ERASMUS Student Exchange Programs: How to Place Students?

Ekrem AKKAYA

Ayşe MUMCU*

Boğaziçi University

ABSTRACT

The purpose of this paper is to offer guidelines for student placement mechanisms used in the ERASMUS exchange markets. The problem at hand resembles a student placement problem, a class of problems that deals with matching students with seats in schools. Using the mechanism to place outgoing Boğaziçi University students as a case, we discuss a set of criteria that a placement mechanism is desired to satisfy. We also propose policy recommendations, and show how the current system can be improved using actual data from the 2009-2010 exchange market for outgoing Boğaziçi University students.

Keywords: ERASMUS student exchange market; student placement problem; matching theory; Turkey.

JEL codes: C78, I23.

* Corresponding author: Department of Economics, Boğaziçi University, Bebek, Istanbul 34342, Turkey. E-mail: mumcu@boun.edu.tr.

1. Introduction

The European Region Action Scheme for the Mobility of University Students (ERASMUS) Program is an international exchange program of higher education institutions to spend a term in other partner institutions with an aim to expose students to benefit educationally, linguistically and culturally from the experience of learning in other European countries; promote cooperation between universities; and contribute to the development of a pool of well-qualified and internationally-experienced future professionals.[1] The program also facilitates the mobility of teaching staff among partner institutions.

The ERASMUS program was established in 1987, and in its first academic year 1987-88 3,244 students from 11 countries participated in it. By 2008-2009 the number of participating students had increased nearly sixty-fold, while participating countries had tripled. Of the 198,523 students that took part in the program in 2008-2009, 168,193 were part of the mobility for study and the remaining 30,330 benefitted from the mobility for placement (traineeship and internship in enterprises and organizations). Besides students, 36,389 teaching staff participated in the program, 28,615 of them with teaching assignments, and 7,774 for a training period. Altogether, 2,747 higher education institutions sent their students or teaching staff on ERASMUS mobility.[2]

The fast-growing interest in the program has created an exchange market where students compete for positions in institutions. Given that certain positions are more sought after, selecting students to place in partner institutions becomes a rationing procedure that allocates scarce resources. All institutions are free to adopt the selection procedure of their choosing; there are no common procedures or guidelines that universities follow in this regard. However, according to the ERASMUS charter, each institution commits to selecting the students it will propose to partner institutions in a fair and transparent way.

This paper aims to make a first attempt in offering guidelines for a mechanism that can be used to place students who satisfy a set of desirable properties in the ERASMUS exchange market, by conceptualizing it as an allocation problem that utilizes matching theory. To this end, procedures employed at the exchange market at Boğaziçi University (BU) will be used as a case in point.[3] We evaluate the mechanism used at BU for the

---

[1] Messer and Wolter (2007) studied the consequences of exchange semesters on a graduate's future academic career or labor market success. Teichler (2004) reports how participants in the exchange program value their experiences.

[2] See Maiworm (2001) for a historical development of the ERASMUS Program since its inception. Most recent information is available at http://ec.europa.eu/education/erasmus/doc920_en.htm#1. Accessed August, 8, 2011.

[3] Boğaziçi University is situated in Istanbul, Turkey, and was founded in 1971 with its roots going back to 1863. It has four faculties (Administrative Sciences and Business Administration, Arts and

academic year 2009-2010 with reference to these properties, and make some policy suggestions that improve upon actual placement outcomes.

The problem at hand can be suitably analyzed by matching theory as it deals with allocation and exchange of indivisible resources in markets, where the price mechanism is sidestepped because either it is immoral or illegal. The market can be one-sided where agents are matched with objects such as dormitory rooms, transplant organs, courses, summer houses, *et cetera*, or it can be two-sided such as matching firms with workers, students with schools, or men with women.

Gale and Shapley's (1962) seminal work introduced the *college admission problem*, where students and colleges are matched by a centrally-administered mechanism.[4,5] The basic model includes a set of students, a set of colleges each with a quota, i.e. the maximum number of students they can admit, students' strict preference relation over colleges, and colleges' responsive preferences over sets of students. A preference relation is a rank order of objects of choice (in this case either students or colleges) and it is *responsive* if, in the case of the preferences of a given college, its preference over sets of students is based on its strict rankings of the students. In other words, a college will always prefer to admit an acceptable student if its quota is not filled, and always prefer to exchange one of its current students with a better one in case its quota is already met.

A solution to the college admission problem is a many-to-one *matching* of students and colleges such that each student is assigned to at most one college and colleges do not take students more than their respective quotas.[6] A *mechanism* is a procedure that picks a matching for each college admission problem. A desirable property of matching is *stability*, which ensures that no students are assigned to a college they do not wish to attend (known

---

Sciences, Education, and Engineering) and two schools with 32 departments in total. There are also six institutes offering graduate degrees. There are about a total of 12,000 students, of which approximately 80 percent are undergraduates. Its full-time and part-time teaching staff is about 900 (Facts and Figures: Boğaziçi University, 2010. http://www.boun.edu.tr).

[4] Here we focus on the college admission problem and its variations, which are related with the problem at hand. The reader may refer to Sönmez and Ünver (2011) for a most recent and comprehensive survey of matching theory and its application to various markets.

[5] Long before economists began to study the allocation and exchange of discrete resources, practitioners had developed procedures that match agents from two sides of the market. For example, the National Resident Matching Program (NRMP) in the U.S. has been matching interns with hospitals via a centralized procedure since 1952. Gale and Shapley (1962), independently of the NRMP, theorized the solution to a centralized two-sided market resembling the NRMP.

[6] The matching can also be either one-to-one or many-to-many. In one-to-one matching, each agent from one side of the market can be matched to one agent on the other, as in a (monogamous) marriage market or kidney exchange market. In a many-to-many matching, each agent from one side of the market can be matched with more than one agent on the other side and vice versa.

as *individual rationality*) and there is no college-student pair that would *block* the matching in the sense that they would prefer to match with each other rather than their current matches. In the same vein, a mechanism is said to be a stable mechanism if it always selects stable matching. Stability is desirable since rational agents can break any unstable matching announced by the central authority.

