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Imperfect competition in two-sided matching markets[☆]

Eduardo M. Azevedo

Wharton, Business Economics and Public Policy Department, United States

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ABSTRACT

This paper considers a simple equilibrium model of an imperfectly competitive two-sided matching market. Firms and workers may have heterogeneous preferences over matches on the other side, and the model allows for both uniform and personalized wages or contracts. To make the model tractable, I use the [Azevedo and Leshno \(2013\)](#) framework, in which a finite number of firms is matched to a continuum of workers.

In equilibrium, even if wages are exogenous and fixed, firms have incentives to strategically reduce their capacity, to increase the quality of their worker pool. The intensity of incentives to reduce capacity is given by a simple formula, analogous to the classic Cournot model, but depends on different moments of the distribution of preferences. I compare markets with uniform and personalized wages. For fixed quantities, markets with personalized wages always yield higher efficiency than markets with uniform wages, but may be less efficient if firms reduce capacity to avoid bidding too much for star workers.

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1. Introduction

Two-sided matching markets are markets where participants on either side have preferences over who they interact with on the other side. Examples include matching CEOs to companies, students to colleges, advertisers to content providers, and many entry-level labor markets.¹ A stable matching is an allocation in which agents do not have incentives to break away from their matches and seek new ones. A well-known result by [Roth \(1985\)](#) shows that no mechanism that always produces a stable matching is strategy-proof for the firms. However, even though these markets have been studied by a large literature, most contributions ignore strategic behavior by firms, assuming them to command insignificant market share, or to act naïvely. This is in contrast to the standard approach in industrial organization, which typically focuses on Nash equilibrium in imperfectly competitive markets. This paper considers how the standard questions in imperfect competition models play out in matching markets. First, I investigate strategic quantity choices by firms, such as colleges or hospitals in centralized clearinghouses. Second, I consider the consequences of strategic behavior to equilibrium outcomes, and third, discuss a modest set of implications for the regulation and design of matching markets.

I consider a model analogous to Cournot oligopoly, but in a matching market. In the model, a number of firms compete to be matched to a set of workers. Both workers and firms have potentially heterogeneous preferences over match partners on the other side. I follow the literature on capacity manipulation games ([Konishi and Ünver, 2006](#); [Kojima, 2006](#); [Mumcu and Saglam, 2009](#); [Ehlers, 2010](#)), assuming that firms strategically set capacity. Workers are then assigned according to a

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E-mail address: eazevedo@wharton.upenn.edu.

¹ See [Gabaix and Landier \(2008\)](#), [Becker \(1973\)](#), [Gale and Shapley \(1962\)](#), [Roth and Peranson \(1999\)](#), [Ginsburg and Wolf \(2003\)](#).

stable matching. This is analogous to the Cournot model, in which firms choose capacities, and prices are given by market clearing. The model departs from the literature in two key ways. First, instead of the standard [Becker \(1973\)](#) or [Gale and Shapley \(1962\)](#) frameworks, I use the [Azevedo and Leshno \(2013\)](#) model, in which a finite number of firms is matched to a continuum of workers.² The continuum model considerably simplifies the analysis, and reveals novel insights akin to standard price-theoretic analyses. Second, I consider the cases of both uniform and of personalized wages.

I first consider the case in which wages are exogenous, and uniform across workers. A surprising result from the matching literature on capacity manipulation is that firms may want to reduce quantities even if wages are fixed ([Sönmez, 1997](#); [Kesten, 2008](#)). The intuition is that, by reducing capacity, firms may create rejection chains, in which a rejected worker causes further rejections, and eventually causes a better worker to apply to the firm. This can increase the quality of the worker pool available to the firm, at the expense of reducing the quantity of workers hired. Unsurprisingly, this result is still true in my model. However, unlike the previous literature, with the [Azevedo and Leshno \(2013\)](#) model, there is a simple first-order condition that quantifies the incentives to reduce capacity. The model shows that, if a firm is negligible compared to the rest of the market, it has no incentives to reduce capacity. However, if a firm has some market power, its marginal revenue from increasing capacity is lower than the productivity of a marginal worker. The reason for this is that, when a large firm hires more workers, it poaches employees from the competition, which leads competitors to be less selective. The first-order conditions show that the wedge in marginal revenue is proportional to the effect of a firm on the selectiveness of its competitors. This result clarifies the link between the matching literature on capacity manipulation games and the Cournot model.

