EXPERIMENT 5

THE MULTIPLIER PROCESS

5.1 Introduction

CORE PROJECTS LINK

Concepts in the experiment are related to the material in:

- Sections 14.1, 14.2, and 14.5 in *The Economy* 1.0

How does an individual's choice of consumption affect the consumption, employment, production, and income of others? How can aggregate demand be derived from the interaction of many consumption choices? Why is there inertia in the reaction to a shock, for example, an increase in the overall level of investment? Why is the increase in production larger than the initial shock?

The aim of this experiment is to let students experience the interdependence of demand choices. The positive feedback between choices allows for an understanding of the multiplier process, aggregate demand, and the business cycle. Students should gain this experience *before* they have been formally introduced to the model of the multiplier. It is important to run the experiment ahead of students reading Unit 14—otherwise they will 'solve the model' by calculating the multiplier and fail to 'experience' the interdependence in decisions that lie behind it. Ideally, it would take place at the end of the session on Unit 13.

The experiment in this chapter is a variant of a beauty contest game, and puts participants in the role of households in an economy. They have to choose their level of consumption. The aim is to set consumption as close as possible to 80% of income. Consumption and a fixed level of investment spending generate production and income. So, participants do not know the level of income when deciding on consumption, as this is created by the simultaneous consumption decisions of everyone in the economy.

Experimental evidence shows that students slowly converge to the equilibrium value that results from the multiplier process. This is in line with the so-called Robertson lag,

in other words, that consumption is chosen as a best response to lagged income. Students experience that excess savings (more than 20% of their income) can result from their choice of too little consumption or from excess consumption by others, resulting in high income. They also experience insufficient savings (less than 20% of their income) as a consequence of excessive consumption or low incomes due to low consumption by others. Students experience the interdependence of income and consumption and learn about the endogenous nature of income in a macroeconomy.

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.

The experiment is based on Johann Graf Lambsdorff and Marcus Giamattei. 2022. *Macroeconomics. Lecture in Economics.*

Citation LINK

Giamattei, Marcus, Johann Graf Lambsdorff and Humberto Llavador (2022). 'The multiplier process'. Experiment 5 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:

- Keynesian Multiplier
- Multiplier model
- Aggregate demand
- Savings and Investment
- Consumption

5.2 Requirements −

Timing LINK

The standard variant of the game consists of 10 rounds of decisions. It can be run in 30 minutes (including some introductory explanation). Remember to allow time for a stimulating discussion.

Resources LINK

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 three students is needed, but the experiment works well with hundreds of students as well.

5.3 Description of the experiment

In this experiment, students are all grouped together in one economy. Each student represents one household deciding on the level of consumption over ten rounds. The goal is to set consumption close to 80% of the household's income. This means that households want to have a consumption rate of 80% and a savings rate of 20%. The chosen level of consumption is then produced by a central producer together with a fixed level of investment goods. This generates household income, which is determined by the average of all consumption decisions + investment. The investment spending in the economy by firms and government combined is exogenous and is 100 per household in the first five rounds. In Round 6, investment is increased to 200 for the remainder of the game.

Total demand is determined by investment and consumption expenditures, aggregated across all households. This income is divided equally across all households and then used for consumption and savings. Any additional consumption spending by a household induces further production and income. The multiplier process is further explained in *The Economy* 1.0, Section 14.2. In the experiment, consumption rate c_1 is equal to 80% and there is no autonomous consumption c_0. For a calculation of the equilibrium values, see *The Economy* 1.0, Section 14.2.

As an example, if we start with a level of investment of 100 per household, this creates production and income of 100. If households want to consume 80% of their income, they should consume 80 and save 20. The increase in consumption increases production and income by 80. Therefore, households should increase their consumption by 80% of 80 = 64, and increase their savings by 20% of 80 = 16. This again increases production and income. The multiplier process stops at the equilibrium level of an income of 500, consumption of 400, and savings of 100. The latter value is equal to the level of the exogenous spending on investment (by firms and government) per household.

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 experiment 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.

5.4 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.

1. Enter 'The multiplier process' in the 'CORE' tab in classEx. Click 'play'.
2. Check that the parameters correspond to your settings. This section uses the default settings. In the default setting, no real payoffs are paid out, but the participant with the smallest deviation is declared the winner of the game.

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

3. Once your students are logged in to classEx, provide them with the student instructions in Section 5.5.

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

   The instructor's screen displays a summary of the instructions and can be used to explain the experiment (Figure 5.1). Emphasize that students are not allowed to communicate with others. Explain the instructions and announce that they will have around one minute to submit their decision. Do not inform them about the change in the level of investment in Round 6. If you pay real payoffs, this will be announced on the instructor screen.