The main issue investigated in matching theory has been the existence of stable mechanisms. Gale and Shapley (1962) showed that every college admission problem admits a stable solution. A stable matching to any college admission problem is found by applying the *student- (college) proposing deferred acceptance algorithm*.[7] Moreover, the student-proposing deferred acceptance algorithm finds the *best* stable matching for all students (Gale and Shapley, 1962) and it is *strategy-proof* for students (Roth, 1985), i.e. no student can obtain a better match by misreporting her true preferences.[8] Strategy-proofness is a useful property when each agent knows only her own preferences and is assured that no one will have an incentive to manipulate the outcome by misrepresenting her preferences. Thus, it rules out costly second-guessing.

The ERASMUS exchange problem differs from the college admission problem in that students are the only active agents with preferences over colleges, and seats in colleges are passive in the sense that they are simply objects to be consumed with no preference over students.[9] In such problems, each school ranks students by their exam scores. We refer to these problems as a *student placement problem* (Balinski and Sönmez, 1999). Thus, the ERASMUS exchange problem is a student placement problem.

A student placement problem consists of a finite set of students, a finite set of schools, a quota for each school, a strict preference profile for students over schools and a remaining unmatched option, and a score profile for students. Each school admits students

---

[7] The student-proposing deferred acceptance algorithm works as follows: In the first step 1, each student proposes her top-ranked college among those for which she is acceptable. Each college *c* rejects all but the best students who have applied for placement, up to its quota. Those that remain are "tentatively" assigned a slot at college *c*. In general, at step k, students who were rejected in the previous step propose to a top-ranked college among those that have not yet rejected them and for which they are acceptable. (If there are no such colleges, students stop proposing.) Each college *c* rejects all but the best students up to its quota among those who have just proposed and those that were tentatively assigned to it at the last step. Those that remain are 'tentatively' assigned a slot at college c. The algorithm terminates when no student proposal is rejected. Each student is assigned to her final tentative assignment. Students who are rejected by all colleges they applied to are not assigned to any college.

[8] Unlike the student-proposing deferred acceptance algorithm, the college-proposing deferred acceptance algorithm is not strategy-proof for colleges.

[9] The placement of high school graduates in universities in Turkey, Greece and China is an example to such problems.

according to their scores.[10] For each student placement problem, an *associated college admissions problem* can be constructed by assigning each school a preference relation based on student rankings according to grades. Consequently, the existence and the various properties of mechanisms in a college admissions problem may be related to the associated student placement problem. We discuss these in more detail later.

Over the years, the developments in matching theory have been quite influential in remedying market failures in a range of markets, from entry-level labor markets[11] to assigning students to K-12 public schools[12] and the kidney exchange market.[13] Our purpose here is to use the theory as a guide in elaborating how to design a fair and transparent selection procedure for the ERASMUS exchange market.

The rest of the paper is organized as follows: Section 2 describes the BU exchange market as a placement problem and introduces the mechanisms used in the academic year 2009-2010. Section 3 introduces a set of desirable properties that a placement mechanism should satisfy, and examines which ones the BU mechanism satisfies. Section 4 uses actual data from the exchange market in 2009-2010 to suggest revisions to the mechanism that will improve actual placement outcomes. Finally, Section 5 concludes the paper.

2. The ERASMUS Exchange Market at Boğaziçi University and the Mechanism Used (for the academic year 2009-2010)

[10] The ERASMUS exchange problem is actually a student placement problem with a one-skill category, which is a special case of a more general class of problems known as the multi-category student placement problem, where colleges rank students according to different grades. For example, the placement procedure used for college admission in Turkey is a multi-category student placement problem, where different schools/faculties admit students based on different scores.

[11] As shown in Roth (1984), the previous NRMP mechanism used from 1952 to 1997 was equivalent to the college-proposing deferred acceptance algorithm. Suffering from instability due to increased numbers of couples seeking positions, NRMP was redesigned by Roth and Peranson (1999) based on the student-proposing deferred acceptance algorithm with a twist to handle the couples' problem. In the hospital-intern market in Britain, several unstable mechanisms have also been abandoned and replaced by stable ones.

[12] In many U.S. states, admission to public K-12 schools is centralized. In New York City, schools prioritized exam scores, while in Boston, geographic and demographic characteristics such as proximity to school and having a sibling in the school came to the fore. The Gale-Shapley student-proposing deferred acceptance algorithm was recently adopted in New York City and Boston, replacing previous mechanisms (Abdülkadiroğlu et al., 2005, 2006).

[13] The New England kidney exchange market was designed by Roth, et al. (2005).

The ERASMUS exchange market for outgoing BU students is a *centralized placement market*. The market consists of two-sides: students and colleges that have an agreement with BU. There is a central authority—the Office of International Relations at BU—that places all BU students in positions offered by partner institutions. A *centralized placement problem* is described by the following components: a set of students, a set of colleges that have an agreement with BU, a quota profile, students' preference relation, and students' ranking.

BU has different types of agreements with its partner institutions, which determine different types of relevant *quotas*. There is a *pool agreement*, which is between BU and the partner colleges, and an associated *pool quota*. These positions are associated with a pool agreement, and any student may be placed in them irrespective of their department or faculty at BU. There is a *faculty agreement* between the faculties at BU and the relevant faculties at partner colleges, and an associated *faculty quota.*[14] Students may be placed in positions associated with a faculty agreement, if they are from that faculty of BU. Finally, there is a *department agreement* between the departments of BU and the relevant departments of partner colleges, and an associated *department quota.* Students may be placed in positions associated with a department agreement if they are from that department of BU.