Although the basic logic of the Cournot model extends to matching markets, some of the results have to be modified. For example, in the undifferentiated Cournot model the incentives for each firm to reduce capacity, as measured by the Lerner index, only depend on the inverse elasticity of demand and market share. This is not true in matching markets, where the incentives to shade depend on very different moments of the distribution of preferences. Therefore, the present model has a wealth of predictions that differ from the standard findings in homogeneous good markets. In particular, we highlight that, while the model assumptions are analogous to Cournot, the results often are not. Therefore, it is not appropriate to view every implication of the present model as analogous to implications of the standard Cournot model.

After considering uniform fixed wages, the paper considers matching markets with personalized wages. To my knowledge, this type of analysis has not been pursued in the literature for markets in which agents have heterogeneous preferences. It is shown that firms still have an incentive to reduce capacity, and a simple first-order condition quantifies by how much. Interestingly, the reasons for reducing capacity are quite different when wages are personalized. The gain is no longer caused by rejection chains, but by the fact that rejecting workers leads other firms to bid less aggressively for the best workers.

The paper then compares markets that have personalized wages and markets that have uniform wages. For example, in the market for junior associates in elite New York law firms, most firms pay every incoming lawyer the same wage. In contrast, senior lawyers are often paid personalized wages ([Ginsburg and Wolf, 2003](#)). A series of papers have debated the desirability of using personalized wages, which is a key market design variable. Notably, [Bulow and Levin \(2006\)](#) have shown that uniform wages may reduce matching efficiency, and compress wages. I show, however, that if firms choose capacities this conclusion may be reversed. In the imperfect competition model, there is a tradeoff. Personalized wages always generate higher matching efficiency for a given level of capacity, but they may increase firms' incentives to shade capacity. If firms are very similar, personalized wages have little impact on matching efficiency, but may induce firms to drastically reduce capacity to avoid entering into a bidding war for the best employees. In that case, markets organized around uniform wages generate higher welfare. However, if firms are more heterogeneous, the loss from matching inefficiency dominates the loss from capacity reduction, and personalized wages generate higher efficiency.

The paper proceeds as follows. Section 2 discusses the basic model, in which workers are paid uniform, fixed wages. Section 3 introduces personalized wages. Section 4 compares these two different institutional settings, and Section 5 concludes. Omitted proofs are in [Appendix A](#).

2. Matching with uniform wages

2.1. Firms, workers, and stable matchings

A finite number I of firms compete for a continuum mass of workers. We use I to denote both the number of firms, and the set of firms $I = \{1, \dots, I\}$. A particular firm is denoted by $i \in I$. Worker of type θ has productivity e_i^θ in $[0, 1]$ at firm i . Note that a worker's productivity may differ in different firms. We denote by e^θ the I -dimensional vector of worker productivity. Each worker has a complete strict preference ordering \succ^θ over the set of all firms, and over being unmatched. Formally, \succ^θ is defined over $I \cup \{\theta\}$, with θ representing being unmatched. Let \mathcal{P} be the set of all such strict preference relations. The set of worker types is $\Theta = [0, 1]^I \times \mathcal{P}$. The distribution of workers is given by a finite measure η in Θ , defined over the σ -algebra containing all open sets.

² [Azevedo and Leshno \(2013\)](#) precede the present study. That paper introduces a matching model that allows for multidimensional heterogeneity in preferences and tractable derivation of comparative statics, two key ingredients in the present model of strategic firm behavior.

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