THE COLOR OF SELF-INTEREST

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Abstract

Engaging undergraduate students in economics courses relies increasingly more on using classroom games or experiments. In this paper we propose a linear form of a popular game-theoretic simulation, and then we suggest multiple applications in a variety of contexts. Playing our game in the classroom, students can see for themselves whether their individual choices, guided by self-interest, tend to lead to nearly optimal group outcomes. With little to no change in the setup of our experiment, we show how any instructor can extend the analysis to exemplify inefficient pure-strategy Nash equilibria, the equality/efficiency trade-off and the issue of who "deserves" more, government redistribution versus private charity to the poor, the free-rider problem, and the tragedy of the commons.

Keywords: student engagement, classroom experiments, individual gains, collective gains, game theory.

JEL Classification: C70, C90, D01, D70

Introduction

There is a growing literature on the use of games and experiments to complement undergraduate-level economics lectures (see, for instance, Dickie, 2010; Kaplan and Balkenborg, 2010; Picault, 2019). While students are more easily engaged in these activities, instructors may sometimes be concerned about their uncertain outcomes or about the possible divergence from the theory being taught.

This paper proposes a linear version of the Bruehler et al.'s (2017) Red/Green simulation and then highlights the abundance of potential applications. Similar to the Holt and Laury's (1997) model that uses playing cards to collect students' choices and then determines earnings based on a linear combination, our approach employs only basic math operations, thus providing a simple-to-implement structure. For instructors who want to emphasize the best/worst possible outcomes, we include complete instructions on how to perform such optimizations using the Excel Solver add-in.

The article is organized as follows. In the next section we show the tradeoffs between our model and Bruehler et al.'s (2017). Then, we present the setup of our simultaneous-move game-theoretic experiment in which participants choose between their direct individual gains and indirect collective gains. The experiment enables students to actively (rather than passively) learn important economic concepts. We also include templates that instructors can use to report the setup and the outcomes. The following section suggests possible in-class applications, including lesson plans and guided classroom discussions. These can be used for college-level courses such as principles of economics, public economics, environmental economics, and game theory. The final section of the paper provides brief concluding remarks.

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Model Comparison

Both our and Bruehler et al.'s (2017) models assume that players choosing green do not contribute to the group wealth while individually getting a larger proportion of the final total wealth. Players choosing red contribute to the group wealth equally, but they individually get a smaller proportion of the final economic pie. The highest possible payoff can be obtained by only one participant, if that student is the only one choosing green.

The core question is: will they focus on a larger piece of the pie, or on making the pie larger? All participants must have complete information in the sense that they should all know the rules of the game (including strategies and payoffs) and that the rules are common knowledge.[3]

Bruehler et al.'s (2017) approach uses exponential functions to quantify the payoffs (π) received by red ($\pi_{Red} = (1 + x)^{\#Red}$) and green players ($\pi_{Green} = B \times (1 + x)^{\#Red+1}$). In the two formulas, *x* is calculated based on the total number of participants, the number of rounds, and the acceleration rate. B is the ratio of the payoff for a single defector (i.e., exactly one green) to the individual payoffs for uniform cooperation (i.e., all red), labeled as "index of temptation." A second indicator is constructed, called "index of infernality," as a ratio of payoffs for all red to payoffs for all green. A link to a Google sheet is provided to help with calculations. For instance, for a round that involves 15 participants, a payoff of 100 if all cooperate, and 1,000 for a single defector, it computes values of 10 and 7.356 for the index of temptation and infernality, respectively.[4] Consequently, students who choose green always receive $B \times (1 + x) = 10 \times 1.3594 = 13.594$ times as many points as students who choose red, regardless of how many cooperate (selecting red) and how many defect (selecting green). In principle, following self-interest (i.e., choosing green) exponentially reduces the number of points that all participants receive (e.g., as extra credit). However, in practice, some experiments may allow negotiations, or some signals may trigger a form of consensus among students. In those cases, payouts increase exponentially, and some instructors may be uncomfortable with giving too many points to students for something other than merit.

