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Efficient implementation with interdependent valuations and maxmin agents

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Abstract

We consider a single object allocation problem with multidimensional signals and interdependent valuations. When agents' signals are statistically independent, Jehiel and Moldovanu (2001) show that efficient and Bayesian incentive compatible mechanisms generally do not exist. In this paper, we extend the standard model to accommodate maxmin agents and obtain necessary as well as sufficient conditions under which efficient allocations can be implemented. In particular, we derive a condition that quantifies the amount of ambiguity necessary for efficient implementation. We further show that under some natural assumptions on the preferences, this necessary amount of ambiguity becomes sufficient. Finally, we provide a definition of informational size such that given any nontrivial amount of ambiguity, efficient allocations can be implemented if agents are sufficiently informationally small.

JEL classification: D61; D82

Keywords: Efficient implementation; Ambiguity aversion; Multidimensional signal; Interdependent valuation

1. Introduction

One of the fundamental problems in mechanism design is the conflict between efficiency and incentive compatibility. That is, there are situations in which efficient allocations are not implementable. A prominent impossibility result is obtained by Jehiel and Moldovanu (2001): in a

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general mechanism design setting with multidimensional signals and interdependent valuations, if signals are statistically independent, then except in some special, nongeneric cases, ex post efficient and interim incentive compatible mechanisms do not exist.[1] This result is obtained under the standard assumption that agents are expected utility maximizers. However, there is both experimental and empirical evidence challenging the expected utility assumption: due to lack of knowledge about the environment, agents may perceive ambiguity, that is, they might not have a unique prior that fully describes the uncertainty that they face, and moreover, agents desire strategies that are robust to their ambiguity.[2] Thus, the primary question we ask is: does the conflict between efficiency and incentive compatibility extend to environments with ambiguity averse agents? In the case of maxmin expected utility (Gilboa and Schmeidler, 1989), our answer is: No. That is, we show that the presence of ambiguity aversion overturns the impossibility result of Jehiel and Moldovanu (2001). In particular, we extend the Myersonian approach to a single object allocation problem with maxmin agents and explicitly identify necessary and sufficient conditions for efficient implementation. In addition, we provide conditions under which the efficient allocation is implementable with a small amount of ambiguity.

Our first step is to derive a necessary condition for an allocation rule to be implementable which generalizes the envelope formula familiar from Bayesian mechanism design. This condition quantifies a nontrivial amount of ambiguity, which we call Minimal Ambiguity, that is necessary for efficient and incentive compatible mechanisms to exist. That some ambiguity is necessary is consistent with the impossibility result obtained by Jehiel and Moldovanu (2001) in the sense that without ambiguity the requirements of efficiency and incentive compatibility become incompatible.

Our next step is to identify conditions under which this necessary amount of ambiguity is sufficient for efficient and incentive compatible mechanisms to exist. A key observation is that if Minimal Ambiguity is satisfied, we can construct efficient mechanisms that satisfy local incentive compatibility constraints. Thus, our question becomes: under what conditions does local incentive compatibility imply global incentive compatibility? In Bayesian settings, Myerson (1981) showed that under a monotonicity condition, global incentive compatibility constraints can be obtained from adding up a sequence of local incentive compatibility constraints. To extend the classic Myersonian approach to environments with maxmin agents, we need to address two issues. The first is to identify the monotonicity condition in our setting. The other is to deal with the nonadditivity of the maxmin representation: the belief used in each constraint is endogenously determined and, hence, the sum of these local constraints can differ from the global one. Regarding the first issue, the desired monotonicity condition turns out to be a multidimensional extension of the familiar single-crossing condition from one-dimensional settings.[3] Regarding the second issue, if each agent's valuation function is linear in his own signal, such nonadditivity does not arise. Otherwise, the linearity condition on valuation functions can be replaced by two other restrictions on preferences: agents' valuation functions satisfy a familiar increasing differences condition and agents' preferences satisfy the comonotonic independence axiom of Schmeidler (1989).

Another contribution of the paper is to identify conditions under which the amount of ambiguity sufficient for efficient implementation can be arbitrarily small. Specifically, we link the

[1] Jehiel and Moldovanu (2001) generalize earlier results by Maskin (1992) and Dasgupta and Maskin (2000).

[2] Experimental results on the Ellsberg paradox reveal that agents exhibit ambiguity averse behavior in many situations (e.g., Ellsberg, 1961; Halevy, 2007). Aryal et al. (2018) find empirical evidence of ambiguity in U.S. timber auctions.

[3] See Dasgupta and Maskin (2000), Jehiel and Moldovanu (2001), and Bergemann and Välimäki (2002).