language and citizenship of respondents as well as on their results on a series of scholastic aptitude and admissions tests.

We have no direct measure of the socioeconomic status of the applicants. Note, however, that the admissions office of the Université de Montréal medical school did not have this information either. Socioeconomic status could therefore not have been used directly as a criterion for admission. We nevertheless attempt to include a measure for socioeconomic status by using aggregate statistics on employment, education, income and family structure derived from the socioeconomic characteristics of the applicant's current address.[7]

The analysis of the determinants of admission to medical school using this data set enables us to test not only whether the admissions process is free from discrimination and arbitrary decisions, but also whether the extensive testing that the medical school does as part of the admissions process is necessary as a supplement to the already-available information on the prior academic performance of the applicants at college or university.

The paper is organized as follows. Section 2 presents the data and descriptive statistics. Section 3 offers a descriptive overview of the decision model. Section 4 proposes a formal statistical model and section 5 discusses the empirical results. Section 6 provides the final remarks.

2. THE DATA AND DESCRIPTIVE STATISTICS

Table 1 presents the symbol and definition of the variables used in the study. Gender (GENDER), age (AGE), citizenship (CITIZEN) and mother tongue (MTONGUE) are personal characteristics of the applicants. Next, we have a series of test scores and

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[6] Over the 1978-1979, 1989-1990 periods, the admission rates of all Canadian faculties of medicine have ranged from 21 % to 25 %. Québec and Ontario faculties of medicine have generally shown admission rates lower than 10 %. See the *Canadian Medical Education Statistics* published by the Association of Canadian Medical Colleges, 1990, Vol. 12, for more details.

[7] We constrained our sample to the applicants living in Québec. There are 93 % of the applicants who resided in Québec at the time of their applications to medical school.

variables related to the quality of the applicant. ZGLB is the global Z-score, a linear combination of the Z-score at college and university levels.[8,9]

Under the Québec education system, "colleges" are institutions between high schools and universities. SCT is the score of the applicant who was asked by the medical school authority to take an entrance examination consisting of psychometrical tests. In our sample, only 888 applicants were invited to take the entrance examination. Of these, 418 were interviewed and a SCI score was given to each one. All these scores were transformed on a 20 to 80 scale. SCGLB is a weighted global score for these last 418 candidates.[10]

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[8] Z-score = (X - M)/S, where X is the student's grade at college (university); M is the grade average of students having taken the same course, the same term, in the same group, in the same college (university); S is the standard deviation. Once the Z-score for each course has been computed, the average of all Z-scores for one student is determined.

[9] If the applicant has more than 50 university credits, only the university Z-score is applied.

[10] SCGLB = 4*ZGLB + 2*SCT + 4*SCI. These weights are used by the admissions committee.

TABLE 1
The Determinants of Medical School Admission :
Symbol and Variable Definition

Symbol	Variable Definition
Variables :	
Personal characteristics	
GENDER	Gender of applicant : 1 if male, 0 if female
AGE	Age of applicant
MTONGUE	Mother tongue of applicant : 1 if mother tongue is French, 0 otherwise
COLL	Academic status : collegian = 1, 0 otherwise
UNIV	Academic status : university student without a degree = 1, 0 otherwise
UNIVD	Academic status : university student with a 1st degree = 1, 0 otherwise
ZGLB	Global Z-score of applicant*
SCT	Score of entrance test*
SCI	Score at interview*
SCGLB	Global score of applicant**
Socioeconomic variables : (at the local census level)	
MACP	Mean number of people in active population 15 years and over in each zip code area
UNEMR	Unemployment rate
PMHS	Percentage of working men in the health sector
PWHS	Percentage of working women in the health sector
PMLSCH	Percentage of men with less than nine years of schooling
PWLSCH	Percentage of women with less than nine years of schooling
PMASCH	Percentage of men with more than nine years of schooling but with no university degree
PWASCH	Percentage of women with more than nine years of schooling but with no university degree
PMUD	Percentage of men with a university degree
PWUD	Percentage of women with a university degree
INCOME	Family mean income
MONO	Percentage of single parent family

* 20 to 80 scale.
** 200 to 800 scale.

