PUBLIC GOODS GAME

1.1 Introduction   −

> **CORE PROJECTS** LINK
>
> The experiment is covered in:
>
> - Section 4.8 in *The Economy* 2.0: *Microeconomics*
> - Section 4.7 in *The Economy* 1.0
> - Section 2.9 in *Economy, Society, and Public Policy*
>
> Concepts in the experiment are related to material in:
>
> - Unit 4 and Unit 10 in *The Economy* 2.0: *Microeconomics*
> - Unit 4, Unit 12, and Unit 20 in *The Economy* 1.0
> - Unit 2 and Unit 11 in *Economy, Society, and Public Policy*

Are humans able to cooperate to achieve socially beneficial outcomes, or do they succumb to free-rider incentives?

This activity presents a classic public goods game. Participants receive an endowment of tokens and they must decide how much to contribute to a common pool. The common pool is a productive public good that returns an equal proportion of the sum of contributions multiplied by a number greater than one. The game can be played with and without the possibility to punish free riders.

Experimental evidence shows that contributions tend to decrease through time. However, when people are allowed to punish free riders, contributions bump up and stay relatively constant. Predicted outcomes reflect the graphs in Figures 4.14b and 4.14c in *The Economy* 2.0: *Microeconomics*, Figures 4.9a and 4.9b in *The Economy* 1.0, and Figures 2.9a and 2.9b in *Economy, Society, and Public Policy*.

The experiment provides students with the experience of a social dilemma situation and gives them an insight into the motivations behind the choice of the individual actors,

including free riding, altruism, reciprocity and the intention of cooperation. They can describe the factors that lead to the dilemma situation and analyze the reasons for a decline in contributions to the public good. In addition, it encourages initial intuitive ideas about solutions to the public goods problem.

You may find it useful to read about the experiences of instructors before getting into the detail of setting up the experiment, especially if you are new to running classroom experiments.

This experiment is based on Benedikt Herrmann, Christian Thoni, and Simon Gachter. 2008. *'Antisocial Punishment Across Societies'*. *Science* 319 (5868): pp. 1362–67.

Citation   LINK

Giamattei, Marcus, and Humberto Llavador (2020). 'Public goods game'. Experiment 1 in The CORE Team, *Experiencing Economics*. Available at https://www.core-econ.org/experiencing-economics [Accessed on (date)].

> ## Key concepts   LINK
>
> This experiment will help students understand the following key concepts:
> - Social dilemma
> - Public good
> - Free rider
> - Social punishment
> - Altruism

1.2 Requirements   −

Timing   LINK

The experiment can be run with or without punishment. Ten rounds without punishment can be easily run in 5–10 minutes, plus 10–15 minutes for instructions, which could also be sent to students before the class. The introduction of punishments requires some extra time, mainly because of the more detailed instructions. For example, five rounds without punishment followed by five rounds with punishments may add an extra 10–15 minutes, including instructions.

Remember to allow time for a stimulating discussion.

Instructors and students need a smartphone, tablet, or laptop that has a web browser and is connected to the internet. For in-class experiments, a projector is recommended to help with instructions, results, and discussion. The experiment will be run in classEx.

Number of participants [LINK]

In our experience, the experiment works very well with groups of any size, and can be run in a classroom or online. A minimum of eight students is needed so that you have at least two groups. See 'What might go differently?' in Section 1.6 for how the results might differ when your group is either very small or very large.

1.3 Description of the experiment   −

In this experiment, students are divided into groups of four anonymous players and play 10 rounds of the same game. The composition of the group is maintained for all 10 rounds. In each round, students receive an endowment of 20 tokens and must decide how many tokens to contribute to a common project. The total amount of tokens contributed to the group's project is multiplied by 1.6 and distributed equally among all four members. Therefore, each player receives 0.4 tokens for each token contributed to the project by any member. At the end of the round, students are told the total amount of tokens contributed to the project and their income (in tokens). Their income equals the number of tokens that each student kept for herself or himself plus the tokens she or he received from the project (the same for all four members).

You can choose to run some rounds with the option of costly punishments. Rounds with punishments incorporate a second stage in which, after seeing each member's contribution, players decide whether to spend tokens in punishing others. Each token paid as punishment reduces the income of the member being punished by three tokens.

Most values, like the endowment, the return from the common project, or the number of rounds with the option of punishment, can be personalized by changing the parameters in classEx. Figure 1.1 in the next section provides details about the classEx parameters.

Note that your results are likely to inspire a lot of class discussion and that this discussion is at least as important as running the experiment, so make sure you also schedule plenty of time for that. classEx shows the results graphically immediately after the last round and stores them for later use. Therefore you can start the discussion as soon as the game is over or keep it for the next session.

1.4 Step-by-step guide   −

Detailed instructions   `LINK`

Go to the ['Quick summary' section](#) if you have previously run the experiment and just need a brief reminder of the instructions.

We've provided two versions of the game. The simplest is a straightforward version of voluntary contributions to a public good (['Public goods game without punishments'](#)). This version is very easy and fast to run, and provides all the elements you need in order to discuss the key concepts: public good, free riding, reciprocity, altruism, and limits to altruism. If you have enough time, a more elaborate version incorporates the option to punish free riders (['Public goods game with punishments'](#)). It is still very easy to play, but the instructions are slightly more complex. However, it will provide the opportunity to discuss policy instruments and solutions to free riding and offer a more optimistic view of the social dilemma.

Public goods game without punishments

This is the simplest version of the game where students only need to decide how much to contribute (from 0 to 20 tokens) in each of the 10 rounds.

1. Enter the 'Public Goods Game' in the 'CORE' tab in classEx. Click 'play'.
2. Check that the parameters correspond to your settings. This section uses the default settings (Figure 1.1), which should work well

   > The parameters should be set to their default values if you have not changed them in a previous session. classEx remembers your last settings.

   for most people. Make sure that the option 'round where punishment begins' shows the value 11, meaning that there are no rounds with punishments. See the ['Advanced settings' section](#) for details if you want to change any of the parameters.

parameters

endowment
> 20

marginal per capita return
> 0.4

round where punishment begins (11 means no punishment)
> 11

maximal punishment
> 10

real payouts
> Game is not played with real payouts ▾

exchange into currency of account (only if played with real payouts)
> 0.02

number of winning groups (only if played with real payouts)
> 1

> back to current game

Figure 1.1 Default values of the classEx parameters. See the ['Parameters' section](#) for a detailed explanation.

