

MISTAKES IN DOMINANT-STRATEGY MECHANISMS

The Mechanism Is Truthful, Why Aren't You?†

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Traditionally, *strategy-proofness* is considered an extreme form of strategic simplicity. When a strategy-proof mechanism is in place, honesty is the best policy; no matter what actions others are taking, the best course of action is to report one's true preferences. For this reason, such mechanisms are often referred to as *truthful*, and the preferences that are reported to them are interpreted at face value.

Truthfulness is thought to reduce the costs of strategizing, promote equity (by not giving advantage to more sophisticated players), provide robustness, eliminate the costs associated with the collection of information on others, and simplify the interpretation of reported preferences.¹ These desirable features led many centralized markets, especially in education and entry-level labor markets, to adopt truthful mechanisms. More specifically, the mechanisms in use are often based on the applicant-proposing version of the deferred acceptance (DA) algorithm, which is strategy-proof for applicants.

But do truthful mechanisms actually induce truthful reporting? Recent evidence that emerged from the Israeli Psychology Master's Match (IPMM) strongly indicates that the assumption of truthful reporting is false. Additional evidence from the field and from the lab suggests that this

phenomenon of preference misrepresentation is pervasive. A recurring finding is that misrepresentation rates are higher in weaker segments of markets. This motivates us to further investigate who are the individuals that misrepresent their preferences under DA and what drives this behavior.

Our hope is that our findings will inform market designers and policymakers about the prevalence of misrepresentation and its systematic nature. A better understanding of when and why individuals misrepresent their preferences can guide these practitioners in designing specific and targeted interventions to promote truthful reporting. For example, if members of particular groups are more likely to (err and) misrepresent their preferences, then this behavior may have equity implications, and targeted interventions may be advisable. If misrepresentation increases when applicants expect to face stronger competition (as we indeed find), then releasing information about affirmative action interventions may amplify their effect.

Understanding the causes of misrepresentation can also inform the interpretation of choice data, which, in turn, influences policy. For example, if students tend to rank schools higher where they have priority, and students have priority in schools in their neighborhood (which is a typical case), then a naïve interpretation of students' reported preferences would overstate the importance that students attach to studying in close proximity to where they live.

In what follows, we review existing evidence of preference misrepresentation under DA and its correlates, and evaluate possible explanations as to why individuals do not report truthfully.

I. Preference Misrepresentation

Preference misrepresentation under DA has been studied both in the field and in the lab. In

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¹See Roth (2008) and Pathak and Sönmez (2008).

the field, stakes are typically high, information is abundant, and applicants give the matching process their full attention. However, evaluating the truthfulness of reported preferences in the field is an inherently difficult task. Alternatives are often not objectively ranked, and any preference report could be reasonable under some circumstances. That is, even if most participants prefer alternative *X* to alternative *Y*, a participant ranking *Y* as his first choice need not be untruthful—he might simply have different preferences.

In unique settings, however, alternatives *are* objectively ranked, thus allowing one to detect evident preference misrepresentations. Hassidim, Romm, and Shorrer (2016) study one such setting. They use data from the IPMM, a matching-with-contracts environment (Hatfield and Milgrom 2005) in which applicants express their preferences over combinations of study track and contractual terms such as funding and degree type (Master's or PhD).² As a result of this feature, in some cases applicants were asked to report their preferences over naturally ranked contracts, i.e., contracts that offered admission to the exact same study track, but in one case students would receive a prestigious no-strings-attached scholarship, and in the other case they would not.³ Hassidim, Romm, and Shorrer examine applicants' reported preferences, given as rank-ordered lists (ROLs), and dub ROLs that contradict the natural ranking *obvious misrepresentations*. In such ROLs, the funded contract may not appear on the ROL (*obvious dropping*) or may be ranked lower than the unfunded contract (*obvious flipping*). They report that out of 704 relevant ROLs, 19.5 percent obviously misrepresented the applicant's true preferences, with obvious dropping and obvious flipping each accounting for about one-half of these observations. Obvious misrepresentation was negatively correlated with various measures of cognitive ability and desirability to programs.