   > With real payoffs, you should inform students that legal recourse is excluded and that payoffs are subject to a technical check on correctness. This way you avoid any legal recourse if you e.g. accidentally set the payoff too high.

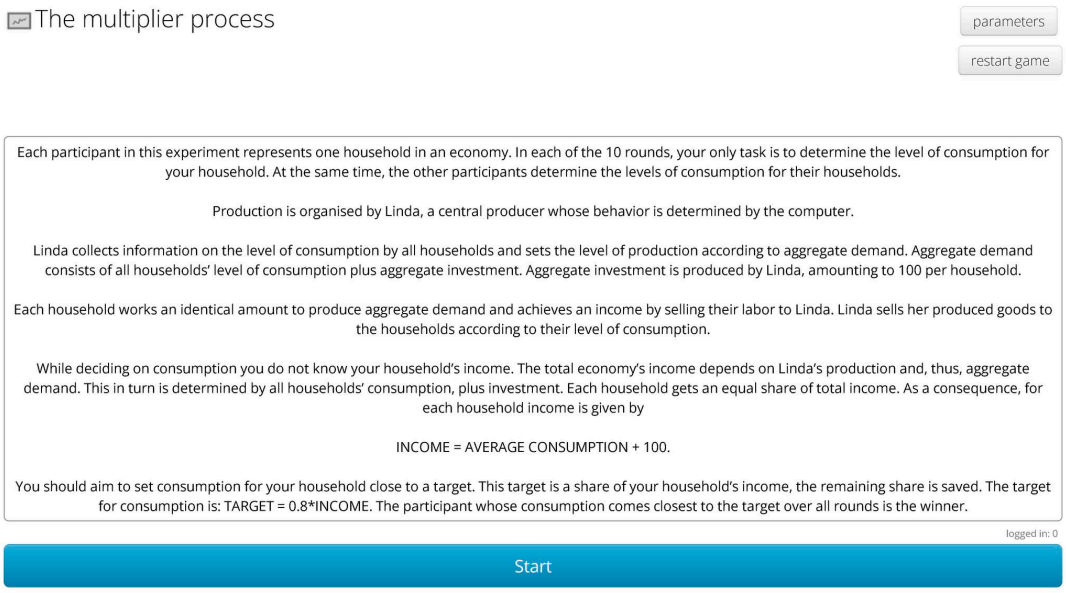

Figure 5.1 Instructions for the game, as displayed in the instructor's screen on classEx.

4. Ask if there are any questions. Then start the first round by clicking the 'Start' button. Students' devices will show a screen similar to that in Figure 5.2.