3. Once your students are logged in to classEx, provide them with the student instructions in Section 1.5.

(Note that these are also available in [the students' version](#) and can be distributed beforehand.)

You will find the general instructions on the instructor's screen, as shown in Figure 1.2. Emphasize that students are not allowed to talk to each other or to make public announcements, no matter how tempting it may become. Tell students that they will have around 10 seconds to submit their contribution, but a bit longer for the first rounds.

parameters

restart game

- You play in groups of **4 players for 10 rounds**. The composition of the group is the same in all 10 rounds.
- At the beginning of each round, **each player receives an endowment of 20** tokens and can decide **how many tokens to contribute to the common project**.
- Each token contributed to the project will be **multiplied by 1.6 and distributed equally among all 4 members of the group**. Therefore, each player receives 0.4 tokens for each token contributed to the project by any member.

logged in: 4

Start

Figure 1.2 Instructions for the game, as displayed in the instructor's screen on classEx.

4. Before starting the first round, ask if there are any questions. Make sure that all students are logged in. Then start the first round by clicking the 'Start' button. Students will see on their devices the screen shown in Figure 1.3.

If necessary, students can still log in while the first round is running, but not later than that.

Figure 1.3 Student contribution screen for a round without punishments.

5. Give students around 10 seconds to submit their contributions. Then end the round by clicking the 'Results' button. Students will receive feedback showing the results of this round and their cumulative income from all rounds (an example is shown in Figure 1.4).
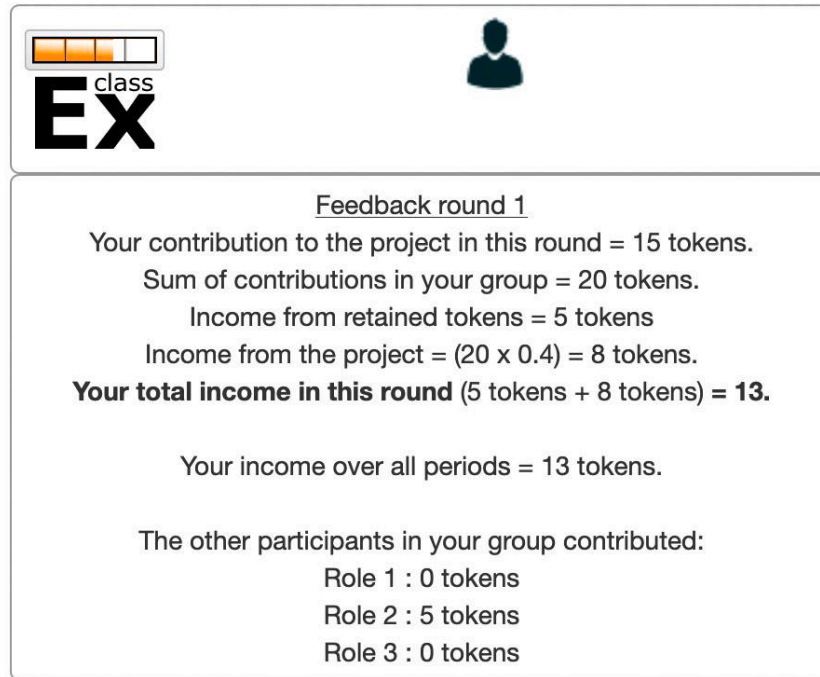
Figure 1.4 Feedback after Round 1 for a student who contributed 15 tokens. Another member of her group (Role 2) contributed to the project with five tokens. The other two members did not contribute.
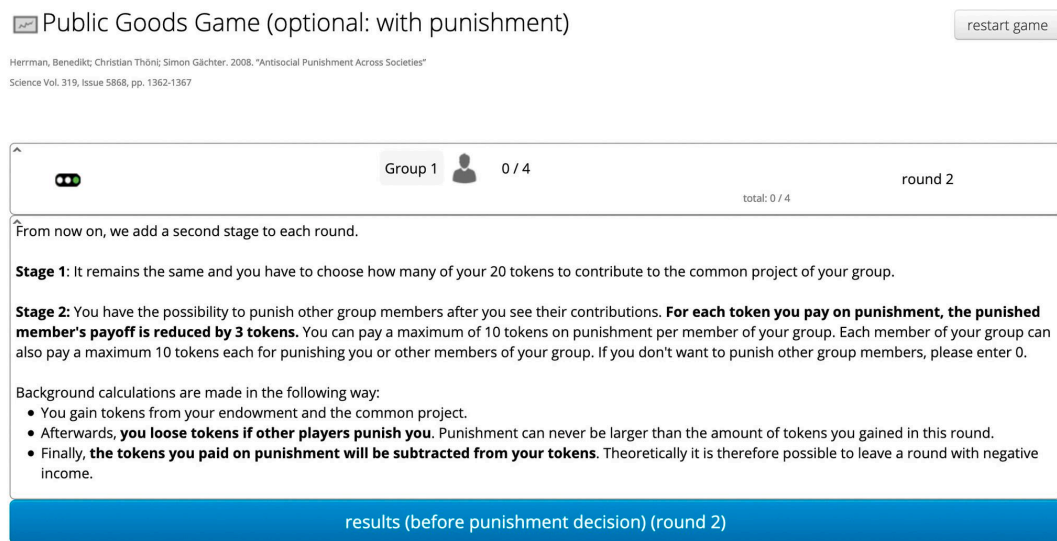
6. Give students time to read the information before starting the next round. You should provide enough time for students to process the information, but not so much that they start talking to each other. Normally, 20 seconds should be enough, but you may want to experiment and find what works best for your groups.
7. Repeat steps 5 and 6 for the remaining rounds.
8. The game finishes after 10 rounds. Show the graphs for the average contributions and the average contributions per group, and start the discussion.

Public goods game with punishments

Follow the steps described in the ['Public goods game without punishments' section](#), except for the following changes.

1. First, you need to change the parameters in classEx to suit a game with punishment in some rounds. Go to parameters and in the box for 'round where punishment begins' specify the first round in which you want the option of punishment to be activated. For example, for an experiment with five rounds without punishments and five rounds with punishments, set the value of the parameter as 6. These instructions assume this structure.
2. Follow steps 3–7 in the ['Public goods game without punishments' section](#) for the rounds without punishments. To avoid students adapting their decisions in anticipation, do not explain the option of punishment yet.

