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Implementing quotas in university admissions: An experimental analysis

Sebastian Braun [a], Nadja Dwenger [b], Dorothea Kübler [c,*], Alexander Westkamp [d]

[a] Kiel Institute for the World Economy, Hindenburgufer 66, 24105 Kiel, Germany
[b] Max Planck Institute for Tax Law and Public Finance, Department of Public Economics, Marstallplatz 1, 80539 Munich, Germany
[c] WZB Berlin and Technical University Berlin, Reichpietschufer 50, 10785 Berlin, Germany
[d] Department of Economics, University of Maastricht, P.O. Box 616, 6200MD Maastricht, The Netherlands

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ABSTRACT

This paper studies the implementation of quotas in matching markets. In a controlled laboratory environment, we compare the performance of two university admissions procedures that both initially reserve a significant fraction of seats at each university for a special subgroup of students. The first mechanism mimics the sequential procedure currently used by the central clearinghouse for university admissions in Germany. This procedure starts by allocating reserved seats among eligible students and then allocates all remaining seats among those who were not already assigned one of the reserved seats in the first part of the procedure. The second mechanism is based on a modified student-proposing deferred acceptance algorithm in which all seats are allocated simultaneously. In theory, the two mechanisms should lead to similar outcomes. Our experimental results, however, suggest that, relative to the sequential procedure, the simultaneous mechanism significantly improves the match outcomes for the beneficiaries of reserved seats.

1. Introduction

Affirmative action constraints play an important role in school choice and university admissions. For example, students from minority groups in the population often receive preferential treatment in school choice programs. This can be implemented by introducing *quotas* for minority students, that is, reserving some seats at each school for students belonging to this group.[1] Such minority seats must be opened up to majority students in case there is insufficient demand from minority students. Otherwise, minority quotas may make all students, including those belonging to the minority, worse off compared to a situation without affirmative action constraints (Kojima, 2012). But *how* are quota systems and affirmative action constraints best implemented in practice? To the best of our knowledge, this paper is the first experimental study of this problem. It complements a growing theoretical literature on matching mechanisms with flexible quota systems, including Abdulkadiroglu (2010), Echenique and Yenmez (2013), Ehlers et al. (2012), Hafalir et al. (2013), Kamada and Kojima (2010), Kominers and Sönmez (2013), and Westkamp (2013).

* Corresponding author.
E-mail addresses: sebastian.braun@ifw-kiel.de (S. Braun), nadja.dwenger@tax.mpg.de (N. Dwenger), dorothea.kuebler@wzb.eu (D. Kübler), a.westkamp@maastrichtuniversity.nl (A. Westkamp).

[1] Equivalently, one can limit the number of majority students allowed to attend each school, as in Abdulkdadiroglu and Sönmez (2003). See Abdulkdadiroglu and Sönmez (2003), Abdulkadiroglu et al. (2005, 2006) for several examples of affirmative action constraints in matching mechanisms.

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In our experiment, we implement two matching mechanisms with quotas in a controlled laboratory environment with complete information and compare their performance. The first mechanism is a simplified version of the centralized procedure currently used to allocate seats in medicine and related subjects at German universities.[2] The German mechanism is *sequential*: in the first step, a significant number of seats are allocated among applicants who have performed exceptionally well in high school (henceforth: *top-grade students*) on the basis of these students' preferences and exogenously given priorities using the well known *Boston mechanism*;[3] in the second step, all remaining seats are allocated among remaining applicants on the basis of students' preferences and criteria determined by the universities using the *deferred acceptance* algorithm of Gale and Shapley (1962).[4] Students are allowed to submit two lists – one for the first, and one for the second part of the procedure.

The second mechanism we implemented in our experiment uses a modified version of the student-proposing deferred acceptance algorithm that was recently proposed by Westkamp (2013). This mechanism allocates all seats *simultaneously* while respecting the quota structure of the German system. In each round of the algorithm, a "regular" student can claim a seat reserved for a top-grade student only if no such student has demanded that seat yet. This is radically different from the sequential mechanism, where a regular student can claim a seat initially reserved for top-grade students if it has not been allocated in a reduced problem in which *only* these seats are available to top-grade students. This difference has important consequences: the simultaneous mechanism is strategy-proof for top-grade students, while the sequential mechanism induces a difficult trade-off between securing a match in the first part, but possibly at a lower ranked university, and competing without priority for a seat in the regular quota. Our goal is to evaluate experimentally how students resolve such trade-offs and how this affects the performance of a matching mechanism with quotas.