Our linear model allows instructors to choose from the start the maximum number of extra-credit points that students can earn (if any), and negotiations among them do not increase the risk of their grades being strongly impacted by the game results. Additionally, a simpler mathematical model makes the assignment easier to understand, which is especially useful in today's education environment marked by a decrease in the students' quantitative skills (see, for instance, Carpenter and Kirk, 2017).

Hence, while Bruehler et al.'s (2017) method is focused on increasing the values of those two indices, our linear model, presented in the next section, offers more control, flexibility, and a simpler way to emphasize individual or group gains. That is, comparing the two approaches translates into a tradeoff between generating greater tension between what is best for an individual and what is best for the whole group, and the ease of understanding for students and the level of control for instructors.

[3] For a thorough definition of complete information see, for instance, Dixit et al. (2020, p. 309).

[4] For the same setup, Bruehler et al. (2017) report a value of 100 for their index of infernality, much greater than what Holt and Laury (1997) would obtain for their linear model (100 versus 3.75, respectively). However, using the same scenario, the index of infernality in Bruehler et al. (2017) is actually equal to 100/13.594 = 7.356, which verifies that the solution given by the online calculator is the correct one, and which brings it significantly closer to 3.75. Moreover, it further decreases if the number of rounds or the acceleration rate is increased.

Experiment Setup and Outcome Layout

Instructors can spend around five minutes explaining the experiment to their students. Next, all students in the classroom must make a binary (red or green) choice, secretly and simultaneously. With a few exceptions, mentioned in the next section, there are two iterations of the game, each taking around five minutes. After the experiment, instructors may encourage their students to discuss the results. The length of the discussion depends on the lesson being taught and on the educators' preferences.

The first iteration could be completely anonymous, in the sense that the students would know before answering the survey question that their names will not be associated with one of the two options: red or green. The second iteration is identical to the first one, with the important exception that the participants would know that their names will be revealed after completion. It is important to note that educators who do not wish to examine whether anonymity impacts simulation results can skip one of the two scenarios. The second round could also allow for negotiations among participants (see *In-class Application 2*, below).

Instructors can adjust the level of conflict between the two choices (red and green) by changing the parameters of the game, presented below. They can also vary the parameters across multiple groups of students or multiple iterations of the experiment to study how humans respond to incentives.

We recommend introducing the activity to students in the following bulleted format (we include this template in the Appendix, for those instructors who wish to easily print copies for their students):

- *Your group's initial endowment (i.e., the number of points that your group starts with) is: <u>I = ...</u>*
- *You will need to choose a color (red or green) and complete the one-question survey.*
- *If you choose **red**, then you receive only ____ of the final total (i.e., total points/___), but you add <u>a = ...</u> more points to the total.*
- *If you choose **green**, then you gain ____ of the final total (i.e., total points/___), but you add nothing to the total.*
- *So, which color will you choose: red or green?*

The answers can be collected in a variety of ways. For instance, instructors who use Moodle can employ a feedback activity which records all necessary information. Other instructors may use Kahoot!,a and the automatically generated reports will include the responses. Although the experiment could be conducted only once, with an entire section of a course, we suggest that forming multiple groups of students and varying the *I* and *a* parameters from one group to another would facilitate comparisons and possible generalizations.

The first decision that needs to be made before conducting the experiment is the ideal range of possible payoffs to be earned by individual students. We believe that the number of potential extra-credit points should be strictly positive, to engage students, but not too large, so that it does not considerably influence the final course grade (unless the game and its applications are central to the course). To illustrate, for each of the two iterations of the game, we set a maximum of 7.5 extra-credit points (in courses where the total, not including extra credit, is 200), or a combined 7.5 percent. It is important to note that instructors who do not wish to offer bonus points solely for playing the game may test their students' comprehension of the accompanying topics, as a requirement for earning credit.

