



Teacher guide to the quantity competition game (Cournot)

Laboratory implementation, theoretical foundations,
experimental evidence, and variants

Behavioral and Experimental Economics Research Lab
Department of Economics



Version 1.0 | September 2026

<https://beer-lab.org/>

How to use this guide

This guide helps you prepare, run, and debrief the **quantity competition (Cournot)** game developed for the Behavioral and Experimental Economics Research Lab (BEER Lab) of the Department of Economics at Tecnológico de Monterrey. It is written for instructors of intermediate microeconomics and industrial organization, with or without prior experience in experimental economics.

The **quick guide** is enough to launch a session. The operational chapters explain every screen. The conceptual chapters present the theoretical benchmarks and the evidence needed to interpret the results. Common rules are explained once; each variant describes only what changes relative to the baseline game.

Author

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For the instructor

This guide covers the English interface. A separate Spanish version exists. The screens in this guide were captured on a local instance of the game with simulated decisions; the numbers they show illustrate the interface and are *not* results from a class. Project only aggregate results: do not link codes to names, student IDs, seats, or individual decisions.

Contents

How to use this guide	i
1 Quick implementation guide	1
1.1 Fact sheet	1
1.2 Minimum sequence	1
1.3 Checklist	2
2 Accessing the platform	3
2.1 Your access: teaching-admin and the game's panel	3
2.2 The panel: minimum vocabulary	5
2.3 Rehearsing before class	7
2.4 Creating the session in class	8
2.5 How your students join	9
3 The baseline game and its screens	12
3.1 Rules, incentives, and benchmarks	12
3.2 Cover page, instructions, and comprehension	12
3.3 Decision, waiting, and result	14
4 Instructor report and debrief	18
4.1 When to reveal	18
4.2 How to read the report	20
5 Theory and evidence	21
5.1 Theoretical benchmarks	21
5.2 Experimental evidence	21
5.3 Regularities worth discussing	22
6 Baseline modes	23
6.1 One round	23
6.2 Ten rounds with the same rival	23

6.3	Ten rounds with a reassigned rival	23
7	Extended variants	24
7.1	Map of treatments	24
7.2	Monopoly	24
7.3	Three and four firms	25
7.4	Communication	25
7.5	No calculator	26
7.6	Each rival's information	26
8	Class plan and interpretation	28
8.1	Suggested 50-minute session	28
8.2	Questions to guide the discussion	28
8.3	Common misreadings	28
9	Operations, privacy, and troubleshooting	30
9.1	Privacy and conduct	30
9.2	Common problems	31
9.3	Data for later analysis	31
10	Annotated bibliography	32
A	Room QR codes	34

List of Figures

2.1	Instructors' page: teaching-admin.beer-lab.org .	3
2.2	The game's card on the instructors' page.	4
2.3	The game's rooms on the expanded card; tick Show extended version to also see the extended ones.	5
2.4	Login screen of the game's panel.	5
2.5	Demo: the game's 20 configurations (6 basic and 14 extended, in Spanish and English).	6
2.6	Rooms: the game's four rooms.	7
2.7	Links of a practice session. The screenshots in this guide were taken on a local copy, which is why the addresses read <code>localhost</code> ; on the server they read <code>cournot.beer-lab.org</code> .	7
2.8	Form of the basic English room: only its three configurations appear.	8
2.9	Room with a session in progress.	8
2.10	Monitor: each participant's round and page, without showing decisions.	9
2.11	The room as students see it.	10
2.12	What a student sees if the session does not exist yet (oTree shows this message in Spanish).	11
2.13	The game's card on teaching.beer-lab.org , the students' page.	11
3.1	Cover page and lab rules.	13
3.2	Instructions: price, cost, profit, and a numerical example.	13
3.3	Comprehension check.	14
3.4	Wrong answer: the message restates the rule without giving the answer.	14
3.5	Production decision with calculator.	15
3.6	Waiting for the market.	15
3.7	Round result.	16
3.8	Decision in round 4, with the history of previous rounds.	16
3.9	End screen: total profit and the instruction to wait for the instructor.	17
4.1	Report with results hidden and the progress counters.	18
4.2	Revealed report: benchmarks, summary, and path of total output (simulated decisions).	19

4.3	Revealed report: early versus late rounds, histogram, and table of markets (simulated decisions).	20
7.1	Monopoly: the calculator only has own output.	25
7.2	Chat before the decision (demonstration messages).	26
7.3	Result with each firm's quantity and profit in the market.	27

Quick implementation guide

1.1 Fact sheet

Purpose	Contrast three benchmarks—joint-profit maximum, Cournot-Nash equilibrium, and price equal to marginal cost—and study how they change with the number of firms, repetition, communication, and information.
Participants	Any number. Markets of the configured size are formed; leftover participants join the first markets (31 students in duopolies: 14 markets of 2 and one of 3).
Market	Inverse demand $P = \max(0, 130 - Q)$, marginal cost 10 ECU, no fixed costs.
Decision	Each firm chooses, simultaneously and privately, an integer q_i between 0 and 100.
Profit	$\pi_i = (P - 10) q_i$ ECU. It can be negative if $P < 10$.
Duration	15–20 minutes for one round; 30–40 for ten rounds or an extended variant, not counting the debrief.
Instructor (you)	teaching-admin.beer-lab.org → the game's card → Open panel . It asks for a username and password (Section 2.1).
Students	The room link cournot.beer-lab.org/room/cournot_en , its QR code (Section 2.5), or teaching.beer-lab.org .
Report	Theoretical benchmarks; averages of q , Q , price, and profit; path of Q by round; early versus late rounds; histogram of q ; anonymous table of markets.

Attention

There are two different pages. **teaching-admin.beer-lab.org** is yours: from there you open the game's panel and download this guide. **teaching.beer-lab.org** is your students' page: from there one can only *play*, not create sessions.

1.2 Minimum sequence

Before class

1. Request panel access from lab.economia@servicios.tec.mx, stating the game, course, num-

ber of students, and date. You will receive the password for the user **admin**.

2. Open teaching-admin.beer-lab.org, find **Quantity Competition (Cournot)**, and click **Open panel**. Enter the username and password.
3. Rehearse in **Demo**: open a configuration and play it in two or three browser tabs to get to know the screens and the report (Section 2.3).

In class

4. Count the students present.
5. In the panel, open **Rooms** and the room **[EN] Quantity Competition** (or the extended one). Choose the configuration, enter the *exact* number of students in **Number of participants**, and click **Create**.
6. Share the room link or project its QR code. Each student clicks **Start**.
7. In the room, click **Monitor the session**: the session page opens, with the **Monitor** (progress) and **Report** tabs. At the end, open **Report**, click **Show results**, and lead the discussion.

After class

8. In the room, click **Close this room**. This leaves it ready for the next group; the session's data are kept under **Sessions**.

1.3 Checklist

- ☐ Panel password received and tested at cournot.beer-lab.org/login.
- ☐ Rehearsal done in **Demo**.
- ☐ Devices, internet, browser, and projector ready.
- ☐ Mode or variant chosen to fit the question of the class.
- ☐ Number of participants in the session equal to the number of students present.
- ☐ Room link or QR code at hand (Section 2.5); tested from a phone.
- ☐ Students told that ECU are experimental units and that there is no cash payment.
- ☐ Monitor and report open; theoretical benchmarks computed before revealing results.

