Restriction on Stating Preferences in College Admissions in Turkey[*]

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Abstract

A central authority designs and implements the college admission process in Turkey. All the applicants are required to take an SAT-like test and submit their preferences over the departments. Then, the central authority places the applicants to the departments by sanctioning them in terms of their test scores. This procedure would be fair if there were no restrictions on stating preferences. However, the applicants are restricted to state only 24 deparments out of the 4022 available departments in their preference forms. By using the college admissions dataset of the year 2005, we estimate that 60181 applicants would state more than 24 departments if they were allowed to. Among them, 4761 applicants had an unfair outcome. These applicants could not be placed to the departments that they deserved in terms of their test scores because they could not state these departments due to the restriction on stating preferences.

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1 Introduction

A central authority designs and implements the college admissions process in Turkey. Each year in June, all the applicants are required to take an SAT-like test. The central authority computes the test scores[1] and each applicant is informed about his test score. After learning the test score, each applicant submits his preference over the departments. For example, the applicant may rank "Istanbul University-Economics" department as his first choice, "Ankara University-Chemistry" department as his second choice, etc. The applicants are restricted to state only 24 departments out of the 4022 available departments in their preference forms.

The central authority places the applicants to the departments by using their test score and preference information. Each department has a certain capacity so that the applicants are sanctioned in terms of their test scores. The sanctioning is done as follows. First, a cutoff test score is computed for each department.[2] Then, each applicant is placed to his most favorite department among the set of departments which have a lower cutoff test score than his test score. Finally each applicant is informed about the department he is placed and the cutoff test scores of all the departments.

Balinski and Sonmez (1999) prove that this procedure is fair because it gives a higher priority to the applicant with the higher test score. Doğan (2007) shows that the fairness result no longer holds if we consider the restriction on stating preferences. The unfairly treated applicants are the ones who deserve certain departments in terms of their test scores but cannot be placed to them because they could not state these departments due to the restriction on stating the preferences.

In this paper, we use the data-set of the year 2005 to measure the effect of restriction on stating preferences. We have the preference and test score information of all the applicants who apply to Turkish colleges in 2005. By using this information, we estimate that 60181 applicants would state more than 24 departments if they were allowed to. Using statistical correlations in applicants' preferences, we simulate the unrestricted preferences for these constrained applicants. By using these results, we find that 4761 applicants had an unfair outcome because of the restriction.

There are many other matching problems where the agents are restricted to state their preferences. For instance, the applicants apply a certain number of universities for the undergraduate

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[1] The details about the calculation of the test scores are given in the appendix.

[2] The exact procedure that the central authority uses in calculating the cutoff test scores is given in the appendix.

admissions in United States, because each application costs time and money. The applicants have to leave out many universities that they desire to apply but cannot due to this cost. For these universities, the applicants cannot state their preferences. Another example is the economics job market. Each economics department invites a certain number of candidates to their schools because of the time and money costs associated with the invitations. The schools cannot express their preferences for the job market candidates who are not invited for the campus visit.

Unlike the other examples, the restriction on stating preferences for the Turkish colleges can be alleviated without any significant cost. The only cost for letting applicants to state more departments is the computer running time in computing the cutoff test scores. This should not be so important in the current state of the computer technology.

In section 2, we explain how the restriction on stating preferences make the admissions procedure unfair. In section 3, we introduce the data-set. In section 4, we simulate the unrestricted preferences for all the applicants. We lay out the results in section 5 and give the conclusion in section 6.

2 Fairness

Balinski and Sonmez (1999) describe the fairness in this context as follows. If the admissions procedure is fair then there can only be two reasons why an applicant is not placed to a department.

1. The applicant is already placed to a more favorite one than this department.

2. The department fills its capacity with applicants with higher test scores.

They show that the current procedure is fair under the assumption that there are no restrictions on stating preferences. In the current procedure, each applicant is placed to his most favorite department among the set of departments that have lower cutoff test scores than his test score. Then, if an applicant is not placed to a department that can be of two reasons. First, the applicant is already placed to a more favorite department of his. Second, the applicant has a lower test score than the department's cutoff test score. That is, the department already fills its capacity with applicants with higher test scores. As you can see, the two reasons under the current procedure coincide with the reasons for a fair procedure. Hence, the current procedure is fair if the applicant can state all his preferences.