The existence of one type of agreement does not prohibit the existence of another. In other words, if there is a pool agreement between BU and a given college, this does not prevent a faculty of that college to have a faculty agreement with the relevant faculty of BU. Similarly, a department of that college is not prevented from having a department agreement with the relevant department of BU. Since each position has its own quota, if a student is placed in a position that is associated with a pool agreement, only the pool quota of this position is affected by this placement; the quota of the position associated with a faculty agreement or a department agreement remains intact.

Partner institutions submit *quotas* for each position they offer to the central authority. The central authority announces the positions along with their quotas, and students submit their *strict preferences* to the authority as a list of up to 12 positions, ranked from most to least preferred. If a partner institution has both a pool and a department agreement with BU, for instance, students from the relevant departments of BU can rank both the pool and the department position of this institution on their list separately.

[14] Here, the term faculty is used as a school of a college as in the Faculty of Economics and Business Administration, and not its teaching staff.

Having received students' preference lists, the central authority ranks students according to their *total university grades* in decreasing order. Each student is interviewed by the ERASMUS coordinator of their department, and receives an interview grade and a language proficiency grade after the interview. In addition, each student receives a university grade related to his or her grade point average (GPA). These three grades add up to a total university grade.

A selection procedure, hereafter called the *BU mechanism*, is used to select students to place in positions. The BU mechanism is a *two-stage* process. Having ranked students according to their total university grades in decreasing order, the central authority applies *serial dictatorship* in order to run the first stage. After the first stage matching is made, students matched with a position are given a certain period of time to confirm that they will attend the program. Some of the students who are matched with a position in the first stage may simply change their minds and decide not to participate in the program or they may become ineligible because of the GPA criterion.[15] These students are then removed from the market, and the positions occupied by them become vacant. The central authority announces these vacant positions along with their quotas and the second stage commences. Students may participate in the second stage only if they are not placed in a position in the first stage. Such students are asked to submit new preference lists to the central authority following its announcement of vacant positions. As in the first stage, serial dictatorship is applied in the second stage. Below is an explanation of the serial dictatorship mechanism, which is applied in both stages:

Step 1: The top-ranked student is placed in the top choice in her preference list (if applicable) and the quota of this position is decreased by one.

Step 2: The second-ranked student is placed in her top choice, if there still is room in this position. If this position is fully occupied, then her second choice is considered and she is placed to her second choice. Following the placement, the quota of this position is decreased by one.

⋮

Step k: The k^{th}-ranked student is placed her top choice, if this position is not fully occupied and the quota of this position is decreased by one. If there is no room left in this position, then her second choice is considered; if there is still space, she is placed in her second choice and the quota is decreased by one. If not, then her third choice is considered, and so on, until she is placed in one of her choices that is not fully occupied, and the quota

[15] Students are removed from the market due to the GPA criterion if their GPA drops to below 2.5/4.0 after the placements are made.

is decreased by one. If each one of her choices is fully occupied, then she is placed in the no-position option, which means the student cannot be matched with a position.

The procedure terminates either if all students have their turn or if all positions are fully occupied, meaning that the preferences of the remaining students will not allow new matches due to quota restrictions.

The following example illustrates how the BU mechanism works:

Example 1:

Let $S=\{s_1,s_2,s_3,s_4,s_5\}$ be the set of students and $X=\{x_1,x_2,x_3\}$ be the set of the positions. Let each position have a quota of one, so that at most one student may be placed in each. Further assume that, because of department or faculty restrictions, the subset of students $S_1=\{s_1,s_2,s_5\}$ can apply to x_1; $S_2=\{s_3,s_4\}$ can apply to position x_2; and all students can apply to x_3. Suppose that the total university grades of the students decrease as their subscripts increase, such that student s_1 has the highest total university grade and student s_5 the lowest. Let the submitted preference lists of the students be as follows:

s_1	s_2	s_3	s_4	s_5
x_1	x_1	x_3	x_3	x_1
x_3	x_3	x_2	x_2	x_3

The table above depicts each student's preferences as an ordered list where positions are ranked from most to least preferred. If students do not specify a position in their preference list, this implies that they prefer not to be matched with that position.

In the first stage, student s_1's is placed in position x_1 after her preferences are considered. The quota of this position is decreased by one and hence becomes zero, meaning that this position is fully occupied. Next, it is student s_2's turn, who cannot be placed in her top choice due to quota restrictions, and is thus placed in position x_3. Continuing in this manner, the first stage results in the following matching,

$$\begin{pmatrix} s_1 & s_2 & s_3 & s_4 & s_5 \\ x_1 & x_3 & x_2 & x_0 & x_0 \end{pmatrix}$$

where position x_0 denotes being unmatched. Suppose that student s_3 withdraws from the program. Then, position x_2 becomes vacant and students that were not placed in a position are expected to submit new preference lists. Student s_5 cannot apply to the only position

available, which now has room for one student, namely position x_2, thus student s_4 is the only student who submits a new preference list as follows:

$$\frac{s_4}{x_2}$$

Then, student s_4 is placed in position x_2 and the second stage ends. Hence, the mechanism yields the following final matching:

$$\begin{pmatrix} s_1 & s_2 & s_3 & s_4 & s_5 \\ x_1 & x_3 & x_0 & x_2 & x_0 \end{pmatrix}$$

One crucial observation is in order: Students are asked to submit strict preferences to the central authority, and placements are made accordingly. In fact, choosing among a college and the relevant faculty and the relevant department positions of that college should make no difference to a rational student, since each of these different positions would lead her to the relevant department of that college. In other words, if three different types of agreement exist with, say Utrecht University—a pool agreement, a faculty agreement of Faculty of Economics and Administrative Sciences, and a department agreement of Economics Department—from a consequentialist point of view, an economics major should be indifferent among these three positions, since she will end up being placed in the Economics Department of Utrecht University, if admitted.[16]

Students may break the indifference by applying a *pool priority rule*, which means that they prefer a position associated with a pool quota to another position, which is associated with the relevant department quota of the same partner institution. Another way of breaking the indifference is to apply a *department priority rule*, which is to favor the position associated with the relevant department quota of a partner institution more than the position associated with the pool quota of the same partner institution. Finally, students may randomize between these two rules by not following any specific rule and simply break the indifference by, say, tossing a coin, which is referred as the *random rule*.[17] As will

[16] Actually, students may also be indifferent to specific positions that are offered by different partner institutions, but eventually will be forced to rank order such indifferences prior to submission. Such instances of indifference are person-specific and also a "knife-edged" phenomenon, as described by Roth and Sotomayor (1990). Thus, the focus here is solely on being indifferent to different positions offered by the same partner institution.

