JOURNAL OF ECONOMICS TEACHING

Incorporating Journal Articles in a Game Theory Course Using Structured Assignments

Assigning journal articles in upper-level undergraduate courses is a good way to show students what economists do. However, this can be difficult because the way economics is presented in journal articles differs dramatically from what students see in most undergraduate courses. Arguably, this gap is even harder to span in game theory courses given that the analytical tools (e.g., payoff matrixes, game trees) are relatively unfamiliar. I present a framework for incorporating journal articles into upper-level undergraduate game theory courses using structured handouts and assignments to guide students through an article's game-theoretic model. I also provide four examples.

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1. Introduction

I recently had a conversation with a student I'll call KT. KT took my Principles of Microeconomics class in her first semester and earned perfect or near-perfect marks on every assignment and exam. During one of her frequent office hour visits, I asked her if she planned to major in economics. She said, "No, but I do plan to get an economics Ph.D.!" Sensing my confusion, she explained she was going to major in math because she believed that would better prepare her for graduate school in economics.

You can debate which undergraduate major is the best preparation for graduate school, but KT's position certainly is not absurd. The way economics is typically presented in undergraduate classes is dramatically different from how it is presented in graduate school or academic journals. To see this, turn to a random page in a best-selling undergraduate textbook (e.g., Varian, 2014; Mankiw, 2021,) and compare what you find with a random page from Mas-Colell, Whinston, and Green (1995) or *Econometrica*.

This difference in presentation is compounded for an undergraduate game theory course because the payoff matrixes and game trees we use in game theory are already a departure from the graphs and equations students encounter in the microeconomics, macroeconomics, and econometrics courses that form the spine of the undergraduate curriculum. It is, therefore, arguably even harder for students to digest game theory journal articles than it is articles on, say, labor economics (Miller, 2021) or immigration (Orlov, 2021).

One option, of course, is not to assign journal articles in undergraduate game theory courses. Indeed, this is likely the most common outcome given Watts and Shaur's (2011) finding that just 22% of instructors in upper-level economics courses assign journal articles. But this seems like a missed opportunity. Students in upper-level courses should get a sense of what economists do, and the most straightforward way to do that is by reading journal articles written by economists. For professors interested in exposing students to interesting applications of game theory from the academic literature, I share several examples of structured assignments I have used successfully in my 300-level game theory course at Kenyon College, a selective liberal arts college where the interquartile range for ACT scores is 31-34 (U.S. News, 2023).

2. Selecting Appropriate Articles

In the game theory literature, games and related concepts are normally presented using mathematical notation. (See, for example, Fudenberg and Tirole's [1995] graduate game theory textbook.) This notation has the great advantage of being both *precise* and *concise*, which allows game theorists to convey exactly what they mean in just one or two compact sentences. However, this notation has the disadvantage of being impenetrable to students without years of college-level training in math. For example, consider Mas-Colell, Whinston, and Green's (1995) definition of a strictly dominant strategy (p. 237):

> **Definition 8.B.1:** A strategy $s_i \in S_i$ is a *strictly dominant strategy* for player *i* in game $\Gamma_N = [I, \{S_i\}, \{u_i(\cdot)\}]$ if for all $s'_i \neq s_i$, we have $u_i(s_i, s_{-i}) > u_i(s'_i, s_{-i})$ for all $s'_i \in S'_i$.

Again, this is precise and concise, but impenetrable (and likely even intimidating) to those not familiar with mathematical notation.

With this in mind, I have had the best luck when I have chosen journal articles that center on game theory but are written for an audience of non-game theorists. For example, later in this paper I will discuss articles that appeared in law and economics journals (Leeson, 2011; 2012), an interdisciplinary social science journal (Leeson, 2014), and a general interest

economics journal (Kingston & Wright, 2010).

The ideal paper will also pair its game-theoretic analysis with a readable, engaging background section on the topic of interest. This way, students who struggle to follow the theory presented in the paper will still learn something about, for example, the importance of dueling in early American history (Kingston & Wright, 2010) or the medieval Catholic Church's use of ordeals to determine a person's guilt or innocence (Leeson, 2012).

