



Teacher guide to the price competition game (Bertrand)

Laboratory implementation, theoretical foundations,
experimental evidence, and variants

Behavioral and Experimental Economics Research Lab
Department of Economics



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

How to use this guide

This guide helps you prepare, run and discuss in class the **price competition game (Bertrand)** 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 game deliberately uses the same market as the lab's quantity competition game (Cournot): same demand, same cost and same configurations. Only the choice variable changes. A class that has already played Cournot can therefore play Bertrand and compare both outcomes with the same numbers.

The **quick implementation guide** gets a session running. The operational chapters explain each 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 in them 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.

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Quick implementation guide

1.1 Fact sheet

Purpose	Contrast two benchmarks —maximum joint profit (the monopoly price) and the Bertrand equilibrium (price equal to marginal cost)—, show that two firms are enough to reach the latter, and compare it with Cournot in the same market.
Participants	Any number. Markets of the configured size are formed; leftover participants join the first markets (31 students in duopoly: 14 markets of 2 and one of 3).
Market	Quantity demanded $Q = \max(0, 130 - p_{\min})$, where $p_{\min}$ is the lowest price in the market; marginal cost 10 ECU, no fixed costs.
Decision	Each firm chooses, simultaneously and privately, a whole-number price p_i between 0 and 130.
Allocation	The firm with the lowest price sells the whole quantity Q ; if k firms tie for the lowest price, each sells Q/k . The others sell nothing.
Profit	$\pi_i = (p_i - 10) \times \text{quantity sold}$ ECU. It is 0 when the firm sells nothing and negative when it sells at a price below 10.
Duration	15–20 minutes for one round; 30–40 for ten rounds or an extended variant, not counting the discussion.
Instructor (you)	teaching-admin.beer-lab.org/en → the game's card → Open panel . It asks for a username and password (section 2.1).
Students	The room link bertrand.beer-lab.org/room/bertrand_en , its QR code (section 2.5) or teaching.beer-lab.org .
Report	Theoretical benchmarks, average posted price, average lowest price, average total output and profit, lowest price by round, early versus late rounds, price histogram and an anonymous table of markets.

Attention

There are two different pages. **teaching-admin.beer-lab.org** is yours: from there you enter 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 access to the panel from lab.economia@servicios.tec.mx, stating the game, course, number of students and date. You will receive the password for the username **admin**.
2. Open teaching-admin.beer-lab.org/en, find **Price Competition (Bertrand)** and click **Open panel**. Enter the username and password.
3. Rehearse in **Demo**: open a configuration and play it in two or three 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] Price Competition** (or the extended one). Choose the configuration, enter the *exact* number of students under **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**: this opens the session page, with the tabs **Monitor** (progress) and **Report**. When play is over, open **Report**, click **Show results** and lead the discussion.

After class

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

1.3 Checklist

- ☐ Panel password received and tested at bertrand.beer-lab.org/login.
- ☐ Rehearsal done in **Demo**.
- ☐ Devices, internet, browser and projector ready.
- ☐ Mode or variant chosen according to the question for 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.
- ☐ Made clear that ECU are experimental units and that there is no cash payment.
- ☐ Monitor and report open; theoretical benchmarks worked out before revealing results.
- ☐ If you will compare with Cournot, results from that session at hand (same market size).

Accessing the platform

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

The page for instructors is teaching-admin.beer-lab.org/en. It does not appear 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.

