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論文の要旨

Usually, equilibrium is thought as an evolutionary solution concept which is reached after players have corrected their biased beliefs and adjusted their strategies. Basically, equilibrium models require three components: strategic thinking (formation of beliefs about others' behaviors); optimization (choosing a best response to those beliefs); mutual consistency (adjustment of beliefs and best responses until they are mutually consistent). However, it is often the case that solutions of equilibrium models are not supported by data in lab or the phenomena in the real world (McKelvey & Palfrey, 1992; Nagel, 1995; Camerer, 2003). A leading explanation of such failures is that the mutual consistency assumption is too strong. So far several models have been proposed to relax the mutual consistency. For example, the level-k model, initially proposed by Nagel (1995) and Stahl and Wilson (1995), partitions players according to 'levels of reasoning': the action of a level-k player is the best response to that of a level -(k-1) player and actions of the level-0 player are assumed to be uniformly distributed over the action set. The Cognitive Hierarchy model proposed by Camerer, Ho and

Chong (2004) is also based on the 'depth of reasoning' idea. Goeree and Holt (2004) propose the Noisy Introspection model to consider the reasoning process reversely, i.e. from a sufficiently large order of belief. In summary, these approaches share the same idea of weakening the mutual consistency assumption, in other words, an involved player is assumed to play according to some beliefs which are not necessarily consistent with his/her opponents' actions.

The other key common argument of the above three non-equilibrium model is that players are assumed to think 'k' step. However, this raise the question that which step an involved player should stop at. It is rather untraceable and arbitrary. A natural thinking is that a player doesn't take the iterative thinking at all, or once a player started iterative thinking, he/she will continue this process until equilibrium is reached. So we argue the 'k' step thinking way is relatively far from real players' decision making process in a game.

In this research, we propose a new theoretical model – the **One-Shot Game Model** to character real player's decision making process as well as handle deviations in several typical games. Simply speaking, in our model, the decision process of a player consists of two steps. Firstly, a player formulates his/her belief about his/her opponents' actions; secondly, based on the formulated belief, a player decides his/her optimal choice. Similar with the existing approaches, the proposed approach also relaxes the mutual consistency assumption and can be regarded as a non-equilibrium approach. However, we distinguish our approach in mainly the following two aspects.

Firstly, we enrich the methods of belief formulation. Speaking in detail, we propose several alternatives possibly reflecting real players' thinking process when formulating his/her belief. For example, a player may deduce that his/her opponent should adopt an action which generates a higher average payoff with a higher probability. This kind of deduction is based on his/her opponent's payoffs and reflect the idea that an involved player should put him/her into his/her opponent's shoes in a game.

Secondly, we utilize the **One-Shot Decision Theory** to solve each player's decision problem. The One-Shot Decision Theory is initially proposed by Guo (2011) which argues that a person makes a decision under uncertainty based on his/her imagined scenario which is most consistent with his/her personality. In order to understand this core argument, let us examine several well-known examples. The expected utility theory tells that the reason why a person buys a lottery is because his/her utility function is convex while the reason why a person buys insurance is because his/her utility is concave. The One-Shot Decision Theory manifests that the lottery buyer is a decision maker who takes into account the scenario which has a low probability to happen but can bring about a large benefit and the insurance buyer is a decision maker who takes care of the scenario which can cause a large loss even with a low probability. Clearly, the One-Shot Decision Theory based explanation is close to the way of human beings' thinking and intuitively acceptable.

We apply our framework to analyze some simple games: the stag hunt game, the chicken game and the battle of sexes. Interestingly, in those games, players' choices are rather robust to the formulated beliefs, in other words, players' choices (or focus points) are only determined by his/her character and is independent of the formulated beliefs.

Utilizing the One-Shot Game Approach, we also analyze two relatively difficult games, namely, the **Capacity Allocation Game** and the **First Price Sealed Bid Auction**. Further, we provide explanations for the abnormalities in those games.

1 Capacity Allocation Game

In a supply chain, the capacity shortage refers to the situation that retailers' demand is higher than the supplier's inventory, as modifications are infeasible in a short term, the supplier has to divide the limited inventory to each retailer. The proportional allocation method is the most popular allocation mechanism and says the supplier provides each retailer the quantity proportional to his/her order. However, under such a natural allocation rule, the Nash equilibrium of such a game is that each retailer submits an order of infinity, which is in contrary to people's intuition as well as deviates from experimental findings (Chen et al, 2012). What is worse, such an equilibrium stays the same even if we change the shape of the utility function and the model parameters, which obviously increases the difficulty of solving such an abnormality.