Astute readers will have already noticed that these recommendations rely heavily, though not exclusively, on the work of Peter Leeson. Leeson is a George Mason University economist whose work focuses on how societies organize themselves in the absence of a well-functioning government. The papers cited here present institutions that seem like historic curiosities – for example, using oracles to settle disputes – and then use game theory to show how these institutions can be seen as ingenious solutions to otherwise intractable problems. Instructors may choose to instead assign Leeson's popular book (2017) summarizing much of this research in lay language. I choose not to use this book both because I want to assign journal articles in my upper-level courses and because I find the tone of the book to be overly informal.

An Initial Example: Medieval Ordeals as a Screening Mechanism in Games with Asymmetric Information

I start my unit on asymmetric information by spending one 50-minute class playing and then modeling Reiley, Urbancic and Walker's (2008) "Stripped-Down Poker," a highly simplified version of poker that still captures essentials such as uncertainty and bluffing. At the next class meeting, I present a straightforward screening game where airlines adjust the (dis)comfort of the coach cabin to create a separating equilibrium where price-sensitive leisure travelers choose to fly coach, while business travelers choose to fly first class. Finally, I assign Leeson's "Ordeals" (2012), stressing that students should read the entire paper but shouldn't worry too much if they find the theory section hard to follow. At the beginning of the following class, we spend five or ten minutes on a general discussion of how the medieval Catholic Church used ordeals. In short, if a person was accused of a crime but there was not sufficient evidence to definitively determine guilt or innocence, a priest might order the accused to carry a red-hot iron bar a certain number of paces or to retrieve an iron ring from the bottom of a vat of scalding water. If the accused was burned, he was found guilty. If the accused was not burned, he was found innocent. Ostensibly, in the latter case, God had intervened to miraculously spare the accused from harm. Leeson, however, argues that the priest was able to secretly rig the ordeal by controlling how hot the iron bar or vat of water was, thereby sparing most, though not all, of the accused who chose to undergo the ordeal. Much like the airline example, the priest adjusts the rate at which he burns those undergoing the ordeal to create a separating equilibrium where only the guilty choose to confess and only the innocent choose to undergo the ordeal.

While this might sound like a simple application of screening mechanisms, I've found that even very bright students struggle with the theoretical model Leeson presents. This is where I make use of the structured handout and the corresponding assignment. Students form small groups and spend about 30 minutes working through a two-page handout (available for download here) that guides them through the creation of the incentive compatibility constraints that create the separating equilibrium described above. I circulate the room, making sure everyone stays on task and on track.

While the algebra involved is simple, many students struggle when thinking about concepts like the historic rate at which people have been burned in an ordeal in terms of a coefficient that falls on the unit interval. In a typical class of about 30 students, there will be one or two math majors who whiz through this exercise. But most students, even with the help

of their classmates and occasional coaching from me, need every bit of 30 minutes to answer the four questions in the handout. In the last 10 or 15 minutes of class, we reconvene to talk through the answers to the questions from the handout. If time allows, I prefer to send students to the board to present and explain their work.

To reinforce these lessons, students leave with an assignment to complete outside of class (available for download here) that is based on the model developed in class but uses specific numerical values for the various parameters.

3. A General Framework

Having had success with this approach to teaching journal articles in class during a 40-lecture semester, I've developed several other structured assignments along these lines. All follow a similar model:

- Introduce a new concept by allowing students to play a game for small cash stakes. [~25 minutes]
- Talk with the class about why they played the way they did, then solve the game formally on the board. [~25 minutes]
- Work through another somewhat more complicated example in class. [25-50 minutes]
- Assign students to read the journal article outside of class, reminding them not to get discouraged if they struggle to understand the game-theoretic model.
- At the next class meeting, briefly discuss the intuition behind the article's model, allow small groups of students to work through a handout guiding them through the model, and then discuss the answers as a class. [50 minutes]
- Send students away with an assignment to complete outside of class where they either complete the derivation of the model from the article, work through a specific numerical example using the same model, or develop another closely related model in a different context.

There are surely scores of articles professors could apply this model to, but what follows are three more examples I've used repeatedly and successfully.

4. Oracles as a Coordination Device in Chicken Games

Students seem to intuitively understand the logic of mixed-strategy Nash equilibrium in zero-sum games with no pure-strategy Nash equilibrium (e.g., Palacios-Huerta, 2003; Rousu, 2008). But the logic can be harder to grasp in games like Chicken where there are both pure- and mixed-strategy equilibria. Making matters worse, playing the mixed-strategy Nash equilibrium in chicken means the players will occasionally crash into one another. While it will depend on the payoffs used in the game, it is easy to create examples where the players' combined expected payoffs at the mixed-strategy Nash equilibrium are lower than their combined payoffs at either of the pure-strategy Nash equilibria, meaning mixed-strategy play is also inefficient.