Accessing the platform

2.1 Your access: teaching-admin and the game's panel

The instructors' page is teaching-admin.beer-lab.org. It is not in the beer-lab.org menu: type the address directly or bookmark it. It gathers all of the lab's classroom games; you can search by title, topic, or JEL code.

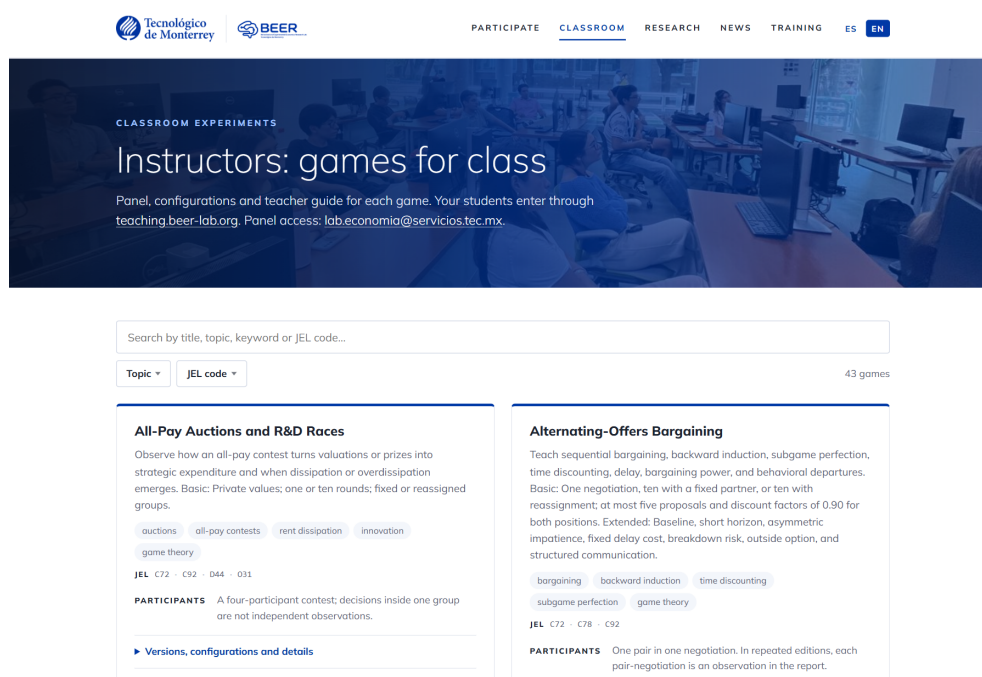


Figure 2.1: Instructors' page: teaching-admin.beer-lab.org.

Each game has a card with its description, number of participants, and duration, and two buttons: **Open panel**, which takes you to the game's panel, and **Teacher guide (PDF)**, which downloads this guide (the **ES** link downloads the Spanish version).

Quantity Competition (Cournot)

Each firm chooses how many units to produce and the price depends on total market output ($P = 130 - Q$, unit cost 10). Duopoly for one round or ten rounds with a fixed or reassigned rival, plus an extended version (monopoly, three and four firms, reassigned markets, chat, no calculator, each rival's result shown).

oligopoly
imperfect competition
Nash equilibrium
collusion

industrial organization

JEL C72 · C92 · D43 · L13

PARTICIPANTS Markets of 2 firms (1, 3 or 4 in the extended version). Works with any class size: leftover participants join the first markets. With reassigned rivals, 5 or more markets avoid repeated matches.

DURATION Approx. 15–20 min (one round) · 35–50 min (ten rounds), including instructions and comprehension check.

► **Versions, configurations and details**

Open panel

Teacher guide (PDF)

ES

Figure 2.2: The game's card on the instructors' page.

Expanding **Versions, configurations and details** shows the list of rooms. Each **open panel** in that list goes straight to the form for creating a session in that room (after you log in).

- **Español:** [open panel](#) — configurations: *[ES] Cournot — duopolio, una ronda, [ES] Cournot — duopolio, 10 rondas, misma empresa rival, [ES] Cournot — duopolio, 10 rondas, rival reasignado*
- **English:** [open panel](#) — configurations: *[EN] Cournot — duopoly, one round, [EN] Cournot — duopoly, 10 rounds, same rival, [EN] Cournot — duopoly, 10 rounds, reassigned rival*
- **Español · extendido:** [open panel](#) — configurations: *[ES] Cournot extendido — monopolio, 10 rondas, [ES] Cournot extendido — tres empresas, 10 rondas, [ES] Cournot extendido — cuatro empresas, 10 rondas, [ES] Cournot extendido — cuatro empresas, 10 rondas, mercados reasignados, [ES] Cournot extendido — duopolio con chat, 10 rondas, [ES] Cournot extendido — duopolio sin calculadora, 10 rondas, [ES] Cournot extendido — cuatro empresas, información de cada rival, 10 rondas*
- **English · extended:** [open panel](#) — configurations: *[EN] Cournot extended — monopoly, 10 rounds, [EN] Cournot extended — three firms, 10 rounds, [EN] Cournot extended — four firms, 10 rounds, [EN] Cournot extended — four firms, 10 rounds, reassigned markets, [EN] Cournot extended — duopoly with chat, 10 rounds, [EN] Cournot extended — duopoly without calculator, 10 rounds, [EN] Cournot extended — four firms, each rival shown, 10 rounds*

Figure 2.3: The game’s rooms on the expanded card; tick **Show extended version** to also see the extended ones.

The game’s panel (<https://cournot.beer-lab.org>) is protected. **Open panel** shows the **Admin Login** screen: type **admin** in **Username** and the password the lab gave you in **Password**. If you do not have it, request it from lab.economia@servicios.tec.mx.

Figure 2.4: Login screen of the game’s panel.

2.2 The panel: minimum vocabulary

The panel is oTree’s. These are the only terms you need:

Demo	Practice sessions. It creates a session with dummy participants that you play yourself in several tabs. Use it to rehearse, never with students.
Rooms	Fixed addresses for class. Each game has four: basic and extended, in Spanish and English. Your students always join through a room.
Create / Number of participants	Create the session in the room and declare how many people will play.
Monitor	Table with the round and the screen each participant is on. It does not show decisions.
Advance slowest participants	Monitor button that moves forward whoever fell behind (Section 2.4).
Report	The instructor report for projecting the aggregate results.
Data	Download of the data as CSV.
Sessions	List of all your sessions, to go back to an earlier one.
Close this room	Frees the room at the end, for the next group.