The remaining variables refer to the applicant's socioeconomic environment. They are not drawn from individual data but from 1986 census data corresponding to the region of the applicant's zip code.[11] For each of these regions, MACP represents the mean number of people in the active population, 15 years of age and over, in each zip code area; UNEMR is the unemployment rate; PMHS and PWHS are respectively the percentage of men and women working in the health sector;[12] PMLSCH and PWLSCH are respectively the percentage of men and women with less than nine years of schooling; PMASCH and PWASCH are respectively the percentage of men and women with more than nine years of schooling, but with no university degree; PMUD and PWUD are respectively the percentage of men and women with a university degree; INCOME is the mean family income; MONO is the percentage of single-parent families.

Obviously, these measures of employment, education, income and family structure are only proxies for the applicant's actual socioeconomic position.[13] Implicitly, we are assuming that the applicant's socioeconomic status can be adequately represented by the mean status in terms of the dimensions described in the area in which he or she currently lives. This phenomenon has been referred by sociologists and economists as the "neighbourhood effects."[14]

Table 2 displays the mean and standard deviation of these variables for those who applied, those who were tested, those who were interviewed, those who were admitted and those who enrolled.

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[11] The first three characters of the area zip code represent a set of well-defined and stable regions for which socioeconomic data are available.

[12] Interestingly, Lentz and Laband (1989) found that in the U.S., "children of doctors are nearly 14 % more likely to be admitted into medical school than are comparable nonfollowers." (p. 396)

[13] For college students, the current address is likely to correspond to their home address. For the other applicants, we assume that their current address reflects their previous home neighbourhood.

[14] See for example, Borjas (1993) and references herein.

TABLE 2
The Determinants of Medical School Admission - Full Sample :
Mean and Standard Deviation

Variables	Applicants				
	Applied	Tested	Interviewed	Admitted	Enrolled
GENDER	0.4699	0.4685	0.4474	0.3923	0.4200
AGE	20.9745 (2.7741)	20.7714 (2.7730)	21.0718 (2.7115)	21.2153 (2.8312)	21.4267 (2.7862)
MTONGUE	0.8361	0.8468	0.8923	0.9043	0.8933
COLL	0.5015	0.5653	0.4617	0.4785	0.4133
UNIV	0.2034	0.1104	0.0981	0.0670	0.0867
UNIVD	0.2951	0.3243	0.4402	0.4545	0.5000
ZGLB	41.3224 (18.5170)	52.1745 (16.4468)	60.8756 (13.8966)	62.4880 (13.4301)	60.2533 (14.4595)
SCT	-	50.1408 (17.3594)	58.9330 (15.5125)	59.2392 (15.3754)	59.3533 (14.9958)
SCI	-	-	50.5335 (16.7740)	63.2488 (10.4032)	64.1133 (10.1238)
SCGLB	-	-	563.5024 (96.6241)	621.4258 (75.1008)	616.1733 (77.9853)
MACP	402.1075 (100.4166)	402.4336 (99.3693)	401.6459 (101.2487)	406.3589 (103.7809)	404.1667 (103.4704)
UNEMR	4.0475 (1.8105)	4.0633 (1.7961)	3.9571 (1.7076)	3.8901 (1.7290)	3.9486 (1.7888)
PMHS	2.9566 (1.6585)	3.0057 (1.7122)	3.0743 (1.8012)	3.2033 (1.8710)	3.2664 (1.8902)
PWHS	9.7402 (2.5541)	9.8807 (2.5684)	9.9376 (2.5355)	9.9569 (2.5222)	9.9681 (2.4205)
PMLSCH	18.8768 (8.2807)	18.6266 (8.1285)	18.1882 (8.0975)	17.6889 (8.0320)	17.6733 (7.7211)
PWLSCH	22.2478 (8.1990)	22.0851 (8.0568)	21.7088 (8.1061)	21.3852 (8.4383)	21.6845 (8.3938)
PMASCH	65.6654 (7.1746)	65.5823 (7.1667)	65.3323 (7.5853)	65.2105 (7.6485)	64.9317 (7.8826)
PWASCH	68.2580 (6.2648)	68.2289 (6.2075)	68.2510 (6.2806)	68.1605 (6.5508)	67.5198 (6.7690)
PMUD	15.4582 (11.0831)	15.7914 (11.2160)	16.4797 (11.8962)	17.1009 (11.9304)	17.3955 (11.9172)
PWUD	9.4938 (7.1662)	9.6856 (7.2222)	10.0396 (7.5934)	10.4530 (7.5635)	10.7942 (7.7265)
INCOME	37293.3789 (9799.4251)	37379.8266 (9890.1053)	37841.0144 (10640.5914)	38300.4115 (11022.9604)	38420.1733 (11705.0299)
MONO	15.6148 (4.4151)	15.7514 (4.4784)	15.8367 (4.6716)	16.1820 (4.8864)	16.6621 (5.0811)
Dependent variable		0.5392	0.4707	0.5000	0.7177
Sample size	1647	888	418	209	150