We utilize the proposed One-Shot Game Approach to analyze such a game. Simply speaking, for each order quantity, say x, a retailer evaluates every possible order quantity, say y, which is submitted by his/her rival with considering the probability of his/her rival choosing y and his/her own payoff when his/her rival chooses y. For x, amongst all possible order quantities submitted by his/her rival, the retailer chooses one with the highest evaluation, which is the imagined scenario (the focus point) for x. Then a retailer evaluates his/her each order quantity, x, based on its focus point, and chooses the one as the optimal order quantity which can bring highest payoff when its focus point (imagined scenario) occurs. Analytical results obtained within our framework matches the experimental findings well.

2 First Price Sealed Bid Auction

The classical solution concept in first price sealed bid auctions is the risk-neutral Bayesian Nash Equilibrium (hereafter RNBNE) (Vickrey, 1961). However, experimental evidence shows that real bidders don't follow it at most time. Generally speaking, there exist two major tendencies. One is that bidders with low valuation tend to bid randomly (Cox et al., 1988), and the other one is that bidders with high valuation tend to overbid (Cox et al., 1982). To the best of our knowledge, until now, there exists no theoretical model providing a unified explanation for those phenomena and we utilize the One-Shot Game Approach to achieve this goal.

In our setting, each bidder is thought to face a decision problem under uncertainty which origins from other bidders' bidding prices. The action set is his/her bidding price and the uncertain factor is his/her rivals' bidding prices. Taking into account the one-time feature of auctions, it is intuitive that a bidder only imagines one bidding price presented by his/her opponents amongst all possible prices for determining his/her bidding price rather than take any kind of average of all possible prices. Taking the possible winning and losing regret into account, analytical results obtained within our framework well explain the deviations observed in first price sealed bid auctions: bidders tend to bid randomly upon drawing a low value and overbid when their valuation is relatively high.

審査結果の要旨

本論文では、ワン・ショット意思決定理論に基づき、新たな行動ゲームモデルを提案し、提案したモデルを用いて、資源配分ゲームとファースト・プライス・オークションに適用し、プレーヤーの行動を分析するとともに、従来のゲーム理論が説明できないいくつかのアノマリーを解決した。研究の貢献は主に以下の三点である。

１．　行動ゲーム理論の代表的なモデルとしてレベルｋモデルが広く応用される。しかし、レベルｋモデルはプレーヤーの推論の回数をレベルごとに細かく分け、かつ期待効用理論をベースにしたモデルであり、プレーヤーの限定的な推論能力と「一回限りのゲーム」の「一回性」を十分に考慮していない。本論文では、プレーヤーの推論能力の限界とゲームの一回性に同時に着目し、ワン・ショット・ゲーム・モデルを提案した。提案したモデルでは、プレーヤーが 2 段階で意思決定を行う。第一段階で、相手の利得を考慮した上で、相手の行動に関する信念を構成する。第二段階では、プレーヤーが構成された信念に基づき、自分の最適選択肢を決める。自分の選択肢ごとに、相手の各行動をとる確率とその行動をとったときの自分の利得を考慮して、相手のすべての行動から一つ選び、選ばれた行動を自分の選択肢の焦点行動とする。焦点行動にもたらされた利得を最大にするように最適な選択肢を求める。焦点行動の選び方によって、プレーヤーがアクティブとパッシブの 2 タイプに分類される。

２．　ワン・ショット・ゲーム・モデルに基づいて、完備情報ゲームである資源配分ゲームを分析した。このゲームには唯一のナッシュ均衡が存在し、なおかつ利得関数のあらゆるパラメーターの値によらず、均衡のときには二人のリテーラーの発注量が発注量上限になっている。しかし、実証研究により、リテーラーの発注量は発注量上限より低い場合もある。提案したモデルに基づき、数理分析を行い、アクティブなリテーラーとパッシブなリテーラーの最適発注量が得られ、それによって、既存なアノマリーを解釈できた。

３．　ワン・ショット・ゲーム・モデルに基づいて、非完備情報ゲームであるファースト・プライス・オークションを分析した。実証研究により、オークションの入札者は、ベイジアン・ナッシュ均衡に従わず、低い評価値をもっている入札者がランダムに値付けをし、高い評価値を

もっている入札者が均衡入札価格より高値をつける、いわゆる throwing away と overbidding いう現象が確認された。提案したモデルをファースト・プライス・オークションに適応し、数理分析を行ったところ、ファースト・プライス・オークションの一般的な性質を説明できるだけではなく、ゲーム理論では説明できない overbidding と throwing away 現象を解明することもできた。特に throwing away 現象については、本研究が初めての理論的説明となる。

本研究で提案したワン・ショット・ゲーム・モデルは今までにない斬新なものであり、行動ゲームと経営科学の研究分野で、理論的な面においても応用的な面においても重要な価値があるといえよう。以上により審査委員一同は本研究院の博士号審査基準(3)に照らして、王超氏の学位請求論文「Theoretical Approaches to One-Shot Games and Their Applications」が、博士（経営学）の学位を授与するものに相応しいものと判断する。