3. Before starting Round 6, the first round with punishments, get the students'
   attention. Tell them that, from now on, each round will have a second stage where
   they can punish other members once they know their contributions. With the help of
   the instructor's screen (Figure 1.5), explain the following instructions.

📈 Public Goods Game (optional: with punishment)   restart game

| | Group 1 👤 0 / 4 | | round 2 |
| | | total: 0 / 4 | |

From now on, we add a second stage to each round.

Stage 1: It remains the same and you have to choose how many of your 20 tokens to contribute to the common project of your group.

Stage 2: You have the possibility to punish other group members after you see their contributions. **For each token you pay on punishment, the punished member's payoff is reduced by 3 tokens.** You can pay a maximum of 10 tokens on punishment per member of your group. Each member of your group can also pay a maximum 10 tokens each for punishing you or other members of your group. If you don't want to punish other group members, please enter 0.

Background calculations are made in the following way:
- You gain tokens from your endowment and the common project.
- Afterwards, **you loose tokens if other players punish you**. Punishment can never be larger than the amount of tokens you gained in this round.
- Finally, **the tokens you paid on punishment will be subtracted from your tokens**. Theoretically it is therefore possible to leave a round with negative income.

results (before punishment decision) (round 2)

Figure 1.5 Instructions for punishing other members of the group.

Each round is now divided into two stages.

Stage 1 remains the same as before and students need to submit their contributions.

In Stage 2, after finding out how much each
member in their group contributed and
receiving the returns from the public good,
students will be able to spend some of their
tokens in punishing other members. Each
token paid on punishing reduces the punished member's payoff by three tokens.
Comment that players must enter a '0' if they do not want to punish another member.

> classEx requires players to enter the number of tokens they wish to pay to punish each of the other members. Players can enter 0 if they do not want to punish another member.

Total payoff for the round equals:

> gains (tokens kept + return from the public good)
> — tokens lost from punishments
> — tokens paid in punishing others.

There are two constraints for punishments. First, a student cannot be punished more
than what she or he gained in the round (first row). Second, a student can spend a
maximum of 10 tokens in punishing each member of her or his group, and the total
expenditure in punishments cannot exceed her or his gains in that round. For example,
a student who contributed 7 tokens, and the total contributions in her project were 15

tokens, would gain 19 tokens. This is calculated as tokens kept (13) + tokens from the project (15 × 1.6 ÷ 4 = 6). Therefore, the student can receive a maximum punishment of 19 tokens, and can spend a maximum of 19 tokens in punishing others, but no more than 10 tokens in punishing one member. A student may end up with negative income in the round if the tokens lost from the punishment received and the cost of punishing add up to more than the tokens gained.

4. Start Stage 1 of Round 6 by clicking the 'Start' button. Students will submit their contributions as before (as shown in Figure 1.3).
5. Start Stage 2 of Round 6 by clicking the 'Results' button, students will then receive information about the session, as the example in Figure 1.6 shows.

Figure 1.6 Stage 2. Students receive feedback on their income and the contributions of the other members in their group, and must decide how many tokens to spend, if any, in punishing each of them.

6. Once students have submitted their punishments, repeat steps 4 and 5 for the remaining rounds.
7. After the last round, show the graphs for the average contributions and the average contributions per group and start the discussion.

Advanced settings `LINK`

This section is not necessary to run the experiment and the class discussion, it just provides further information on personalizing the classEx settings and parameters. You can skip it and go directly to the ['Student instructions' section](#) if you just want to follow the standard settings, as we used in the 'Public goods game without punishments' and 'Public goods game with punishments' sections.

Parameters

classEx allows you to personalize many of the settings for the experiment by changing the parameters. Figure 1.7 presents the default values and an explanation of each of the parameters. Notice that the number of members in a group is fixed at 4 and cannot be changed. The number of rounds is also fixed, at 10, and cannot be changed. However, you can stop the experiment at any moment, effectively running fewer rounds, because at the end of each round both the instructor's screen and the students' screens report all the information up to that point.

Figure 1.7 Explanation of the parameters. The figure presents the default values.

The last three parameters are only used if you want to reward some randomly chosen groups for their actual payoffs. First, set 'game is played with payouts' to activate this

option. You can also set the number of groups who receive a reward ('number of winning groups'), as well as the exchange rate for a token (for example, 'exchange into euro'). At the end of the experiment, classEx identifies the selected groups, and members of those groups receive a 'winning code' that they can show to receive their reward.

Allocation of types

Students are randomly divided into groups of four members. If the number of participants in your group is not a multiple of four, classEx creates dummy players who will always choose to play the Nash-equilibrium strategy (that is, they contribute 0 to the public good in all rounds).

Downloading the data from your experiment

The data from your experiment is recorded by classEx and can be downloaded as an Excel file from the 'data' menu in the instructor's screen. The Excel file can be downloaded at any time during the game or once it has finished. It will show all recorded data at the time of the download. Data can also be accessed later by opening the game again, selecting the corresponding session from the 'previous results' menu, and choosing the 'download as Excel file' option from the 'data' menu.

Each run is identified with a unique runID. The following table describes the most relevant variables included in the Excel file.

Tab	Variables
players	Information about participants. • playerID: a unique player identification code assigned by the program • logtime: time of first entry • externalID: participant personal identification code (only if this option has been selected by the instructor)
decisions	Information about decisions made by participants. Decisions are identified by playerID, round, and variable name. List of variables used in this experiment: • contribution: amount contributed in each round • punish_roleX: amount spent to punish other player in role X • punishment_round: average punishment received by other members of the group (not multiplied by 3 yet) • totalpayoff_without: total payoff across rounds
globals	Information about parameters, like endowment, currency and maximum amount of punishment
matching	Matching of playerIDs to groups

Tab	Variables
contracts	[Empty for this experiment]
payoffs	List of real payouts, together with a winning code (only for games played with this option)
stagehistory	Internal code for tracking the progress of players throughout the stages of the game

Quick summary LINK

This section is intended for instructors who have already run the experiment in the past and just need a brief reminder of the instructions to get them going. It assumes that your students are already logged in classEx and ready to start the experiment.