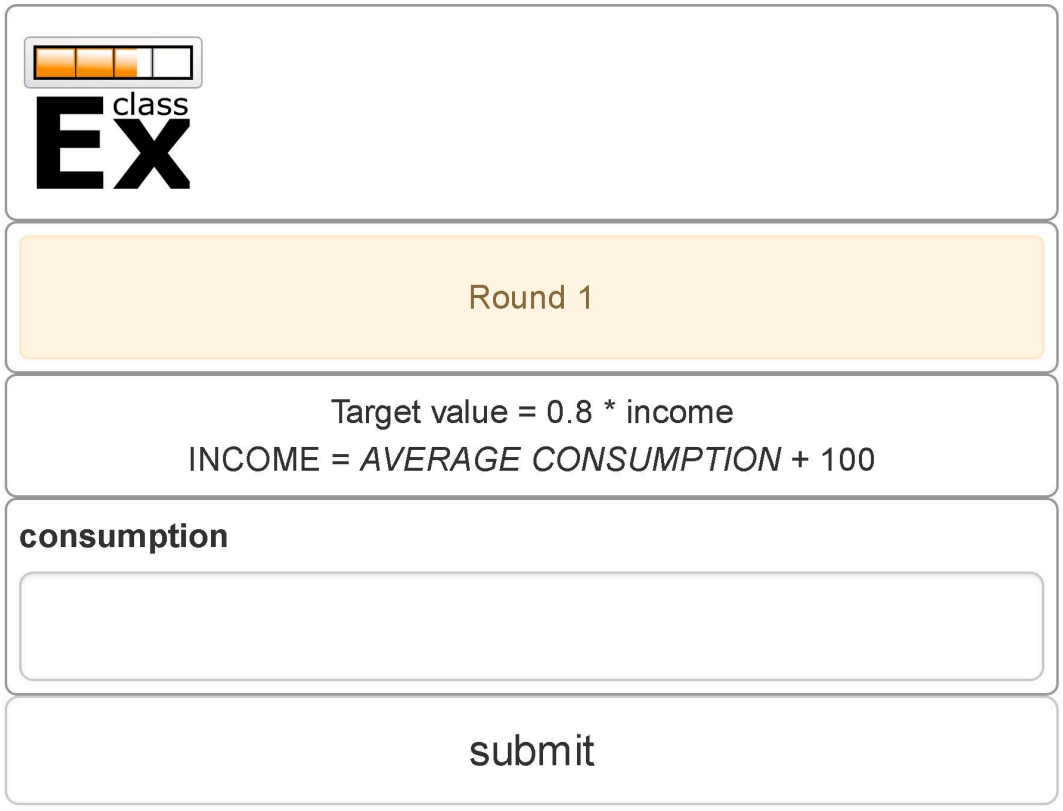

Figure 5.2 Student decision screen.

5. Give students around one minute to submit their decision. Then start the next round. Students will receive feedback as in Figure 5.3 on their devices and can directly enter their decision for the next round.

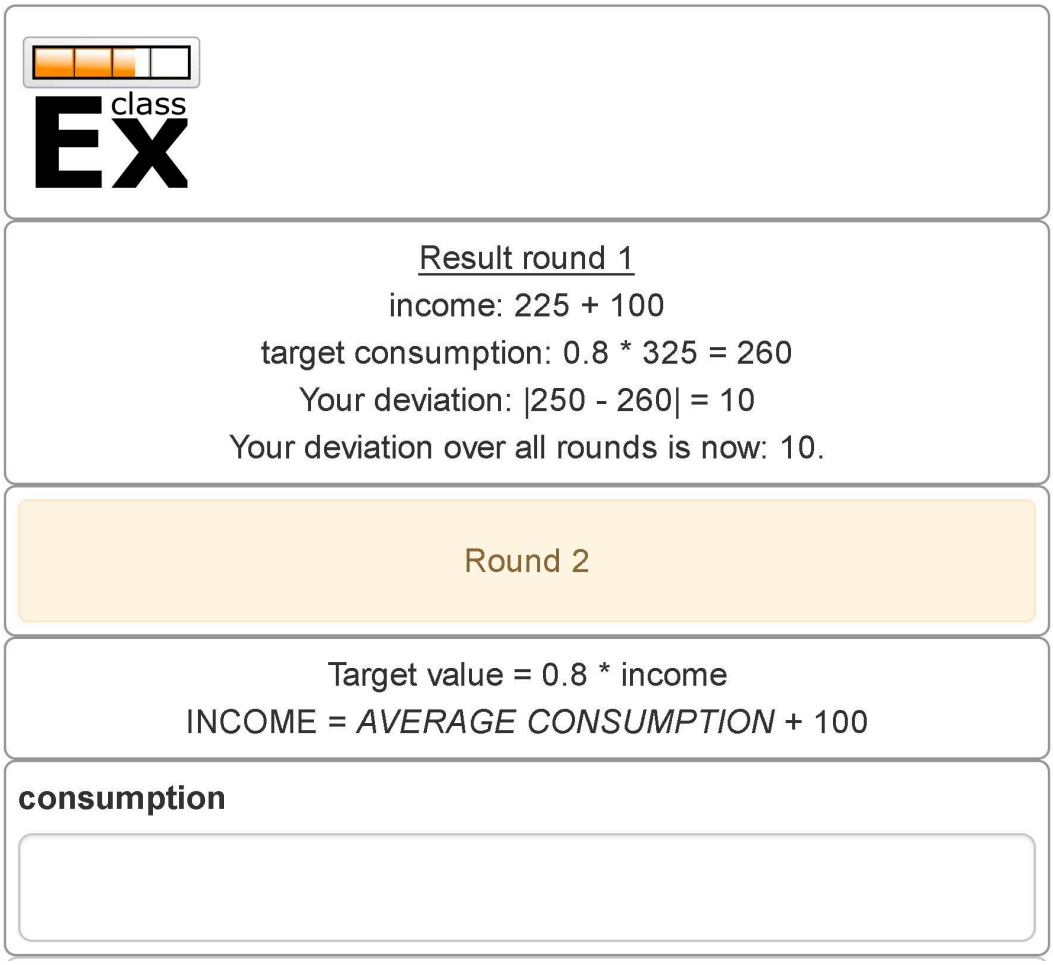

Figure 5.3 Feedback after each round.