The second important decision is choosing the proportions of the final pool of points to be awarded as extra credit to individual students choosing red or green. To illustrate, in this paper we use one fifth and one half, respectively, with the observation that only players selecting red contribute to the total group wealth (and nobody abstains). Instructors who want to guide more students toward green and show that self-interested individuals do not actually help optimize general prosperity, can decrease the relative proportion of benefits assigned to red and place constraints on group payoffs (see an example below, as part of the third major decision). Note that, given fixed proportions, the participants' aggregate payoffs are not limited to the final number of points (or the wealth) that they accumulate in the game, which is equal to the initial endowment plus contributions from red players (if any). That is, just like the government, the instructor can "borrow" to finance a deficit. To avoid confusion, everywhere in this paper, payoffs refer to the extra credit that students actually/potentially get.

The third decision involves setting the group's initial endowment (I) and the marginal group wealth (a) contributed by each additional red. We recommend choosing an initial endowment such that, when considering the number of students (N) in the group, it results in a round value for the marginal wealth (see equation 2 below), which makes calculations easy to understand for students. Given that the optimal case for an individual player is when they are the only one choosing green, which gives them 7.5 points, we obtain:

$$7.5 = \frac{I+(N-1)a}{2}, \tag{1}$$

which results in the following equation for the marginal group wealth:

$$a = \frac{15-I}{N-1} \tag{2}$$

It can be argued that, in real life, some people prefer to be taxed more (thus to contribute more), hoping that they will enjoy even greater benefits. Therefore, instructors who want to account for this possibility may choose not to over-incentivize the green option. Conversely, those who want to emphasize a collective action problem will parametrize the game to highlight the conflict between individual and group interests.

Supposedly, if nobody contributes to the economic pie, the slices are smaller than in the opposite case of unanimous contribution. We use this observation to illustrate how instructors can place constraints on payoffs, if needed. A lower total group payoff if all choose green versus all red translates into the following inequality, using the proportions specified above:

$$N\frac{I}{2} < N\frac{I+Na}{5}, \text{ or equivalently,} \tag{3}$$

$$Na > \frac{3}{2}I \tag{4}$$

In this case, after deciding on the group size (N), instructors may want to choose values for a and I such that inequality (4) holds.

Regarding outcomes, once all responses are submitted for both/all rounds, the payoffs that are communicated to students can be calculated (for each round) using the following two formulas:

$$\pi_R = \frac{I+Ra}{5} \tag{5}$$

$$\pi_G = \frac{I+Ra}{2} \tag{6}$$

where π_R is the payoff to each red, π_G is the payoff to each green, and R is the number of red players. Formulas (5) and (6) can be easily implemented in a spreadsheet, so that students immediately know the outcomes of the experiment and can start discussing implications or economic applications (see the net section). The group payoff (π) can be calculated as follows.

$$\pi = R \times \pi_R + G \times \pi_G = R\frac{I+Ra}{5} + (N-R)\frac{I+Ra}{2}, \tag{7}$$

where the only new variable, *G*, is the number of green players.

We suggest that, before analyzing the outcomes in detail, it helps to review the parameters assigned to each group and the extreme values of possible payoffs. Table 1 provides a template and an example of possible values for each item for a fictional group of students that we call Group 1, or simply *G1*. We assume that five students have participated ($N = 5$) and that they have been given an initial endowment of three points ($I = 3$). Also, each red adds three points ($a = 3$) to the total, implying that if all five choose red, then the group payoff is equal to 18 (here, $\pi_{red} = R\frac{I+Ra}{5} + 0\frac{I+Ra}{2} = 5\frac{3+5\times3}{5} = 18$). Note that, in this case, the group wealth ($W = I + Ra$) is also equal to 18, meaning that the instructor does not need to "borrow" points. If all participants choose green ($R = 0$), then the group wealth remains equal to the initial endowment ($W_{green} = I = 3$), while the group payoff is at the minimum ($\pi_{green} = \pi_{min} = N\frac{I}{2} = 5\frac{3}{2} = 7.5$).

The number of red players (R_{max}) needed to maximize the group/average payoff can be easily computed in MS Excel using the Solver add-in, as follows. *N*, *I*, *a*, *R*, and *G* should each occupy a cell (with appropriate headers). In the Solver menu, the *Set Objective* (*To: Max*) references the cell that calculates the group payoff (see equation 7), *By Changing Variable Cells* is the number of red players (*R*), and *Subject to the Constraints* specifies that *R* is an integer less than or equal to *N*. We recommend selecting the *Multistart* (i.e., global optimization) check box in the *Options* sub-menu. Then, the optimal number of green players (G_{max}) is simply *N* minus R_{max}. For minimization, the only change is that the *Objective* should be set to *Min*. Preparing this Excel file could take 10 – 15 minutes and could be reused for different groups of students, simply updating the parameters and re-running the Solver.