Public goods game without punishments

1. Check that the parameters are set according to your preferences. Figure 1.1 shows the default values for a session without punishments.
2. Explain the instructions to your students (see Section 1.5 or the students' version) and ask if there are questions. Remind the students that decisions are personal and that talking to each other or making public communications is not permitted. Do not mention that there will be some rounds with punishments, even if that is the case.
3. Run the first round:
   a. Click the 'Start' button. Give students approximately 10 seconds to submit their contributions.
   b. End the round by clicking the 'Results' button. Students receive feedback on their earnings. Give them around 20 seconds to read the information before starting the next round.
4. Repeat step 3 for the remaining rounds, slightly reducing the time for each round after a couple of rounds. Remember that after each round, students receive feedback on their earnings from that round, their cumulative payoffs, and the contributions of the other three members (anonymized).
5. The game finishes after 10 rounds. After the last round, show the graphs for the average contributions and the average contributions per group and start the discussion as outlined in Section 1.7.

Public goods game with punishments

1. Remember to set the parameters in the round in which the option to punish is activated, Figure 1.7.
2. Follow steps 2–4 in the 'Quick summary', 'Public goods game without punishments' section above for the rounds without punishments.
3. The instructor's screen will show the new instructions before the first round with punishments. Explain the instructions and ask if there are any questions.
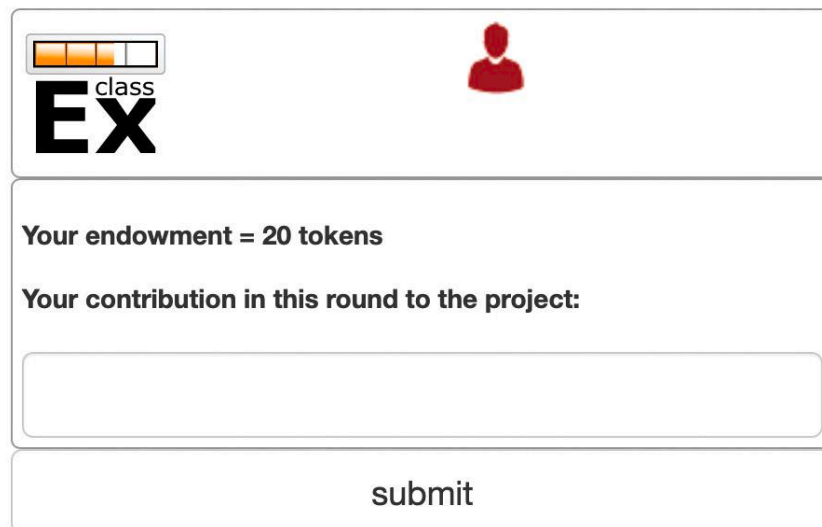
a. Stage 1—Give students approximately 10 seconds to submit their contributions.

b. Stage 2—Click the 'Results' button. Students receive before-punishment feedback (as before) and must decide how much to spend on punishing other members (from 0 to 10 tokens (or the value set in the parameters if you changed them)).

c. After students have submitted their punishments, click the 'Start' button to start the next round. Students receive after-punishment feedback and must decide on their contribution.

4. Repeat for the remaining rounds.

5. There is a maximum of 10 rounds. Show the graphs for the average contributions and the average contributions per group and start the discussion.

1.5 Student instructions ‒

These are also available in <u>the students' version</u>.

A <u>PDF of the student instructions and homework questions</u> is also available.

This experiment consists of 10 rounds. You will be in a group of four students and will remain in the same group for all 10 rounds. You will not know who the other three members of your group are. In each round, you will receive 20 tokens and you must decide how many tokens to contribute in a project; you can contribute any number between 0 and 20 tokens. You will keep any remaining tokens for yourself. Your screen will look like Figure A.

Figure A The classEx contribution screen

After all the members of your group have contributed, you will receive feedback on the total contribution to your project and on the tokens you gained in that round (your 'income'), as well as the number of tokens you have accumulated so far (Figure B).

Figure B The classEx feedback screen

Your reward or payoff will be your final accumulated *income* at the end of the 10 rounds. Your *income* in each round consists of the number of tokens you kept for yourself plus 0.4 times the total number of tokens contributed to the project. That is:

$$\text{Income in a round} = (20 - \text{tokens you contribute}) + 0.4 \times \text{total contribution to the project}$$

This is because the project produces 1.6 tokens for each token contributed, and all members of the group receive the same *return* from the project (1.6/4 = 0.4). For example, if the total contribution is 60 tokens, then you and all other members of the group receive 60 × 0.4 = 24 tokens from the project. If you had contributed 15 tokens, then your *income* in that round would be (20 – 15) + 24 = 29 tokens. If, on the other hand, you had contributed 5 tokens to the project, your *income* in that round would be (20 – 5) + 24 = 39 tokens.

Remember, your reward or payoff will depend exclusively on *your* total income.

> Remember, all your decisions must be kept private. You must not communicate with other students nor make public announcements, no matter how tempting it might become.

It is very important that you abide by the following rules: All your decisions must be kept private. You must not communicate with other students nor make public announcements, no matter how tempting it might become.

You can use the following questions to test your understanding of the rules.

1. Each group member has 20 tokens. Suppose that the other three members of your group contribute nothing to the project.
    a. What is your income if you contribute nothing?
    b. What is your income if you contribute 20 tokens?

2. Each group member has 20 tokens. Suppose that the other three members contribute 12 tokens in total to the project (excluding your own contribution).
    a. What is your income if you contribute 20 tokens?
    b. What is your income if you contribute 0 tokens?

3. Each group member has 20 tokens. Suppose that you contribute five tokens to the project.
    a. What is your income if the total contribution to the project (including yours) is 12 tokens?
    b. What is your income if the total contribution to the project (including yours) is 48 tokens?

Show answers

1.6 Predictions   −

Predicted results   LINK

At the end of the experiment, you will see two graphs on the instructor's screen. The first will show the average contributions per round for the whole class. The second will show the average contributions per round for each of the participating groups. You may expect to obtain something similar to the graphs in Figures 1.8 and 1.9, which show the results from the reference example in classEx: an experiment without punishments run with a class of 40 students at Pompeu Fabra University in 2019.

The reference example and its data can be accessed from the 'previous results' menu in the instructor's screen of classEx. It is highlighted in bold and always appears first in the list of previous runs.

