Using Experiments and Media to Introduce Game Theory into the Principles Classroom

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Abstract
This educational note describes several video clips from the TV show "Golden Balls" and two short classroom experiments that can be used to introduce the topic of game theory into the principles classroom. It also suggests some additional resources that can further improve teaching the topic.

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I. Introduction

Recent research in behavioral psychology suggests that humor, games, and fantasy are more than just fun (Brown 2009).[1] Plenty of play not only makes us happier, but also makes us smarter. Play helps conceptual memory to be developed by firing up the cerebellum and increasing neuron activity in the executive portion of the frontal lobe. A large number of pedagogical papers have emerged over the past twenty years suggesting that more "playful" methods of teaching economics are also more effective than the common "chalk and talk" strategies. These alternative pedagogical tools range from the use of media in the classroom[2] to a variety of classroom demonstrations and experiments.[3]

In this educational note, I show how video clips from the popular British game show "Golden Balls" can be used as an effective pedagogical tool in teaching game theory to students in principles classes. In addition, I describe two short experiments that I use to demonstrate the prisoner's dilemma (PD) game and the tragedy of the commons. These supplemental classroom activities are meant to break the monotony of the typical lecture, bring some humor to the classroom, and get students reflecting on the underlying concepts by actively making choices. Unlike most classroom experiments,

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[1] A TED presentation by Stuart Brown on the topic can be seen at www.youtube.com/watch?v=HHwXlcHcTHc.
[2] For example, see Holian (2011), Diamond (2009), Hall and Lawson (2008), Mateer and Li (2008), and Mateer (2004).
[3] An excellent website with hundreds of different games that economists play is http://www.marietta.edu/~delemeeg/games/.

these short classroom activities can be performed in a few minutes and require minimal preparation time. I provide real incentives (usually in the form of extra credit points), allowing students to relate the studied material to their own lives and thus obtain a deeper grasp of its meaning and importance.

Teaching game theory in the principles course is important because students need a good understanding of the topic in order to better study a wide variety of business and economic phenomena. For example, the study of analytical anarchism often involves extensive use of game theory.[4] My experience shows that students not only enjoy these classroom activities, but also demonstrate greater interest in the subject matter, better concentration during lectures, and ultimately superior understanding of the studied material.

II. Split or Steal

When teaching game theory, I usually start with the classic version of the PD game.[5] What makes the PD so attractive from a pedagogical point of view is its simplicity and applicability to a broad range of human interactions. For example, psychologists have used the PD to model addiction, environmental scientists have used it to describe climate change, and political scientists have used it to explain the rise of the state (Mueller 2003). Economists often use the PD game to explain collusive behavior in oligopolistic markets.

While students often find the classic version of the PD quite interesting, it is nevertheless a situation that is not very common in real life, so they tend to be suspicious about the assumptions, outcome, and implications of the game. This is why I show them several video clips from the popular TV show "Golden Balls."[6] In the final round of this show, the two remaining contestants play a one-time version of the PD game called "Split or Steal." Contestants are asked to choose one of two golden balls—one with "SPLIT" printed inside and one with "STEAL"—to determine how the jackpot will be divided between them. If both players choose the "split" ball, the jackpot is equally divided. If one player chooses to steal and the other chooses to split, the player that steals gets all of the money while the other player gets nothing. Finally, if both players decide to steal, no one gets anything. This show provides an excellent natural experiment of the PD in which real people play for real payoffs, often substantial amount of money. Figure 1 shows the payoff

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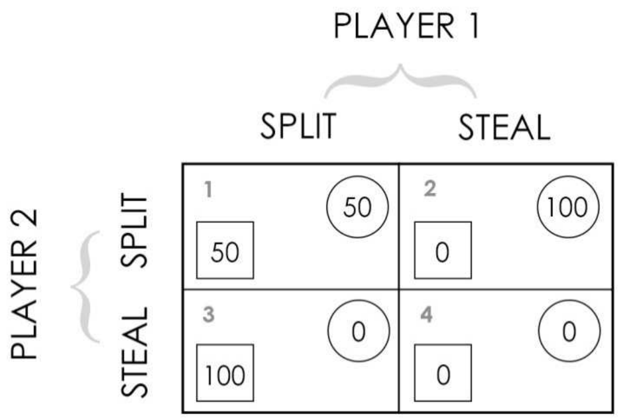
[4] For example, see Stringham (2005).

[5] My favorite is found in Singer (2000, p. 48).

[6] Another video clip that can be used to illustrate the same game is from the movie *The Dark Knight*. The clip can be accessed at http://criticalcommons.org/Members/gdmateer/clips/dark_knight_ferry_final.m4v/view. While students enjoy seeing their favorite heroes, they tend to trust real world experiments more. Therefore, I prefer to show them the "Split or Steal" video clips and, only if time permits, use movie scenes to reinforce the ideas.

matrix for players 1 and 2 in a generalized version of the game. The payoffs for player 1 are in circles and those of player 2 in squares. The payoffs represent the proportion of the jackpot that players capture.

