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Market and non-market mechanisms for the optimal allocation of scarce resources

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ABSTRACT

A number of identical objects is allocated to a set of privately informed agents. Agents have linear utility in money. The designer wants to assign objects to agents that possess specific traits, but the allocation can only be conditioned on the willingness to pay and on observable characteristics. I solve for the optimal mechanism. The choice between market or non-market mechanisms depends on the statistical linkage between characteristics valued by the designer and willingness to pay.

1. Introduction

A large amount of scarce resources, ranging from broadcasting rights to scarce medical interventions, is periodically allocated by governments or other public institutions. Allocation methods can be generally classified into two categories: (i) *market mechanisms*, if objects are exchanged for money (e.g., auctions or posted prices); (ii) *non-market mechanisms*, if objects are allocated free of charge (e.g., lotteries and priority lists based on observable characteristics).[2]

Market mechanisms are optimal if maximizing welfare of the recipients is the underlying goal of the allocation. Under a set of standard assumptions (i.e., when income effects are absent) Pareto-efficiency alone mandates that the resources be assigned to those who are willing to pay the most for them. Payments must be requested in order to extract information on the willingness to pay. Nevertheless, non-market mechanisms, often coupled with resale-bans, are used in a large number of circumstances, ranging from the allocation of intensive care facilities to the allocation of tickets for concerts.[3]

Two major questions arise. *Under which conditions are non-market mechanisms preferable to market mechanisms? Why are non-market mechanisms so popular?* I develop a theory that addresses both of them.

In my model the objective of the designer can be different from welfare or revenue maximization (e.g., maximizing the number of lives saved in the context of allocating scarce medical resources). As a consequence, non-market mechanisms may

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[2] In this paper I will also consider hybrid mechanisms, which combine features of both market and non-market mechanisms (see Evans et al., 2009). I will not analyze mechanisms, such as waiting lines, which exploit individuals' willingness to engage in costly effort (see Condorelli, 2012).

[3] See Okun (1975) and Elster (1992) for details on the use of non-market mechanisms in practice.

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also be optimal. In particular, market mechanisms are optimal when willingness to pay for the scarce resource is positively associated to those unobservable traits of the agents which are valued by the designer (e.g., effectiveness of the treatment in the context of allocating scarce medical resources). Conversely, the use of non-market mechanisms may be optimal when the statistical dependence between the characteristics valued by the designer and willingness to pay, coupled with binding incentive constraints, prevents the designer from extracting any useful information. Banning resale is necessary in this case. Otherwise, agents with higher willingness to pay would buy the objects from the recipients, upsetting the initial allocation.[4]

The contribution of this paper is twofold, in response to the two questions above. First, and foremost, my analysis provides guidance on selecting among market and non-market mechanisms. For any given policy objective, the normative question of which type of mechanism should be used becomes an empirical one. A take away is that market mechanisms may be optimal even in cases where the allocation objective is not directly related to standard economic welfare. This point has substantial policy implications but, somewhat surprisingly, it has never been formally stated in the economic literature (at least to my knowledge). For example, consider the allocation of scarce medical resources. The medical profession, and policy-makers alike, appear to be strongly against the idea of assigning scarce medical resources to the highest bidder.[5] Instead, need-based criteria, such as saving the highest number of lives, are classic and long-standing rationing principles.[6] I show that opposition to market mechanisms cannot be motivated solely by arguing that the underlying objective of the allocation is different from welfare or revenue maximization. Such considerations also apply to a number of different allocation problems. For instance, my analysis is relevant for the allocation of places in selective state-funded schools.[7]

The use of non-market mechanisms has been previously motivated appealing to moral principles (e.g., Calabresi and Bobbitt, 1978; Walzer, 1983), or to psychological externalities (e.g., the sentiment of repugnance in Roth, 2007). The second contribution of this paper is to offer a new positive theory that may help explaining observed variation in the choice of mechanisms used to allocate scarce resources. Non-market mechanisms prevail if extracting information on willingness to pay cannot help the designer to achieve its goal, either because of incentive problems or because willingness to pay is totally uninformative. However, whether this force has substantial explanatory power (e.g., it explains why radio-spectrum is auctioned to the highest bidder, while places in selective schools are not rationed using prices) is an empirical question that lies outside the scope of this paper.

The formal apparatus is standard. Agents have linear utility in money and their willingness to pay is determined by a set of observable and unobservable characteristics. The designer has an interest in assigning objects to individuals with certain characteristics, some of which may be private information. Because the designer can only condition the final allocation on willingness to pay, relevant incentive constraints are one-dimensional and the mechanism design problem can be solved using standard techniques (following Myerson, 1981).[8] In particular, incentive constraints imply that the designer must select an allocations that offers, to any given agent, the object with higher probability the higher is his willingness to pay. Therefore, even though willingness to pay contains relevant information, non-market mechanisms are optimal when higher willingness to pay is associated with lower expected payoff to the designer.[9] In this case the designer would like to sort types based on willingness to pay, giving priority to lower types, but the best she can do is to condition the allocation on observable characteristics only.[10]

One important feature of my model is that the designer is only capable of extracting information on the willingness to pay. This is the consequence of two assumptions. First, I assume that objects are identical. If objects were heterogeneous, non-market mechanisms could be used to extract information (e.g., see Hylland and Zeckhauser, 1979; McAfee, 1992, and Budish, 2011). Second, I assume that the designer cannot ask the agents to engage in costly activities, such as spending time in line (see Condorelli, 2012). While these assumptions simplify the analysis substantially, my main insights do not hinge on them. First, the conclusion that mechanisms that do not extract any information can be optimal because of binding incentive constraints would still be valid in a setting in which the designer had more instruments to extract information. Second, even if objects were heterogeneous and the designer was able to screen agents by having them to exert a costly

[4] Throughout the text I use the term "willingness to pay" even though the term "ability to pay" is often used in the context of specific applications. Willingness to pay seems more accurate, given that the two terms differ only in cases where an individual faces hard budget constraints. Someone could be *willing to pay* but *unable to pay* only if the liquidation value of his wealth (plus the debt he could obtain with no collateral) exceeds the value of the resource to him. Casual empiricism suggests that this is unlikely in most cases of interest.

[5] For example, surveying methods of allocation for scarce medical interventions, Persad et al. (2009) state: "we do not regard ability to pay as a plausible option for the scarce life-saving interventions we discuss". Resistance to the introduction of monetary markets for organs for transplant is also documented in Becker and Elias (2007) and in Roth (2007).

[6] For example, this principle is behind governmental contingency-plans for the allocation of influenza vaccine (see Emanuel and Wertheimer, 2006) and responses to bioterrorism (see Phillips, 2006).

[7] In the UK admission to selective schools is often based on merit only. See for example the *School Admissions Code* from the UK Department of Education.

[8] Two types of a given agent with the same willingness to pay cannot be screened because they have the same preferences over object-money bundles.

[9] For instance, consider the allocation of influenza vaccines. The value of vaccinating an individual depends, in addition to observable characteristics that make him more prone to contract the disease (e.g., age), on the (unobservable) number of people with which he has close contact during his typical workday. However, the willingness to pay for a vaccine, especially in case of a high-risk disease, will be positively correlated to individual wealth and income. In turn, income and wealth are likely to be inversely correlated with the number of people with which an individual might be exposed in his workday. Hence, a non-market mechanism is likely to be optimal in this case.

[10] The fact that objects are randomly assigned does not mean that the designer is *ex-post* indifferent among recipients. This explain why resale must be banned. Allowing resale induces positive correlation between willingness to pay and ownership, something that the designer wants to avoid when non-market mechanisms are optimal.