Figure 1.8 shows that average contributions started at around 5.5 tokens, and declined over time, ending up at around two tokens.
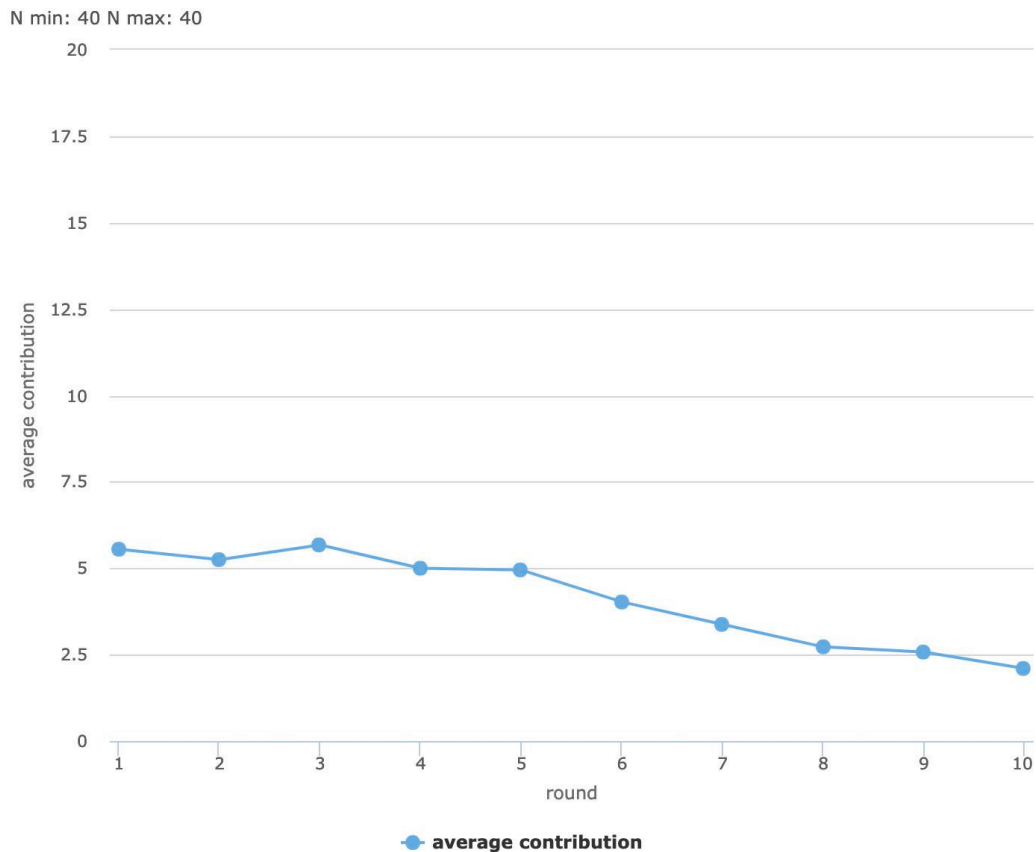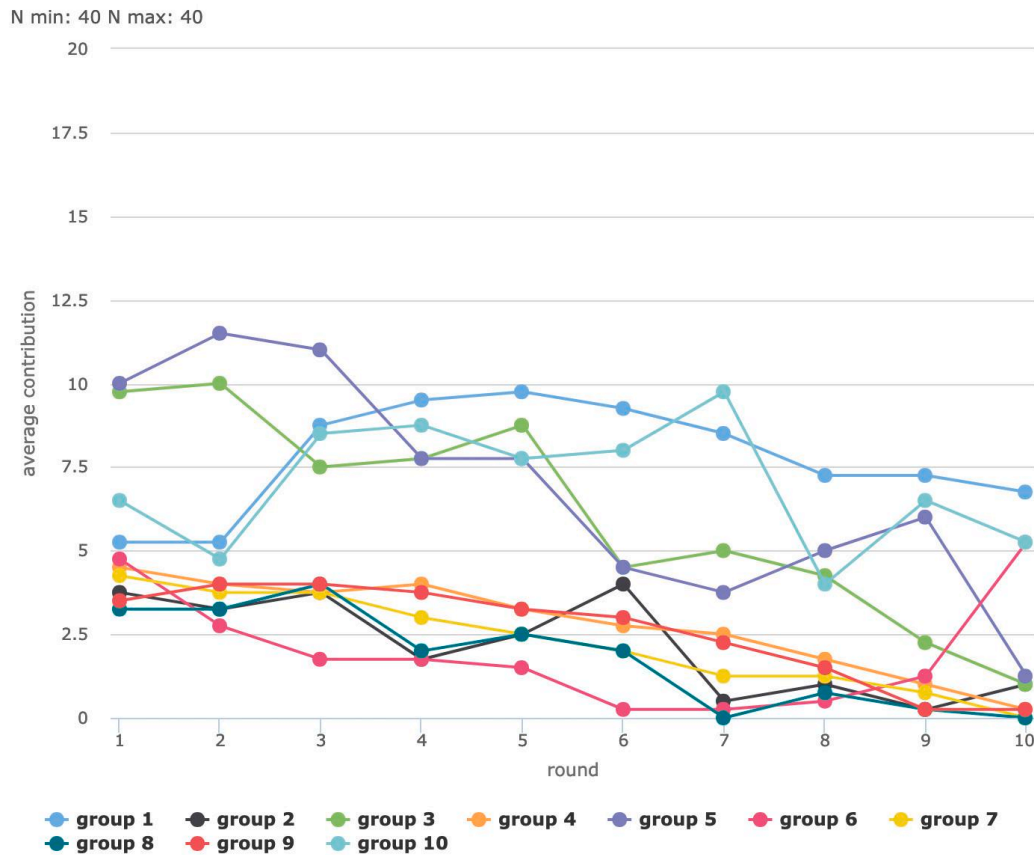
Figure 1.8 Average contribution in a session run without punishments at Pompeu Fabra University on 10 April 2019 in a class of 40 first-year students.

In Figure 1.9 you can see that all groups had some students contributing a positive amount in the initial period, despite the fact that contributing nothing is a dominant strategy. Initial contributions were higher in some groups than in others, showing perhaps different levels of altruism or different expectations about the altruism of others. Many groups followed the declining trend reaching very low contributions by the final period, which is likely to be a response to the free-riding behaviour of other members. This is indeed the reasoning that most of our students gave when asked. However, there are also some groups who managed to maintain *high* contribution levels and who even increased them for some rounds (see groups 1 and 10). From asking our students, we found out that these cases responded to a large contribution by a single student who expected to pull the others to cooperate in future rounds, sometimes with more success and sometimes with less success.