Dogan (2007) shows that the fairness result no longer holds when there is restriction on stating preferences. This is because of a third reason why an applicant is not placed to a department: The

applicant scores higher than the cutoff test score of the department and he prefers this department to his current placement. However, he could not state this department in his preference form due to the restriction on stating preferences. This third reason violates the condition of a procedure to be fair and the applicant who is not placed because of this reason is unfairly treated.

Let's demonstrate how the existence of restriction on preferences violates fairness with a simple example.[3] Assume that there are four applicants (1 through 4) and two departments (A and B) with a capacity of two each. The preferences and the test scores of the applicants are shown in Table 1.

Table 1: Preferences and Test Scores of the Applicants			
Applicant #	First Choice	Second Choice	Test Score
1	Department A	Department B	100
2	Department A	Department B	90
3	Department A	Department B	30
4	Department B	Department A	20

First, we deal with the case where there are no restrictions on stating preferences. In this case, the applicants can state all their choices. The central authority will compute the cutoff test scores and placement results as follows.[4]

Table 2: Placement Results		
	Cutoff Test Scores	Placement Results
Department A	90	Applicant 1, Applicant 2
Department B	20	Applicant 3, Applicant 4

Note that, all but applicant 3 are placed to their most favorite departments. Applicant 3 could not be placed to department A because this department's capacity is already filled with applicants who score higher than him. This demonstrates that the procedure is fair when there are no restrictions on stating preferences.

Now, let's suppose that the applicants are restricted to state only one department in their preference forms. After the applicants learn their test scores and their ranking among all the applicants, they need to submit their preferences. This imposes no difficulty for applicant 1 or 2 because they know that they rank in top two and the capacity of each department is two. So,

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[3] A similar example is given in Dogan (2007)

[4] The applicants do not gain by misrepresenting their preferences in this example. See Dogan (2007) for a proof.

they know that they will be placed to the department that they state in their preference forms. Therefore, they both state department A under the restriction.

Unfortunately, applicant 3 does not have an easy choice. This is because, he has imperfect information about the preferences of the other applicants. If he knew their preferences, then he could easily state department B as his choice. Let's assume that applicant 3 has a prior belief that both applicant 1 and applicant 2 prefers department A to department B with probability 1/2. With these beliefs, he makes the calculation in table 3.

Table 3: Placement calculation for Applicant 3				
Probability Assigned By Applicant 3	Applicant 1 States:	Applicant 2 States:	Placement when Applicant 3 states Department A	Placement when Applicant 3 states Department B
1/4	Department A	Department A	No Placement	Department B
1/4	Department A	Department B	Department A	Department B
1/4	Department B	Department A	Department A	Department B
1/4	Department B	Department B	Department A	No Placement

We can easily say that applicant 3 would state department A in his preference form given the calculation in Table 3 and his actual preference stated in Table 1. Let's suppose that applicant 4 has the same prior belief about the applicants 1 and 2 as the applicant 3. Moreover, let's suppose that he has a prior belief that applicant 3 prefers department A to department B with probability 1/2. Then a similar calculation will be done for applicant 4 and we see that he will state department B in his preference form. The central authority will receive these preference forms and announce the following result.

Table 4: Placement Results under Restriction		
	Cutoff Test Scores	Placement Results
Department A	90	Applicant 1, Applicant 2
Department B	20	Applicant 4

This outcome is unfair for applicant 3. He prefers to be in department B rather than his existing no placement result. He also has a higher test score than the cutoff test score for department B.

Unfortunately, he cannot be placed to this department although he deserves in terms of his test score.

3 Data

We use the college admissions data-set of the year 2005 in our analysis. There are 1614984 applicants who took the college admission set in June 2005. The central authority informed these applicants about their test scores. The central authority also announced a minimum threshold test score below which the applicants could not submit preference forms. There were 988471 applicants who had test scores higher than this threshold, however only 394893 applicants[5] submitted their preference forms. There were 4022 departments with a total capacity of 198204.