Leeson (2014) presents a historical example of oracles being used to resolve conflicts, arguing this is efficiency enhancing because it allows the aggrieved parties to coordinate on one of the pure-strategy Nash equilibria and avoid playing the mixed-strategy Nash equilibrium. You can download the handout I use in class here and the assignment students complete outside class here.

5. Trial by Battle as a Way to Transfer Property in the Absence of a Functioning Property Market

In my experience, it is not hard to convince students that it is easier to solve a Cournot duopoly problem using calculus than using graphical analysis and algebra as, for example, you would see in textbooks like Frank (2014). But like most textbook examples of continuous-strategy games, this one only uses the power rule. Professors looking for an example that goes beyond the power rule might consider the all-pay auction. In this type of auction, all parties pay what they bid, with those submitting higher bids having a higher chance of winning the auction. While this sounds peculiar, life is full of all-pay auctions. Political candidates, for example, bid by spending money on advertising and campaign rallies. The candidate who spends more is more likely to win, but the loser must still pay.

What makes this a more challenging example is that individual A's probability of winning is a function of her bid as a proportion of all bids. In the case of two bidders, individual A's probability of winning is a/(a + b) where a is individual A's bid and b is individual B's bid. Assuming *v* is the value of the item up for auction, individual A's expected payoff is

$$\left(\frac{a}{a+b} \right) v - a,$$

or the probability she wins the auction times the value of the good she wins, minus the price she pays whether she wins or loses. Because *a* enters into both the numerator and the denominator of the first term, taking the derivative with respect to *a* requires using the quotient rule.

Leeson (2011) describes the tradition in Norman England of parties in a land dispute hiring champions to fight on their behalf. This was an all-pay auction in the sense that the party whose champion won the battle received (or maintained) the right to the land, and while more skilled champions were more likely to win and therefore were more expensive, both parties had to pay their champion win or lose. Leeson argues that these violent auctions meant land was more likely to be put to its highest-valued use. The feudal chain of lord-tenant relationships meant anyone above you in the chain could block the sale of your land, making straightforward exchanges of money for land uncommon. However, this chain of lord-tenant relationships didn't prevent land from changing hands after a trial by battle because the Anglo-Normans believed God had favored the winning party's claim.

You can download the handout I use in class here and the assignment students complete outside class here. Note that this assignment focuses on a different all-pay auction example drawn from biology, not history.

6. Dueling to Protect Creditworthiness in an Infinitely Repeated Game

One of the primary lessons students learn about repeated games is that while the outcome in any given round of a finitely repeated game may not differ from what you would expect to see in a one-shot game, outcomes in an *infinitely* repeated game can be dramatically different. Kingston and Wright (2010) model an infinitely repeated game where players borrow or lend to finance a risky project. This is a game of asymmetric information in that only the borrower knows whether the project succeeds. If the project succeeds, the borrower must decide whether to repay the lender or to default, keeping all the profits for himself. How can we compel borrowers to repay loans when their project succeeds? Through dueling. A lender who is not repaid (either due to failure or default) loses his honor if he does not challenge the borrower to a duel. A borrower who does not accept a challenge loses his honor. A dishonored

player is viewed as uncreditworthy, so he cannot borrow going forward. He also cannot issue challenges, so he should not lend.

You can download a handout that guides students through the first several steps of deriving Kingston and Wright's (2010) model here and an assignment that guides students through the remaining steps here.

7. Conclusions

The economics instructor's primary job is to present economic concepts clearly and engagingly. This can be done with a combination of classroom lectures, textbooks, and sources from the popular media. But another important element of teaching economics, particularly at the upper level, is to show students what economists do when we are not in the classroom. The best way to do this is by assigning the kinds of journal article economists write when we are not teaching. This can be a challenge. But with a bit of creativity, instructors can find readings and create structured assignments that allow students to learn about economic concepts while also learning what economists do.

In this paper, I present a framework for teaching game theory articles using structured handouts and assignments that guide students through the article's theoretical model. I also present four examples of papers and assignments for instructors to use. I suggest choosing journal articles that focus on game theory but that are written for non-specialists. Ideally, articles will also include a background section that is accessible to students who struggle to follow the theory.

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