Figure 1.9 Average contribution by group in a session run without punishments at Pompeu Fabra University on 10 April 2019 in a class of 40 first-year students.

All these observations provide good grounds for an active in-class discussion where students reflect on their behaviour and their expectations about the behaviour of others. You can follow the list of questions in Section 1.7 to guide your discussion, and read the experiences of other instructors provided in Section 1.10.

For sessions with punishments, you may expect average contributions to increase in the first or second round after the option of punishing is introduced. Then contributions flatten and slightly fall by the last rounds (Figure 1.10). Indeed, most students will increase their contributions under the threat of being punished, but those with a lower cooperative spirit may try to free ride in the last round. However, behaviour may vary substantially from one group to another. In most groups, punishment may act as a mechanism to start cooperation and sustain it. For other groups, it may not be enough to discourage free riding. Lack of reciprocity drives members towards not contributing. All these different individual decisions prove very useful in engaging in a debate on issues related to trust, social norms or prosocial behaviour.
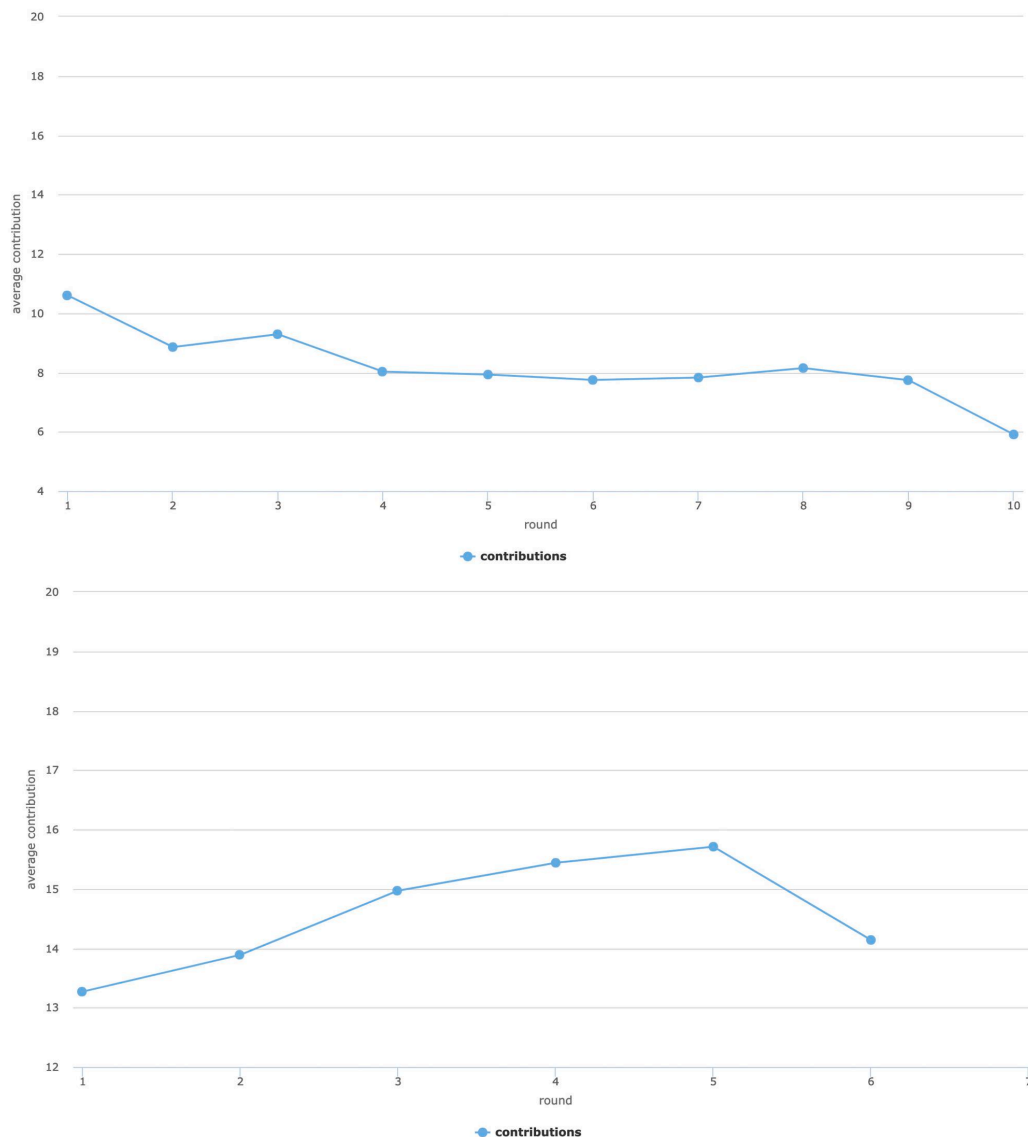
Figure 1.10 Average contributions without punishments (top graph) and with punishments (bottom graph). Game played online at Pompeu Fabra University on 6 October 2020 with a group of 99 first-year students.

What might go differently? LINK

In this game, maximum gains are obtained when all members cooperate and contribute their whole endowment. This outcome is not obtained because there are individual incentives to free ride on the contribution of others. Besides, students who contribute little or nothing generate disappointing expectations of reciprocity, triggering the observed decline in contributions. In groups where students are particularly prone to cooperation, as it may be the case in small classes, or when individual incentives are not strong enough or sufficiently well defined, the average decline in contributions may not happen, and contributions may even increase as cooperation gets reinforced by previous *altruistic* behaviour.

In those cases, we like to compare the outcomes in the classroom with [Figure 4.14b](#) in *The Economy* 2.0: *Microeconomics*, [Figure 4.9](#) in *The Economy* 1.0, or [Figure 2.9a](#) in *Economy, Society, and Public Policy*, as representative of the common observation. Then we start a discussion with students about the differences, pointing at incentives and altruism.

In very large classes, average contributions still tend to decline, but they may present many different group behaviours, cluttering the average-contribution-by-group graph and hindering its explanation. In those cases, you can classify the groups according to their behaviour, show those with similar paths together, and ask students to come up with explanations for the different patterns. For an example of this, see [the second instructor's experience in Section 1.10](#) and [Figures 1.11](#) and [1.12](#) shown there.