In this panel, **Demo** lists only this game's 20 configurations and **Rooms** only its four rooms. If another game appears, do not start the session and notify the lab.

oTree
Demo
Sessions
Rooms
Data
Server Check

Demo

[ES] Cournot — duopolio, una ronda
[ES] Cournot — duopolio, 10 rondas, misma empresa rival
[ES] Cournot — duopolio, 10 rondas, rival reasignado
[EN] Cournot — duopoly, one round
[EN] Cournot — duopoly, 10 rounds, same rival
[EN] Cournot — duopoly, 10 rounds, reassigned rival
[ES] Cournot extendido — monopolio, 10 rondas
[ES] Cournot extendido — tres empresas, 10 rondas
[ES] Cournot extendido — cuatro empresas, 10 rondas
[ES] Cournot extendido — cuatro empresas, 10 rondas, mercados reasignados
[ES] Cournot extendido — duopolio con chat, 10 rondas
[ES] Cournot extendido — duopolio sin calculadora, 10 rondas
[ES] Cournot extendido — cuatro empresas, información de cada rival, 10 rondas
[EN] Cournot extended — monopoly, 10 rounds
[EN] Cournot extended — three firms, 10 rounds
[EN] Cournot extended — four firms, 10 rounds
[EN] Cournot extended — four firms, 10 rounds, reassigned markets
[EN] Cournot extended — duopoly with chat, 10 rounds
[EN] Cournot extended — duopoly without calculator, 10 rounds
[EN] Cournot extended — four firms, each rival shown, 10 rounds

Juegos de mercados / Market games — BEER Lab

Competencia en cantidades (Cournot) / Quantity competition (Cournot)

Figure 2.5: Demo: the game's 20 configurations (6 basic and 14 extended, in Spanish and English).

oTree Demo Sessions Rooms Data Server Check	
Rooms	
Current rooms:	
[ES] Competencia en cantidades	
[EN] Quantity Competition	
[ES] Competencia en cantidades — extendido	
[EN] Quantity Competition — extended	

Figure 2.6: Rooms: the game's four rooms.

2.3 Rehearsing before class

In **Demo**, click a configuration: a practice session is created and its links page appears. Open each link **P1**, **P2**, ... in a different tab and play as each student would; then open **Report**. These sessions do not affect your classes.

oTree Demo Sessions Rooms Data Server Check

[EN] Cournot — duopoly, 10 rounds, same rival: session 'ac0jhdv0' (demo)

[New](#)
[Links](#)
[Monitor](#)
[Data](#)
[Payments](#)
[Report](#)
[Description](#)

Below are temporary links for testing and demonstration. To launch a real study, either create persistent links by setting up a [room](#), or create a session through the [sessions](#) page.

Choose one of the following options to play the session:

Combined views

Split-screen view
[Launch](#)

Grid view
[Launch](#)

Session-wide testing link
 Open the below link in up to 4 browser tabs.

<http://localhost:8021/join/zuhepako>

Single-use links
 Open each link in its own browser tab.

P1	http://localhost:8021/InitializeParticipant/c94pkjc8
P2	http://localhost:8021/InitializeParticipant/z84jyw9g
P3	http://localhost:8021/InitializeParticipant/907wdseo
P4	http://localhost:8021/InitializeParticipant/mg1nrwdl

Figure 2.7: Links of a practice session. The screenshots in this guide were taken on a local copy, which is why the addresses read `localhost`; on the server they read `cournot.beer-lab.org`.

Attention

Do not rehearse with the room link open in several tabs of the same browser: oTree recognizes the browser and all the tabs would be the same person. To rehearse, use **Demo**.

2.4 Creating the session in class

In **Rooms**, open the room for the language you will use. The form offers only that room's configurations. Choose the configuration, enter the number of students present in **Number of participants**, and click **Create**.

The screenshot shows the oTree interface for creating a new session. At the top, there is a navigation bar with links: oTree, Demo, Sessions, Rooms, Data, and Server Check. Below this, the page title is 'Room: [EN] Quantity Competition'. Underneath, it says 'Create a new session'. A light blue box contains the text: 'English room. Only the configurations of this game, language and edition are shown below.' Below this, there is a 'Session Config' section with a dropdown menu showing '[EN] Cournot — duopoly, one round'. Below the dropdown is a 'Number of participants' input field, which is currently empty. Below the input field, it says 'Must be a multiple of 1'. At the bottom of this section is a blue 'Create' button. Below the 'Create' button, there is a link 'Configure session' with a gear icon, and the text 'App sequence'.

Figure 2.8: Form of the basic English room: only its three configurations appear.

The room then shows that a session is in progress, with the link **Monitor the session** and the button **Close this room**.

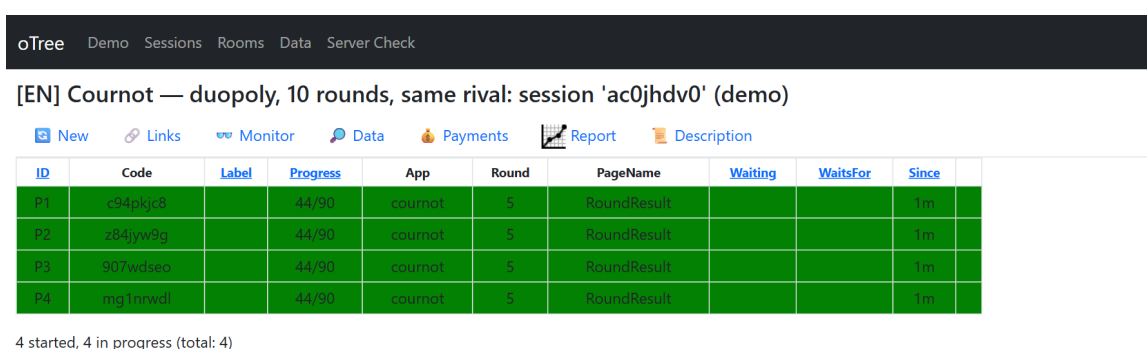
The screenshot shows the oTree interface when a session is in progress. At the top, there is a navigation bar with links: oTree, Demo, Sessions, Rooms, Data, and Server Check. Below this, the page title is 'Room: [EN] Quantity Competition'. Underneath, a green box contains the text: 'Session y10uz7ha is taking place in this room.' Below this, there is a link 'Monitor the session' and a button 'Close this room'. Below the green box, there is a section titled 'Start links' with the text: 'These URLs will stay constant for new sessions, even if the database is recreated.' Below this, there is a section titled 'Room-wide URL' with the text: 'Here is the room-wide URL anyone can use. Don't use this link when testing in multiple tabs on the same browser, because all tabs will be assigned to the same participant, using a cookie.' Below this, there is a link 'http://localhost:8021/room/cournot_en'. At the bottom, there is a section titled 'Hard-coded links' with the text: 'Generally, you should provide your participants with the room-wide URL above. But in special cases where you need to open (or re-open) a specific participant's link, by using the participant code, you can use the below links.' Below this, there is a link 'Show/Hide'.

Figure 2.9: Room with a session in progress.

Attention

Declare the exact number, with no spare places. The lab's general guide suggests creating a few extra places; not in this game. Markets are formed when the session is created: if you declare more participants than actually join, some markets are left incomplete and their members wait indefinitely. If one student more than declared arrives, they see a message in Spanish, “La sesión está llena” (the session is full); in that case, before starting, click **Close this room**, create another session with the right number, and ask everyone to open the link or the QR code again.