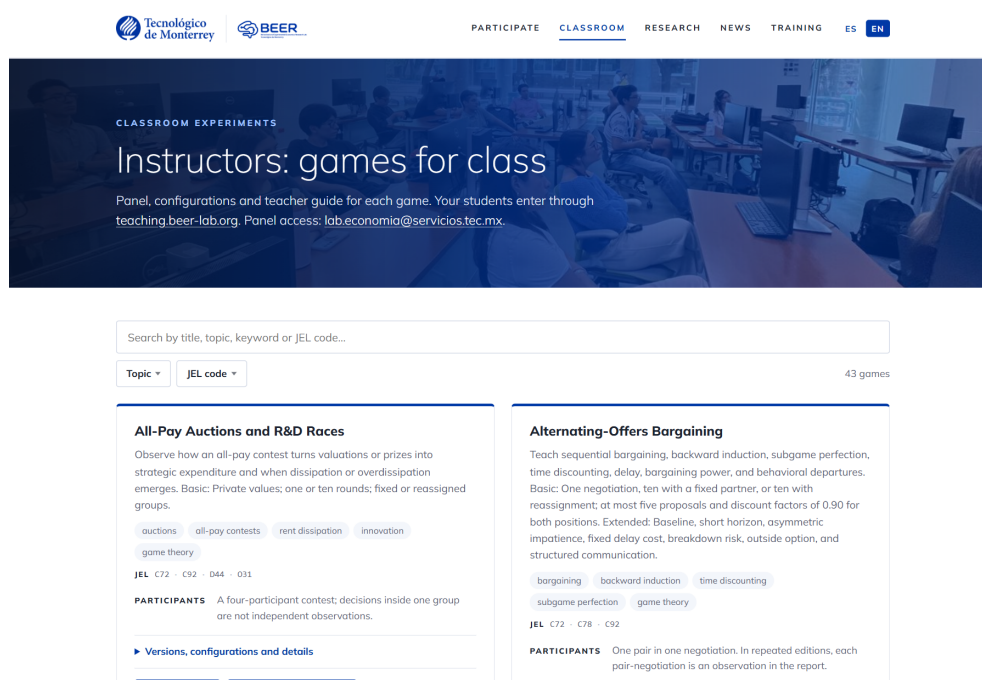


Figure 2.1: Page for instructors: [teaching-admin.beer-lab.org](https://teaching-admin.beer-lab.org/en).

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

Price Competition (Bertrand)

Cournot's twin on the same market (demand $130 - p$, unit cost 10): each firm posts a price and all demand goes to the cheapest one.

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
price competition
Bertrand paradox
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. Same design as Cournot so both can run in parallel.

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 page for instructors.

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

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

Figure 2.3: The game's rooms in the expanded card.

The game's panel (<https://bertrand.beer-lab.org>) is protected. **Open panel** shows the **Admin Login** screen: type **admin** under **Username** and the password the lab gave you under **Password**. If you do not have it, ask 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 admin interface. These are the only terms you need:

Demo	Practice sessions. 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 in 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 screen each participant is on. It does not show decisions.
Advance slowest participants	Monitor button that moves forward whoever has fallen behind. In this game it has a cost: read section 2.4 before using it.
Report	The instructor report for projecting aggregate results.
Data	Data download in CSV.
Sessions	List of all your sessions, to go back to an earlier one.
Close this room	Frees the room when you finish, 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] Bertrand — duopolio, una ronda
[ES] Bertrand — duopolio, 10 rondas, misma empresa rival
[ES] Bertrand — duopolio, 10 rondas, rival reasignado
[EN] Bertrand — duopoly, one round
[EN] Bertrand — duopoly, 10 rounds, same rival
[EN] Bertrand — duopoly, 10 rounds, reassigned rival
[ES] Bertrand extendido — monopolio, 10 rondas
[ES] Bertrand extendido — tres empresas, 10 rondas
[ES] Bertrand extendido — cuatro empresas, 10 rondas
[ES] Bertrand extendido — cuatro empresas, 10 rondas, mercados reasignados
[ES] Bertrand extendido — duopolio con chat, 10 rondas
[ES] Bertrand extendido — duopolio sin calculadora, 10 rondas
[ES] Bertrand extendido — cuatro empresas, información de cada rival, 10 rondas
[EN] Bertrand extended — monopoly, 10 rounds
[EN] Bertrand extended — three firms, 10 rounds
[EN] Bertrand extended — four firms, 10 rounds
[EN] Bertrand extended — four firms, 10 rounds, reassigned markets
[EN] Bertrand extended — duopoly with chat, 10 rounds
[EN] Bertrand extended — duopoly without calculator, 10 rounds
[EN] Bertrand extended — four firms, each rival shown, 10 rounds

Juegos de mercados / Market games — BEER Lab

Competencia en precios (Bertrand) / Price competition (Bertrand)

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

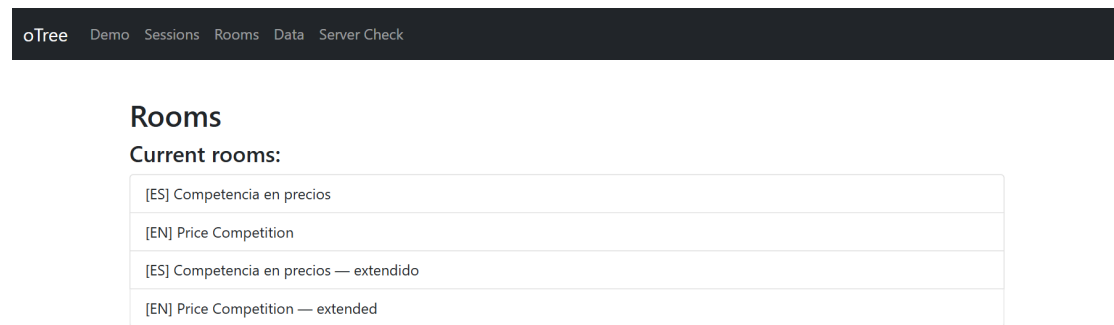


Figure 2.6: Rooms: the game's four rooms.