There were 47 % female applicants, but only 39 % of those were admitted. The mother tongue of 84 % of the applicants was French[15], but over 90 % of those were admitted. The average age of those chosen for testing was somewhat younger than that of those who applied, but at the interviewing stage, the average age was higher than

[15] This is typically the case for college students. Detailed descriptive statistics for each category of applicants is available upon request.

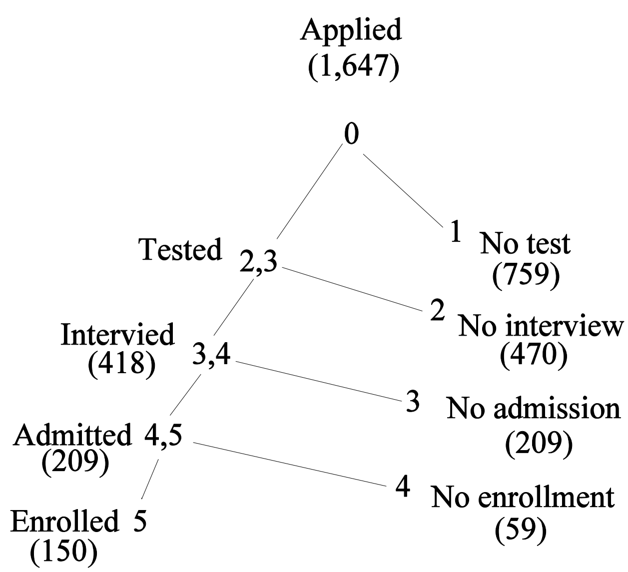
that of the applicants, and rose even higher at the admissions and enrollment stages. The mean Z-scores rose progressively over the stages from application to testing, to interviewing and to admission.

3. THE DECISION MODEL: A DESCRIPTIVE OVERVIEW

The decisions of the admissions committee are based, at least in principle, on the series of test scores discussed in the previous section that are related to the quality of the applicant.

The tree structure of Figure 1 illustrates the decision model that is used. Each node of the choice tree indicates a decision made by the admissions committee of the medical school for each applicant.

FIGURE 1
Admission and Enrollment Tree to Medical School



Starting at the top of the tree (applied) and moving toward the bottom (tested, interviewed, admitted), the members of the committee determined which branch each applicant would take. The first decision at node "0" is to allow an applicant to take a test or not. At node (2,3), the committee decides whether or not to interview the applicant. At node (3,4), the decision to admit an applicant is taken. Up to this point, the applicants who desisted prior to testing, interviewing and admissions are considered among those rejected by the committee.[16] At the final node (4,5), the applicant who has gained admission decides whether to enroll or not.

In Table 3, we calculate the continuation probabilities for our applicant categories - college students (COLL), university students (UNIV), university students with a first degree (UNIVD) - at the different decision nodes.

TABLE 3
Continuation Probabilities at Each Decision Node by Category of Applicants

Category of Applicant	Tested	Interviewed	Admitted	Enrolled
College students (COLL)	61 %	38 %	52 %	62 %
University students (UNIV)	29 %	42 %	34 %	93 %
Graduate university students (UNIVD)	59 %	64 %	52 %	79 %

Of particular interest is the fact that 61 % of the college applicants were invited to take the entrance examination; however, only 38 % of those tested were invited to the interview. For the university students, only 29 % were tested, but 42 % of those tested were interviewed. For the graduate university students, 64 % were interviewed, and 52 % of those were admitted. How do we explain some of these discrepancies of Table 3 among the different categories of applicants? As we indicated at the outset of this paper, a rule in many medical schools is to admit a given percentage of each of these categories.[17] A fundamental related question is : what category of applicant is most adversely affected by these quotas and why? Does the medical school follow its own stated rules?[18]

In Tables 4.1 to 4.3, we rank the candidates in *descending* order (college, university and graduate students) according to their global score at each of the decision nodes.