In table 5, we see the distribution of applicants in terms of the number of choices that they made. Note that, the number of applicants who stated 1 through 23 departments never exceeds 18000 but the number of applicants who stated all 24 departments is 72217. Given this information, we predict that many applicants would state more than 24 departments if they were allowed to.

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[5] There are non-selective departments in Turkey. We exclude the preferences for these departments in our analysis. More institutional details are given in the appendix.

# of Departments Stated	# of Applicants	# of Departments Stated	# of Applicants
Table 5: The Distribution of the Departments Stated			
1	17652	13	12343
2	15944	14	12978
3	14967	15	12704
4	15829	16	12259
5	15384	17	12138
6	16109	18 ([6])	17581
7	14711	19	10231
8	14957	20	11402
9	14130	21	10480
10	14932	22	11381
11	13680	23	16438
12	14446	24	72217

In the next section, we will simulate the unrestricted preferences for the applicants who filled all their 24 choices. In order to do this, we have to answer two questions.

1. Among the applicants who filled all their 24 choices, who would make more choices if there were no restrictions?

2. What extra choices the constrained applicants would make if they were allowed to state more choices?

Table 6 and 7 give some statistics that will help us to answer these two questions. In table 6, we see that the proportion of applicants who stated 24 choices and less than 24 choices were different for different departments. Mathematics was a popular choice for the applicants who stated all their

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[6]The applicants were restricted to state only 18 selective departments in the years before 2005. They could state up to 24 selective and non-selective departments combined. This rule changed such that the applicants could state 24 selective departments in 2005. The peak in the number of applicants who stated 18 departments make us believe that some of these applicants were unaware of the rule change. There is also another unexpected peak in the number of applicants who stated 23 selective departments. Most of these applicants stated a non-selective department as their 24th choice. We believe that many of these applicants disliked the idea of being out of the higher education system and preferred to have at least a seat in a non-selective department.

24 choices but agricultural economics was not. This information helps us to resolve the question of which applicants were constrained. We will assume that an applicant who stated departments that were popular among the applicants who stated all their 24 choices is more likely to be constrained and would state more departments if he was allowed to.

Table 6: Proportion of the Applicants Stated Department Categories		
Department Category	% of applicants stated less than 24 choices	% of applicants stated 24 choices
Economics	68	32
Mathematics	60	40
Medical Science[7]	67	33
History	62	38
Electrics-Electronic Engineering	70	30
High School Geography Teaching	57	43
Law School	81	19
Marketing	94	6
Agricultural Economics	98	2
Arabic Language and Literature	92	8
All Departments:	82	18

Once we decide on which applicants would make more than 24 choices, we need to find what these extra choices would be. To do this, we use the composition of the choices in the preference forms. In table 7, we see that 81744 applicants stated 333020 economics departments in their preference forms. Those who stated economics had 27% of their choices in economics, 18 % of their choices in business, 8 % of their choices in Public Governance, etc. This picture is quite different for the applicants who stated medical science in their preference forms. There were less applicants who stated medical science and more than half of their choices were in health related professions. We use such correlations in preferences to form the new choices for the constrained applicants.[8]

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[7]Both medical science and law are undergraduate degrees in Turkey.

[8]There are three possible reasons why an applicant who wants to be an MD did not state economics that often. First, it is about preferences. An applicant who wants to be in a health related profession might not want to be an economist. Second, it is about the level of the cutoff test scores of the departments. Some applicants give a very high weight to the level of the cutoff test scores when they choose the departments. If the cutoff test scores of medical

Table 7: Composition of Choices			
Applicants Who Stated Economics At Least Once	% of choices	Applicants Who Stated Medical Science At Least Once	% of choices
Economics	27	Medical Science	40
Business	18	Pharmacy	12
Public Governance	8	Dentistry	8
Public Finance	7	Computer Engineering	6
Turkish Literature	3	Electrics-Electronics Engineering	5
Number of Applicants:	81744	Number of Applicants:	35757
Number of Choices	333020	Number of Choices:	218520

Lastly, we will rank the additional choices with the existing choices. Note that a applicant may even leave out his most preferred department when he is restricted. He may not be willing to give up a valuable spot in his preference form if his chances of being accepted to this department is low. To rank the new departments, we again use the information in the preference forms.