6. Repeat steps 4 and 5 until you have played five rounds. When you start Round 6, inform students that the level of investment has changed. The following text is displayed on the instructor screen: 'From this round, investment changes from X to Y. Therefore, INCOME = *AVERAGE CONSUMPTION* + Y' where X and Y are 100 and 200 in the standard settings.
7. Repeat steps 4 and 5 until you have played all 10 rounds. End the experiment by clicking on 'Display results and disburse payoffs'. This displays the results chart on the instructor's screen, showing the development of choices over time. For more information on how to read the graph see the 'Predicted results' section. If you do not want to disburse payoffs, you can click on 'Only show results'.
8. If you choose to pay a real payoff, this is disbursed to the one participant with the smallest deviation, and they are informed about their earnings from the experiments. Figure 5.4 shows the feedback screen at the end of the experiment. If the student is

the winner, they are informed about the payoffs and gets a winning code to show to the person who pays out the money.

> Tell students to keep their winning code private and to take a screenshot of it so that you can pay them, for example, at the end of the lecture. If you want to guarantee a higher level of anonymity, you can also delegate this to your office. See advanced settings for the payout procedure.

If you chose not to pay real payoffs, the last box in Figure 5.4 is not shown. In this case, you may ask which participant had the smallest deviation, and give them some praise in front of the class.

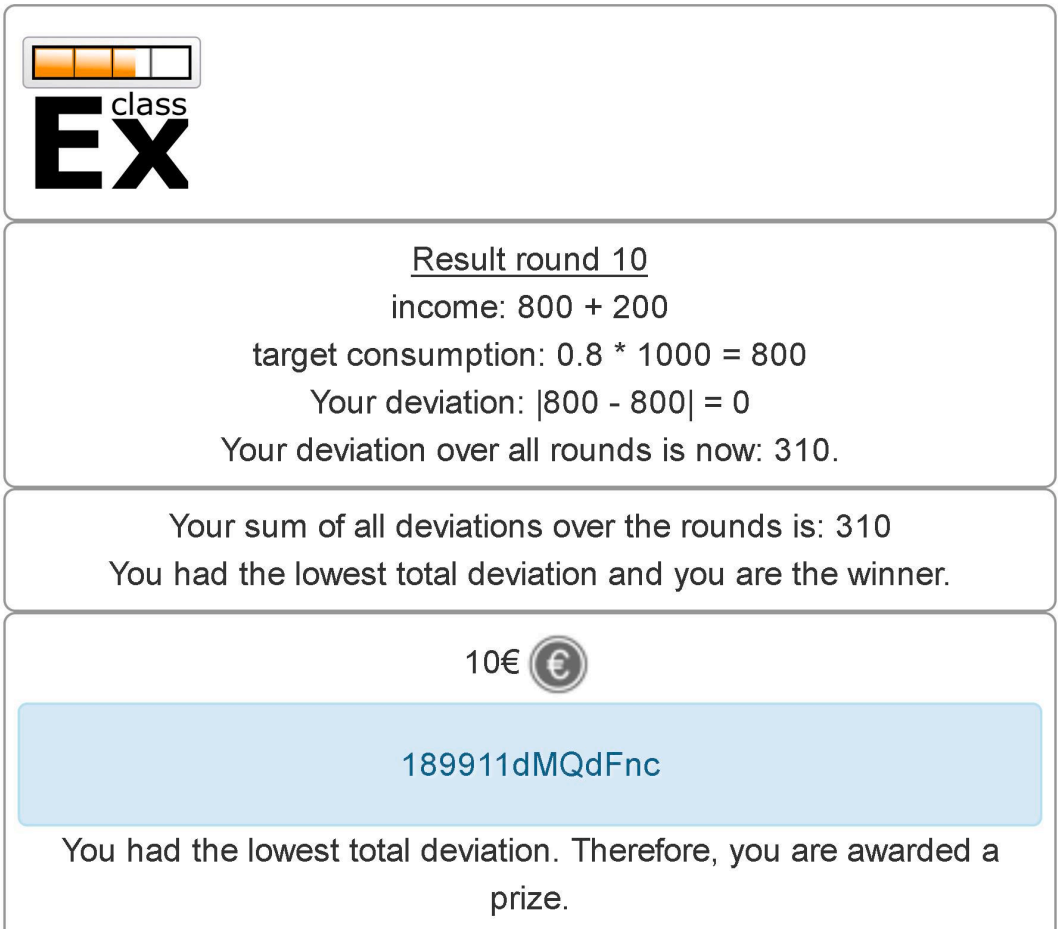

Figure 5.4 Feedback at the end of the experiment.

