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Optimal allocation without transfer payments [☆]

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ABSTRACT

Often an organization or government must allocate goods without collecting payment in return. This may pose a difficult problem either when agents receiving those goods have private information in regards to their values or needs. In this paper, we find an optimal mechanism to allocate goods when the designer is benevolent. While the designer cannot charge agents, he can receive a costly but wasteful signal from them. We find conditions for cases in which ignoring these costly signals by giving agents equal share (or using lotteries if the goods are indivisible) is optimal. In other cases, those that send the highest signal should receive the goods; however, we then show that there exist cases where more complicated mechanisms are superior. Also, we show that the optimal mechanism is independent of the scarcity of the goods being allocated.

1. Introduction

One of the basic problems in economics is how to allocate scarce resources or goods. One of the fundamental difficulties afflicting such allocation is private information: knowing who desires the goods the most. While markets work well with such allocation, the market is not always a feasible or desired mechanism for allocation. In case of kidneys it may be unethical to have a market, while in case of sports or concert tickets it may be undesirable to sell the tickets to the highest bidder.[1] Finally, with the allocation of charitable goods, it is not only undesirable to collect payment in return but those needing it the most are also the least able to pay for it.[2] Hence, we often see markets being replaced with other mechanisms.

One method used, in place of allocating to who is willing to pay the most, is instead to allocate them to who is willing to work the hardest. Sport and concert tickets are given, often using first-come first-serve mechanism, that is, whoever is willing to wait the longest before the promoters start selling, gets the right to buy tickets. Allocation of research funds

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[1] See Roth et al. (2004) and Roth (2007) for a description of the current method used to allocate kidneys and the perceived ethical difficulties (repugnance) of moving to a market-based system for organ donation and other potentially distasteful transactions. With tickets, there is sometimes a desire for a wider audience. Indeed, the Metropolitan Opera in New York received a several million dollar grant to widen audience by selling prime orchestra tickets for $20 each, 10 percent of their usual price (Gardner, E., *USA Today,* October 5, 2006).

[2] Che et al. (2012) provide further examples of non-market allocation caused by wealth constrained agents.

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by agencies like National Science Foundation in USA and Economic and Social Science Research Council in UK to various universities and individuals are done based on research proposals (where a well-crafted proposal has a higher chance of being funded). A common feature in these examples is that in order to convey their valuation, individuals must incur a socially wasteful cost. As with waiting overnight in a long line, generally at least part of this effort is socially wasted.[3]

Another mechanism that is common with charity, but, surprisingly, also prevalent elsewhere, is to allocate evenly or randomly using a lottery (among those appearing identical when classified according to public information).[4] Often baseball playoff tickets are offered via a lottery.[5] Likewise, NCAA College bowl tickets are distributed by a lottery amongst only the season ticket holders. Research funds are often handed evenly amongst certain groups or individuals. For example, most universities hand out fixed research grants to all new staff. Allocating goods equally (ex-ante) has the disadvantage of ignoring any private information, but has the advantage of saving the potential recipients' effort.

Both of these mechanisms are potentially optimal. Using signals such as waiting in line increases the probability that the good will be allocated to the person who values it the most; however, this naturally also wastes effort. It is a problem of interest to determine which mechanism is optimal in view of this trade-off between efficient allocation and saving wasteful effort.

In this paper, we solve this problem and find the optimal mechanism to allocate homogeneous, not-necessarily-divisible goods when the signals made by the agents competing for the goods are socially wasted. By doing so, we depart from the standard mechanism design (Myerson, 1981) in three respects. First, the objective is to maximize the ex-ante social surplus (utilitarian welfare) rather than just the payoff of the designer. This follows along the lines of Krishna and Perry (2000) whose objective is to maximize efficiency. Second, the signals are wasted and there are no means for sending non-wasteful meaningful signals (such as paying with money). Third, in addition to an agent's value depending upon his type, we also allow for the agent's cost of signalling to also depend upon the agent's type. Given the first two deviations, the third is natural since the designer now cares about the agents' cost of signalling (which may vary among agents). We can see this last deviation is non-trivial with the following example. Say agent A values an item at 3 and standing in line for an hour costs him 1 and agent B values an item at 8 and standing in line for an hour costs her 1. Now compare this to the case when agent B' values an item at 16 and standing in line for an hour costs her 2. Agents B and B' are identical in willingness to signal (wait) for the object; however, with our objective, the mechanism should favor B' over A more than B over A. While each agent's ordinal preferences over allocations (and even lotteries) are the same as before, the utilitarian representation of these preferences would be different. This is crucial when one considers surplus as utilitarian welfare. Indeed, in our results we discuss two cases that are identical in willingness to signal but in one a lottery is optimal and in the other a contest is optimal.[6]

With our objectives, we find the necessary and sufficient conditions for when allocating the goods randomly is optimal. A particular sufficient condition (but not necessary) is if we order types according to willingness to signal, then if this willingness to signal is concave in percentile among types, then a lottery is optimal. When the costs do not depend upon type, another sufficient condition for a lottery to be optimal is that the distribution of values has the often-assumed increasing-hazard-rate property.

In addition, we find the necessary and sufficient conditions for when distributing the objects to those who work the hardest (a contest) is optimal. In this case, it would require either an unbounded value or the cost of signalling for the highest type would be zero. These conditions would seem unusual in practice.

We also find cases when other mechanisms can be optimal, such as using a contest but randomly allocating the objects amongst any that meet a certain threshold of effort (a contest with a bid cap). One interesting result of our paper is that an optimal mechanism does not depend upon scarcity of the goods being allocated. We also show that our results extend to where a designer may favor one type over another (other interim efficient allocations).

There are many papers examining contests or lotteries, but as opposed to this paper, most study the case where a seller wishes to maximize revenue. Amongst these, Moldovanu and Sela (2001) study the best way to split prize money in a contest, and Gavious et al. (2002) analyze contests, where depending on the nature of the cost function bid caps may be more profitable or not. Also, Goeree et al. (2005) rank lotteries and contests in fund raising mechanisms and Fullerton and McAfee (1999) model research tournaments and show that it is optimal to limit the number of participants to two.

One paper that does examine allocation with a benevolent designer and thus close in spirit to our paper is Che et al. (2012). They find that when agents have wealth constraints in a pure market, those that value goods the most cannot

[3] Without grant money at stake, most researchers would not start a project by writing a detailed, polished research proposal. This indicates at least some of the effort is wasted (used inefficiently).

[4] To avoid confusion, we call a lottery as a mechanism that randomly allocates an object or objects. Unless mentioned otherwise, everyone is given an equal chance. Note this usage of lottery distinguishes it from a raffle in that in a raffle chances are sold.

[5] More precisely, the price is set below the market clearing price. Since the demand exceeds supply, a lottery was used to determine who has the right to buy tickets. Among the baseball teams that have used a lottery system was 2006 New York Mets, 2007 Cleveland Indians, 2008 Chicago Cubs, and the 2009 Philadelphia Phillies (see Mucha, 2009).

[6] In a world with two agents each with an equal change of being either type described here, a lottery (random allocation) would yield a surplus of 5.5 with agent types of A and B and a surplus of 9.5 with agent types of A and B'. An incentive-compatible mechanism with wasted signals that gives the object to a type B (B') over a type A would ask a signal of 15 (30) from type B (B') agents. This would yield an expected surplus of 4.875 with type B agents and 9.75 with type B' agents. Hence, with type B agents a lottery would be optimal and with type B' agents this screening mechanism would be. This demonstrates that allowing for a variation on the cost of signalling creates a richer environment for study.