Table 1. Experiment Setup.

	G1	*G2*	*G3*	…
Num. Students (*N*)	5			
Initial Endowment (*I*)	3.0			
Additional Wealth for Each Red (*a*)	3.0			
Group Wealth If All Red (W_{red})	18.0	($W_{red} = I + Ra = I + Na$)		
Group Wealth If All Green (W_{green})	3.0	($W_{green} = I$)		
Group Payoff If All Red (π_{red})	18.0	($\pi_{red} = R\frac{I+Ra}{5} = N\frac{I+Na}{5}$)		
Group Payoff If All Green (π_{green})	7.5	($\pi_{green} = G\frac{I+0(a)}{2} = N\frac{I}{2}$)		
Maximum Group Payoff (π_{max})	19.5	(use the Solver as above)		
Maximum Average Payoff (π_{maxAve})	3.9	($\pi_{maxAve} = \pi_{max}/N$)		
Num. Red for π_{max} (R_{max})	4	(use the Solver as above)		
Num. Green for π_{max} (G_{max})	1	(use the Solver as above)		
Minimum Group Payoff (π_{min})	7.5	(use the Solver as above)		
Minimum Average Payoff (π_{minAve})	1.5	($\pi_{minAve} = \pi_{min}/N$)		

Table 2 provides a template and shows hypothetical results for two iterations of our experiment, one where the players' individual choices are kept secret after completion (Panel A) and one where their choices are revealed after completion (Panel B). Whether survey answers remain anonymous or not needs to be announced in advance, as it may influence the participants' actions.

Table 2. Experiment Outcomes.

Panel A. Anonymous.	*G1*	*G2*	*G3*	…
Num. Red (R)	0			
Num. Green (G)	5			
Payoff to Each Red (π_R)	N/A			
Payoff to Each Green (π_G)	1.5			
Total Payoff (π)	7.5			
Average Payoff (π_{Ave})	1.5			

Panel B. Names Revealed.	*G1*	*G2*	*G3*	…
Num. Red (R)	1			
Num. Green (G)	4			
Payoff to Each Red (π_R)	1.2			
Payoff to Each Green (π_G)	3.0			
Total Payoff (π)	13.2			
Average Payoff (π_{Ave})	2.6			