If a student disconnects mid-activity, their market stops at the waiting page, because there is no time limit for the decision. Ask them to reopen the room in the same browser: they resume where they were. If they cannot, use **Advance slowest participants** in the Monitor. The advanced firm is recorded as producing 0 units that round, so its rival effectively acts as a monopolist; that market enters the report's averages.



The screenshot shows the oTree Monitor interface for a session titled "[EN] Cournot — duopoly, 10 rounds, same rival: session 'ac0jhdv0' (demo)". The interface includes a navigation bar with links for New, Links, Monitor, Data, Payments, Report, and Description. Below the navigation bar is a table with columns: ID, Code, Label, Progress, App, Round, PageName, Waiting, WaitsFor, and Since. The table lists four participants (P1, P2, P3, P4) who are all in progress (44/90) and have reached the RoundResult page. The status at the bottom indicates "4 started, 4 in progress (total: 4)".

ID	Code	Label	Progress	App	Round	PageName	Waiting	WaitsFor	Since
P1	c94pkyc8		44/90	cournot	5	RoundResult			1m
P2	z84jye9g		44/90	cournot	5	RoundResult			1m
P3	907wcheo		44/90	cournot	5	RoundResult			1m
P4	mg1nrvdl		44/90	cournot	5	RoundResult			1m

4 started, 4 in progress (total: 4)

Figure 2.10: Monitor: each participant's round and page, without showing decisions.

2.5 How your students join

Students need no account and nothing to install; a phone or computer browser is enough. They have three ways in, all leading to the same room:

1. **QR code.** Project the one for the room you will use (below, and full-page in Appendix A). They scan it with their phone camera.
2. **Room link.** Share it in the class chat or on Canvas: https://cournot.beer-lab.org/room/cournot_en.
3. **Catalogue.** On teaching.beer-lab.org they find **Quantity Competition (Cournot)** and click their language's button (**English**, or **English · extended** if they tick **Show extended version**).



English, basic

cournot.beer-lab.org/room/cournot_en



English, extended

cournot.beer-lab.org/room/cournot_extended



Español, básica

cournot.beer-lab.org/room/cournot_es



Español, extendida

cournot.beer-lab.org/room/cournot_extendido

What participants will see

Students open the room and click **Start**. If you have not created the session yet, the room shows a short waiting message in Spanish (“Por favor espere”) and lets them in automatically as soon as you create it; that is why you can share the link or QR code from the start of class. They need no email or password: they receive an anonymous code.

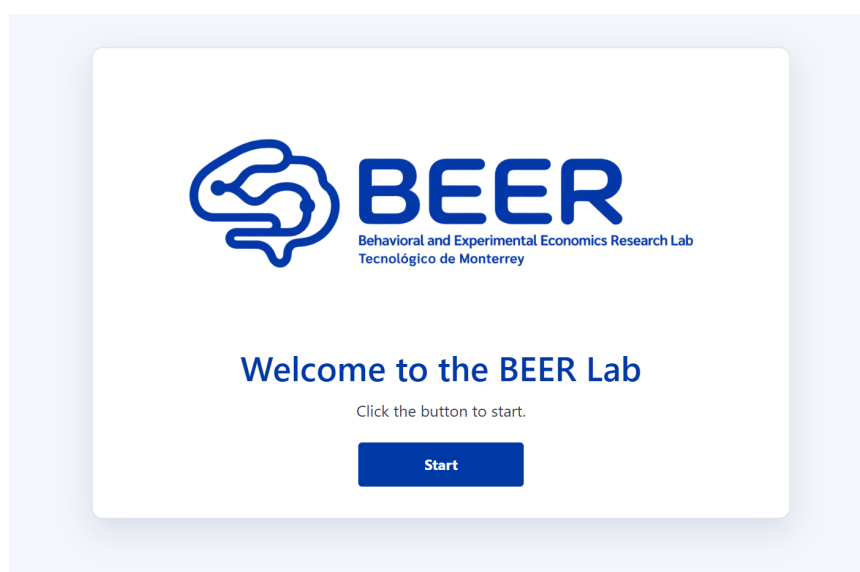


Figure 2.11: The room as students see it.

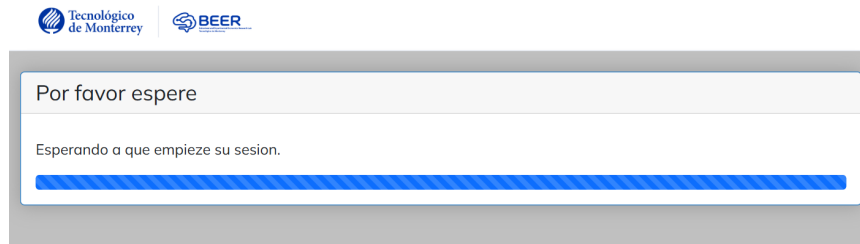


Figure 2.12: What a student sees if the session does not exist yet (oTree shows this message in Spanish).

The language is set per room: a session created in the English room only receives those who enter through the English room. If your group is mixed, choose one language for everyone.

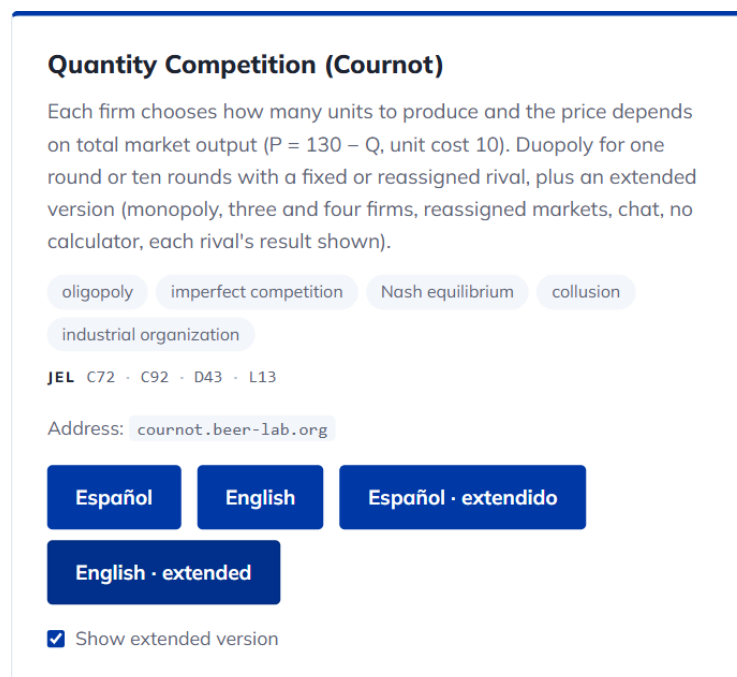


Figure 2.13: The game's card on teaching.beer-lab.org, the students' page.

The baseline game and its screens

3.1 Rules, incentives, and benchmarks

Each firm simultaneously chooses how many units to produce, $q_i \in \{0, 1, \dots, 100\}$. Everything produced is sold at the market-clearing price,

$$P = \max(0, 130 - Q), \quad Q = \sum_{j=1}^n q_j, \quad \pi_i = (P - 10) q_i.$$

An additional unit brings the firm the margin $P - 10$, but lowers by 1 ECU the price of *all* its units and of its rivals' units. Each firm internalizes only the effect on its own units; that is why, acting on its own, it produces more than what maximizes joint profit.