Importantly, the rate of obvious misrepresentation is only a lower bound for the prevalence of preference misrepresentation, as applicants may

also misrepresent their preferences over programs. In a post-match survey, 20.2 percent of the respondents reported misrepresenting their preferences over programs. The vast majority of these applicants had not submitted an obvious misrepresentation.

Additional evidence comes from the National Resident Matching Program (NRMP), the clearinghouse through which physicians find their first job in the United States.⁴ Rees-Jones (2016) conducted a survey among medical school seniors who applied for a position through the NRMP. Seventeen percent of the respondents reported that their ROL did not represent their true preferences, with about one-third reporting that the reason for their behavior was "strategic." Rees-Jones (2016) also documents a negative correlation between misrepresentation and academic achievement, and a positive correlation between misrepresentation and the competitiveness of the residencies being applied to.

In the 2015 NRMP applicant survey (NRMP 2015, p. 8), which covers the entire population of applicants, 5 percent of US medical seniors and 17 percent of independent applicants reported that they "ranked the programs based on the likelihood of matching (most likely first, etc.)." Similarly, only 75 percent of independent applicants reported that they had ranked the programs in the order of their preferences, while the number among US seniors is 92 percent. The independent applicant category comprises the weaker segments of the market.⁵

Other evidence comes from school choice settings. In Mexico City, a centralized process is used to assign more than 200,000 students to public high schools (eleventh and twelfth grade) every summer. Seats are allocated through a variant of serial dictatorship,⁶ using student ROLs, which are reported in March, and with priorities based on performance in a centralized screening exam held in June. After students are assigned, the minimal score that was sufficient to gain admission to each program is made public.

⁴The NRMP famously uses a variant of the doctor-proposing DA (Roth and Peranson 1999).

⁵The independent applicant category includes prior graduates (cf. seniors) of allopathic medical schools, students and graduates of international medical schools, and students and graduates of schools of osteopathy.

⁶Serial dictatorship is a special case of DA where all schools share the same ROL.

²This feature is necessary to assure that the mechanism has good properties such as stability and strategy-proofness, as contractual terms could potentially affect applicants' preferences over programs (see, e.g., Sönmez 2013). For details on the IPMM, see Hassidim, Romm, and Shorrer (2017).

³By contrast, if there is stigma attributed to funding, as in Aygün and Turhan (2017), contracts are not naturally ranked.

Chen and Pereyra (2016) compare reported preferences with responses to a voluntary survey held in conjunction with the submission of ROLs. They find that at least 20 percent of the students in their relevant sample submitted an ROL that appeared contradictory to their survey responses: they declared that they wished to attend a certain university, but did not rank first any of the elite high schools that guarantee admission to this institution. Chen and Pereyra interpret this behavior as preference misrepresentation, and report that it is more common among academically weaker applicants and among applicants of lower socioeconomic status.

Another indication of preference misrepresentation in the Mexico City high school match comes from the field experiment of Bobba and Frisancho (2015). The authors show that giving students information about how well they are expected to perform on the centralized screening exam that determines priority changes their submitted ROL. Prior to the submission of ROLs, about three months before the screening exam was to be held, the authors held a mock exam in numerous classrooms in Mexico City. A subset of the students who took the exam were informed about their performance. The authors show that informing students about their performance in the mock exam made ROLs more aligned with performance on the exam; i.e., the match became more assortative. They further show that the effect of their intervention is concentrated in the group of students who had initially been pessimistic about their performance on the exam.

Truthfulness under DA has also been evaluated in the lab, an approach pioneered by Chen and Sönmez (2006). In the lab, participants are endowed with (known) preferences. Thus, while the stakes are typically significantly lower than in the field, detecting misrepresentation is simple, and parameters of the environment can be easily manipulated.

Chen and Sönmez find that a significant fraction of subjects (on average 36 percent) were not truthful under DA. This finding was corroborated in numerous follow-up studies, which also connected misrepresentation with having more information about other players' payoffs (Pais and Pintér 2008), having lower cognitive ability (Basteck and Mantovani 2016), and having lower priority (Hassidim, Romm, and Shorrer 2016; Li 2016).

II. Possible Explanations

We now turn to the question of why individuals do not report their true preferences under DA. We suggest four potential explanations to this phenomenon.⁷

Failing to Identify the Dominant Strategy.—Participants may be unaware that truthful reporting is the dominant strategy. In some cases, such as the Mexico City high school match, the formal instructions do not spell out the dominant strategy. In the common case in which instructions are explicit about the optimal strategy, participants may be unable to understand the meaning of a dominant strategy.