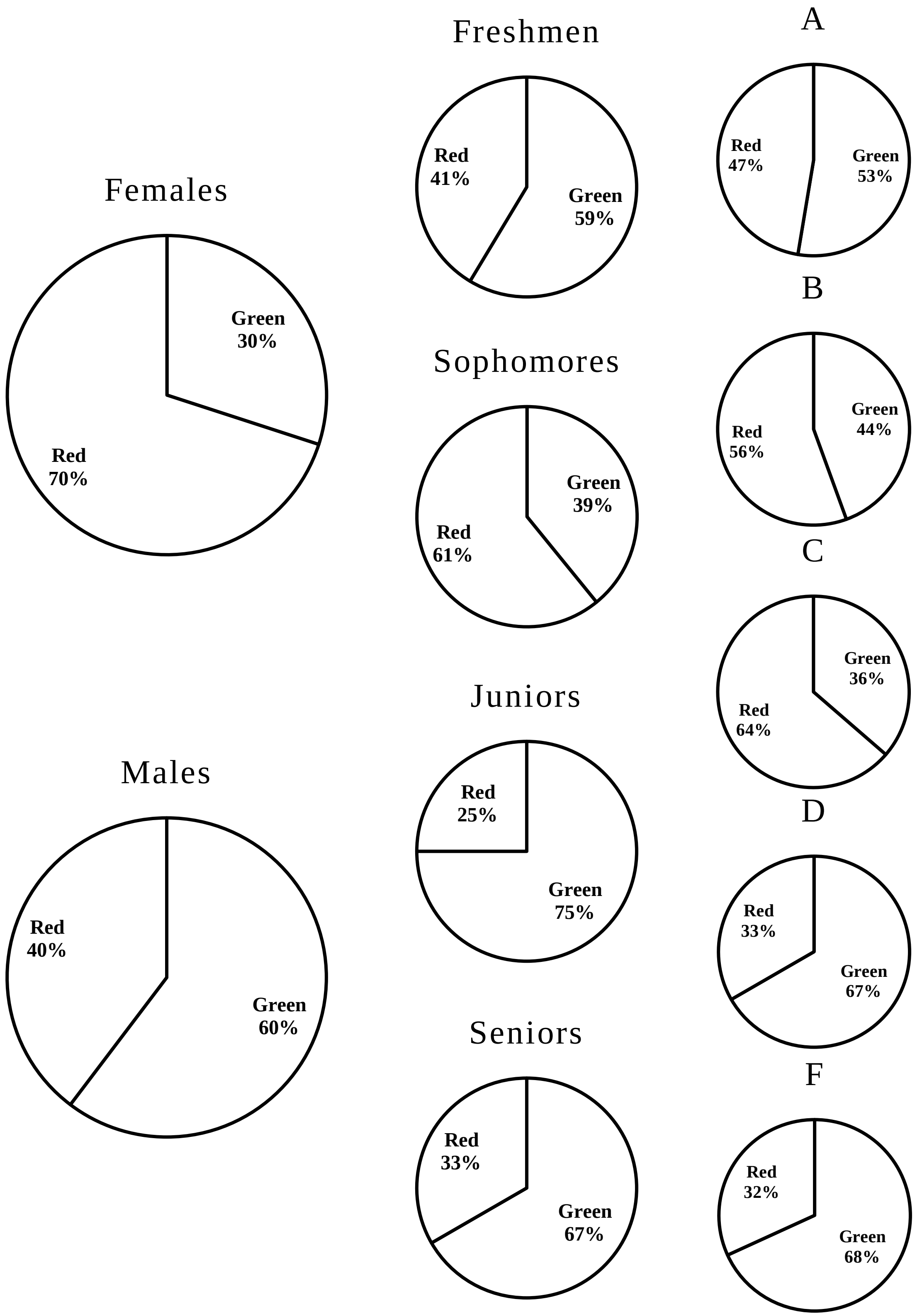
Under anonymity, each participant in the hypothetical *G1* cohort chooses green, hoping that the others choose red. Their actions result in an inefficient Nash equilibrium outcome (to be discussed in the next section), with an average payoff equal to the minimum, rather than the maximum (see the last row of Table 1).

Comparing the two panels of Table 2, instructors can examine whether anonymity (or the lack of anonymity) significantly alters the players' behavior. In Panel B we assume that a single student is concerned enough with judgement from the others and therefore decides to contribute. That student earns one-fifth of the six points (three from contribution, in addition to three from the endowment), while each of the four green players earns one-half of the six points. In this case, the instructor "borrows" $13.2 - 6 = 7.2$ points.

Instructors may also be interested to compare students' choices based on gender/sex (female or male), level (freshman, sophomore, junior, or senior), and current (say, midterm) grade in the course (A, B, C, D, or F). For instance, studies show that women are more socially oriented, while men are more individually oriented (see Eckel and Grossman, 1998). Molina et al. (2013) use a sample of 1,229 high school students and also find that female students are more cooperative than their male peers. Another study by Jones (2008) shows that more successful students defect less than weaker ones.

In Figure 1 we suggest a way to present the overall results, using pie charts, which we call *action clocks*. For all groups combined, we could hypothetically report that under anonymity, female, sophomore, and B – C students are more likely to select red and thus contribute to collective wealth. Action clocks could also separately show that, knowing that their names will be revealed, male, freshman, senior, and D – F students are more likely to choose green, indicating that for them individual gains are more important than group prosperity.

Figure 1. Action Clocks – Anonymous.



