

## **Expert or Victim? How the Way in Which Game Theory Is Taught Affects Payoffs in** an Iterated Cournot Game

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Abstract. This paper shares exploratory findings from a classroom study that investigated whether the sequence in which international students learnt about game theory influenced their performance while playing an iterated Cournot game. We found that gender has no major impact on cooperative behaviour, but prior familiarity with the concept of the prisoner's dilemma coincided with slightly greater instances of sustained cooperation. The most common outcome across all students was an inability to identify either the highest mutual payoff (sustained cooperation) or the unilaterally optimal strategy (defection). The sequence of instruction had a significant impact on student's results, and the group that was least likely to find the Nash equilibrium was in fact the group that was provided the most learning opportunities to identify it. Finally, we found that an exposure to game theoretic concepts was positively associated with cooperative (i.e. non-selfish) outcomes.

Keywords: Cournot, game theory, Nash equilibrium.

JEL codes: A23, C71

## 1. Introduction

In our experience game theory can be one of the most fun topics to teach in an economics course. Students typically arrive in class wanting to think more strategically, and the prevalence of examples and real-life applications make the content engaging. And yet game theory exemplifies the fact that knowledge accumulation can be a double-edged sword.

Consider the classic centipede game. Player 1 and player 2 make a sequential decision to either cash in a pot of money, or pass the pot to the other player. The pot starts in the possession of player 1, and contains £5. If player 1 stops the game,

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they receive £4 and player 2 receives £1. If they pass the pot to player 2, the value of the contents doubles, to £10. Now player 2 has a decision to make – cash it in (in which case they will receive £8 and player 1 receives £2), or pass it back. Each time the pot is passed between players the total value doubles, but whoever cashes it in receives 4 times the amount of their opponent. If the pot is passed between players 6 times, such that the value reaches £320, the game ends and player 1 receives £256 and player 2 receives £64.

Students typically recognise that it is in both players interests to cooperate with each other – if they reach the end they are both better off than if they fail to cooperate (player 1 would prefer £256 to £4 and player 2 would prefer £64 to £1). However, at each stage of the game whoever is in possession has an incentive to renege on this commitment. Usually the pot moves back and forth for a few rounds, but once they approach the endgame the penny drops. Player 2 realises that if they defect on their final turn, and cash in the pot instead of passing it back to player 1, they can obtain a bigger reward (£128 on the penultimate round would beat the £64 received in the endgame). If player 1 is thinking strategically, they should anticipate this, and therefore defect on the round prior. Which means player 2 should have defected earlier. This is a great example of backwards induction (i.e. look at the endgame, and work your way back), and demonstrates that the "solution" to the game - which occurs if both players are acting strategically – is mutually suboptimal.<sup>2</sup> If the students achieve any cooperation at all they will receive bigger pay-outs then if they immediately defect. It therefore seems odd to describe their behaviour as irrational. Indeed, a key insight from game theory is that sometimes being an expert can also make you a victim. A mutually naïve strategy is superior to a mutually strategic one.<sup>3</sup>

This article presents the findings from a two-year study involving a diverse group of 341 masters students. All students played an iterated Cournot game but we alternated the sequence of learning so that some students received a theoretical lecture first. It is commonly accepted that learning economics can induce selfish behaviour (Kahneman 2011, pp. 55-56), but does the way in which concepts are taught affect that? Our findings investigate the relevance of gender and prior knowledge of students to their proclivity to cooperate, as well as the relevance of the instruction sequence for observed outcomes and average payoffs.

The rest of this paper will proceed as follows. Section 1 surveys the relevant literature, and finds an existing lack of attention to the sequence of instruction. Section 2 explains the design of our study, to demonstrate how we are filling the gap. Section 3 presents key charts to help summarise findings relating to student characteristics, observed outcomes, and average payoffs, Section 4 concludes.

<sup>2.</sup> The "solution" is for Player 1 to stop the game at the first opportunity.

<sup>3.</sup> This doesn't mean that it's good to be naïve, it just means that having a naïve opponent can outweigh the handicap of being naïve yourself. It is always better to be strategic, but mutually strategic players receive lower payoffs than mutually naïve ones.

## 2. Using Game Theory in the Classroom

There is an extensive history of utilising experiments to learn about important economic phenomena, and strategic issues that relate to industrial organisation are particularly suitable topics. For a literature review of papers published since 2000 that use experimental economics to understand oligopoly markets, see Potters and Suetens (2013), while Brandts and Potters (2018) provide a more recent survey of experimental studies relating to game theory concepts. In this paper, we are particularly interested in the pedagogical insights from student based experiments. It seems obvious that game theory should be a focal point for interactive teaching - the concepts lend themselves to enjoyable activities and student engagement, and as Brokaw and Merz (2004) point out, "active learning arouses audience interest while introducing important concepts" (p.259). O'Roark and Grant (2018) employ comic books to demonstrate practical examples that simplify the key concepts, and the utilisation of games have become significant parts of economics courses. Becker (2000) and Bergstrom and Miller (2000) provide good examples of resources that advocate and advise instructors on how to use class room games, and Jacobson and Luedtke (2023) introduce articles with instructions for engaging, interactive games that vary from serving simple economic applications to targeting complex interdisciplinary learning objectives.

Although Dixit and Skeath (1999) suggest that simple bargaining games should be played on the first day of class, there's also a potential downside of exposing students to game theory - it may affect their behaviour and proclivity to cooperate with each other. Indeed, it is widely acknowledged that economics courses may make students more selfish, and less socialist in inclination. According to Landsburg (2018, p.19) it is commonly reported that students who take economics courses are less willing to contribute to left-of-center political organisations. Some studies attempt to understand the impact of monetary incentives on student outcomes, for example Rouso et al. (2015) find that students who play a prisoner's dilemma game with real money achieve higher test scores. Kahneman (2011 p.55-56) meanwhile, argues that using money in experiments primes respondents to be more independent and more selfish. That said, and more recently, Girardi et al (2024), find no clear link between studying economics and students self-interest, or indeed on their views on other people's self-interest. Indeed, classroom settings are well known for developing student's social capital, and encouraging team work and group allegiance. We therefore wonder whether fun activities do more to promote collective betterment than the specific learning objective (which in this case is to identify a prisoner's dilemma) does to prompt selfish behaviour.

Liberman *et al.* (2004) created a study where students were told to play a standard prisoner's dilemma.<sup>4</sup> Some of the participants were introduced to the game as "the Wall Street game" and others played "the community game".