FIND OUT MORE

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.

Parameters

classEx allows you to personalize the settings for the experiment by changing the parameters. The parameters are described in the following table.

Payoff	This selection allows you to switch between the two variants of the game. With the setting 'Standard', you play the standard variant of the game, described above. With 'Deduction if Savings > Investments', you play an additional variant of the game, which is not discussed in this text. You can contact the authors if you would like more information on the variant.
Aggregation method	You can choose how consumption decisions should be aggregated. The standard setting is the mean of all consumption decisions, as it is easier to explain to students. If you have a small group of students and you expect manipulations (such as by entering extremely high values), you can choose the median that is less prone to manipulation.
Marginal consumption rate	You can change the marginal consumption rate (called c_1 in *The Economy*). The value should be 0% or above, but below 100%. The standard setting is 80%, yielding an equilibrium income of $1/(1 - c_1) = 5$ times the level of investment. Equilibrium consumption is $c_1/(1 - c_1) = 4$ times the level of investment.
Investment Round 1–5	You can change the level of investment in Rounds 1–5. The standard setting is 100, yielding an equilibrium income of 500 and an equilibrium consumption of 400.
Investment Round 6–10	You can change the level of investment in Rounds 6–10. The standard setting is 200, yielding an equilibrium income of 1,000 and an equilibrium consumption of 800.
Naming	The game can be framed with participants being households in a (closed) economy (standard setting) or countries in the world economy. The latter framing can be used if you want to play the game in a course with a focus on international economics.
Real payoff	If you turn this on, the participant with the smallest deviations over all rounds receives a fixed monetary payoff. If not, this person is only declared winner of the game.
Amount payoff	Specify the amount of the fixed monetary payoff (if turned on).

Currency of payoffs

In the settings of your classEx account, you can set the currency used. You can access the setting by clicking on your name in the top-right corner and selecting 'course data'.

Paying participants

classEx automatically assigns winning codes that are unique for each run of the game. They contain the number of the run and an alphanumeric code to verify the winner. The instructor can verify the winning codes by logging into classEx and not selecting the role as 'experimenter/lecturer', but selecting 'administration'. After logging in, a screen like Figure 5.5 is shown.

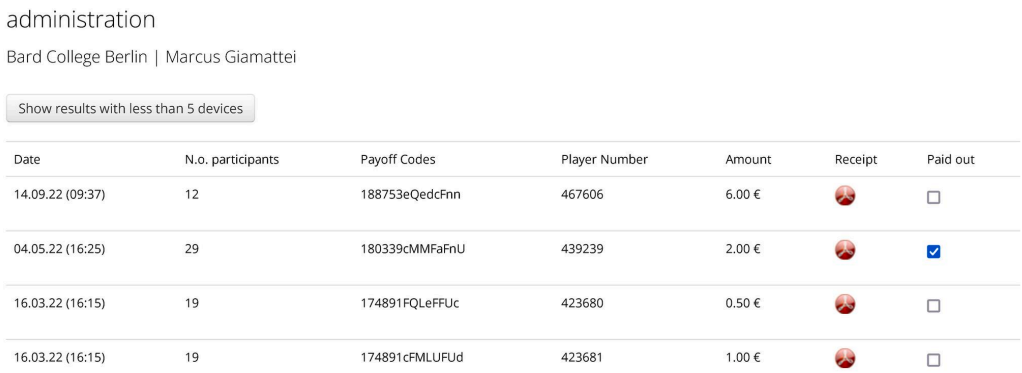

Figure 5.5 Administration screen.

This screen shows all payoffs made with that account. The list contains the date of the experiment, the number of participants, winning codes and amount, and the internal playerID. Ticking the box in the last column allows you to note if the payoff has been paid out or not. The PDF symbols create a receipt that may be used for administrative purposes. If payoffs should be made by a third person (for example, the instructor's office), this person can log into the administration mode and make the payments.

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 on the instructor's screen. The Excel file will show all recorded data at the time of the download, so you should wait until you have finished the game before you download it. 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 is: • 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. In this experiment the decision is the consumption decision made by the participant.
globals	Information about parameters, like the variant and payoff settings (if they deviate from the default values)
matching	Matching of playerIDs to groups (not needed for this experiment)
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 to classEx and ready to start the experiment.