TABLE 4.1
Tests and Cessations by Categories of Students
and Their Global Score (ZGLB) Ranking

[16] Overall, less than 5 % have desisted. This percentage represents too few people to add a separate branch to each node of the model.

[17] This rule will be taken into account in our estimations using interaction variables.

[18] In the admissions guide, it is stated that the candidates are asked by medical school authorities to take an entrance exam according to their Z-score. It is also stated that based on a global score with weights 6*ZGLB+4*SCT, the candidates are invited to an interview. Finally, the committee decides to admit or not on the basis of global score of the applicant, SCGLB.

	Tested	Not Tested	Total
College students (COLL)			
Rank ≤ 502	480	22	502
Rank > 502	22	302	324
Total	**502**	**324**	**826**
University students (UNIV)			
Rank ≤ 98	92	6	98
Rank > 98	6	231	237
Total	**98**	**237**	**335**
Graduate students (UNIVD)			
Rank ≤ 288	263	25	288
Rank > 288	25	173	198
Total	**288**	**198**	**486**
TOTAL	**888**	**759**	**1,647**

TABLE 4.2
Interviews and Cessations by Categories of Students and Their Global Score (6 * ZGLB + 4 * SCT) Ranking

	Interviewed	Not Interviewed	Total
College students (COLL)			
Rank ≤ 193	183	10	193
Rank > 193	10	299	309
Total	**193**	**309**	**502**
University students (UNIV)			
Rank ≤ 41	40	1	41
Rank > 41	1	56	57
Total	**41**	**57**	**98**
Graduate students (UNIVD)			
Rank ≤ 184	164	20	184
Rank > 184	20	84	104
Total	**184**	**104**	**288**
TOTAL	**418**	**470**	**888**

TABLE 4.3
Admissions, Enrollments and Cessations by Categories of Students and Their Global Score (SCGLB) Ranking

	Admitted	Enrolled	Desisted	Not Admitted	Total
College students (COLL)					
Rank ≤ 100	84	(52	32)	16	100
Rank > 100	16	(10	6)	77	93
Total	**100**	**(62**	**38)**	**93**	**193**
University students (UNIV)					
Rank ≤ 14	13	(12	1)	1	14
Rank > 14	1	(1	0)	26	27
Total	**14**	**(13**	**1)**	**27**	**41**
Graduate students (UNIVD)					
Rank ≤ 95	79	(62	17)	16	95
Rank > 95	16	(13	3)	73	89
Total	**95**	**(75**	**20)**	**89**	**184**
TOTAL	**209**	**(150**	**59)**	**209**	**418**

In Table 4.1, we consider the tested-nontested decision by the committee. Of the 502 college students who were tested, 22 students (4 %) were not among the top-ranked 502 college students according to their global Z-score. This was also the case for 25 of the 288 tested graduate students (9 %).[19] In Table 4.2, we describe the situation for the interview/noninterview component of the admissions process. Here, 20 of the 184 interviewed graduate students (11 %) were not among the first 184 best graduate students following their global score at that stage. Finally, Table 4.3 shows that a strong performance by the medical school committee in admitting and enrolling the best is achieved for the category of university students. Only one of the first 14 top-ranked university students was not admitted and a single student refused to enroll. The school performance and cognitive abilities are not as good for the other categories. For the college students, 16 (16 %) who were admitted did not rank among the top 100, and 32 of the 84 (38 %) best college students admitted decided not to enroll at the school. For the graduate students, these proportions are : 16 (17 %) graduate students admitted were not among the first 95 top-ranked of that group and 17 (22 %) among the best 79 admitted have not enrolled. Finally, if we list the 209 applicants

[19] It was suggested that some applicants' Z-scores were discounted on the basis of the educational institution where they were obtained. Although, since 1989, the Z-score has been officially corrected by the "perceived" quality of the college, this was not the situation for our sample of applicants in 1987. If weights were used at that time to adjust the Z-scores, it was not stated in the medical school guide for applicants.

among the 418 interviewed by their global score (SCGLB), we note 119 college students, 29 university students and 61 graduate students. Therefore, to get 34 graduate students (95 - 61), the committee had to pass over 19 college students and 15 university students who had scored better than these 34 graduate students.