For the instructor

Before playing, ask for two predictions: what total output maximizes the market's *joint* profit? And what output would each firm choose if it believes the rival will not change its own? The gap between the two answers organizes the discussion.

3.2 Cover page, instructions, and comprehension

The cover page introduces the BEER Lab and the rules of conduct. Participants confirm they have read them. The instructions describe only the action: they do not mention “Cournot”, “Nash”, or “collusion”, nor do they suggest a quantity.



Welcome to the BEER Lab

The **Behavioral and Experimental Economics Research Lab** of the Department of Economics at Tecnológico de Monterrey is a space for learning about economic decisions through controlled activities.

Today you will make decisions as the manager of a firm. Your earnings depend on your decisions and on those of other people.

During the session

- Do not talk or communicate with other people, except through the means shown on screen.
- Make your decisions individually.
- Follow the on-screen instructions. Do not refresh or close this page.
- If you need help, raise your hand.

I have read and understood the lab rules.

☐ Yes ☐ No

Start

Powered by [oTree](#)

Figure 3.1: Cover page and lab rules.

Instructions

Round 1 of 10

You manage a firm. Your firm and one other firm sell the same product in a market. In each round, each firm decides how many units to produce, from 0 to 100, without knowing what the others decide. Everything produced is sold at the market price.

Price and earnings

The price depends on the total production in the market (the sum over all firms): **price = 130 – total production**. The price is never below 0.

Producing each unit costs 10 ECU.

Your earnings = (price – 10) × your units. If the price is below 10, earnings are negative.

Example: if you produce 35 and the other firms produce 50 in total, total production is 85, the price is $130 - 85 = 45$ and your earnings are $(45 - 10) \times 35 = 1225$ ECU.

- There will be 10 rounds. Your earnings from all rounds are added up.
- You will stay in the same market, with the same firms, in every round.
- The decision screen has a calculator to try out combinations before deciding.
- At the end of each round you will see the price, your earnings and the total production of the other firms.
- Amounts are in ECU (experimental currency units). There is no cash payment.

Continue

Powered by [oTree](#)

Figure 3.2: Instructions: price, cost, profit, and a numerical example.

The example uses 35 own units and 50 from the others ($Q = 85$, $P = 45$, profit 1225 ECU). These numbers match no theoretical benchmark for 1 to 4 firms, so the example does not work as an anchor. Under monopoly the example is 50 units ($P = 80$, profit 3500 ECU). The check asks for the price and the profit in that same case; after a mistake it restates the rule and lets the participant try again. The number of attempts is recorded in the data.

Tecnológico de Monterrey | BEER

Before you start

Round 1 of 10

Answer based on the instructions.

If you produce 35 and the other firms produce 50 in total, what is the price?

☐ 45 ☐ 80 ☐ 85 ☐ 95

In that same case, what are your earnings?

☐ 1050 ECU ☐ 1225 ECU ☐ 1400 ECU ☐ 1575 ECU

Check

Powered by gTree

Figure 3.3: Comprehension check.

Tecnológico de Monterrey | BEER

Por favor corrija los errores.

Before you start

Round 1 of 10

Answer based on the instructions.

If you produce 35 and the other firms produce 50 in total, what is the price?

☐ 45 ☐ 80 ☐ 85 ☐ 95

Check the price: 130 minus total production.

In that same case, what are your earnings?

☐ 1050 ECU ☐ 1225 ECU ☐ 1400 ECU ☐ 1575 ECU

Check

Powered by gTree

Figure 3.4: Wrong answer: the message restates the rule without giving the answer.

3.3 Decision, waiting, and result

The decision is simultaneous and private. Students type the quantity or use the slider. The **calculator** lets them try combinations of “my firm produces” and “the other firms produce in

total” and shows price and profit; it records nothing. Sliders start at 0 and the decision box starts empty, so no value is suggested.

Your production decision Round 1 of 10

This round there are 2 firms in your market.

Units your firm will produce (0 to 100)

The price depends on the total production in the market (the sum over all firms): **price = 130 - total production**.
The price is never below 0. Producing each unit costs 10 ECU.

Calculator
Try out combinations. The calculator does not record any decision.

If my firm produces 25

and the other firms produce in total 45

Price: **60** My earnings: **1250** ECU

Confirm production

Powered by oTree

Figure 3.5: Production decision with calculator.

After confirming, the screen waits for the other firms in the market.

Please wait

Waiting for the decisions of the other firms in your market. Please keep this page open.

Figure 3.6: Waiting for the market.

What participants will see

“Please wait” means that other firms in the same market have not decided yet. It is not an error. Participants should not close or reload the page.

The result shows own output, the other firms’ output (as a total), total output, price, the round’s profit, and cumulative profit. In later rounds the decision screen includes the history.

Round result

Round 1 of 10

Your production

35

Production of the other firms

30

Total production

65

Price

65

Your earnings

1925 ECU

Cumulative earnings

1925 ECU

Next round

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Figure 3.7: Round result.

Your production decision

Round 4 of 10

This round there are 2 firms in your market.

Units your firm will produce (0 to 100)

The price depends on the total production in the market (the sum over all firms): $\text{price} = 130 - \text{total production}$.
 The price is never below 0. Producing each unit costs 10 ECU.

Calculator

Try out combinations. The calculator does not record any decision.

If my firm produces

0

and the other firms produce in total

0

Price: 130 My earnings: 0 ECU

Confirm production

Previous rounds

Round	Your production	Other firms	Total production	Price	Your earnings
1	35	30	65	65	1925
2	38	30	68	62	1976
3	40	30	70	60	2000

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Figure 3.8: Decision in round 4, with the history of previous rounds.

End of the activity

Round 10 of 10

Your total earnings

19432 ECU

Round	Your production	Other firms	Total production	Price	Your earnings
1	35	30	65	65	1925
2	38	30	68	62	1976
3	40	30	70	60	2000
4	42	32	74	56	1932
5	40	30	70	60	2000
6	41	30	71	59	2009
7	40	34	74	56	1840
8	40	30	70	60	2000
9	39	31	70	60	1950
10	45	35	80	50	1800

Thank you for participating. Please wait for your instructor.

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Figure 3.9: End screen: total profit and the instruction to wait for the instructor.

Instructor report and debrief

4.1 When to reveal

Report is a tab of the session page: reach it from the room with **Monitor the session**, or from **Sessions** if the session is over. It opens with results hidden. At the top it shows participants, markets, completed rounds, and markets still pending in the current round, so you can project it from the start without giving anything away. Click **Show results** when pending markets reach zero; **Refresh** adds new rounds and **Hide results** covers them again.



Figure 4.1: Report with results hidden and the progress counters.