[17] Faculty agreements are not focused on here, hence a faculty priority rule is not mentioned, since comparing the pool priority rule with the department priority rule is similar to and stronger than comparing the department priority rule with the faculty priority rule. Consequently, faculty agreements and hence faculty quotas are ignored in the analysis.

be discussed below, how students break ties will have consequences not in terms of their own placement but that of other students.

3. Properties Satisfied by the BU Mechanism

The solution to a placement problem is *matching* students with positions such that no position is assigned to students in excess of its quota, and no student is matched with more than one position. Some students may also be unmatched. There are various properties that are desirable for a placement mechanism to satisfy. In this section, a set of desirable properties, viz. individual rationality, non-wastefulness, fairness, Pareto-efficiency, and strategy-proofness, will be described, and whether or not the BU mechanism satisfies them will be discussed.

Individual rationality: A matching is *individually rational* if none of the students is assigned to a position they do not wish to attend. A mechanism is *individually rational* if it always picks an individually-rational match. If students are indeed rational, then they would not include a position in their rank order list that is unacceptable to themselves. Since they are placed only according to their submitted preferences, the resulting matching outcome, hence the mechanism used at BU, is individually rational.

Non-wastefulness: A matching is *non-wasteful* if, whenever student prefers a position to her placement, there is no empty slot at that position under the current matching. A mechanism is *non-wasteful* if it always picks non-wasteful matching. The BU mechanism fails to satisfy non-wastefulness because of two reasons: First, students are restricted to submit a preference list of a certain length (up to 12 positions) to the central authority. Therefore, students may not be able to submit all the positions acceptable to them. If students remain unmatched during the selection process (i.e. if all their choices were considered but could not be matched due to quota restrictions), and acceptable positions not on their list are still vacant, then the mechanism is wasteful.

Second, according to the BU mechanism, students placed in a position in the first stage are not allowed to partake in the second stage. Consider a situation where students are matched with a position in the first stage, and another position they prefer more than their current match becomes available in the second stage that is not fully occupied by students with higher total university grades. In this case, the matching outcome, hence the mechanism, is wasteful.

Fairness: A matching is *fair* if, whenever student s_1 finds student s_2's assignment more preferable, s_1 ranks below s_2 in terms of scores.[18] A mechanism is *fair* if it always picks a fair matching. A one-stage serial dictatorship is a fair mechanism, which can be argued as follows (Balinski and Sönmez, 1999): according to serial dictatorship, the preferences of students with higher total university grades are considered before the preferences of students with a lower total university grade. In addition, each student's preferences are considered according to her submitted list; hence a position favored by one student is considered earlier if it is ranked higher on her list. In cases where students with higher total university grades are matched with positions that are not their top choice, then the positions on their preference list, which are ranked above the position they are matched with, should already be fully occupied. Thus, another student with a lower total university grade cannot be matched to one of these positions either, and hence, fairness is guaranteed.

The BU mechanism, however, fails to satisfy fairness. Since only those students who have not been matched with a position in the first stage participate in the second stage, fairness may fail to be satisfied, if a student is matched with a position in the second stage that is preferred by another student with a higher total university grade, but who was already placed in a less favored position. To better illustrate how the fairness property fails, a sample situation is constructed below:

Let $S=\{s_1,s_2,s_3\}$ be the set of students and $X=\{x_1,x_2\}$ be the set of positions with each position having a quota of one. Further assume that every student can apply to each position, and all students find all positions acceptable. Assume that student s_1 has the highest grade and student s_3 has the lowest grade of all. Let students have common preferences such that their submitted preference lists are as follows:

s_1	s_2	s_3
x_1	x_1	x_1
x_2	x_2	x_2

After the first stage, the following matching is made:

$$\begin{pmatrix} s_1 & s_2 & s_3 \\ x_1 & x_2 & x_0 \end{pmatrix}$$

Now assume that student s_1 withdraws from the program and position x_1 becomes available. Student s_3 is the only student who has not been placed in a position, and thus will be the only student who takes part in the second stage. Submitting a preference list with only

[18] This property is also known as the elimination of justified envy.

position x_1 on it, s_3 will be matched with this position. Thus, after the second stage, the following matching is made:

$$\begin{pmatrix} s_1 & s_2 & s_3 \\ x_0 & x_2 & x_1 \end{pmatrix}$$

Student s_2 has a higher score but nonetheless is matched with a second ranked choice, while a lower ranked student occupies a top choice—thus fairness fails to be satisfied.

Pareto Efficiency: A matching *Pareto dominates* another matching if no student is worse off and at least one student is better off. A matching is *Pareto efficient* if it is not Pareto dominated by another matching. A mechanism is Pareto efficient if it always picks a Pareto efficient matching. Under strict student preferences, the one-stage serial dictatorship induced by students' ranking according to score is the unique Pareto efficient and fair mechanism (Balinski and Sönmez, 1999). If it were the case that there are either pool or department agreements for each college but not both, then there would be no indifferences in students' true preferences. Then, the unique fair outcome induced by simple serial dictatorship is Pareto-efficient.

However, when there is both pool and department quota for the same partner institution, depending on how students break indifferences, the resulting fair and Pareto efficient matching will be different. The following example illustrates the situation.