4 Unrestricted Preferences

We find the unrestricted preferences for the applicants who stated all 24 choices in four steps.

Step 1: Finding the constrained applicants and the number of unrestricted choices that they have.

Using the information in table 5, we find that the number of applicant who make 11 through 23 choices averages 12928. Since the standard deviation of this variable is low (2166), we can fairly say that the applicants who would make 24 and more choices in the absence of restriction is around this number.[9] Given this information, we assume that the applicants would make at most 5 additional choices and the applicants are distributed evenly across these extra choices. The distribution of the applicants in terms of the number of unrestricted choices is given in table 8.

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science and economics department are quite different then the applicants who state medical science would not go for economics departments. Third, it is about the types of test scores that different departments require. We will provide more details on that in the appendix.

[9] The standard deviation would be even lower if the applicants did not have the problems stated in footnote 6.

Table 8: The Distribution of the Departments Stated in the Absence of Restriction	
Number of Departments Stated	Number of Applicants
1 through 23	The same as in[10] Table 5
24	12036
25	12036
26	12036
27	12036
28	12036
29	12037
Total	394893

Step 2: Computing the degree of restriction that each applicant faced.

Let's take an applicant, say Asya, who filled all 24 choices and compute her degree of restriction. Let's denote the choices that Asya made under restriction be d_k ($k = 1, ..., 24$), d_1 being her highest ranked department and d_{24} being her lowest ranked department. Let R_{d_k} be the number of applicants who stated the department d_k and stated all 24 choices and U_{d_k} be the number of applicants who stated the department d_k but stated fewer choices than 24 in their preference forms. Then the degree of restriction (DR) for Asya is computed as follows:

$$DR(Asya) = \frac{\sum_{k=1}^{24} R_{d_k}}{\sum_{k=1}^{24} (R_{d_k} + U_{d_k})}$$

Then, we suppose that the applicants with the highest degree of restriction will make 29 choices when they are not restricted. The applicants who have the least degree of restriction would state 24 choices as they do in the restricted case.

Step 3: Finding the new choices for the applicants who were constrained.

Let's say that we find that Asya would make 27 choices in step 2. Then, we need to find 3 new choices for her that she would state in the absence of the restriction. There are 3998 (4022-24) departments that she did not put in her preference form. Let x_j (j=1, ...,3998) denote those

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[10]The preferences of applicants who make less than 24 choices might change when there is no restriction as well. For instance, as mentioned in footnote 6, most applicants who made 23 choices stated a non-selective department as their 24th choice. These applicants might state an additional selective department if we relax the restriction.

departments. Let f(x_j,d_k) be the frequency of the applicants who stated x_j and d_k in their preference forms. Then let the degree of likelihood (DL) of department x_j be in Asya's preference form be:

$$DL(x_j, Asya) = \sum_{k=1}^{24} f(x_j, d_k)$$

We choose three departments with the highest DL value to be Asya's new departments.

Step 4: Ranking the new choices.

Let a_1, a_2 and a_3 be Asya's new choices where a_1 has the highest DL value and a_3 has the lowest. We incorporate these new preferences to the existing preference one by one. We first take a_1 and compare with d_{24}. If more applicants ranked d_{24} higher, then a_1 becomes the new 25. choice. Otherwise we make the same comparison with a_1 and d_{23}. Say, by doing this comparison, we find that a_1 is more favorite than d_k but less favorite than d_{k-1}. Then department a_1 be Asya's new k'th choice. We do the same procedure for other new choices to find the unrestricted preference ranking of Asya.

