Logic and Economics: Preface

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Logic and Economics: Preface

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This special issue consists of five papers on the logical approach to economics (and game theory). Logic may be described as a scientific study of reasoning and inferences. The reader may wonder why we study economics from the viewpoint of logic. One motivation is to extend our understanding of the concept of rationality. Economics treats economic agents or game players as idealized people who make decisions and behave in economic and/or game situations. Rationality in economics is treated typically as an attribute of an outcome or the behavior of the player. This approach has been fruitful, but it is recognized to have some limitation for further research. In the logical approach, we take a radically different view of using the word "rationality" to describe the player's reasoning ability.

The logical approach makes a clear distinction between symbolic expressions and their associated meanings. Such fundamental notions have been developed in the pursuit of human reasoning and foundations of mathematics in the field of mathematical logic. We believe that following formal logic is a good research strategy for a rigorous analysis of reasoning and inferences in economics.

We cannot expect a unique theory of rationality or bounded rationality. Even if we confine ourselves to the view of rationality as the reasoning ability of a player, there are still many facets. Bounded or unbounded intrapersonal and interpersonal introspections are such facets. A limit case for interpersonal ones is related to common knowledge, and has still multiple facets. Also, the truth or falsity of an individual belief is also related to the rationality in our sense. The papers in this issue will talk about some facets in constructed formal theories.

In the recent literature of game theory, it has been typical to do logical considerations with extant game theoretical constructs such as information partitions and/or subjective probabilities. We do not take this typical research strategy, since it constrains us to the conventional game theoretic thoughts. We question the foundations for these conventional thoughts. One example that the extant

game theoretic constructs cannot capture is the distinction between symbolic expressions and their associated meanings. This distinction enables us not only to have more accurate descriptions but also to consider new societal phenomena. For this reason, we adopt the logical approach to economics.

We also note that although we take the logical approach and borrow fundamental notions from the logic literature, our logical approach is not simply applications of extant results in the field of logic. Considerations of economic and game theoretical phenomena in terms of logic raise genuinely new problems in logic itself. Therefore, our undertaking is, hopefully, beneficial for both economics and logic.

The papers in this issue were chosen so as to show some scopes of the new approach. Although the approach is still in a germinating stage, the papers show that the approach can faithfully treat epistemic phenomena essential in economics.

The five papers in the issue are as follows:

The first paper by myself is an introduction to epistemic logics and their applications to game theoretic problems. I have tried to explain why we take fundamental notions in logic seriously for economics, in addition to showing some explanations of their applications.

The second paper is written by Nobu-Yuki Suzuki and myself on bounded interpersonal inferences and decision making in games. This paper considers problems of shallow epistemic interactions rather than ones of deep interactions such as common knowledge. In the case of common knowledge (belief), the infinite nested repetition "player 1 believes that 2 believes that 1 believes that..." is required. On the other hand, by shallow epistemic depths, we mean that this nested structure is bounded in a certain manner. The paper also relativizes the view of decision making: A prediction-decision criterion is adopted by each individual player rather than a single solution concept is assumed for all the players. The paper gives a general consideration of prediction-decision criteria in games. We emphasize that each player considers his and other players' decision making to some shallow depths.

The third paper is written by Oliver Schulte as an introduction to the recent literature of belief (theory) revision. In economics, the Bayesian updating of subjective probability has been dominant as an almost unique theory. However, this approach treats basic beliefs of an agent as a summarized prior subjective probability, and is silent of what basic beliefs owned by an agent and their change are. In the theory of belief revision, an agent is assumed to have some beliefs expressed explicitly as sentences and to revise their beliefs when the agent receives new information. Since this process is about changes in a theory owned by an agent, it is sometimes called *theory revision*. The paper gives an extensive survey of this literature, including Schulte's own contributions.

The fourth is a note by Mariko Yasugi and Sobei Oda on a puzzle, which is a simpler variant of the famous "muddy children puzzle". A "solution" for this puzzle has been discussed a lot in the literatures of game theory and computer science. The aim of the note by Yasugi and Oda is not to add a new solution to the puzzle, but to investigate the structure of the puzzle from the proof-theoretic

point of view. Especially, it clarifies the meaning of not believing and revising beliefs in the puzzle.

The last paper is written by Holger Sturm, Frank Wolter and Michael Zakharyachev on common knowledge predicate logics. Finitary epistemic logics need to be extended to incorporate the concept of common knowledge, since the entirety of the common knowledge is not captured in the standard finitary epistemic logics. This extension is needed also for the purposes of game theory. In the case of propositional logics, which can treat finite games with pure strategies, such extensions are known to be successful. To treat a game with mixed strategies, a predicate extension, in which quantification, say $\forall$, is needed. However, Frank Wolter, one of the authors of the paper, showed in a different paper that such extensions do not work in the case of predicate logics. The present paper shows that when the language is restricted in a certain manner, Wolter's difficulty can be avoided.

I hope that the above five papers show some scope of the logical approach, as well as that this issue induces further developments in the approach.

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