Example 2:

Let $S=\{s_1,s_2,s_3\}$ be the set of students and $X=\{x_1,x_2,x_3\}$ be the set of positions such that x_1 and x_2 are the positions of the same partner institution with x_1 being the position associated with pool agreement and x_2 being the position associated with department agreement, and x_3 is the position of another partner institution associated with department agreement. Assume that each position has a quota of one, the position x_3 is not applicable for s_1 and s_3 but applicable for s_2, and the position x_2 is not applicable for s_2 but is applicable for s_1 and s_3. Suppose also that s_1 has the highest grade and s_3 has the lowest grade of all. Let the preferences of students be as follows: student s_1 is indifferent between x_1 and x_2; student s_2 strictly prefers x_1 to x_3; and student s_3 is indifferent between x_1 and x_2. Now, if students apply the pool priority rule, then the submitted preferences of the students are;

s_1	s_2	s_3
x_1	x_1	x_1
x_2	x_3	x_2

The serial dictatorship places student s_1 in position x_1, student s_2 in position x_3, and student s_3 in position x_2; so the resulting matching is as follows:

$$\begin{pmatrix} s_1 & s_2 & s_3 \\ x_1 & x_3 & x_2 \end{pmatrix}$$

On the other hand, if students applied the department priority rule, then the submitted preferences would be;

s_1	s_2	s_3
x_2	x_1	x_2
x_1	x_3	x_1

This time serial dictatorship places student s_1 in position x_2, student s_2 in position x_1, and student s_3 is unmatched with a position; i.e. the following matching is made:

$$\begin{pmatrix} s_1 & s_2 & s_3 \\ x_2 & x_1 & x_0 \end{pmatrix}$$

Student s_1 is indifferent to the two rules, whereas student s_2 prefers the department priority rule to the pool priority rule, and student s_3 prefers the pool priority rule to the department priority rule. Either s_2 gets the better position at the expense of s_3 or *vice versa*.

As observed, applying the pool priority rule favors some students at the expense of others, and applying the department priority rule reverses the situation. By applying the pool priority rule, students from a department with high total university grades may obstruct other students from different departments to be placed in positions that are associated with pool quotas of partner institutions. Doing this, they enable weaker students from the same department to occupy positions associated with the relevant department quotas of the same partner institutions.

Applying the department priority rule, on the other hand, has an opposite effect. Students from a department with high total university grades obstruct other students from the same department with lower total university grades by occupying positions that are associated with relevant department quotas of partner institutions. Other students from different departments with total university grades higher than the obstructed students will then occupy positions that are associated with pool quotas of the same partner institutions.

Strategy-proofness: A matching is *strategy-proof* if no student is able to secure a better position by misrepresenting her preferences. A mechanism is strategy-proof if it always picks strategy-proof matching. Let P_s be the true preference of student *s* and *x* be the position she is placed in. Let us assume that student *s* aims to misrepresent her true preferences and be placed in a position she ranks higher than *x*. However, since each position favored more than position *x* is already occupied by other students with higher total university grades, student *s* cannot be placed in a position that is more preferable than *x*. Hence, student *s* cannot secure a better position by misrepresenting her true preferences, and therefore the mechanism is strategy-proof.

However, as mentioned earlier, applying the pool priority rule or applying the department priority rule favors some students at the expense of some others. This fact suggests the possibility of *coalitional manipulation*. Coalitional manipulation simply means that for a set of agents (here students), some agents in the coalition are better off and the remaining ones are not worse-off by misrepresenting their preferences (Martinez et al., 2004).

Consider for example a coalition of students who belong to the same department. If the objective of a department is to place as many of its students as possible to positions offered by partner institutions, and if this department has students with both high and comparatively lower total university grades, then this department may advise its students to apply the pool priority rule to facilitate the placement of its lower ranked students.

4. Data Analysis and Policy Proposals

In this section, actual data of the 2009-2010 exchange market for outgoing BU students are used, which consist of students preference lists, the quotas for each position, and the actual final matching. The data also include non-ERASMUS agreements; however, the same procedure is used in both markets. First, some statistical facts about the data and the final matching will be presented.

There were 634 quotas at 274 different positions in 194 partner institutions.[19] A total of 481 students applied to the exchange program; 368 were placed in a position in the first stage and the remaining 113 were unmatched. Of 368 who were placed in a position in the first stage, 296 students confirmed their participation in the program and the remaining 72 either changed their minds or became ineligible and hence were removed from the market. Though the number of positions exceeded the number of students who applied to

[19] Of the total, there were 482 quotas at 220 different positions in 141 partner institutions in the ERASMUS exchange market.

the exchange program, there were still students who were not placed in a position and there were positions that were not associated with a student. This means that some positions were not acceptable to any students.

Of 113 who were not placed in a position in the first stage, 59 students participated in the second stage and the remaining 54 did not submit new preference lists for the second stage, which means that they did not want to take part in the second stage. In the second stage, 46 students out of 59 were placed in a position and 13 remained unmatched. Of 46, 15 students either withdrew from the program or became ineligible and hence were removed from the market and the remaining 31 guaranteed their study abroad.

Altogether, 327 students were placed in a position—296 in the first stage and 31 in the second stage—and 154 students either did not find placement or removed from the market. Among all students who applied, 78 submitted 12 choices to the central authority (which is the maximum number of choices allowed); 10 of them were not placed in a position in the first stage. The reason for this may be traced to the restriction put on the quantity of submitted preferences. Eight students out of 10 participated in the second stage and two of them failed to find placement in the second stage as well.

Considering the actual data from 2009-2010, one observation immediately emerges: The rationality assumption for students fails to hold for some students. Nineteen students out of the 481 listed only the pool quota or the relevant department quota (without violating the eligibility criterion) of a partner institution, but not both positions simultaneously; yet, as mentioned, these positions lead students to the same places, namely to the relevant department of that partner institution. These students did not submit 12 choices (which is the maximum quantity allowed), so this behavior cannot be justified by the restriction put on the quantity of submitted preferences. Since these students should be indifferent to these two positions, according to the rationality assumption, they should have submitted both of these positions, and furthermore, these two positions should have been submitted consecutively. There were two other students who submitted both these positions but not consecutively: the pool position and the department position at Utrecht University were the seventh and the eleventh choice of Student 40, respectively, and the department position and the pool position at Utrecht University was the third and the sixth choice of Student 363, respectively.