1. Check that the parameters are set according to your preferences.
2. Explain the instructions to your students (see Section 5.5 or the student website) and ask if there are questions. Remind students that decisions are personal and that talking to each other is not permitted. Do not mention that there are different levels of investment.
3. Run the experiment.
   a. Click the 'Start' button. Give students approximately one minute to submit their decision.

b. End the round by clicking the ‘Results’ button. Students receive feedback on their deviation. Repeat a and b for 10 rounds. When Round 6 starts, announce that the value of investments has changed.

4. Show the results graph, disburse payoffs (if needed), and start the discussion as outlined in Section 5.7.

5.5 Student instructions

These are also available in the students’ version.

A PDF of the student instructions and homework questions is also available.

Each participant in this experiment represents one household in an economy. In each of the 10 rounds, your only task is to determine the level of consumption for your household. At the same time, the other participants determine the levels of consumption for their households.

Production is organized by Linda, a central producer whose behaviour is determined by the computer.

Linda collects information on the level of consumption by all households and sets the level of production according to aggregate demand. Aggregate demand consists of all households’ level of consumption plus aggregate investment. Aggregate investment is produced by Linda, amounting to 100 per household.

Each household works an identical amount to produce aggregate demand and achieves an income by selling its labour to Linda. Linda sells her produced goods to the households according to their level of consumption.

While deciding on consumption you do not know your household’s income. The total economy’s income depends on Linda’s production and, thus, aggregate demand. This in turn is determined by all households’ consumption, plus investment. Each household gets an equal share of total income. As a consequence, for each household, income is given by

$$\text{INCOME} = \text{AVERAGE CONSUMPTION} + 100$$

You should aim to set consumption for your household close to a target. This target is a share of your household’s income and the remaining share is saved. The target for consumption is: TARGET = 0.8 × INCOME. The participant whose consumption comes closest to the target over all rounds is declared the winner.

5.6 Predictions

Predicted results LINK

At the end of the experiment, you will see the results in the line chart. You can expect to obtain something similar to the graph in Figure 5.6, which shows the results from the reference example in classEx: an experiment run with 21 students at the University of Passau (Germany) in 2022.

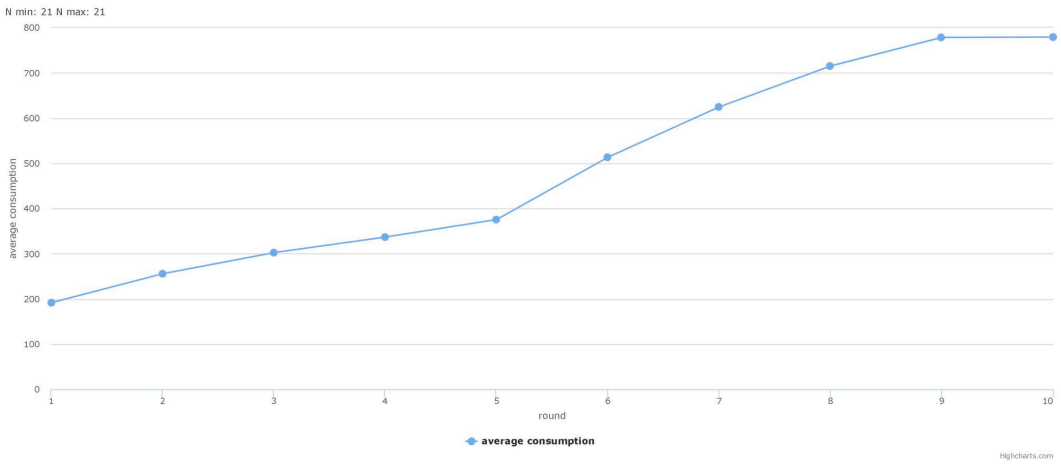

Figure 5.6 Results matrix in a session run with 21 participants at the University of Passau in 2022.

In classEx you can see the values by hovering over the points in the graph.

Figure 5.6 shows the average consumption decision over the ten rounds. Let's focus on Rounds 1 to 5 first. Average consumption started with a value of 191. Consumption increased with each round, rising to 375 in Round 5. Consumption tends to converge to equilibrium consumption of 400. The results show the lagged adjustment of the Keynesian multiplier, called the Robertson lag. Households base their decisions not on the (unknown) current income but on previous income, potentially serving as a proxy for current income. Due to this lag, the adjustment towards equilibrium is sluggish and incomplete.

The equilibrium can be calculated by assuming that everyone chooses the same level of consumption in equilibrium. This symmetry assumption helps to solve the problem. The participant should set consumption C close to 0.8 × income, which is C + 100, so that $C = 0.8(C + 100)$. Solving for C gives $C = 400$.