In-class Applications

Application 1. Inefficient Pure-Strategy Nash Equilibrium Outcomes

Lesson Plan

Many students who take an introductory game theory course are puzzled by the possibility that rational players might end up in Pareto-inferior equilibria (see, for instance, Vriend, 2000). While numerous examples exist in any textbook in this field, nothing is more revealing to students than their own actions leading to a jointly worse outcome. The hypothetical participants in *G1*, when selecting green or red simultaneously and anonymously, arrive at such an inefficient pure-strategy Nash equilibrium: they all choose green, and none is willing to switch to red on their own, given the worse payoff to red when all others pick green. Their average (or group) payoff is then at the minimum level.

After presenting the definition of the Nash equilibrium and a textbook example of the occurrence of a Pareto-inferior equilibrium, instructors conduct the experiment as described in the third section. If they are concerned that some participants might choose red, it is a good idea to reduce the value of a and/or increase I and to be prepared to repeat the game multiple times. Once the results are announced and the red players see that their payoffs are lower, they will switch to green and approach the inefficient Nash equilibrium (see, for instance, Holt and Laury, 1997).

In-Class Discussion

After reviewing the experiment setup (Table 1) and reporting the results (Table 2), the instructor can ask some of the following questions, to stimulate discussion:

i. Why did you decide to choose green/red?
ii. What could convince you to choose differently?
iii. Is all green a Nash equilibrium? Why?
iv. Is all red a Nash equilibrium? Why?
v. How far were you from the maximum/minimum payoff?
vi. What is the main conclusion of the experiment?

Application 2. Equality versus Efficiency and Who "Deserves" More

Lesson Plan

The pursuit of equality, where all players contribute and benefit evenly by choosing red, results in collective prosperity that is inferior to the efficient outcome ($\pi_{red} < \pi_{max}$). For instance, for our hypothetical *G1*, as shown in Table 1, $\pi_{red} = 18$, while $\pi_{max} = 19.5$. Similarly, if all players value individual rewards more than communal well-being and therefore choose green, then they each receive half of the initial endowment, which is significantly less than the maximum average payoff. So, considering the equality/efficiency tradeoff, unanimous contribution/self-interest is not optimal. Efficiency, or maximum group payoff, results from a combination of strictly positive numbers of red and green players. This begs the question of who supposedly deserves to be green and thus gain a higher payoff.

After presenting the concepts of equality and efficiency, and the tradeoffs between the two, instructors conduct the experiment as described in the third section. We recommend playing multiple rounds to accommodate the following four scenarios, which explore the reasons why some deserve greater benefits than others and how the size of the endowment influences preferences for equality/efficiency:

i. Given that higher risk is associated with higher expected return, perhaps players who need points the most are willing to risk more (by not increasing the pool of points, but hoping that the others will contribute), expecting to improve their course grade significantly.
ii. Students are allowed to negotiate and influence each other before simultaneously submitting their answers. This brings with it the cost of spending additional time on the experiment (around 15 – 20 instead of 10 minutes).
iii. Zitelmann (2021) points out that lottery winners represent one of the most important categories of people who deserve to be rich according to surveys conducted in seven countries, including the United States. Moreover, given the random nature of lotteries, winners are less envied than those who build their wealth based on merit. This paradoxical observation can be tested using a variation of our experiment: in one iteration, students use their strategic skills, and, in another iteration, the green action is dictated by the outcome of a random event (e.g., a six on a die roll). Then, the red players are surveyed to compare their envy toward the richer green players, across the two rounds.
iv. Assuming access to a very large (or very small) endowment, it is interesting to investigate whether people are more drawn to either equality or efficiency. In this case, the experiment would consider initial endowments (*I*) at the two extremes, in two separate iterations. Will participants just choose the larger proportion of a large endowment, or will they decide to contribute, believing that the smaller proportion of an even larger endowment is fruitful enough? How about for a small endowment?