Figure 1. Payoff Matrix for Sarah and Steve



This game is very similar to the PD. The only difference is that in the classic version of the PD, if one player defects, the other one is better off defecting, too. Thus, stealing is always the dominant strategy. In "Split or Steal," however, stealing is only weakly dominant.[7] This means that while the contestants who choose to steal have no reason to change their strategy, those who choose to split have an incentive to change their strategy to steal to improve their payback if they think that the other player is going to steal.

III. Stealing as a Better Strategy

In the first video,[8] the two players, Sarah and Steve, face the variation of the PD game just described. I prefer to show this video among many others because the jackpot of £100,000 provides a significant monetary incentive, and students tend to be far more interested when the stakes are higher. Figure 2 gives the payoff matrix for Sarah and Steve.

As the payoff matrix shows, stealing is a weakly dominant strategy for both players. This is to say that neither player has an incentive to change their strategy if they have already decided to steal, but if they have chosen to split

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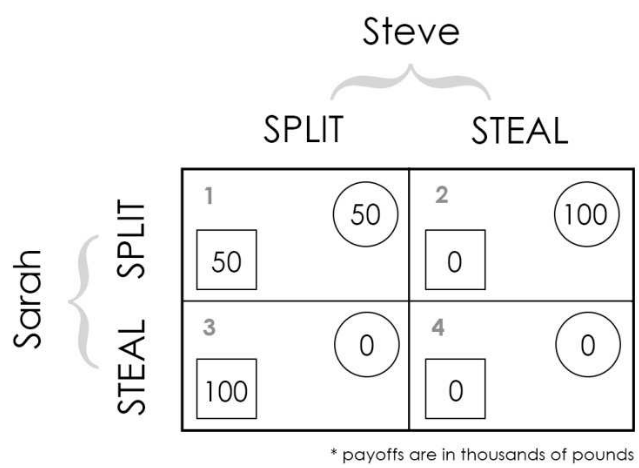
[7] It could be argued that preventing the other player from "stealing" the whole jackpot can bring some partial satisfaction to the player. Thus, if the payoff from stealing when the other person chooses to steal is greater than 0, then "Split or Steal" has the classic form of the PD game.

[8] The video can be accessed at: http://criticalcommons.org/Members/botzata/clips/split-or-steal-sarah-and-steve.mp4/view or downloaded at http://borisnikolaev.com/media/Split or Steal - Sarah and Steve.mp4.

the jackpot, and believe that the other player will pursue the same strategy, then they have an incentive to promise to split yet ultimately change their strategy to steal in order to capture a bigger payoff.

Figure 2. Payoff Matrix for Sarah and Steve



Thus, cells 2, 3, and 4 represent a Nash equilibrium and a possible solution of the game. That is, in these cells, players cannot do any better by changing their strategy. For example, Sarah's best strategy when Steve plays SPLIT is to play STEAL so she can claim the whole jackpot. If Sarah knows that Steve is going to play STEAL, however, she will be indifferent between playing STEAL or SPLIT as either of these strategies is going to earn her nothing.

I usually stop the video right before the players reveal their final choices and ask my students to put themselves in their shoes and tell me what they would do if they were making the choice. The following questions can be used to stimulate classroom discussion:

1. How do you expect players to act if they are trying to maximize their expected payoff from the game? (i.e., What is the dominant strategy in this game?)
2. Is it rational for the players to steal? Split?
3. Does this game have a Nash equilibrium? If so, which cell(s) represent it?
4. Do you expect the behavior of the players to differ if there is a smaller/larger amount of money at stake?
5. Do you expect Sarah to act differently than Steve? Was Steve justified in thinking that Sarah is also going to cooperate?
6. What do you think players should do while negotiating to maximize their chances of capturing a bigger payoff at the end?

An additional benefit to using videos from the "Golden Balls" show is that it has been a subject of extensive scientific research. Asem, Dodler, and Thaler (2011), for instance, analyze the behavior of the participants in the show and discover that cooperation is surprisingly high for amounts of money that would normally be considered consequential but look tiny in their current context. They also find that males are less cooperative than females, but this gender effect reverses for older contestants because men become increasingly cooperative as their age increases.

These results can be followed by a discussion of human nature and self-interest. I usually assign a reading by Peter Singer (2000, p. 48) in which he uses the PD game to attack rational self-interest. In his example, he shows that two selfish cavemen that are attacked by a saber-tooth tiger have lower chance of survival than two selfless ones. He generalizes that cooperation is wired in human nature through evolution.