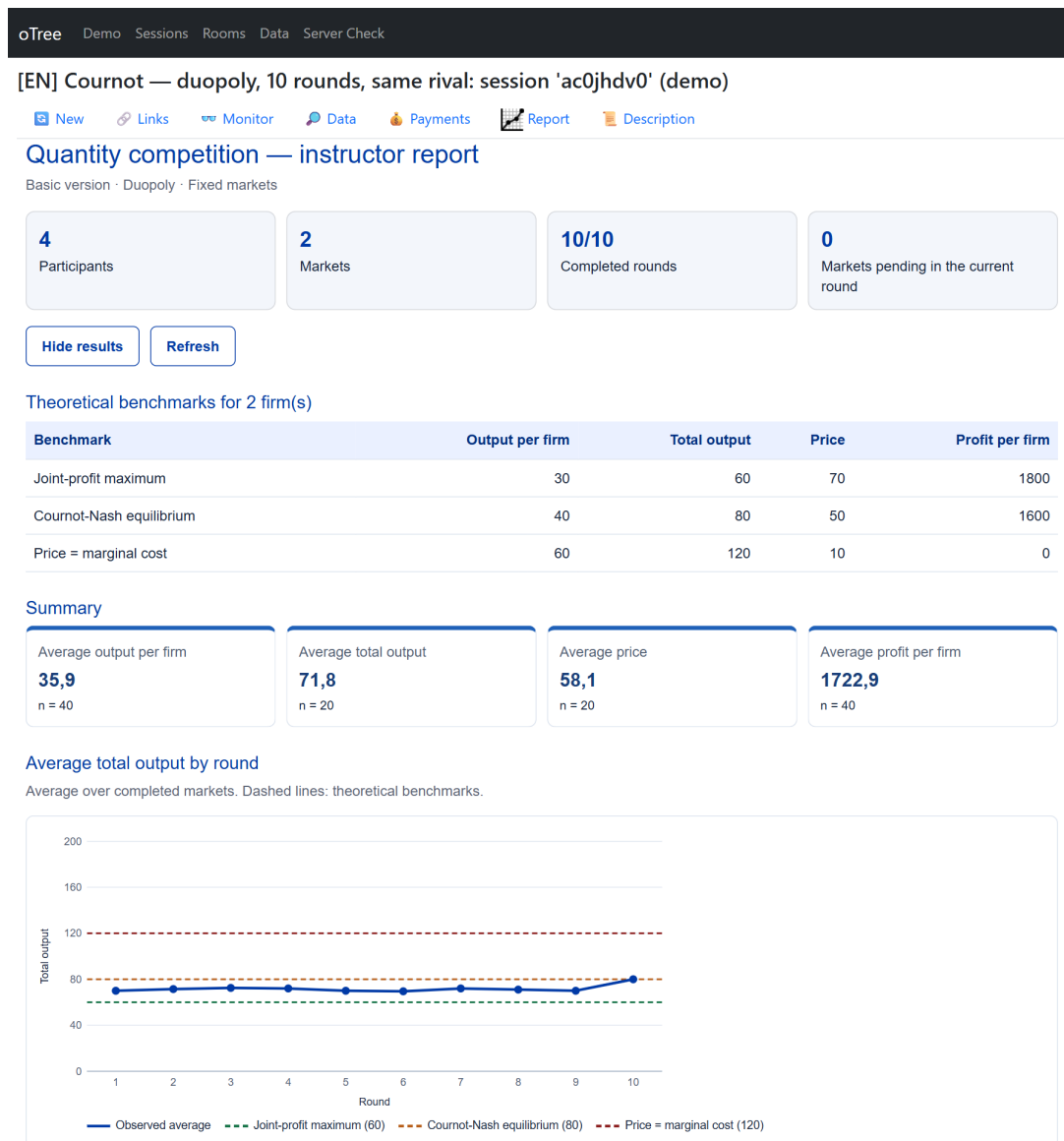


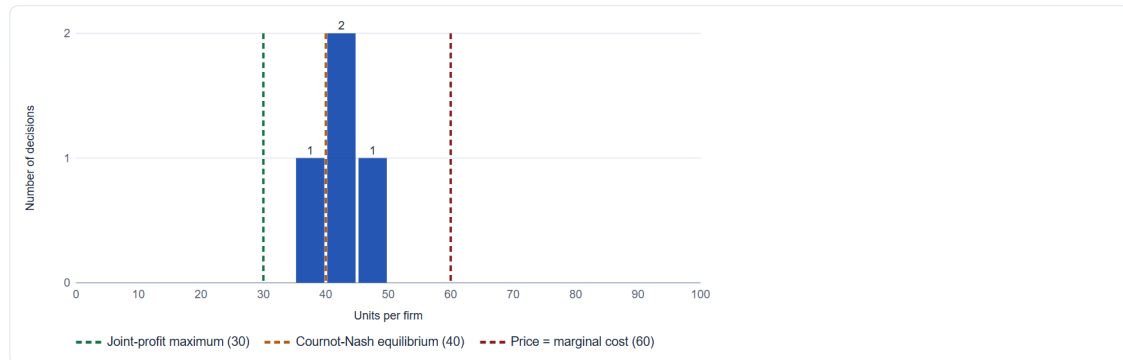
Figure 4.2: Revealed report: benchmarks, summary, and path of total output (simulated decisions).

Early rounds versus late rounds (total output)

	Average total output
Rounds 1–3	71,3
Rounds 8–10	73,7

Distribution of output per firm

Decisions in the last completed round.



Markets in the last completed round (Round 10)

Market	Firms	Units per firm	Total output	Price
Market 1	2	40 + 40	80	50
Market 2	2	45 + 35	80	50

Individual data: Data → Custom export (cournot). Chat messages: Data → Chat.

Figure 4.3: Revealed report: early versus late rounds, histogram, and table of markets (simulated decisions).

4.2 How to read the report

1. Start with the number of complete markets. Averages and charts use only markets of the configured size, because the benchmarks depend on n ; markets with an extra firm appear in the final table and in a notice.
2. Compare average total output with the three lines: joint-profit maximum, Cournot-Nash, and price equal to marginal cost.
3. Over several rounds, look at the path and at the early-versus-late table before talking about learning.
4. The histogram (last completed round, or the only round) shows the heterogeneity the average hides: some firms near the collusive quantity, others near or above Nash.
5. The table of markets shows combinations such as “30 + 45”: useful for discussing who “breaks” a tacit agreement, without identifying anyone.

Debrief script

Ask first what the class expected. Then reveal the path and the histogram. Ask those who produced little and those who produced a lot to explain their reasoning, without singling anyone out. Finish by computing the best response and the equilibrium together on the board.

Theory and evidence

5.1 Theoretical benchmarks

Theoretical foundation

With n symmetric firms, $a = 130$, and $c = 10$, firm i maximizes $(130 - q_i - Q_{-i} - 10) q_i$. The first-order condition gives the *best response* $q_i = (120 - Q_{-i})/2$. In the symmetric Cournot-Nash equilibrium, $q^N = 120/(n+1)$. The joint-profit maximum requires $Q = 60$, that is $q^M = 60/n$, and the competitive outcome ($P = 10$) requires $Q = 120$, that is $q^C = 120/n$.

n	Joint-profit max.		Cournot-Nash		$P = MC$
	$q / Q / P$	π	$q / Q / P$	π	
1	60 / 60 / 70	3600	= monopoly	3600	120 / 120*
2	30 / 60 / 70	1800	40 / 80 / 50	1600	60 / 120
3	20 / 60 / 70	1200	30 / 90 / 40	900	40 / 120
4	15 / 60 / 70	900	24 / 96 / 34	576	30 / 120

*Unreachable with the 100-unit cap; in practice the monopoly has no such benchmark.

