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Cognitive ability and games of school choice

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ABSTRACT

We take school admission mechanisms to the lab to test whether the widely-used manipulable Immediate Acceptance mechanism disadvantages students of lower cognitive ability and whether this leads to ability segregation across schools. Results show this to be the case: lower ability participants receive lower payoffs and are over-represented at the worst school. Under the strategy-proof Deferred Acceptance mechanism, payoff differences are reduced, and ability distributions across schools harmonized. Hence, we find support for the argument that a strategy-proof mechanism "levels the playing field". Finally, we document a trade-off between equity and efficiency in that average payoffs are larger under Immediate than under Deferred Acceptance.

1. Introduction

School choice provides access to good schools to otherwise disadvantaged students. Unsurprisingly then, notions of fairness and equality feature prominently in the public debate accompanying the selection of a particular school choice mechanism. In this paper, we pick up on an often voiced concern that strategically complex mechanisms may disadvantage students who are less able to identify optimal application strategies.

This concern was a key motivation for the Boston School Committee when in 2005, after two years of intense discussions, it replaced its Immediate Acceptance (IA) by the strategy-proof Deferred Acceptance mechanism (DA)[1] (Abdulkadiroğlu et al., 2006). As Superintendant Payzant summarized it at the time:

> A strategyproof algorithm "levels the playing field" by diminishing the harm done to students who do not strategize or do not strategize well.

Concerns for students who fail to strategize well under a manipulable mechanism were not limited to the city of Boston; for example, similar arguments were brought forward when Chicago abandoned its previously used mechanism in 2009 or when England ruled variants of IA illegal in 2007 (Pathak and Sönmez, 2013). Nevertheless, variants of the IA continue

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[1] See Subsection 2.1 for a detailed description of both mechanisms, also known as the Boston and Gale-Shapley mechanism.

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to be widely used around the globe, for example in Cambridge, Denver, Minneapolis, and Seattle (Kojima and Ünver, 2014), Barcelona (Calsamiglia and Güell, 2014), Berlin (Basteck et al., 2015) or Tallinn (Veski and Põder, 2016).

A first theoretical analysis of the harm that IA inflicts on unsophisticated applicants is offered by Pathak and Sönmez (2008). They assume that some applicants report their preferences sincerely while all other applicants play a mutual best response. While sincere applicants would be at a disadvantage under IA, this is no longer the case under DA where it is a weakly dominant strategy to report truthfully.

However, evidence for misrepresentation of preferences under DA abounds, both in the lab (e.g. Chen and Sönmez, 2006; Pais and Pintér, 2008; Calsamiglia et al., 2010; Klijn et al., 2013; Featherstone and Niederle, 2016; Kawagoe et al., 2018) and in the field (e.g. Hassidim et al., 2016; Artemov et al., 2017; Rees-Jones, 2018; Shorrer and Sóvágó, 2017). Where such misrepresentations are payoff-relevant mistakes – and where applicants differ in their propensity to make such mistakes – DA may no longer provide a more level playing field than IA.

In order to better identify students who might be harmed in practice as well as the strategic mistakes that they make, we conduct a laboratory experiment that allows us to control students' preferences and test for their cognitive ability. In line with recent experimental findings that connect subjects' cognitive ability and their ability to identify optimal strategies (e.g. Gill and Prowse, 2016; Fehr and Huck, 2016), we hypothesize that low ability subjects fare worse than their peers of higher ability. Moving beyond these existing investigations, we compare the gap between high and low ability subjects *across* different mechanisms to see whether the gap is reduced as we move from IA to the strategy-proof DA.

We analyze three possible forms that such a gap might take: (i) a difference in strategies used, (ii) a difference in payoffs that arises as a result, as well as (iii), specific to our school choice setting, the effect on ability segregation. Under the realistic assumption of correlated preferences over schools, a higher propensity of mistakes by low ability applicants may cause them to be over-represented at less preferred schools. Hence, if DA helps them to avoid mistakes, we should also expect it to equalize the distribution of students' abilities across schools, compared to IA. Because by design we can rule out preferences over peers as well as correlations between ability and preferences or school priorities, we are able to isolate ability segregation that emerges solely due to applicants' varying strategic aptitude, and see how it is affected by the choice of admission mechanisms.

Finally we investigate a potential trade-off between equity and efficiency that arises in the choice between IA and DA. While decisions on whether and how to manipulate under IA may be challenging for some applicants, they may also reveal information on cardinal preferences (Miralles, 2009; Abdulkadiroğlu et al., 2011). For example only applicants with a particularly strong preference should apply at an over-demanded school, while applicants who are almost indifferent between over- and under-demanded schools should apply to the latter. As a consequence, schools would be more likely to admit students that value it more, which would increase welfare from a utilitarian perspective.

Manipulation under IA typically takes the form of moving up under-subscribed schools in the submitted rank-order list. For instance, the West Zone Parents Group in Boston advised parents (Pathak and Sönmez, 2008):

> One school choice strategy is to find a school you like that is under-subscribed and put it as a top choice, OR, find a school that you like that is popular and put it as a first choice and find a school that is less popular for a safe second choice.

The first advised strategy is to manipulate the reported first choice by listing a less demanded school (*Skip-the-Top*). The second advise is to reveal truthfully the most preferred choice and manipulate the second choice by listing a school that is most likely still available in the second round (*Skip-the-Middle*). Using two different preference profiles, our set-up is designed to bring out both manipulations. In equilibrium under IA, students predominantly skip-the-middle in the first preference profile, while a majority of students skip-the-top in the second preference profile.

Results can be summarized as follows. We find strong support for the leveling-the-playing-field hypothesis. Under IA low ability subjects earn significantly lower payoffs than high ability ones in both preference profiles while differences are smaller and (mostly) not significant under DA. Low ability students report truthfully more often than high ability ones under IA. This is not the only mistake they are more prone to. They also report truthfully *less* often under DA; when they are cautious and misrepresent their first preference under IA, they are more likely to rank an unavailable school second. More generally, high ability subjects' strategies are more responsive to changes both in the mechanism and the preference profile. Low ability subjects are found at a particular disadvantage where it would be optimal to play Skip-the-Middle, i.e. to demote the second most preferred school on the submitted rank-order list. We argue this is due to the higher strategic complexity of this type of manipulation, compared to Skip-the-Top which requires analysis only of the first round of the algorithm.

As a consequence, substantial ability segregation emerges under IA, where low ability students are over-represented at the worst school. In the preference profile where subjects should skip-the-middle, other schools admit up to 45 percent more high ability students than the worst school. In contrast, the ability distributions at schools are harmonized under DA.

Overall, average payoffs are close to the equilibrium predictions under DA. While applicants fall short of the equilibrium benchmark under IA, average payoffs are still significantly higher than under DA in both preference profiles. Those gains are mostly concentrated in the hands of high ability subjects. Thus, our results highlight a substantial trade-off between efficiency and equity in school choice mechanisms.

The leveling-the-playing-field hypothesis has influenced policy-making for more than a decade. Yet, the associated empirical evidence is scant. To the best of our knowledge, no experiment has addressed it so far. With respect to field evidence,