The results can also be connected to failures in the iterative elimination of dominated strategies, known from behavioural game theory. This is also known as limited reasoning. The equilibrium level of consumption can be reached by best-responding

when guessing what others will do. If I expect all other participants will choose 300 (and I neglect my influence on the average consumption), then I should set consumption to $C = 0.8(300 + 100) = 320$. If I know that everyone knows that and I assume that everyone else choses 320, best-responding leads to $C = 0.8(320 + 100) = 336$. If you repeat these steps, you arrive at the equilibrium consumption of 400. This iterative process requires an unlimited amount of reasoning steps, and experimental economics has shown that subjects tend to perform fewer steps of reasoning on average (in the case of the Robertson lag, only one step). This gives a further explanation of why the adjustment is so slow. Keynes himself was confident on subjects' forecast rationality, and focused his concern about inertia more on the aggregate multiplier effects linked with producers' exposure to unplanned changes in inventory. In his lecture notes Keynes (1973, p. 181) considered this to be a shortcoming: 'I now feel that if I were writing the book again I should ... have a subsequent chapter showing the difference it makes when short-period expectations are disappointed.'

In Round 6, the economy is hit by a shock, and investments are increased from 100 to 200. As you can see from Figure 5.6, the reaction to this shock is again sluggish. Average consumption increases to only 513 in Round 6 while it should double to the equilibrium value of 800. These results can be used to discuss the Robertson lag again, but now you can put more focus on the power of the multiplier, where an increase of investment by 100 leads to an increase in income by 500.

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 5.7 to guide your discussion, and read the experiences of other instructors provided in Section 5.10.

What might go differently? LINK

As in any coordination game, the results are context-dependent and can be easily influenced by any form of public announcement. Therefore, it is important not to allow any communication during the experiment (with the exception of discussing the game briefly with neighbours before starting).

Students may ask about the consumption values that they are allowed to choose. You do not need to tell them this at the beginning. Some may find it out by trying high values. It is possible to choose consumption values between 0 and 5 times the level of investment (that is, 500 in Rounds 1–5 and 1,000 in Rounds 6–10). If they choose higher values, an error message will appear. If students, by accident, are close to the equilibrium value of 400 already in Round 1, no convergence towards the equilibrium may be observable. This is unlikely, however. Due to the upper limit on values, it is common to start with average values below the equilibrium.

Students who skip a round by not entering a consumption decision are assigned a penalty of the maximal deviation in this round. This is necessary as the winner is determined by adding up deviations over all rounds.

5.7 Discussion

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

Interpreting the graphs LINK

Comments under 'What might go differently?' in Section 5.6 Predictions above provide useful further information.

- Describe how the line charts can be read.
- Explain how the results on consumption translate to the development of income over time.

  > Income is average consumption plus a fixed value of 100 for investments.

Reflecting on the decisions that players made LINK

- What drove your decision in the first round? How did this change in further rounds?
- Describe the role of your expectations about the other players.
- Describe your thoughts when you received the first feedback about the previous consumption and income values.

Link to theory LINK

- Describe how you should respond if other players choose consumption of 100 on average.
- Assume that everyone does the same in equilibrium. Try to solve mathematically what the optimal consumption choice is.
- Determine the level of savings in each round and compare them to the level of investment. Use data from three participants who recall their first-round values. Link these values to the capital market: loans are supplied by those who save more than they invest; loans are demanded by those who invest more than they save.
- Discuss the statement: 'Loans are demanded by those who consume above the equilibrium.' Explain that this statement is wrong. The correct statement would be that loans are demanded by those who consume more than the average. Illustrate this point by reference to the data from three participants.
- What can we say about the role of expectations?
- Comment on this statement: 'It is important not to think only about the way the other will think, but also to think about what the other thinks about the way I will think.'

> Higher-order expectations open up an advanced discussion that can be used to stimulate students' interest.

Relating the experiment to real life LINK

- How is the experiment connected to the multiplier process?
- How do the consumption decisions of other people influence your decision to consume in reality? How can the experiment help to explain how a small downturn can become contagious?
- In the experiment, income is unknown when deciding on consumption. How does this relate to your own experience? Is there a difference between a microeconomic analysis and a macroeconomic one?

A hypothetical situation LINK

- Assume that investments drop to 50. Explain how the adjustment will take place.

Critical evaluation of the experiment LINK

- In the experiment, the multiplier had a value of 5. Do you consider this to be realistic?