All benchmarks are integers for $n = 1, \dots, 4$. The 100-unit cap keeps the monopoly quantity (60) inside the range, so choosing the maximum does not “hit” it by accident.

The duopoly illustrates the dilemma: if both firms produce 30, each earns 1800 ECU; but if the rival produces 30, the best response is 45, with profit 2025 ECU. Producing 30 is not a best response, which is why the agreement is unstable in a one-shot interaction.

5.2 Experimental evidence

Quantity-setting oligopoly experiments have a long tradition. [Holt \(1985\)](#) rejects the consistent-conjectures hypothesis in laboratory duopolies and finds outputs close to Cournot, with some tacit agreements when pairs are repeated. [Holt \(1995\)](#) and [Potters and Suetens \(2013\)](#) survey the literature; the meta-analysis by [Engel \(2007\)](#) documents that collusion decreases with the number of firms.

[Huck et al. \(2004\)](#) compare markets of 2 to 5 firms: tacit collusion occasionally appears in duopolies and is rare with three or more firms; with four or more, output tends to match or exceed the Nash

level. Their title sums up the result: “two are few and four are many.”

Information matters too. When each firm sees each rival’s output and profit, imitating the most successful firm pushes the market toward outcomes more competitive than Nash ([Vega-Redondo, 1997](#); [Huck et al., 1999](#); [Offerman et al., 2002](#)).

5.3 Regularities worth discussing

- In duopolies, total output usually lies between the joint-profit maximum (60) and Nash (80), with much heterogeneity across markets.
- With fixed pairs and several rounds, attempts at tacit agreements appear; with a reassigned rival they are harder to sustain.
- As the number of firms rises, total output approaches or exceeds Nash, and the price falls.
- Early rounds are noisy; the comparison with the last rounds shows whether the market settles down.

Attention

The results of one class are descriptive. Without random assignment across treatments, enough markets, and a research protocol, a difference between two sessions does not estimate a causal effect. Over ten rounds, decisions within the same market are not independent observations.

Baseline modes

The three baseline modes are duopolies with a calculator and aggregate feedback (each firm sees the other firms' total output, not each firm's).

6.1 One round

`cournot_en_1_round` removes strategic history. It suits an introduction to best responses and Nash equilibrium in a short class. The histogram includes all decisions.

6.2 Ten rounds with the same rival

`cournot_en_10_fixed_partner` keeps markets fixed for all ten rounds. It supports a discussion of tacit collusion, signaling through the quantity produced, and punishment (producing more after the rival “breaks” the agreement). Do not announce aggregate results between rounds.

6.3 Ten rounds with a reassigned rival

`cournot_en_10_random_partners` forms new random markets every round. It reduces the scope for reputation and punishment within a pair; compare it with the fixed-rival mode to discuss why repetition with the same people makes cooperation easier.

Extended variants

7.1 Map of treatments

All variants last ten rounds and use the same market ($P = 130 - Q$, cost 10, $q \in [0, 100]$).

Variant	What changes	Teaching question
Monopoly	$n = 1$	Do students find the monopoly optimum without rivals?
Three firms	$n = 3$	How does the outcome change with the number of firms?
Four firms	$n = 4$	“Two are few and four are many”?
Four firms, reassigned markets	$n = 4$, new markets every round	Is there any room left for tacit collusion without a repeated relationship?
Communication	Duopoly with a 60-second chat before each round	Do explicit cartels form? Are they stable?
No calculator	Duopoly without the calculator	How much does a tool for computing the best response help?
Each rival’s information	$n = 4$; at the end of each round each rival’s quantity and profit are shown	Do firms imitate the most successful firm?

7.2 Monopoly

Each participant is the only firm in their market: the instruction reads “price = 130– your production.” There is no waiting and no interaction. The benchmark is $q = 60$, $P = 70$, profit 3600 ECU. It is useful as a baseline before the duopoly or to check that the class masters the condition “marginal revenue equals marginal cost.”

Your production decision

Round 1 of 10

Units your firm will produce (0 to 100)

The price depends on how much you produce: $\text{price} = 130 - \text{your production}$. The price is never below 0.
Producing each unit costs 10 ECU.

Calculator

Try out combinations. The calculator does not record any decision.

If my firm produces

50

Price: 80 My earnings: 3500 ECU

Confirm production

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Figure 7.1: Monopoly: the calculator only has own output.

Debrief script

Compare the distribution of q with 60. If there is dispersion, ask how students searched for the maximum: by trying values on the calculator or by computing?

7.3 Three and four firms

Markets have 3 or 4 firms; the instructions and the decision screen state the size. Per-firm benchmarks change (table in Chapter 4), but the joint-profit total output is still 60. The variant with reassigned markets forms new markets every round.

Debrief script

Project the path of Q next to that of a duopoly session, if you have one. Ask why coordination is harder with more firms: more people to convince, a smaller weight of each firm on the price, and a greater temptation to produce more.

7.4 Communication

Before each decision, the firms in a market can write to each other for 60 seconds in an anonymous chat ("Firm 1", "Firm 2"). What is written binds no one. The evidence shows that communication facilitates collusion in experimental oligopolies (Waichman et al., 2014; Fonseca and Normann, 2012).

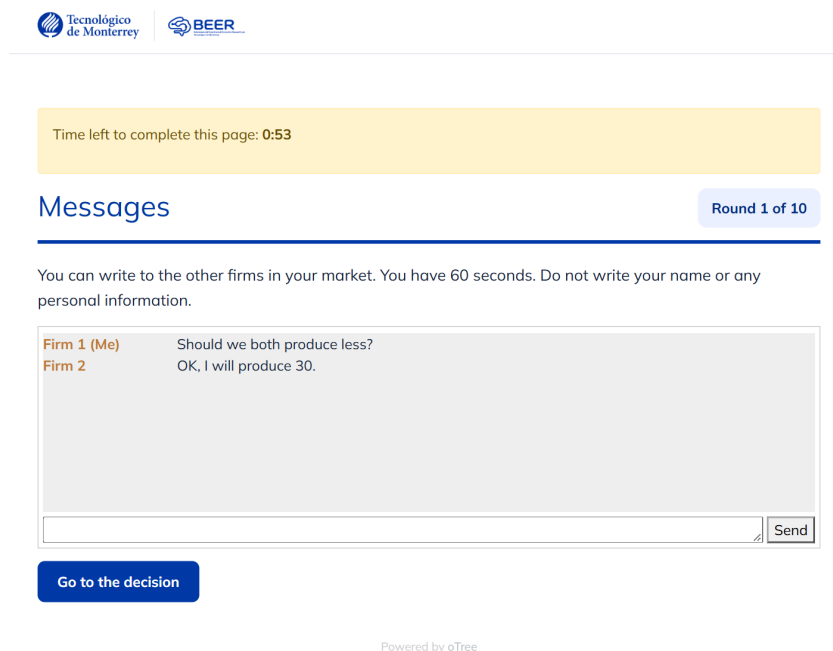


Figure 7.2: Chat before the decision (demonstration messages).