Subsequent analysis will corroborate the role of the quality of the candidates in the decision process and confirm or infirm some ot the problems raised in this descriptive overview.

4. A SEQUENTIAL PROBIT MODEL

The sequence of decisions of the structure of Figure 1 and the dichotomous character of the dependent variables refer to a sequential-response model.[20] The sequential-response models are easy to handle as the probability of choice at each stage is independent of the choice at the previous stage. To estimate the sequential- response models we maximise the likelihood functions of dichotomus models repeatedly.

Equation (1) which represents the utility of the committee and of the applicant at the end of the process is defined as :

$$U_{ijkl} = V_{ijkl} + \epsilon_{ijkl} , \qquad (1)$$

with a systematic part

$$V_{ijkl} = \beta ' X_i + \alpha ' Y_j + \gamma ' Z_k + \delta ' W_l , \qquad (2)$$

where X_i, Y_j, Z_k and W_l refer to the vectors of explanatory variables specific to alternatives i, j, k, and l, respectively. ϵ_{ijkl} is the random part of the utility with the error terms assumed to be independent and identically distributed.

As for any binary model, utilities are associated with the node to which the branches lead. At node (2,3) of the tree structure of decisions of Figure 1, for example, the committee decides whether or not to interview the applicant with utilities U_2 and U_3. At node (4,5), the applicant enrolls if $U_4 > U_5$. The probability P_{ijkl} for the l-th alternatives to be chosen is

$$P_{ijkl} = Pr[(\epsilon_{ijhl} - \epsilon_{ijhl'}) < V_{ijkl} - V_{ijkl'}] \qquad l \neq l' \quad (3)$$

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[20] The presentation of the sequential-response model borrows from Amemiya (1975). For an interesting study of sequential binary models applied to access to the higher education institutions, see Weiler (1986).

If we assume each choice is made according to a dichotomous probit model and consider :

y=1,	if the candidate was not invited to take an entrance test
y=2,	if the candidate has been tested, but not interviewed
y=3,	if the candidate has been interviewed, but not admitted
y=4,	if the candidate has been admitted, but not enrolled to medical school
y=5,	if the candidate enrolled to medical school,

then the probability of applicant being tested, P_i, is :

$$P_i = P(y \neq 1) = L(\beta' X_i), \tag{4}$$

where L represents a binomial probit function.
Similarly we define P_j the probability that the applicant is interviewed, P_k the probability of being admitted to the medical school and, finally, P_l the probability of the applicant to enroll.

$$P_j = P(y=3 \text{ or } y=4/y\neq 1) = L(\alpha' Y_j) \;. \tag{5}$$

$$P_k = P(y=4 \text{ or } y=5/y\neq 1,\; y\neq 2) = L(\gamma' Z_k) \;. \tag{6}$$

$$P_l = P(y=5/y\neq 1,\; y\neq 2,\; y\neq 3) = L(\delta' W_l) \;. \tag{7}$$

The parameters β, α, γ, and δ are obtained successively by estimating equation (4) with all observations in the sample (1647 observations at node 0), equation (5) with all observations for which $y \neq 1$ (888 observations at node (2,3)), equation (6) with all observations for which $y \neq 1$ and $y \neq 2$ (418 observations at (3,4)) and, finally, equation (7) with all observations for wich $y \neq 1$, $y \neq 2$ and $y \neq 3$ (209 observations at node (4,5)).

5. THE EMPIRICAL RESULTS

Table 5 presents the results of the sequential probit model. It shows that the quality of the applicant is a positive determinant in all steps leading to admission at the medical school of the Université de Montréal. Despite the importance of the test scores in the admissions process and relatively good pseudo-R^2s, some problems detected in the descriptive statistics were confirmed in the formal analyses of the data.