This explanation is supported by the numerous findings relating low cognitive ability with higher rates of misrepresentation (Basteck and Mantovani 2016; Hassidim, Romm, and Shorrer 2016). In the 2014 IPMM post-match survey, 18 percent of the 310 respondents thought they could possibly gain from “behaving strategically,” which indicates that they did not understand that truth-telling was dominant. An additional 21 percent of the respondents reported that while they thought that truth-telling was dominant, they did not understand why.

Mistrust.—Participants may doubt the veracity of the advice provided by the market maker. They may also be skeptical about the market maker's commitment to use the advertised mechanism. In the 2015 IPMM post-match survey, out of the 51 respondents who provided a verbal explanation of misrepresentation, 3 (5.8 percent) mentioned that they mistrusted the system. According to Gross, DeArmond, and Denice (2015, p. 27), in Denver and New Orleans, where strategy-proof mechanisms are being used to allocate school seats, parents report that “they were told to provide the full number of choices in their true order of preference.” However, these authors add that “few parents actually trusted this message. Instead, they commonly pursued strategies that matched their

⁷We do not think that inputting mistakes account for much of the misrepresentation observed in the field. This is supported not only by the fact that user interfaces are typically simple, but also by the significant percentage of individuals who report intentionally misrepresenting their preferences in different markets and countries.

own inaccurate explanations of how the match worked.”

When individuals do not fully understand the mechanism, or do not trust the information they were given, they may resort to naïve theories of matching mechanisms. A natural idea in such theories is that the mechanism rewards higher ranking with increased probability of matching (provided that higher-ranked alternatives are not available). The behavior (that such theories suggest is optimal) is consistent with the optimal behavior in many decentralized markets, as well as with the optimal behavior in centralized markets that use mechanisms such as immediate acceptance (Boston Mechanism).

Self-Selection.—If participants assign a zero probability to being matched to a desired alternative, then they believe that there is no loss in ranking this alternative lower, or dropping it from their ROL altogether (Chen and Pereyra 2016). Moreover, participants may decide to drop some alternatives which they think they are very unlikely to get. In the 2015 IPMM post-match survey, 18 out of the 51 respondents who provided a verbal explanation of preference misrepresentation mentioned that they did not rank some program because they thought that chances of admission to the program were low. While self-selection considerations could explain why some applicants in the IPMM did not include the funded option in their ROL, it is less likely that such considerations account for the flipping observed in 10.4 percent of the relevant ROLs.

Nonclassical Utility.—Participants may derive utility from things other than their assignment. We suggest two such utilities: *ego utility* and *social preferences*.

Ego utility (Kőszegi 2006): Participants may distort their choices to avoid receiving information about their desirability or priority, as this may hurt their self-image. In particular, they may lower the ranking of some alternatives or even not rank them at all. It is unlikely that concerns about self-image preservation account for misrepresentation in environments such as the Mexico City high school match, where students know their screening exam scores and cut-off scores for admission are made public shortly after the match is finalized.

Social preferences: Participants may derive utility from altruistic behavior. In the 2015 IPMM post-match survey, three respondents claimed that they did not rank a funded position since they preferred to see the money allocated to someone who needed it more. We believe that such considerations are not likely to arise when money is not involved.

III. Conclusion

Misrepresentation under DA is prevalent across markets and countries. We presented possible explanations as to why individuals do not report truthfully. It is worth noting that while some of the explanations are related to personal traits (e.g., trust, altruism, or cognitive ability), some, such as self-selection, are related to the subjective perception of desirability to the other side of the market. The explanations are not mutually exclusive—they may coexist and interact. We believe that further efforts should be devoted to understanding this phenomenon.

The past decade has witnessed significant advances in the study of matching mechanisms, and we now have a much better grasp of the incentives induced by various designs. This stands in contrast with our limited understanding of the effects of human psychology on behavior in matching markets, and the resulting economic implications. In order to fully capitalize on the advances in the theoretical study of matching markets and to be able to apply them in real life, a better understanding of the interaction between users and matching mechanisms is indispensable.

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