Debrief script

Compare total output with the duopoly without chat. Then read aloud, without identifying markets, some agreements and whether they were kept (**Data** → **Chat**). Connect this to competition policy: why the law targets communication between competitors and not only high prices.

7.5 No calculator

A duopoly identical to the baseline, but the decision screen has no calculator. [Requate and Waichman \(2011\)](#) find that presenting the information as a profit table or as a profit calculator yields indistinguishable outcomes, whereas adding a best-response option moves output toward Cournot and reduces tacit collusion. This variant compares a simple calculator with no aid at all; the direction of the effect in your class is an open question.

Debrief script

Ask how students decided without a tool. If dispersion is larger than in the duopoly with a calculator, discuss computation costs and bounded rationality.

7.6 Each rival's information

Four-firm markets. At the end of each round each participant sees, in addition to the price, the output and the profit of each firm in their market. In the other configurations they see only the other firms' total output.

Round result

Round 1 of 10

Your production

20

Production of the other firms

71

Total production

91

Price

39

Your earnings

580 ECU

Cumulative earnings

580 ECU

Firms in your market

Firm	Your production	Your earnings
Firm 1	24	696
Firm 2 (your firm)	20	580
Firm 3	25	725
Firm 4	22	638

Next round

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Figure 7.3: Result with each firm's quantity and profit in the market.

With this information, copying the firm that earned the most in the previous round is a simple rule. In Cournot all firms in a market sell at the same price; if that price exceeds cost, the firm that produces the most earns the most, so imitation pushes toward high outputs and, in the limit, toward the competitive outcome ([Vega-Redondo, 1997](#); [Huck et al., 1999](#)).

Debrief script

Compare the path with the four-firm variant without this information. Ask: did anyone copy whoever earned the most? Why does that rule lead to producing more than is good for the group?

Class plan and interpretation

8.1 Suggested 50-minute session

0–5 min	Access to the room, lab rules, and formation of markets.
5–12 min	Instructions, example, and comprehension check.
12–30 min	Ten decision rounds. Do not reveal the report between rounds.
30–33 min	Class predictions: optimal joint output and equilibrium output.
33–43 min	Path, histogram, and table of markets.
43–48 min	Best response and equilibrium on the board; published evidence.
48–50 min	Applications: cartels, mergers, number of competitors, and competition policy.

8.2 Questions to guide the discussion

1. What total output maximizes joint profit? Why does no firm want to stay there on its own?
2. If your rival produces 30, how much should you produce? And if it produces 40?
3. Which observed output looks most like Cournot-Nash? Which markets came close to collusion?
4. Did behavior change with repetition? Were there “punishments” after a round of high output?
5. What would happen to the price if more firms entered the market?
6. Which real markets resemble this game: oil, cement, airlines on a route?

8.3 Common misreadings

Hasty reading	Correction
Producing little is irrational.	It can be an attempt at tacit collusion in expectation of reciprocity, especially with a fixed rival.
The equilibrium maximizes profits.	The Cournot-Nash equilibrium does not maximize joint profit; it is stable because no one gains by deviating alone.
More firms lower the price because they are more efficient.	The cost is the same; the price falls because each firm internalizes a smaller share of its output’s effect on the price.

Hasty reading	Correction
The average describes every market.	Look at the histogram and the table: collusive and competitive markets usually coexist.
A difference between two classes is causal.	That requires comparable assignment and enough independent markets.

Operations, privacy, and troubleshooting

9.1 Privacy and conduct

- Do not ask for names, student IDs, or demographic information during this activity.
- Project the aggregate report. Keep codes, markets, and individual screens private.
- Ask students not to write personal information in the chat; the screen itself reminds them.
- Do not use the session to grade anyone for their decision.
- Treat the session as a teaching activity unless there is a research protocol with specific consent.

9.2 Common problems

Situation	Action
I opened <code>teaching.beer-lab.org</code> and cannot find how to create the session	That is the students' page. Use <code>teaching-admin.beer-lab.org</code> → Open panel .
The panel asks for a username and password	Username admin and the lab's password. If you do not have it, write to <code>lab.economia@servicios.tec.mx</code> .
"Por favor espere" before starting	You have not created the session in that room yet, or the student opened another room (other language or edition). Once you create it, they enter automatically.
"Please wait" for a long time during the game	Check Monitor : a firm in the market is missing. Ask them to reopen the room in the same browser; if they cannot, use Advance slowest participants (that firm is recorded with 0 units for the round).
"La sesión está llena" (session full)	More students joined than were declared. Before starting: Close this room , a new session with the right number, and everyone opens the link again.
A market never completes	More participants were declared than joined. Close the room and create a new session with the right number.
A market has one extra firm	This happens when the class is not a multiple of the market size. It is intentional: the instructions announce it and the report sets those markets apart.
Several tabs of one browser are the same participant	Normal with the room link. To rehearse, use Demo .
Not Found on a <code>/p/...</code> link	The individual link belongs to an earlier session. Share the room again (link or QR code), not the individual link.
I want to see a session from another day	Panel → Sessions → the session → Report or Data .
Report without data	There are no complete markets in the round yet. Wait and click Refresh .
Negative profits	They occur if total output exceeds 120 ($P < 10$). They are part of the game; ECU are not converted into money.

9.3 Data for later analysis

Data → **Custom export (cournot)** provides one row per participant and round: session, anonymous code, round, language, edition, treatment, configured number of firms, matching type, chat, calculator, feedback, market, actual market size, firm number, quantity, other firms' output, total output, price, profit, and attempts on the comprehension check. Chat messages are in **Data** → **Chat**. Treat repeated decisions within a market as dependent.

Annotated bibliography

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- [Holt \(1995\)](#): classic survey of industrial organization experiments.
- [Huck et al. \(1999\)](#): information about rivals, imitation, and learning in Cournot.
- [Huck et al. \(2004\)](#): number of firms and collusion (“two are few and four are many”).
- [Engel \(2007\)](#): meta-analysis of collusion in oligopoly experiments.
- [Requate and Waichman \(2011\)](#): profit table, calculator, and best-response option.
- [Potters and Suetens \(2013\)](#): survey of recent oligopoly experiments.
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Room QR codes

Project or print the page of the room you will use. Students scan it with their phone camera and click **Start** (**Comenzar** in the Spanish rooms).

Quantity Competition

English room



`cournot.beer-lab.org/room/cournot_en`

Scan the code and press **Start**.

Quantity Competition

English room, extended version



`cournot.beer-lab.org/room/cournot_extended`

Scan the code and press **Start**.

Quantity Competition

Sala en español



`cournot.beer-lab.org/room/cournot_es`

Escanee el código y pulse **Comenzar**.

Quantity Competition

Sala en español, versión extendida



`cournot.beer-lab.org/room/cournot_extendido`

Escanee el código y pulse **Comenzar**.