Another observation that implies the failure of the rationality assumption for some students is that some listed positions they were ineligible for. Ignoring applicability, or equivalently eligibility, caused them to waste one (or sometimes more) choice(s). Hence, the rationality assumption seems not to hold for some students. This may indicate they did

not fully understand the selection procedure being used, and thus were unaware of the existence and meaning of the different types of quotas.

Based on the analysis in the previous section, some policy recommendations will now be made that will improve the matching outcomes.

Proposal 1: Removing the restriction on the length of the rank list students submit.

Discussion: As shown above, restricting the length of the submitted preference list may cause the non-wastefulness property to fail. However, officials who deal with these lists have raised concerns regarding the practicality of relaxing the limit on the list. First, if there are too many applicable positions that are also deemed acceptable by too many students, then it may become extremely difficult to deal with the preferences that students submit. Second, the main hesitation of the central authority on this issue is that the rationality of students cannot be taken for granted. Students may simply submit a preference list without considering whether a given position is acceptable to them or not. Thus, keeping this restriction may prevent students from submitting every applicable position as though each of these positions were also acceptable to them. However, neither concern seems to be warranted from the observation of the data.

Data Analysis: Proposal 1 aims to guarantee the satisfaction of non-wastefulness. Improvements resulting from modifying the mechanism according to Proposal 1 may be observed by randomly assigning additional positions to preference lists submitted by students that respect applicability. Especially those 10 students who submitted 12 choices but were not placed in a position in the first stage should be observed to see if some will find placement after the modification of the mechanism. However, while randomly assigning additional positions to the submitted preference lists, acceptability may fail to be satisfied. Assigning an applicable position randomly does not guarantee acceptability of that position by the student. Therefore, in order to support the theoretical results with actual data, true student preferences are required.

Proposal 2: Placements made in the first stage should be tentative in the sense that every student should participate in the second stage after some (if any) of the students withdraw from the program or become ineligible. In the second stage placement, the already submitted preference lists of the students should be considered.

Discussion: Practically, it is useful to have a second stage to place unmatched students in a market where there might be vacancies following the first stage placements. Vacancies arise, as discussed above, due to uncertainties in the students' academic performance and/or financial situation, or simply because they change their mind and

withdraw from the market. In its current implementation, the presence of a second stage placement may cause the failure of both fairness and non-wastefulness.

If there were only one stage, then both fairness and non-wastefulness would be satisfied if the restriction on the quantity of the submitted preferences were lifted. Making the first stage placements tentative translates to making the selection procedure work as a one-staged process. The first stage would thus remove all the students who changed their minds and withdrew from the program or become ineligible, and the second stage would be the real selection stage. Since students' total university grades do not change in the second stage and no additional students are included, the rank of every student would either remain the same or increase compared to the first stage, thus they would be placed either in the same position as they were tentatively placed, or in a position more favorable than the tentative placement. Furthermore, none of the students can occupy a position that is preferred by another student with a higher total university grade, since all students participate in the second stage. Thus, fairness is satisfied.

The only problem with the proposed modification arises if students' preferences change over time. This may result from them being unsure of their true preferences during the first stage, or receiving new information about school characteristics that cause them to compile a differently ranked list. Or their genuine school preferences may be interdependent in the sense that their ranking are not simply over positions but rather over who these positions are matched with. Thus, after the first-stage placements are realized, having observed the matching, students revise their ranking list.[20]

Data Analysis: Following Proposal 2, placements made in the first stage will be considered tentative. Then, having removed those students from the market who changed their minds and withdrew from the program or became ineligible, the serial dictatorship will be applied once again including all students who are not removed from the market for the second stage, and final placements will be determined. Finally, resulting placements will be compared to placements made by the current mechanism, to observe the improvement.

Before comparing the resulting placements, let us examine a particular case to observe how the new placements, which result by using the modified mechanism, are

[20] In fact, officials raised concerns over abolishing the new preference submission in the second round on the grounds that this would limit students' choice. However, it should be noted that while the submission of new preferences favors students who enter the second round, it might hurt those who confirm their match at the end of the first round. Then, the decision to be made depends on the relative weight put on the welfare of the two groups.

obtained. The students who were ranked 33rd and 40th according to total university grades were both placed in the University of Amsterdam in the first stage, and were then removed from the market either because they changed their mind or they became ineligible. Consequently, the central authority announced two quotas for this position before the second stage. In the second stage, the 177th student was the only student placed in this position. Students who were ranked 74th and 84th were placed in Utrecht University and Fontys University of Applied Sciences, respectively. Utrecht University was the third choice of the 74th student and Fontys University of Applied Sciences was the third choice of the 84th student. Since both students were placed in their third choices in the first stage, they could not participate in the second stage. However, both indicated a preference for the University of Amsterdam over their current placements. The University of Amsterdam was the second choice of the 74th student, and the top choice of the 84th. In other words, both would have liked to be placed in this position instead of their current placements. Also, they both had higher total university grades than the 177th student. Hence, the failure of fairness is noticeable. In addition, the failure of non-wastefulness should also be observed, since it was announced that the University of Amsterdam had two quotas prior to the second stage, and only one student was placed there. While applying the modification, the first stage placements of the 74th and 84th students will be made tentative, so that they may be placed in the University of Amsterdam in the second stage and fairness will be satisfied. Having placed them in the University of Amsterdam, the positions they tentatively occupy will have one additional quota, and it will be possible to place other students in these positions according to their preferences.