TABLE 5
The Determinants of Medical School Admission :
Results from the Sequential Probit Model

Variable	Estimated Coefficient (Standard Error)			
	Tested	Interviewed	Admitted	Enrolled
GENDER	-0.20198	0.36946	-0.01190	0.17735
	(0.2119)	(0.3438)	(0.7754)	(0.2259)
GENDER*COLL	0.30203	-0.58964	-0.28651	-
	(0.2435)	(0.3834)	(0.8329)	
GENDER*UNIVD	0.24285	-0.21307	-0.47225	-
	(0.2546)	(0.3998)	(0.8315)	
AGE	0.01169	-0.09117	0.12488	-0.11803
	(0.0465)	(0.0616)	(0.1843)	(0.0738)
AGE*COLL	0.03006	0.28262*	0.01960	-
	(0.0668)	(0.0964)	(0.2486)	
AGE*UNIVD	-0.00040	0.10503	-0.23373	-
	(0.0547)	(0.0755)	(0.2014)	
MTONGUE	-0.57381**	0.19327	-0.35001	0.01954
	(0.3048)	(0.5179)	(1.0199)	(0.4129)
MTONGUE*COLL	1.10819*	-0.32082	0.23929	-
	(0.3386)	(0.5849)	(1.1174)	
MTONGUE*UNIVD	0.65424**	0.56925	0.53483	-
	(0.3604)	(0.5745)	(1.1156)	

TABLE 5 (continued)

	Estimated Coefficient (Standard Error)			
Variable	Tested	Intervied	Admitted	Enrolled
COLL	0.34939	-3.70935**	0.55087	-1.77560*
	(1.3903)	(1.9686)	(4.7629)	(0.6424)
UNIVD	1.31909	-0.56114	6.15892	-1.19388*
	(1.2637)	(1.6820)	(4.0877)	(0.5818)
ZGLB	0.07978*	0.07961*	0.02320*	-0.04305*
	(0.0034)	(0.0053)	(0.0084)	(0.0111)
SCT	-	0.05406*	0.00936	0.00303
		(0.0042)	(0.0064)	(0.0072)
SCI	-	-	0.10643*	0.01347
			(0.0094)	(0.0105)
MACP	-	-	0.00114	-0.00159
			(0.0017)	(0.0019)
UNEMR	-	-	-0.06604	-0.03083
			(0.0881)	(0.1002)
PMHS	-	-	0.08930	-0.08007
			(0.1024)	(0.1070)
PWHS	-	-	-0.06882	0.03811
			(0.0473)	(0.0483)
PMASCH	-	-	-0.03133	0.13400*
			(0.0587)	(0.0682)
PWASCH	-	-	0.00861	-0.13518*
			(0.0529)	(0.0615)
PMUD	-	-	-0.04132	0.02181
			(0.0579)	(0.0716)
PWUD	-	-	0.00712	0.02493
			(0.0694)	(0.0825)
INCOME	-	-	-0.000002	0.00003
			(0.00002)	(0.00003)
MONO	-	-	0.02493	0.02674
			(0.0357)	(0.0406)
OTHER STATISTICS				
INTERCEPT	-4.24261	-7.22996*	-8.66991*	5.24126
	(1.0566)	(1.4015)	(4.2852)	(3.2081)
Log of the likelihood function	-578.3455	-278.7589	-118.6224	-99.6320
χ^2	1116.4217	670.4649	342.2263	49.4917
Degrees of freedom	12	13	24	18
Maddala's pseudo-R^2	0.4923	0.5300	0.5590	0.2109
McFadden's pseudo-R^2	0.4911	0.5460	0.5906	0.1990

Significant at the 5 % level ** Significant at the 10 % level.

The global Z-score (ZGLB) is very significant in explaining the decision to permit a college student to take an entrance test. Table 5 indicates that that decision is also positively influenced by having French as a first language for the collegians (MTONGUE*COLL).

The results of the entrance test (SCT) and the global Z-score (ZGLB) play a major role in securing an invitation for an applicant to be interviewed. For college students being older (AGE*COLL) is also advantageous, but not for the university students without a degree (AGE). However, the college students are clearly at a disadvantage at this interview decision node, as shown by the negative statistically significant dummy variable (COLL). This result is consistent with the information provided in Table 3.