5   Results

From the previous section, we acquire the unrestricted preferences. From the original data-set, we have the test scores and the restricted preferences. Now we can compare the placement results with the restricted and the unrestricted case. There are two type of applicants who have different placement results under restriction than under no restriction: The directly affected applicants and the indirectly affected applicants. The directly affected applicants do not state the department that they are placed under the unrestricted regime when there is restriction. That is why they lose their seats when they are restricted. The number of these applicants who have this direct effect is given in column 1 of table 9. There is a snow ball reaction to this first effect. Some applicants would be placed to the seats that the directly affected applicants could not be placed due to the restriction. Some other applicants would be placed to the seats that were left by the applicants who were placed to the seats that were left by the directly affected applicants, etc. We call this latter group of applicants as the indirectly affected applicants. The second column of table 9 gives the total number of applicants who are placed to different departments depending on whether there is restriction or not. In other words, column 2 is the addition of the number of the directly affected applicants and indirectly affected applicants. The number of the indirectly affected applicants are two to three times of the number of the directly affected applicants.

11

Table 9: Results.			
# of Choices Applicants Can State	# of Directly Affected Applicants	Total # of Affected Applicants	# of Unfairly Treated Applicants
28	263	1078	263
27	867	2860	889
26	1691	5293	1806
25	2679	8380	3006
24	3785	12783	4761

The total number of seats changed due to restriction is not our primary concern. Some applicants benefit from the restriction and some lose. In the third column of the table 9 we have the number of unfairly treated applicants. These applicants are the ones who deserve their more favorite department in terms of their test scores but could not be placed due to the restriction. That is, there is at least one department that they prefer to their placement under the restriction and their test score exceeds the cutoff test score of this department.

6 Concluding Remarks

We crudely predict that 60181 applicants would state more than 24 choices if there were no restrictions on stating preferences. Among these applicants, 4761 applicants were unfairly treated because of the restriction on stating preferences. This number is quite large. Restoring the fairness by removing the restrictions on stating preferences comes at an insignificant cost. We believe that this problem will be resolved for the Turkish college admission system in the near future.

It would be harder to restore fairness in other contexts. For instance, there are college specific costs that require application fee in the U.S college admission system. More cooperation among colleges might reduce this cost to a minimum. That would increase the number of applicants who are placed fairly to the U.S colleges.

7 References

Balinski, Michel and Tayfun Sonmez (1999) "A Tale of Two Mechanisms: Student Placement ", Journal of Economic Theory 84, p. 73-94.

Dogan (2007) "Two Sided with Restrictions on Stating Preferences", Working Paper

8 Appendix

In the appendix, we provide more details about the college admission system in Turkey.

8.1 Selective vs. Non-Selective Departments in Turkey

We ignore the preferences for the non-selective departments in the analysis. This is because, we want to preserve simplicity and we find the problem of getting into selective departments more interesting. All the computations and statistics given in the main text ignore the preferences for the non-selective departments.

As we mentioned, the applicants are restricted to state 24 departments. The applicants can state selective departments and/or non-selective departments in their preference forms. However, the total number of these departments cannot exceed 24.

There are two types of non-selective departments in Turkey.

a. Open Education: The students of the open education do not attend formal lectures. They study at home and take midterms and finals of their courses from the exam centers located in the cities. The applicants who meet the threshold to submit preferences get an automatic admission to all of the departments of the institution. The applicants still have to state which open education department they want in their preference forms.

b. Vocational Higher Education: The applicants are given priority for their success in their high schools and the type of high school that they graduate to be admitted to these institutions. The college admission test do not play any role. The applicants still have to state these departments in their preference forms in order to be placed.

8.2 Computation of the Test Scores

The college admission test has five components: Mathematics, Science, Social Sciences, Turkish and Foreign Languages. The central authority computes four categories of test scores by giving a different weight to these components. These weights are given in table A1.