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 if you were each student; then open **Report**. These sessions do not affect your classes.

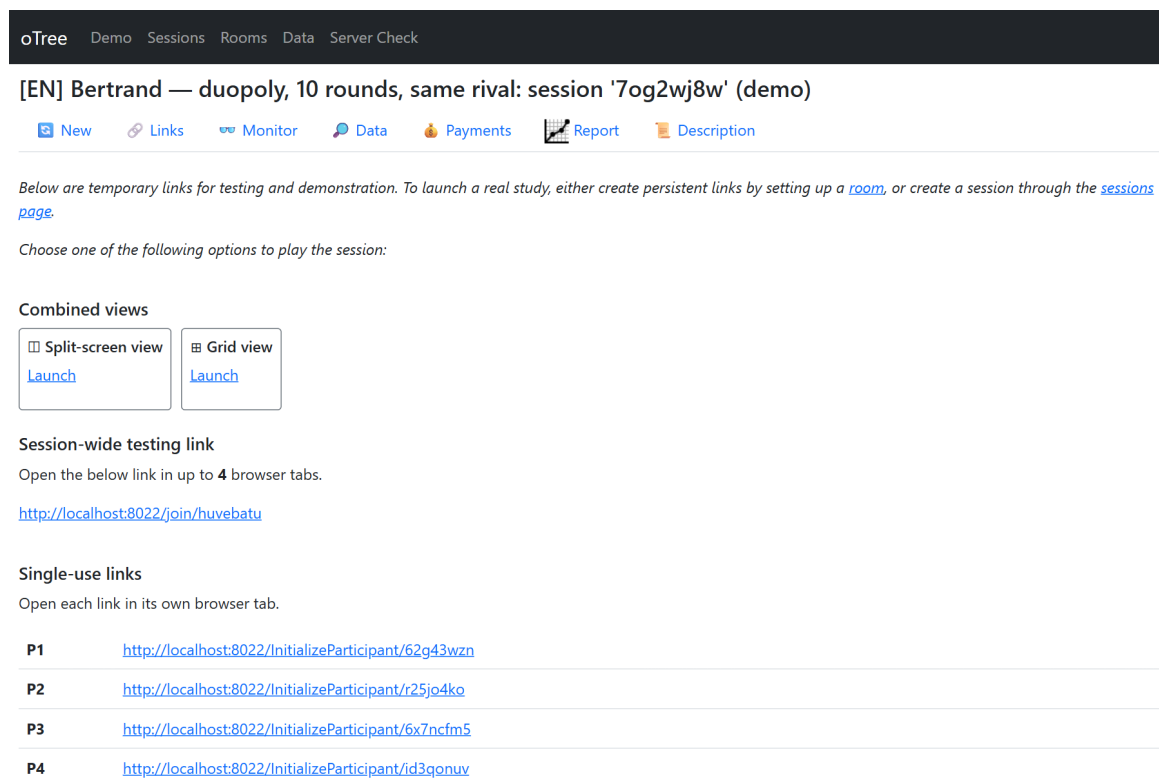


Figure 2.7: Links of a practice session. The screenshots in this guide were taken on a local copy, which is why the addresses read `localhost`; on the server they read `bertrand.beer-lab.org`.

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 under **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] Price 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] Bertrand — duopoly, one round". Underneath, there is a "Number of participants" section with a text input field and a note "Must be a multiple of 1". A blue "Create" button is located below the input field. At the bottom, there is a link "Configure session" with a gear icon, and the text "App sequence" is visible.

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

The room then shows that a session is taking place, 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] Price Competition". A light green box contains the text: "Session 8vduyugn 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." Underneath, 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:8022/room/bertrand_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 will see a message in Spanish, even in the English rooms: “La sesión está llena” (the session is full). In that case, before starting, click **Close this room**, create another session with the correct number and ask everyone to open the link or the QR code again.