Table 1 shows the improvements obtained by modifying the mechanism. All the placements resulting from the current and modified mechanisms will not be reported here; the focus will be on those students whose placements changed after applying the modified mechanism, and their new placements, to observe the improvement.

Table 1: Comparison of the current and modified mechanisms.

Student Rank	Current Placement (CP)	Rank of CP	New Placement (NP)	Rank of NP
74	Utrecht Uni.	3	Uni. of Amsterdam	2
84	Fontys Uni.	3	Uni. of Amsterdam	1
125	Heinrich Heine Uni.	4	Uni. of Erfurt	2
149	Tilburg Uni.	2	HEC Uni.	1
177	**Uni. of Amsterdam**	**3**	**Uni. of Erfurt**	**6**
184	Uni. of Aarhus	6	Uni. of Erfurt	2
198	Heinrich Heine Uni.	7	Uni. of Aarhus	4
205	Michigan State Uni.	6	Utrecht Uni.	1

218	Uni. of Gent	6	Utrecht Uni.	4
227	Uni. Catholique Louvain	3	Tilburg	2
230	Uni. Catholique Louvain	4	Tilburg	3
239	Roskilde Uni.	4	Utrecht	3
249	Uni. of Maastricht	4	Uni. of Gent	1
251	Uni. Catholique Louvain	4	Tilburg	3
263	Jönköping Uni.	7	Uni. of Gent	5
272	Uni. North Carolina	6	Uni. of Aarhus	4
292	Uni. Jyvaskyla	9	Uni. of Gent	7
295	Euromed Marseille Uni.	8	Uni. Catholique Louvain	7
305	Uni. Maalardalen	9	Uni. Catholique Louvain	5
323	Uni. of Aarhus	4	Uni. of Uppsala	3
325	Tallinn Uni.	5	Uni. of Aarhus	4
329	**Uni of Erfurt**	**4**	**Not nominated**	
338	Victoria Business Uni.	6	ERASMUS Uni.	4
372	Uni. North Carolina	5	Uni. of Aarhus	2
382	**Uni. of Gent**	**3**	**Uni. Catholique Louvain**	**5**
383	**Utrecht Uni.**	**1**	**Uni. of Maastricht**	**2**
384	**Uni. of Maastricht**	**5**	**Not nominated**	
390	West Virginia Uni.	6	Michigan State Uni.	4
393	Uni. of Alberta	3	Uni. of Aarhus	1
420	Jönköping	4	ZHW	1
425	**Uni. of Gent**	**2**	**Stockholm Uni.**	**4**
429	**Tilburg**	**1**	**Uni. Köln**	**3**

Table 1 shows that the placement of 32 students changed when the modification was applied to the data; 25 of them are better off and 7 of them are worse off. Although an improvement in terms of Pareto efficiency is not the case, an improvement in terms of fairness is obtained.

Students whose current and new placements are written in bold in the table above are the ones who are placed in the second stage of the BU mechanism currently used. They

are worse-off by the modified mechanism, since it was they who initially caused the fairness property to fail.

Proposal 3: The set of objects that students are asked to submit a preference list from should be the set of colleges rather than the set of positions. If some institutions in the exchange market have both the pool and the department quota, then the central authority should adopt a pre-announced rule on how to break ties rather than leaving it up to the student to rank colleges that offer both the pool and the department positions on their lists.

Discussion: As mentioned earlier (assuming that students are rational), students are indifferent to different positions offered by partner institutions that lead them to the same place, namely the relevant department of that partner institution. Since they are expected to submit strict preferences to the central authority, they can apply different types of rules to break indifferences. As shown, different rules to break these indifferences favor some students over others, and hence some departments over others, as a result of which there are multiple Pareto efficient and fair matching outcomes. Leaving this decision to students creates randomness in outcomes where one's behavior has consequences not for oneself, but for others. This not only creates confusion among students (students exhibit irrationality in ranking institutions that have different types of agreements, as seen below in data analysis), but also leads to a non-transparent system by giving departments an incentive to manipulate the outcome in favor of their students. This can be avoided by asking students to simply submit their preferences for partner institutions, while the central authority itself may implement a desirable, pre-announced priority rule. Obviously, the main policy parameter that the authority would need to decide on would be the tiebreaker rule.

Data Analysis: Proposal 3 tries to modify the mechanism to make it transparent and remove the possibility of coalitional (departmental) manipulation. In the data analyzed there is only one partner institution, Utrecht University, which offers both a pool position and some department positions simultaneously.[21] Since Utrecht University stands alone in this regard, the effect of Proposal 3 cannot be supported by the data at hand. Students who are placed in Utrecht University through pool quota are all students from departments without a department agreement. However, example 2 above illustrates how an instance of coalitional manipulation may come into play.

[21] These are the departments of Physics, Political Science and Psychology.

5. Concluding Remarks

In 2010, 34 countries exchanged 213,266 students as part of the ERASMUS exchange program for student mobility. BU has been participating in the program since 2004 and in the past six years (as of the academic year 2009-2010), 767 outgoing students visited partner institutions and 637 incoming students visited BU in exchange. When non-ERASMUS exchange students are included, these numbers climb to 1,221 and 1,058 for the outgoing and incoming students, respectively. In 2011, 613 students from BU applied to be an ERASMUS exchange student and 464 of them were placed in positions at partner institutions.

In this paper, we modeled the ERASMUS exchange market for outgoing BU students as a placement problem, and analyzed the properties of the mechanism used to match students with positions in partner institutions. We have shown that the BU mechanism used in 2009-2010, two-stage serial dictatorship, satisfies individual rationality, Pareto-efficiency and strategy-proofness, but fails to satisfy non-wastefulness and fairness, and is not immune to coalitional manipulation.