The relevance of this analysis is not limited to the specific context of the German university admissions system, since similarly structured strategic problems can be expected to arise in most sequential allocation procedures: Dur and Kesten (2012) show that if a set of objects is allocated by means of a two-step procedure such that (i) the mechanism used for the first step is non-wasteful and individually rational, and (ii) the mechanism used for the second step is non-wasteful, then the two-step procedure as a whole may be neither strategy-proof, nor efficient, nor non-wasteful. In particular, even if two strategy-proof mechanisms are pasted together, we cannot expect to obtain a strategy-proof sequential mechanism. Despite this deficiency, sequential mechanisms are used in practice to allocate goods in essentially static allocation problems. Apart from the German university admissions mechanism, examples are the allocation of teaching jobs in Turkey, where tenured positions are always allocated before fixed term contractual positions, and school choice systems in the US, where seats at so-called exam schools are often allocated before seats at regular schools.[5]

Our main result is that the simultaneous mechanism significantly improves the matching outcome of top-grade students relative to the current sequential mechanism. The sequential mechanism, designed to work in favor of top-grade students,[6] actually harms them. The reason is that top-grade students often fail to use the sequential system to their benefit. In particular, these participants often accept a relatively undesirable match in the first part of the procedure although a better match could have been obtained in the last part of the procedure. The differences between the two mechanisms persist also in later rounds of the experiment although they become smaller over time due to learning effects. Our findings suggest that the modified student-proposing deferred acceptance algorithm could be a valuable tool for redesigning university admissions in Germany – and seems also well suited to address matching problems with complex constraints in other contexts.[7]

Our experiments shed light on implementation issues in a matching environment. An interesting feature of our environment is that essentially all equilibria of the sequential mechanism yield the same outcome as the simultaneous mechanism under truth-telling. The crucial difference, however, is that top-grade students often have to misrepresent their preferences in order to reach this outcome. In our experiments we explained the basic strategic properties of the two mechanisms to participants (see Section 3.1 for details). We find that despite this advice, a significant share of participants fail to choose optimal manipulation strategies in the sequential mechanism – even in situations where weakly dominant strategies exist.

[2] The admissions market for medical disciplines is characterized by a dramatic shortage of available seats: in the winter term 2010/2011, there were 56 000 applicants for 13 000 places.

[3] In the actual German procedure, the priority based part consists of two completely separate sub-steps: one in which up to 20% of available capacity is allocated among top-grade applicants, and another in which up to 20% is allocated among waiting-time applicants. Waiting-time applicants typically have almost no chance of being admitted in the two-sided part of the procedure, see Braun et al. (2010). In the experiment we therefore take the group of students that receives preferred treatment to consist only of top-grade students.

[4] The actual German admissions procedure employs the university-proposing deferred acceptance algorithm in the second stage of the procedure. In the experiment, we chose to change this part of the procedure to the student-proposing variant in order to focus on the problems caused by the sequential assignment of seats. See Section 3.2 for details on the differences between the actual German admissions procedure and the version we implemented in our experiment.

[5] See Dur and Kesten (2012) for a theoretical analysis of the mechanisms used in these two examples.

[6] The quota for top-grade students was implemented in order to allow top-grade students to freely choose their university: "The ratio legis for this quota [the quota for top-grade students] is that the top-grade students can pick "their" university." (statement by the director of the German central clearing house, http://latnrw.de/lat-blog/wp-content/uploads/2012/11/doc20120827154027.pdf, accessed on February 2, 2013, translation by the authors).

[7] Westkamp (2013) shows that a generalization of the modified student-proposing deferred acceptance algorithm can handle much more complex constraints than those of the German system. For example, the mechanism can be used to implement the constraints that (1) x% of total capacity at a university/school should initially be reserved for a special group of applicants (e.g., siblings of existing students in case of school choice) and (2) any remaining capacity should be distributed equally among sexes. This is not possible with the type of affirmative action constraints considered in Abdulkadiroglu and Sönmez (2003).