I am not so quick to draw such conclusions, but I use the occasion to remind my students that:

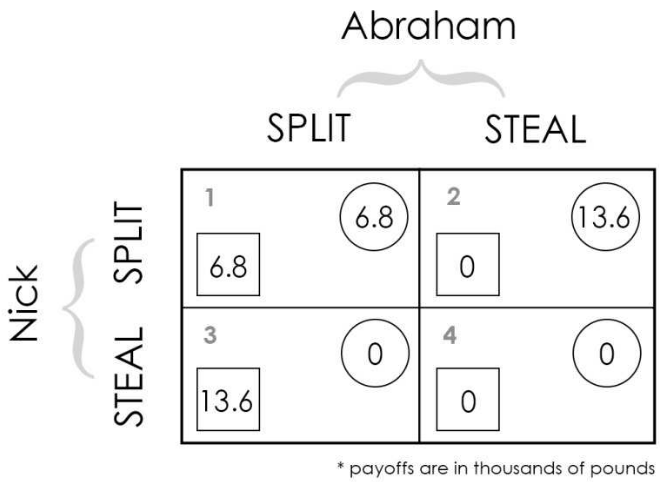
1. Assumptions matter in economic modeling (e.g., when we change the assumption of the PD that players are altruistic instead of self-interested, we get a completely opposite result).
2. Game theory is just a tool that is used for analyzing human behavior: it is not inherently good or bad.
3. It is rare that in the real world the PD is played only once. On the contrary, in the real world games are often repeated and the outcome that we observe is a result of a long process of interaction. If this is the case, rational self-interest is not necessarily contradicting with cooperation as both can emerge over the long run.

IV. From Stealing to Trust

In this second video clip from the show,[9] the two players, Nick and Abraham, start with the usual setup of the game, trying to decide how a jackpot of £13,600 will be split between the two. Figure 3 shows the payoff matrix for the two players.

[9] The video can be accessed at: http://criticalcommons.org/Members/botzata/clips/split-or-steal-abraham-and-nick.mp4/view or downloaded at http://borisnikolaev.com/media/Split or Steal - Abraham and Nick.mp4.

Figure 3. Payoff Matrix for Abraham and Nick

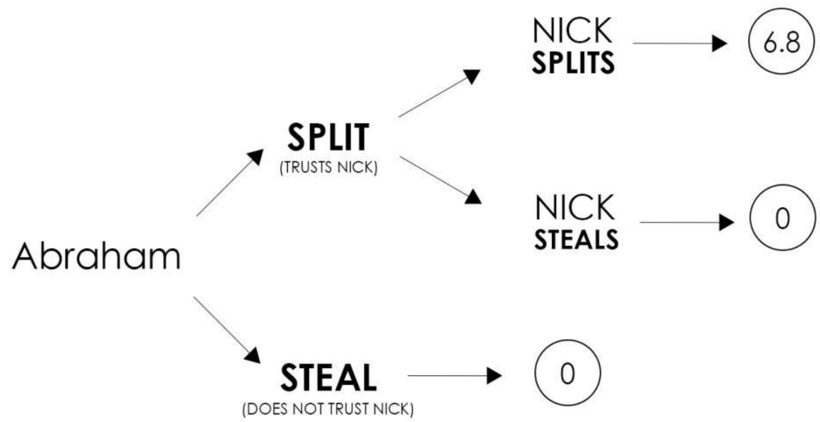


What is interesting about this particular episode is that Nick recognizes that he can't trust Abraham to split the jackpot. He also recognizes that he can't trust Abraham even if Abraham tries to persuade him that he will split the jackpot. This is because each player has an incentive to convince the other player that they are going to split, yet ultimately steal to capture a bigger profit. What Nick does then is to create a meta-game that transcends the rules of the PD game that both of them are playing. He persuades Abraham that he will inevitably choose the "STEAL" ball. Thus, if Abraham decides to steal, neither one of them will get anything. Yet, if Abraham decides to split, Nick promises that he will split the jackpot with him outside of the game.

This changes the PD game in which both players are making a decision simultaneously to a trust game in which one of the players makes a decision, and then the other one does. In trust games, usually Player 1 (the trustor) receives a given amount of money and then chooses how much of the money to "trust" or keep. The trusted amount is multiplied by a factor (e.g., two) and given to Player 2 (the trustee), who decides how much of it to return to Player 1 and how much to keep. One can think of the amount of money sent by the trustor as a measure of trust, and of the amount of money returned by the trustee as a measure of reciprocity.

In this "Split and Steal" episode, Nick sets himself as the trustee (Player 2), promising Abraham that if he gets the jackpot, he will split it 50-50 with him. Notice how many times Nick repeats to Abraham to trust him, trying to subconsciously establish the rules of the trust game. Abraham is now the trustee, trying to decide whether to trust Nick and give him any money at all. The only difference from a typical trust game is that if Abraham decides not to give Nick any money, he is not going to receive anything, either. In other words, while stealing will leave both players with empty hands, at least splitting the jackpot leaves a possibility for Abraham to receive something back. This is how Nick removes the incentive for Abraham to promise to split, yet lie and steal at the end. Figure 4 shows Abraham's decision tree.