Among the various scores in the admission equation, only the global Z-score ZGLB and the interview score, SCI, are significant with the latter carrying a much greater weight in the decision with a coefficient 5 times larger than the estimate of ZGLB. This result somehow contradicts the commitee's own rules to admit or not on the basis of the global score or the applicant. Sociodemographic variables are introduced as determinants of admission on the grounds that the interview might have revealed this kind of information to the admissions committee. The use of data gathered from postal districts to infer this information about individuals is crude, but given socioeconomic clustering, informative. None of these measures, however, are statistically significant.

Even when offered an admissions slot, many candidates decline to enroll. Of course, some may have been admitted to another medical school and have chosen to enroll there. For the enrollment equation (last column of Table 5), not all the best decide to enroll at the Université de Montréal, as indicated by the negative and significant estimate of the ZGLB variable. This is particularly the case for college students (COLL). The negative and significant coefficient estimate is consistent with Table 4.3. 32 of the 84 best college students who gained admission desisted. Based on the postal district data, PMASCH (the percentage of men in a postal district with more than nine years of schooling but no university degree) has a positive and significant impact on the decision of admittees to enroll, but PWASCH (the percentage of women in a postal district with more than nine years of schooling but no university degree) has a negative and significant impact. If, as is intended, these variables capture the level of education of the admittee's parents, then those whose fathers only completed high school are more inclined to enroll, while those whose mother's only completed high school are not inclined to enroll. Further research would be required to determine what interpretation, material or psychological, could be attached to these results.

Finally, we found no evidence of sex discrimination : all the gender coefficient estimates of Table 5 were insignificant.

6. IMPLICATIONS AND CONCLUDING REMARKS

Statistical evidence from the sequential probit model tends to support the hypotheses that the admissions process was meritocratic and free from sex discrimination. Some arbitrary decisions were made, however. For example, the decision to permit a college student to take an entrance examination is positively influenced by having French as a first language. Information obtained by ranking applicants on the basis of their global performance also indicates that the medical school failed to admit the "best" candidates and that many among the best admitted chose not to enroll.

College students were particulary affected by the committee's decisions. Of the 888 applicants who passed the admissions test, 502 or 56.5 % were collegians. Yet, only 12 % of college students gained admission. Thirty-four graduate students admitted by the committee had a global score lower than 19 college students who were not admitted. Finally, 38 % of the best college students admitted decided not to enroll at the school.

The perplexing problem that apparently faced the committee was, given its entrance quotas, how to get rid of those excellent college students that keep reappearing in all phases of the admissions process. In more general terms, given that the committee has different applicant categories by level of education attained and that ex ante it wants a given proportion from each category in the program, it must find ways to achieve these quotas. The existence of quotas might also explain the otherwise mysterious interview effect where, according to the results of the sequential probit, the interview score seems to matter most in gaining admission — a result that contradicts the medical school guide for applicants. Quotas also appear to dicourage some of the best college students from enrolling, whereas all but one of the best university student accepts the admissions offer by the medical school. These admitted university students were most likely themselves prior victims of quotas, having been precluded from earlier entry to the medical school sometime during the past few years ago by better college students.

If "meritocratic" ordering among all the applicants is the only criterion that should matter in the admissions process, how can meritocratic admission best be achieved in the context of quotas for certain applicant categories? The interview component (which is certainly costly and not as transparent as one could wish) can be replaced by a larger battery of positive tests. These tests might include many dimensions of ability along with cognitive abilities. For example, questions on the level of motivation of medical work, knowledge of medical-related sciences, questions related to acquired health experience can be included. If the medical school authority is still doubtful about the acuity of its tests, a simple solution will be to admit the top 20 % performers among the applicants and reject the bottom 20 % of the applicants. The remaining slots could be filled at random from those applicants in the middle range of the test-score distribution.[21] Finally, the proportion of applicants by different categories

[21] These proportions are only examples and depend on the medical school degree of confidence in the tests.

admitted at the medical school should be determined ex post and not ex ante.

With academic institutions under increasing financial stress and hence (quite apart from professionally imposed restrictions) often forced to limit the number of doctors they can train, the existence of entrance quotas makes the choice of the best students more difficult and critical. This empirical study suggests that a focus on increasing the importance of objective testing will increase the likelihood of selecting and enrolling the best applicants.

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