Table A1: Weights for different categories of test scores					
	Math	Science	Turkish	Social Sciences	Foreign Languages
Quantitative	1.1	0.7	0.3	0.1	-
Verbal	0.3	0.1	1.1	0.7	-
Equally Weighted	1.0	0.1	0.8	0.3	-
Foreign Languages	-	-	0.7	0.1	1.4

The cutoffs test scores of the departments are computed in terms of one of these four categories. For instance, a quantitative cutoff test score is computed for an engineering department whereas an verbal test score is computed for a Turkish literature department.

Now we are ready to comment on footnote 8. In this footnote, we try to explain why the composition of the applicants who state economics and medical science departments differ. One reason is that applicants are evaluated in terms of different test score categories for these departments. An equally weighted cutoff test score is computed for an economics department whereas a quantitative test score is computed for a medical science department. Then, an applicant who wants to be placed to a medical science department would allocate more time to science test rather than the social science test during the test preparation and while solving the test. This puts him to a disadvantageous position for being placed to an economics department.

Table A.2 gives the composition of choices in terms of departments in different categories. We see that the applicants made most of their choices in the same category for reasons mentioned in footnote 8. For instance, 153879 applicants who had at least one department in quantitative category in their preference forms stated 90% of their choices in departments of the quantitative category.

Table A2: Composition of Choices in Terms of Departments in Different Categories.					
	% Quantitative	% Verbal	% Equally Weighted	% Foreign Languages	# of Applicants
Quantitative	90	1	9	0	153879
Verbal	1	72	26	1	124929
Equally Weighted	12	12	75	0	193023
Foreign Languages	1	3	3	93	22541

The last step in computation of the test score is to add a component reflecting the high school

performance. This component is affected by three factors. First, higher points are given to applicants who have higher GPA. Second, higher points are given to applicants who graduate from high schools which perform well in the test. Third, applicants graduated from certain high schools are given higher points when they state certain types of departments in their preference forms. For instance, an applicant who graduates from a vocational high school gets a higher point when he is evaluated for a department of his specialty in high school, whereas he gets a lower point for choosing a department of a different specialty.

8.3 Computation of the Cutoff Test Scores

We need to solve a multi-category placement problem before computing the cutoff test scores. The departments are divided into four categories in terms of the weights given to the different components of the college admission test. The departments are divided to hundreds of categories in terms of the computation of the high school performance of the applicants. We simplify and aggregate the categories for this latter group into seven categories.[11] In sum, the departments are divided into 7*4=28 categories.

First we explain how the single category placement problem is solved, then we will explain the solution to the multi-category placement problem.

8.3.1 Single Category Placement Algoritm

First, the applicants are sorted in terms of their test scores computed in the single category. Starting from the highest scoring applicant, the applicants are placed to their most preferred department among the set of departments that did not fill its capacity yet. For instance, take the 1000th applicant. If his first choice is not filled, then we place him to his first choice. However, if his first choice is filled by the 999 applicants who score above him then we look at his second choice and use the same procedure.[12]

After placing all the applicants, we look at the lowest scoring applicant placed to each department in order to get the cutoff test scores.

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[11] We get only 91% of the placement results right when we do this simplification. However, the simplification saves us a lot of computer run time.

[12] This is the only fair placement algoritm. For a formal proof, see Dogan (2007)

8.3.2   Multi-Category Placement Algoritm

There are many possible solutions to this placement problem (Balinski and Sonmez (1999)). We describe the one that the central authority uses.

First Step: The applicants are sorted in terms of the test scores computed in the first category. By ignoring the preferences for the departments that do not belong to the first category, the applicants are placed to departments by the single-category algoritm described above. Then, we use the same procedure for all the other categories. Note that, the applicant can be placed more than one department. For instance, the applicant may be placed to a department from the third category and another department from the eleventh category. If there is such an applicant we move to step 2. Otherwise, the algoritm stops.

Second Step: We take the applicants who are placed more than one department. We find their most preferred department and delete their choices ranked below this department. For instance, if this most preferred department is a third choice for an applicant, then we would rewrite his preferences such that he has only the first three choices.

After forming the new preferences in the second step, we repeat the first step. We continue this procedure until all the applicants are placed to at most one department. Then, we look at the lowest scoring applicant placed to each department in order to get the cutoff test scores.