7-2021

Are simple mechanisms optimal when agents are unsophisticated?

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We study the design of mechanisms involving agents that have limited strategic sophistication. The literature has identified several notions of *simple* mechanisms in which agents can determine their optimal strategy even if they lack cognitive skills such as predicting other agents' strategies (strategy-proof mechanisms), contingent reasoning (obviously strategy-proof mechanisms), or foresight (strongly obviously strategy-proof mechanisms). We examine whether it is *optimal* for the mechanism designer who faces strategically unsophisticated agents to offer a mechanism from the corresponding class of simple mechanisms. We show that when the designer uses a mechanism that is not simple, while she loses the ability to predict play, she may nevertheless be better off no matter how agents resolve their strategic confusion.

CCS Concepts: • **Theory of computation: Algorithmic mechanism design**;

Additional Key Words and Phrases: Simple mechanisms; Complex mechanisms; Strategic confusion; Robustness

ACM Reference Format:
Jiangtao Li and Piotr Dworczak. 2021. Are Simple Mechanisms Optimal when Agents are Unsophisticated?. In *Proceedings of the 22nd ACM Conference on Economics and Computation (EC '21), July 18–23, 2021, Budapest, Hungary.* ACM, New York, NY, USA, 2 pages. https://doi.org/10.1145/3465456.3467606

1 EXTENDED ABSTRACT

It is widely accepted that "real-life" economic agents are not as rational as their counterparts in economic models. When agents have limited strategic sophistication, researchers naturally lose confidence in the performance of mechanisms that require the participants to engage in complicated mental tasks. For example, achieving a Bayesian Nash equilibrium in a mechanism requires each agent to know the distribution of the other agents' private information and correctly forecast the other agents' play; this is why strategy-proof (SP) mechanisms are generally perceived as being superior for practical purposes. Following the mounting evidence that even dominant strategies are difficult to identify for real-life agents, several recent papers have identified mechanisms in which agents can determine their optimal strategy under even weaker assumptions about their strategic sophistication. Li [1] proposes the notion of obviously strategy-proof (OSP) mechanisms in which agents can determine their optimal strategy even if they cannot engage in contingent reasoning. Pycia and Troyan [3] strengthen the notion of simplicity even further by relaxing the assumption that agents can predict their own future moves, and define (among other intermediate concepts) strongly obviously strategy-proof (SOSP) mechanisms.

For the purpose of this paper, we call a mechanism *simple* if, given the assumed level of strategic sophistication, agents can determine their optimal strategy in the mechanism. For example, if we

*The order of author names was picked uniformly at random.

EC '21, July 18–23, 2021, Budapest, Hungary

ACM ISBN 978-1-4503-8554-1/21/07.
https://doi.org/10.1145/3465456.3467606

are only comfortable assuming that agents do not play weakly dominated strategies, then a SP mechanism is simple because a dominant strategy can be identified as the unique strategy (up to payoff equivalence) that is not weakly dominated for such agents. If the designer instead offers a mechanism that is not SP, she can no longer predict how agents will behave. More generally, we call a mechanism *complex* if it creates *strategic confusion* for the agents, understood as the inability to determine their optimal strategy in the mechanism.

The key observation of this paper is that the inability of the designer to predict the outcome of a complex mechanism need not be a sufficient reason for the use of simple mechanisms. As long as the designer is ultimately concerned with maximizing her own payoff —which is typically assumed in mechanism design—in many cases complex mechanisms are unambiguously preferred by the designer to simple ones.

Since a complex mechanism, by definition, leads to a set of possible outcomes, we need to specify what we mean by the designer preferring a complex mechanism to a simple one. We analyze two notions. Under *weak dominance*, the complex mechanism generates a weakly higher expected payoff to the designer, no matter how agents resolve their strategic confusion (no matter which strategy they choose from the set of strategies they can identify as potentially optimal), and generates a strictly higher expected payoff in some cases. Under *strong dominance*, the designer obtains a strictly higher expected payoff in all cases, regardless of how agents behave when they are "confused."

We show that weak dominance of the best simple mechanisms by a complex mechanism can be achieved in many economic environments; in particular, under weak assumptions, it is possible in any quasi-linear setting in which the designer maximizes revenue. We also prove that posted-price mechanisms are not weakly dominated under the solution concepts of SP and OSP (but not SOSP) when there is only a single buyer and complex mechanisms must satisfy a strong notion of individual rationality.

More surprisingly, strong dominance is also possible; we emphasize that the notion of strong dominance is particularly demanding because it means that the designer can achieve—in an unambiguous manner—a strictly higher payoff than in the best simple mechanism, under the same assumption about agents' rationality. Our results provide insights about the circumstances under which strong dominance can or cannot occur. In particular, we show that in environments that violate a property that we call "accommodation of additional types" there always exists some objective function for the designer under which the best simple mechanism is strongly dominated. We provide an example demonstrating that strong dominance can occur even in settings with a single agent; in that case, the designer can use randomization to confuse the agent and obtain a strictly better outcome than in the best simple mechanism. Finally, we show that strong dominance cannot take place in environments in which the binding incentive-compatibility constraints form a tree in the type space; an example is the revenue-maximization problem of Myerson [2] in the regular case.

Overall, the message of the paper is that one should not take the use of simple mechanisms for granted when agents are strategically unsophisticated; rather, their optimality should be carefully established for each environment in question.

A full version of the paper can be found at:
https://cpb-us-e1.wpmucdn.com/sites.northwestern.edu/dist/1/2465/files/2021/06/SimpleOptimal.pdf.

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