In-Class Discussion

After reviewing the experiment setup (Table 1) and reporting the results (Table 2 and Figure 1), the instructor can promote discussion asking some of the following questions, numbered according to the above four scenarios:

i. Does Figure 1 show that D and F students are more likely to choose green? Do they actually earn a significant number of points? Assuming that A and B students anticipate that, what would their best response be?
ii. Has certain players' charisma contributed to earning more points? Can we extrapolate that to an entire society and conclude that more influential people do better for themselves?
iii. Why would the red players feel more envy towards the green ones, if their action was based on strategic skill rather than chance? In real life, what proportions of a person's success should come from skill/strategy/talent versus chance?
iv. If you were offered a small endowment, would you feel entitled to a large proportion? If you were offered a large endowment, would you consider it fair to contribute, so that payoffs increase for everyone? Would your answers change behind the Rawlsian (1971) *veil of ignorance* (which presents a way to make decisions, ignoring personal circumstances)?

Application 3. Government Redistribution versus Private Charity to the Poor

Lesson Plan

Throughout its history as a developed country, the United States has been struggling with the paradoxical existence of poverty in its midst, raising questions on whether and how the poor should be helped. According to a poll conducted in 2001 by the National Public Radio (NPR), the Kaiser Family Foundation, and the Harvard University Kennedy School, 48 percent of the respondents consider that the main cause of poverty is the poor not doing enough to help themselves, while 45 percent say that the cause is uncontrollable circumstances.[5] This significant difference of opinion stimulates further debates on whether the poor should be helped through government redistribution or through private charity.

Roberts (1984) explores the relationship between government redistribution and private charities. Two of the major ways in which the government can help the poor are the progressive income tax system and the welfare system (e.g., Medicaid, food stamps, Temporary Assistance for Needy Families, etc.), while private foundations can conduct charitable activities. Roberts (1984) points out that the government and the private donors have different motives for assisting those in need: gaining political support and altruism, respectively. He finds that there is more government redistribution than is desired by altruists.

After presenting the concepts of government redistribution and private charity, as well as the benefits and drawbacks of each approach, the instructor conducts the experiment as described in the third section, but with a small adjustment. In this new variant of our simulation, students are made aware that some of them (without revealing exactly who) struggle to pass the course and are encouraged to discuss among themselves how contributions from altruists (choosing red) can help improve their situation (grade in the course). The debate should also focus on the fairness of this allocation and the possible reasons for the lack of success in the course, that is, lack of trying versus circumstances (to mirror the poll results mentioned above). Then, they proceed to select green or red anonymously and simultaneously. Once the results of the experiment are obtained, a second set of results is considered in which the "government" (instructor) decides how the additional wealth is allocated (say, D and F students are green, while the rest are red).

In-Class Discussion

After reviewing the experiment setup (Table 1) and reporting the results (Table 2 and Figure 1), the instructor can promote discussion, asking some of the following questions:

i. Do our results confirm greater "government" (i.e., instructor) redistribution than is desired by altruists (i.e., red players)?
ii. Is "government" allocation more or less effective at helping the "poor" than "private charity"? Why?
iii. How about in terms of fairness?
iv. Can we expect the same in real life? How would you solve the paradoxical problem of poverty?
v. Can you identify additional reasons, other than altruism, that may motivate private donors?

Application 4. Why Do People Cooperate?

Lesson Plan

Fowler (2005) points out that it is more costly to cooperate with unfamiliar people because some may turn out to be defectors, resulting in a "free-rider problem" for contributors. So, why do people still contribute and why has cooperation evolved throughout history? In theory, as such a

[5] See the complete results of the poll here: https://legacy.npr.org/programs/specials/poll/poverty/results1.html.

strategic situation is repeated multiple times, especially if it is played anonymously, more and more people choose to defect and reap the benefits of the public good without paying for it. In the absence of government intervention, this diminishes the public good more and more. Fowler (2005) theorizes that there is a certain type of people, the so-called "moralists," who ignore the nonparticipants and, even though they incur a cost for contributing to the public good, they receive a certain benefit from engaging in an altruistic behavior (in our case, choosing red).

After discussing the concepts of cooperation and free riding, instructors conduct the experiment as described in the third section. More than two iterations can be run if needed to prove the point.