Finally, if avoiding communication among students is challenging, you can slightly speed up the pace by reducing the time to make decisions and the time between rounds.

1.7 Discussion   −

A good discussion following the experiment is important. Ask your students the following questions to frame the discussion.

Interpreting the graphs   LINK

Comments in the ['Predictions', 'What might go differently' section](#), and in *The Economy* 2.0: *Microeconomics* ([Section 4.8](#)), *The Economy* 1.0 ([Section 4.7](#)), or *Economy, Society, and Public Policy* ([Section 2.9](#)) provide useful further information.

- Is the line representing contributions constant, or does it decrease?
- Did all groups behave in the same way? What could explain different initial contributions, and the different trends between groups?

Relating the experiment to real life   LINK

- Which situations in real life may be similar to the game you just played?
- Are contributions to public goods repeated in time?
- How is this situation (the class experiment) different to the real-life situations we have just discussed?

  > The game can be related to classical examples of public goods provision like environmental damage and climate change. It can also be related to group projects or team work.

Reflecting on the decisions that players made   LINK

- Which of you reduced your contributions after rounds passed, and would you tell us why?

- Did any of you increase contributions? Why?

> Try to relate their answer to an economic mechanism. For instance, if the student saw no contribution in the group, this would be similar to not having incentives to give more than others.

A hypothetical situation   LINK

- Imagine our local government asks you to contribute to a children's library in our city to save it from closure. You know you won't use the library because you wouldn't personally use the books. Would you contribute?
- Why?
- Would this context change the results of today's activity? In what ways would the results be different?

> Use this situation to discuss altruistic preferences.

Running the game again   LINK

- Would the results be different if we repeated the game with the same players?

Link to theory   LINK

- Game theory predicts there is a dominant strategy of not contributing. How would you change the models to account for the results from the experiment that we just experienced?
- Would you say the models predict our results well?
- For example, consider the tendency. Does it seem to converge to theory?
- How does your mental process during this game differ from your mental process resolving a theoretical exercise? Does it matter?

Critical evaluation of the experiment   LINK

- Which aspects in the experiment did you not like?
- Which assumptions have been used in the experiment?
- How do these assumptions compare to real-life situations?
- Do you think the behaviour would change if the game was played for real money?

> There is always a standard argument in the discussion that people would behave differently if the game was played for real money. One option is to play with small payouts, which can be set up in the parameters. Otherwise, instructors can confront students with the result from standard laboratory experiments which look quite similar to the predictions from the 'Predictions' section.

1.8 Homework questions   −

These questions can be set for students to work on outside the classroom or can be completed and discussed in the classroom. They may help students reflect on their experience and understand theirs and others' behaviour in the experiment.

Data from your experiment can be downloaded as an Excel file from the 'data' menu in the instructor's screen in classEx. You can use this data to create your own questions. A description of the data variables can be found in the ['Downloading the data from your experiment'](#) section.

The following text is also available in [the students' version](#).

Remember that each participant receives 20 tokens in each round.

1. Assume the other three participants in your group are contributing everything in the first round.
    a. What is your payoff if you contribute everything?
    b. What is the total payoff in this case for all participants?
    c. What is your payoff if you contribute nothing?
    d. What is the total payoff in this case for all participants?

2. Now let's assume the other three participants are contributing 10 tokens in the first round.
    a. Answer questions 1a–d again.
    b. What can you conclude about the statement 'My expectation of the contributions of others' does not matter in the public goods game.'

3. Free riders
    a. Describe what is meant by 'social dilemma' and 'free rider'.
    b. What parameters of the game are responsible for the social dilemma?

Hint: For question 3, which values do you have to change to make it not a social dilemma?

1.9 Further reading   −

Also available in [the students' version](#).

- ['Games people play'](#) (*The Economist*, 20 January 2015) explains how the proportion of self-interested, cooperators and reciprocators can determine the equilibrium outcome (based on [Kurzban and Houser, 2005](#)).
- ['The usefulness of managers'](#) (*The Economist*, 13 October 2019) presents a variation of the game to study the influence of managers in the contribution to public goods (based on [Billinger and Rosenbaum](#)).
- ['Costly punishment across human societies'](#) (Henrich et al, 2006) shows that punishing deviators is a common feature in all societies. Although punishments vary across societies, more altruistic groups are more willing to pay the cost of punishing non-cooperators.
- CORE *The Economy* 2.0: *Microeconomics*, [Section 4.8](#).

- CORE *The Economy* 1.0, .
- CORE *Economy, Society, and Public Policy*, .

1.10 Instructor experience   −

In this section, we hear from instructors about their experience of running the experiment with their students.

MARCUS GIAMATTEI

Bard College, Berlin, Germany   LINK

I use the public goods game in a principles of economics course to start the chapter about public goods, common resources and externalities.

I play the public goods game directly in the first lesson of the chapter as an ice breaker. It allows students to understand the crucial dilemma situation and still remains a very simple game. As the first game in the lecture, I use it without the punishment option and only play 10 rounds of the original public goods game. I prefer this approach of teaching first by experience and discuss the theoretical issues and the model only afterwards to start with an intuitive approach to the problem.

After playing the game, I start with a discussion about the personal strategy within the game and a discussion about the implications for the group. For quite some time the focus should be on the actual play and the own behaviour in the game before broadening the implications. This is followed by some general questions about the Nash equilibrium and the role of expectations. I also discuss how repetition can influence the result. Students have quite a hard time understanding the problem, namely that it is in their best interest to play selfishly because they see the high social payoff and have to learn to choose between the individual and collective rationale.

The advantage is that the game follows the parameters from the original game exactly so that after playing the game and discussing the class results, students can be confronted with the results from the original study and the replication of these settings over many countries allow a broad discussion.

After that discussion, I normally do another game about common resources (which is also implemented in classEx—the fishing pond. Those two games are then the framework to discuss different types of goods together with excludability and rivalry. Later, I return to the public goods game and use a version with punishment. Peer punishment can be shown easily within the public goods setting. This then allows another discussion about different solutions to the social dilemma.