5.8 Homework questions

Registered instructors can access answers to question 5.

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 their and others' behaviour in the experiment.

Please note that the questions are based on the standard parameters.

For question 1, you have to share a screenshot of the results screen with your students. If your results screen does not show the predicted results, you can use Figure 5.6 and share it with the students.

For question 2, you have to share data from the experiment in Round 1. Data from your experiment can be downloaded as an Excel file from the 'data' menu on 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.

1. Your instructor shared with you the results of the game that you played.

a. Determine the equilibrium level of consumption and income if investments are fixed to 100.
b. Explain the development of consumption over time and give reasons for the slow adjustment.

2. Your instructor shared with you the consumption data from the experiment. Take the five highest and the five lowest consumption choices from the first round. Calculate their level of savings. What can you conclude about the overall level of savings?
3. Read Section 14.2 in *The Economy* 1.0 and draw Figure 14.2 for the values of the game played in class. What can you conclude about autonomous consumption?
4. Consumption is $C = c_0 + c_1 \times Y$ and $Y = C + I$. Solve the system for the equilibrium values of C, S, and Y. What can you conclude if the consumption rate c_1 is equal to 0? What happens if the consumption rate is 1?
5. For this exercise you will need the Multiplier Model Excel Simulator. Assume that in this economy, net exports are zero and taxes are levied as a proportion of income.

   We are going to start by using the Excel Simulator to consider the effect of a 100% increase in investment when the marginal propensity to consume (MPC) is 0.5.

   a. Figure 1 in the Simulator shows the standard multiplier model from Section 14.2. Label the initial goods market equilibrium (GME) with an *A* and the new GME with a *Z*. Explain what it means when the economy is in goods market equilibrium.
   b. How does Figure 2 relate to Figure 1? (Hint: look at the labels on the axes)
   c. Now label the initial GME on Figure 2 with an *A* and the new GME with a *Z*.

   Figure 3 shows a breakdown of the changes happening to investment, income-dependent consumption, and output (income) over time or in each 'spending round'.

   d. Write down the aggregate demand equation for this economy. Identify investment and income-dependent consumption in the equation.
   e. Recall the definition of MPC. Explain what it means when the MPC is 0.5.
   f. The first change in income-dependent consumption happens in spending Round 2 and has a value of 5. Explain why. (Hint: you might find it helpful to look at the aggregate demand equation you wrote down for question d.)
   g. What is the value of the next change in income-dependent consumption? Explain why.
   h. What is the link between the changes in Y, investment, and income-dependent consumption?
   i. Now sketch what a line showing the changes in aggregate demand would look like on Figure 3. (Hint: Think carefully about the timing and the GME.)

   Now let's look at the importance of the MPC.

j. Change the MPC value firstly to 0.2, then to 0.8. Describe and explain the changes to all three figures in each case.

Economists use models like this to make projections or forecasts of how changes to components of aggregate demand will affect GDP.

k. Imagine the UK economy is in recession and that the government is uncertain about the proportion of credit-constrained households, so estimates a range for the marginal propensity to consume from 0.5 to 0.65. What is the forecast range for the change in GDP, *in percent,* due to a 5% rise in investment as a consequence of some favourable government policies?
l. In the Simulator, we used a single number to represent the MPC of the entire population, but in reality, the MPC may differ between individuals. Suggest some reasons why people might have different marginal propensities to consume. In your answer, propose four households of different ages, employment status (such as employed, unemployed, retired), and home ownership status (such as renter, home owner with no mortgage, home owner with a mortgage) and explain why you think the MPC would vary across these households.
m. Use your results in k. and l. to comment on the relationship between a recession, credit constraints, household characteristics, the MPC, and the effectiveness of government policy.

5.9 Further reading

Also available in the students' version. You may assign Section 18.2 from *The Economy* 1.0 if you play the variant of the game.

- CORE. *The Economy* 1.0, Sections 14.1 and 14.2
- Marcus Giamattei and Johan Graf Lambsdorff. 2015. 'Balancing the Current Account: Experimental Evidence on Underconsumption'. *Experimental Economics* 18 (4): pp. 670–696.

5.10 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

The Keynesian multiplier game is a useful way to introduce the Keynesian multiplier and to experience the model. It allows first experiential contact with the model and shows students how sluggish the adjustment may be especially in big groups. It can

therefore be used effectively in an introductory macro lecture. After the experiments, teachers can derive the Keynesian multiplier in general and the Keynesian cross as shown in Figure 14.2 of *The Economy* 1.0.