In-Class Discussion

After reviewing the experiment setup (Table 1) and reporting the results for each iteration (Table 2), the instructor can ask some of the following questions, to stimulate discussion:

i. Have more students chosen green than in the previous iteration? Why?
ii. Considering that green gives a larger slice of the pie than red, why do some people choose red, and thus contribute to the public good (here and in real life)?
iii. Do you think that government intervention is necessary to limit the free-rider problem?

Application 5. The Tragedy of the Commons

Lesson Plan

Based on the famous articles by Lloyd (1833) and Hardin (1968), the "tragedy of the commons" shows how a resource is depleted if it becomes public (i.e., common) property. Quoting Madison (1788) that "if men were angels, no government would be necessary," Hardin (1968) notes that not all men are angels. If only one non-angel acts in their own self-interest and uses the "commons" more than the others, then this results in a comparative advantage and unethical gains. That incentivizes other men to turn into non-angels, which depletes the public resource. This is an example of market failure. As with other types of market failure, an intervening and regulating government should solve the problem. Ostrom (1990) proposes another solution, where the individuals create their own self-regulating, durable, and cooperative institutions.

Using our experiment, instructors can emphasize that, even if initially some students choose red, seeing that the green players consistently outperform them, they will turn green (i.e., non-angels) in subsequent rounds, which will reduce payoffs and lead to a partial deterioration of the common good.

Instructors can explain the tragedy of the commons, market failures, and possible solutions to market failures. Then, they conduct the experiment as described in the third section. This lesson can be simulated in more than two iterations, with the last one where students are allowed to negotiate and set rules in order to prevent further decline of common-pool resources.

In-Class Discussion

After reviewing the experiment setup (Table 1) and reporting the results for each iteration (Table 2), the instructor can ask some of the following questions, to stimulate discussion:

After the first iteration:

i. What is the proportion of red players in the total? What is the value of group wealth?

After the second iteration (and subsequent ones if needed):

ii. What is now the proportion of red players in the total? What is the value of group wealth now? How can you explain the changes from the previous round?

After the final iteration:

iii. What is now the proportion of red players in the total? What is the value of group wealth now? What rules have you used to prevent further decrease in common resources? How have you enforced them?

Conclusions

The economic way of thinking proves to be challenging for many undergraduate students who struggle to assimilate principles or models even when they are not too abstract or math intensive. One way to solve this problem is to adopt and adapt various classroom games, experiments, or simulations. Ideally, these activities should be easy to implement and understand, their outcomes should confirm the theory's predictions (or help identify cases where the predictions do not hold in practice), and, if possible, they should provide a basis for future analyses later in the semester. We believe that our article meets these criteria.

The simple setup, presented in the third section, asks for the values of six parameters: maximum individual reward, proportion of final wealth that goes to each green, proportion of final wealth that goes to each red, number of students in the group, initial endowment, and marginal group wealth for each red. Based on these values and the binary choices made by participants, payoffs are calculated using equations (5) and (6).

One possible immediate use is verifying the tension between direct individual gains obtained by self-interested economic agents and indirect collective gains, which assume that at least some economic agents contribute to group prosperity.

We further propose several in-class applications, from a more specialized exemplification of Pareto-inferior Nash equilibria to a more general "tragedy of the commons." Other instructors will certainly be able to find additional applications, which they can employ either in introductory or in more advanced chapters or courses.

Our linear adaptation of Bruehler et al.'s (2017) Red/Green experiment is not trying to detract from the merits of their work. As explained in the Model Comparison section, we recognize that our method has its drawbacks compared to the original experiment, but we argue that the benefits of our simplified version outweigh the costs. Moreover, instructors can easily modify the maximum number of extra-credit points they give to their students, as well as any other parameters.

Future research will assess the effects of our experiment and its applications on student engagement and performance.

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Appendix. Student Handout Template

- *Your group's initial endowment (i.e., the number of points that your group starts with) is: I = ...*
- *You will need to choose a color (red or green) and complete the one-question survey.*
- *If you choose **red**, then you receive only ____ of the final total (i.e., total points/___), but you add a = ... more points to the total.*
- *If you choose **green**, then you gain ____ of the final total (i.e., total points/___), but you add nothing to the total.*
- *So, which color will you choose: red or green?*