From Boston to Shanghai to Deferred Acceptance: Theory and Experiments on a Family of School Choice Mechanisms

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Abstract

School choice has been one of the most important and widely-debated education policies in the past two decades, with game theory playing a major role in the adoption of school choice mechanisms. Similarly, college admissions in China have gone through many local experimentations, with a rich variety of mechanisms used in various provinces.

In this paper, we investigate a family of proposal-refusal school choice mechanisms, including the Boston, Shanghai, and Deferred Acceptance (DA) mechanisms as special cases, and spanning the entire class of the Chinese parallel mechanisms. In our theoretical analysis, we first present a family of *proposal-refusal* mechanisms in which each member is characterized by some positive integer $e \in \mathbb{N}_+$ of rounds through which the proposal and refusal process continues before assignments are made permanent. More precisely, the mechanism works as follows: During rounds 1 through e, students apply to schools in order of reported preference from the most preferred to the least, and schools tentatively admit applicants up to their capacity in order of priority going from the highest to the lowest. At the end of round e students tentatively held at a school are permanently accepted into that school. The remaining students participate in a new proposal and refusal process from round $e+1$ through round $2e$. The process continues in this fashion until no student remains unassigned.

It is quite easy to see that as e increases, we go from the familiar Boston mechanism ($e = 1$) to the Chinese parallel mechanisms ($e \in [2, \infty)$) which include the Shanghai mechanism ($e = 2$), and from those to the DA ($e = \infty$). In this framework, we find that, as one moves from one extreme member of this family to the other, the experienced trade-offs are in terms of efficiency, stability and strategic immunity. Within this family, Boston is the only Pareto efficient mechanism given truthtelling, and DA is the only mechanism that is strategy-proof and stable. We provide property-based rankings of the members of this family following the works of Kesten (2006ab) and Pathak and Sonmez (2011). Specifically, we show that the members of this family can be ranked according to their immunity against strategic action. Under certain restrictions on the problem domain, any given member is *more manipulable* than a member with a higher e number. On the welfare side, a more subtle comparison result emerges. The number

P. Coles et al. (Eds.): AMMA 2011, LNICST 80, pp. 58–59, 2012.

of students receiving their reported first choices diminishes with an increasing e. As far as stability or Pareto efficiency is concerned, the ranking is ambiguous within the general class of mechanisms while the Shanghai mechanism is *more stable* than the Boston mechanism which is *more efficient* than the Shanghai mechanism.

Since the theoretical efficiency ranking in this family of mechanisms assumes truthtelling, which is a dominant strategy only under DA, it is important to assess the behavioral response to members of this family. On a broader level, as the theoretical ranking for stability or Pareto efficiency is ambiguous, empirical rankings of aggregate performance measures for these mechanisms in different controlled laboratory settings are informative for policymakers in reforming school choice or college admissions.

For these reasons, we evaluate three members of this family in two environments in the laboratory. In both environments, we find that participants are most likely to reveal their preferences truthfully under the DA mechanism, followed by the Shanghai and then Boston mechanisms. Consistent with theory, DA achieves a significantly higher proportion of stable outcomes than either Shanghai or Boston. However, the efficiency comparison is sensitive to the environment.

Our empirical findings on the manipulability and stability of the Boston mechanism compared to DA are consistent with earlier experimental work on school choice. However, we differ from previous research in that we present the first experimental evidence for the performance of the Shanghai mechanism. Lastly, our theoretical characterization of the complete set of Nash equilibria provides a benchmark for analyzing the experimental data, which reveals that stable Nash equilibrium outcomes are significantly more likely to arise than the unstable ones even when the latter Pareto dominates the former. To our knowledge, this is the first experimental evidence on equilibrium selection in school choice mechanisms.