



Incomplete information and singleton cores in matching markets

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Abstract

We study ordinal Bayesian Nash equilibria of stable mechanisms in centralized matching markets under incomplete information. We show that truth-telling is an ordinal Bayesian Nash equilibrium of the revelation game induced by a common belief and a stable mechanism if and only if all the profiles in the support of the common belief have singleton cores. Our result matches the observations of Roth and Peranson [The redesign of the matching market for American physicians: some engineering aspects of economic design, *Amer. Econ. Rev.* 89 (1999) 748–780] in the National Resident Matching Program (NRMP) in the United States: (i) the cores of the profiles submitted to the clearinghouse are small and (ii) while truth-telling is not a dominant strategy most participants in the NRMP truthfully reveal their preferences.

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1. Introduction

In entry-level professional labor markets new workers search for their first positions at firms. Such markets differ in how they match workers and firms. In a decentralized market, workers and firms are themselves responsible in looking for partners. For example, in the first half of the 20th century the entry-level medical markets in the United States and the United Kingdom were decentralized. This had the effect that hospitals (the firms) were offering promising medical

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students (or workers) earlier and earlier contracts.¹ By the 1950s students often signed a contract two years before finishing. This caused inefficiencies and subsequent regret among the participants of the entry-level medical market: either the student did not develop as expected and the hospital could have later hired a better physician or the student developed much better than expected and could have gotten a job at a better hospital. Thus, the realized matching was often unstable: some students and hospitals were committed to now unacceptable partners or unmatched pairs were preferring each other to their committed partners. Due to these problems entry-level medical markets in the U.S. were reorganized from the 1950s by centralizing them through the National Resident Matching Program (NRMP). Each year a clearinghouse announces the open positions at each hospital and the finishing medical students who will be available (around 20,000 per year). Salaries are not negotiated and included in the job description. Therefore, each participant's preference is a ranking over his potential partners. Then all participants submit their preference lists to the clearinghouse and a mechanism determines a matching for the submitted lists. In other words, a centralized matching market together with a mechanism induces a preference revelation game. The success of the reorganizations depended on which mechanism was used in determining the matching between students and hospitals. A mechanism is stable if it always selects a stable matching of the declared profile. It has been observed that stable mechanisms perform better than unstable ones.²

There is a considerable amount of literature analyzing strategic incentives in centralized matching markets when the submitted lists are common knowledge among the participants. A central result is that no stable mechanism exists for which stating the true preferences is a dominant strategy for every agent under complete information (Roth [16]). Thus, for any stable mechanism there are situations at which some agents gain by manipulation. Sönmez [25] showed for general allocation problems with indivisibilities that a mechanism is incentive-compatible (truth-telling is a dominant strategy), Pareto-optimal and individually rational only if for each profile the core is a singleton and the mechanism chooses this allocation. Since a matching market may not have a singleton core and stability implies both individual rationality and Pareto-optimality in our model, Sönmez's result implies in our model Roth's [16] result.

Roth and Peranson [20] have examined submitted preference lists by hospitals and students in the NRMP for the years 1987, 1993, 1994, 1995, and 1996 and found that the number of stable matchings for the submitted profiles were surprisingly small. To explain this unexpected fact, Roth and Peranson [20] suggest the following conjecture (they call it a new kind of "core convergence" result)³: As the size of the market increases, the number of stable matchings becomes smaller provided that each participant only ranks (in his/her reported preference ordering) at most a fixed number of positions (which remains small when the number of participants increase). Moreover, the small size of the core suggests limited ability to benefit from manipulating submitted preferences. Thus, Roth and Peranson [20] infer that a significant number of participants truthfully reveal their preferences. Under the more realistic context of incomplete information, our paper will show in a simplified matching market why participants truthfully reveal their preferences *and* the cores of the submitted lists are small.

¹ Roth and Xing [23] and Niederle and Roth [15] describe other entry-level professional labor markets experiencing unravelling of appointment dates.

² Niederle and Roth [15] report the existence of about 100 markets and submarkets organized via stable mechanisms and that only three of them were abandoned after being used for several years.

³ It is well-known that in the two-sided, one-to-one matching markets the effective coalitions are only individuals or pairs, and hence, the core coincides with the set of stable matchings.

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