The non-wastefulness property fails to be satisfied both because of the restriction put on the length of the list of preferences students submit and because matching is finalized in the first stage before moving into the second stage. We offer that restrictions on the length of preference list should be lifted. In addition, placements in the first stage should be kept tentative, and the algorithm in the second stage should be applied to the whole market participants, including those who are placed in the first stage. This not only overcomes wastefulness, but also makes the matching outcomes fair. We used the actual data from 2009-2010 to verify the improvements that can be achieved by keeping first stage placements tentative.

Although the BU mechanism is strategy-proof, it is not coalitional strategy-proof. The reason for this is that the mechanism relies on strict student preferences regarding positions. However, this does not need to be the case if a partner institution offers both a pool position to which all students may apply, and some department positions, to which only students in the relevant department may apply. In cases of indifference, applying different tiebreaking rules so that strict preferences may be submitted to the central authority favors different students and hence different departments. While none of the students can secure a better position by applying different rules to break indifferences, the rules they apply affect other students. Consequently, departments may manipulate the mechanism by advising their students with departmental interests in mind, i.e. to send a higher number of students to more desired positions. To overcome this problem, we proposed that rather than relying on students' choice of breaking indifferences, the central authority itself may announce *ex ante* and apply the desirable priority rule. This makes the mechanism more transparent and removes the room for departmental manipulations.

Moreover, one common criterion the authorities use in measuring the success of a placement mechanism is to focus on the number of students who are matched with their first choice. This, however, is not a good measure of fit if the mechanism is not immune to strategic manipulation. If students, rather than revealing their genuine rank order, submit their lists by strategically excluding those top schools that they think very difficult to get in, a criterion that defines success as the percentage of students being matched with their top choice would of course be misleading, as they will be based on revealed preferences instead of genuine ones.[22]

The main message for the authorities that design the selection procedure in a placement problem is that the rules introduced for practical concerns may create problems that are not immediately visible. A systematic approach is therefore required to test whether the matching outcome and the mechanism used to this end satisfy desirable properties. A mechanism should be easy to understand, fair, immune to misrepresentation of private information, and Pareto efficient. In the ERASMUS exchange market, if students' preferences are independent of one another and if students have full knowledge of their own preferences, then a mechanism that satisfies the above properties exists, which is the serial dictatorship with tentative placement in the first stage. If students' genuine preferences are interdependent, then we cannot guarantee the existence of individually-rational and fair mechanisms for any preference profile.[23] If, on the other hand, students are not sure of their rankings, this may be overcome with the help of advisors who would discuss the characteristics of each possible position available to the student to determine which suits her needs best, which will then facilitate the ranking of positions.

[22] The old mechanism, known as the Boston mechanism, was used to match K-12 students with schools in Boston, and suffered from this fallacy as well (Abdülkadiroğlu et al., 2005).
[23] See Mumcu and Saglam (2010) for a matching model with interdependent preferences.

Acknowledegement

This paper is based on Ekrem Akkaya's MA thesis (Akkaya, 2010). We are grateful to Şermin Abdullah, İrem Afşar, Hasan Bedir and Nilüfer Özyurt for providing us relevant data and information on the mechanism used at Boğaziçi University. We thank Fikret Adaman, Begüm Özkaynak and İsmail Sağlam for useful comments and discussions. The usual caveat applies.

References

Abdülkadiroğlu, A. and T. Sönmez (2003) "School Choice: A Mechanism Design Approach," *American Economic Review*, 93, 729-747.

Abdülkadiroğlu, A., P.A. Pathak, A.E. Roth, and T. Sönmez (2005) "The Boston Public School Match," *American Economic Review, Papers and Proceedings*, 95(2), 368-371.

Abdülkadiroğlu, A., P.A. Pathak, A.E. Roth, and T. Sönmez (2006) "Changing the Boston School Choice Mechanism," *The National Bureau of Economic Research*, January 2006, w11965.

Akkaya, E. (2010) "Erasmus Exchange Program: A Placement Problem," Unpublished MA thesis. Department of Economics, Boğaziçi University, Turkey.

Gale, D. and L. Shapley (1962) "College Admissions and the Stability of Marriage." *American Mathematical Monthly*, 69, 9-15.

Maiworm, F. (2001) "ERASMUS: Continuity and Change in the 1990s" *European Journal of Education*, 36 (4), 459-472.

Martinez, R., J. Massó, A. Neme, and J. Oviedo (2004). "On Group Strategy-proof Mechanisms for a Many-to-one Matching Model," Unitat de Fonaments de l'Anàlisi Econòmica (UAB) and Institut d'Anàlisi Econòmica (CSIC) in its series UFAE and IAE Working Papers with number 577.03.

Messer, D and S.C. Wolter (2007) "Are Student Exchange Programs Worth It?," *Higher Education*, 54, 647-663.

Mumcu. A and I. Saglam (2010) "Stability of One-to-One Matchings with Externalities," *Mathematical Social Sciences*, 60 (2), 154-159.

Sönmez, T. and M.U. Ünver (2011). "Matching, Allocation, and Exchange of Discrete Resources," in: J. Benhabib, A. Bisin, and M. Jackson (eds.), *Handbook of Social Economics*, Vol. 1A. The Netherlands: North-Holland, (2011) 781-852

Roth, A.E. (1984) "The Evolution of the Labor Market for Medical Interns and Residents: A Case Study in Game Theory," *Journal of Political Economy*, 92, 991-1016.

Roth, A.E. and E. Peranson (1999) "The Redesign of the Matching Markets for American Physicians: Some Engineering Aspects of Economic Design," *American Economic Review*, 89, 748-780.

Roth, A.E., T. Sönmez, and M.U. Ünver, (2005) "A Kidney Exchange Clearinghouse in New England," *American Economic Review, Papers and Proceedings*, 95, 2, 376-380.

Roth, A.E and M.A. Sotomayor (1990) *Two sided matching: A study in game-theoretic modeling and analysis.* Econometric Society Monographs, No.18.

Teichler, U. (2004). "Temporary Study Abroad: The Life of ERASMUS Students," *European Journal of Education*, 39 (4), 395-408.