HUMBERTO LLAVADOR

## *Universitat Pompeu Fabra, Barcelona, Spain* `LINK`

I have used this experiment both in the classroom and online. I do it before starting Unit 4 of *The Economy* 1.0, which puts students in the right mind to confront the concepts presented there. I like to combine it with two other games: the prisoner's dilemma and the ultimatum, also implemented in classEx. I run them in that order (from easier to more challenging to play), finishing with a few (5–6) rounds of the public goods game with punishments. It takes me around 40–50 minutes to run all three, including instructions. I do not send the instructions beforehand.

In the classroom, with a smaller size group of around 40 students, I start the discussion right after the experiment. First I let students discuss their individual choices among themselves. Before showing each result, I ask them what they expect to observe and why. Then I show the graph, after which we compare their expectations with the actual results, trying to find explanations for divergences. Finally, I ask them for real-life situations that show the dilemma in the game. Remember, this session is run prior to introducing Unit 4, so they have not been exposed to game theory or the idea of social dilemmas.

In the online session, I have over one hundred students. Interestingly, running all three games takes a similar time as in the in-the-classroom session. I also run the experiments before Unit 4 with all students at once, but I keep the results back, and the discussion takes place in the classroom with smaller groups, after they have studied that unit. This is because we need to adapt to the schedule of the course, and to make the most of the smaller size in-person sessions. In this case, I just show the graphs (first without punishments and then with punishments, as in Figure 1.10) and use the findings to reinforce the concepts and explanations students have studied in the book. Then, I shift the focus to different decisions among groups. With so many students, it is common to obtain a variety of patterns. Often the average-contribution-by-group graph is difficult to interpret, showing the many different paths that groups may follow (see Figure 1.11). Before the in-class discussion, I like to put together groups showing similar behaviour (Figure 1.12) and, once in the classroom, we try to make sense out of them.

In both situations, online and in the classroom, students easily understand the social dilemma they experienced, as well as the concepts of free riding, reciprocity and cooperation, and they reflect on the difficulty of achieving and sustaining the socially optimal outcome.
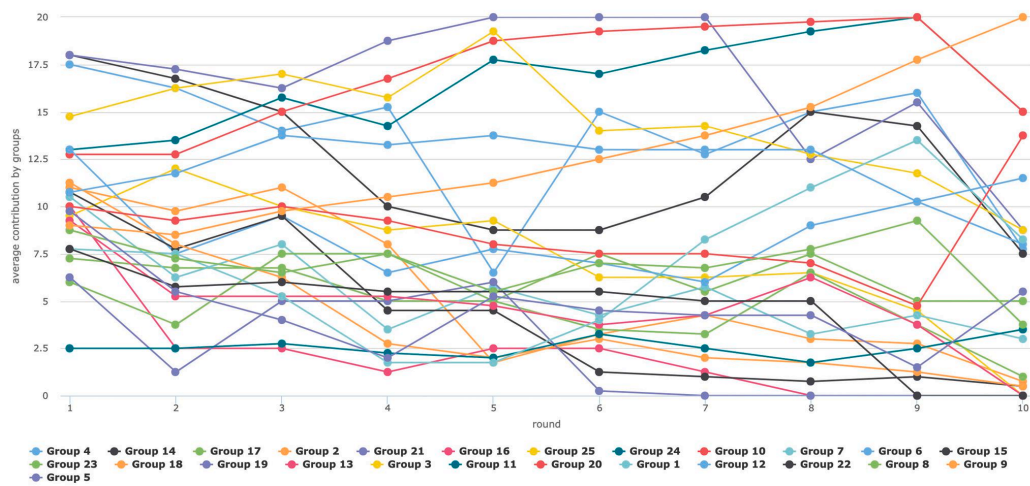
Figure 1.11 Average contribution by group, showing all the groups together. The session ran online without punishments at Pompeu Fabra University on 6 October 2020 with a group of 99 first-year students.
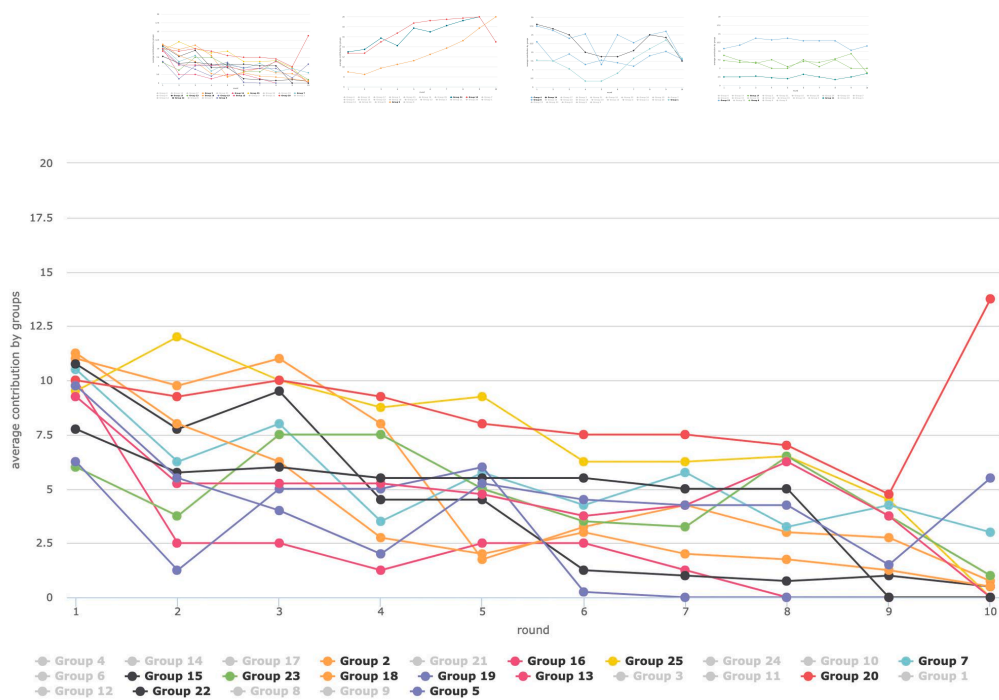
Declining contributions

Each line shows the average contribution in a group of four students. Most groups (13/25) show declining contributions, with different starting points.

Figure 1.12 Average contribution by group. The groups are sorted into four categories according to their behaviour. Group 25 (not classified) combined high and increasing contributions for the first seven rounds (cooperation) with a fast and sharp decline later

on. The session ran online without punishments at the Pompeu Fabra University on October 6, 2020 with a group of 99 first-year students.