Figure 4. Abraham's Decision Tree



The only sensible decision that is left for Abraham is to trust Nick, because it is the only option that gives him some hope for a reward. At the end, Nick chooses the split ball. He does so even before Abraham makes up his mind, which shows that he is certain that his psychological manipulation will work. The whole episode is funny to watch because of Abraham not realizing what is going on, and in a leap of desperation, he tries to talk about the importance of keeping one's word and reciprocity. Yet, Nick completely disregards his comments, reinforcing his determination that if he does not trust him, he will lose everything.

V. The Student's Dilemma

This is a very simple game that I use at the beginning of class or right after I discuss the PD to show how the game can play itself out in a real-world setting. I provide students with real incentives (usually extra credit points) to get them involved in the game and get them thinking about the consequences of their own decisions. The setup of the game is very simple: I ask students to lay their heads down on their desks (so they cannot see what other students are doing), and at a snap count, they have the option to either raise their hand or not. If nobody raises their hand, each one of them will receive one extra credit point on their first exam. If only one person raises their hand, this one person will receive ten points on their first exam. But if more than two students raise their hand, nobody gets any points. In other words, if students cooperate, they are rewarded. The payoff matrix is very similar to the one in the "Split or Steal" video clips described above. Again, while students have no reason to change their strategy if they have already decided to raise their hand, they have an incentive to raise their hand if they believe that everybody else won't.

My experience shows that more often than not, two or more students will raise their hands and nobody will win any points. Regardless of the result, I ask my students if this is an expected outcome and to walk us through their reasoning in making their choice. Often, students, without realizing it, will give a very similar logic to the one that I am trying to teach them.

I often play a second round of the game, and sometimes even a third round. By extending the game into several periods, I am able to extend the discussion and introduce the idea of a super game (repeated game). It is often the case that students, especially if they have cheated in the first round, cooperate in the second one. This shows that a repeated PD game is very different than a one-shot game. I can then relate the outcome of the game to our previous discussion about self-interest and cooperation.

Hemenway, Moore, and Whitney (1987) develop a similar game to illustrate some of the difficulties involved in price coordination (collusion) under circumstances of imperfect competition. Their game is an excellent way to extend the discussion from a more generalized version of the PD to a more specific case that explains the behavior of firms in oligopolistic markets. However, their game involves more preparation time, and instructors should be expecting to spend a significant portion of the class performing it.

VI. The Student's Tragedy

The tragedy of the commons is another phenomenon that can be modeled as a multiplayer version of the PD game (see, e.g., Binmore 2007). It is a type of social dilemma in which it is rational for a large number of players to act in their own self-interest, but in doing so, they end up hurting not only society, but also themselves in the long run.

In this next experiment, I demonstrate the tragedy of the commons in the classroom. To do this, I bring a bag of candy to class (usually one that has more than one hundred individual pieces). To set up the experiment, I throw sixty pieces of candy around the room. Then I propose the following game: Students will play individual rounds of fifteen seconds in which they will have a chance to collect as much candy, the common resource, as they can. At the end of each round, I will double the "population" of candy up to its sustainable level of sixty units (e.g., if students collect forty-five pieces of candy, there will be fifteen pieces remaining, which I will double to thirty for the second round). To make the game more realistic, I offer the following payoff:

- One extra credit point for each seven pieces of candy collected per round.
- The student that collects the most candy each round gets five extra credit points.

While some students think that this is a childish and naive approach to teaching economics, they are quite fascinated with the outcome and implications of this game. Without exception, every single time I have played this game, students exhaust the common resource, the candy, within five to ten seconds. It not only makes for quite a sight to see them run through the room in an effort to collect as many pieces of candy as they can, but it is precious to see the disappointment in their faces when I tell them that their own self-interest has deprived all of them of As on their final exams. To explain why this is so, I first ask them what is the sustainable (and optimal) level at which to collect candy, and then I tell them that if they had collected the candy in a sustainable way, all of them eventually could have earned enough extra credit to get an A on their final exams. However, they did not. Then I follow with a discussion of why common resources are often exploited and why property rights are important for society to function efficiently.[10]

VII. Conclusion

I have found games and the use of media to be effective at engaging students in classroom learning. In this short educational note, I described two classroom experiments that can be used to demonstrate and apply some of the principles that students learn when first introduced to the topic of game theory, and in particular, the PD game. I also described several video clips from the TV show "Golden Balls" that are an excellent application of the PD but can also be used to extend the discussion to more complex models such as super games and trust games.

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[10] A more sophisticated version of this game can be found in Giraud and Herrmann (2002).

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