If a student disconnects midway, their market stops at the waiting page, because there is no time limit for deciding. Ask the student to reopen the room in the same browser: they resume where they were. If that is not possible, you can use **Advance slowest participants** in the Monitor, but know the consequence: the advanced firm is recorded with a **price of 0**. At price 0 it has the lowest price, sells all 130 units and loses 1300 ECU $((0 - 10) \times 130)$; its rivals sell nothing and earn 0 that round. That market enters the report's averages with lowest price 0 and quantity 130, which drags the average lowest price down. Each click advances a single page, so it has to be repeated every round. If the absence happens at the start, it is usually better to close the room and create a new session with the correct number.

ID	Code	Label	Progress	App	Round	PageName	Waiting	WaitsFor	Since
P1	62g43wzn		44/90	bertrand	5	RoundResult			1m
P2	i25jp4ko		44/90	bertrand	5	RoundResult			1m
P3	6x7nclm5		44/90	bertrand	5	RoundResult			1m
P4	id3gonuv		44/90	bertrand	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; the browser on their phone or computer is enough. They have three routes, all leading to the same room:

1. **QR code.** Project the one for the room you will use (below, and full size in appendix A). Students scan it with their phone camera.
2. **Room link.** Share it in the class chat or on Canvas: https://bertrand.beer-lab.org/room/bertrand_en.
3. **Catalogue.** At teaching.beer-lab.org they find **Price Competition (Bertrand)** and click their language's button (**English**, or **English · extended** if they tick **Show extended version**).



English, basic

bertrand.beer-lab.org/room/bertrand_en



English, extended

bertrand.beer-lab.org/room/bertrand_extended



Español, básica

bertrand.beer-lab.org/room/bertrand_es



Español, extendida

bertrand.beer-lab.org/room/bertrand_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”, please wait) and lets them in automatically as soon as you create it; so you can share the link or the QR code from the start of class. They need no email or password: they receive an anonymous code.

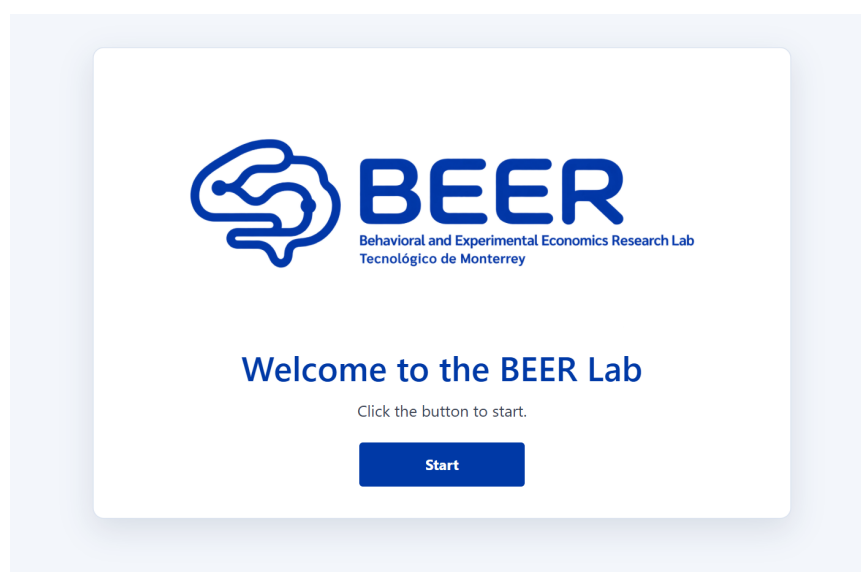


Figure 2.11: The room a student opens.

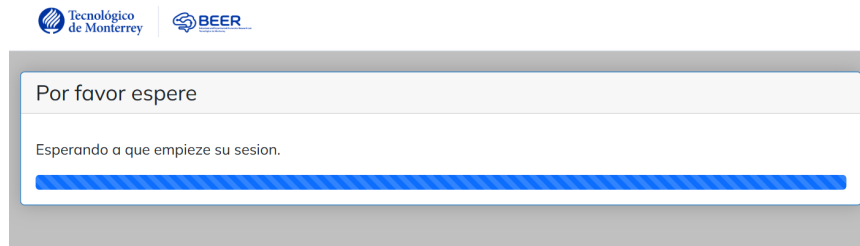


Figure 2.12: Student waiting page if the session does not exist yet; oTree shows it in Spanish in every room (“Por favor espere”: please wait; the text below says the session has not started yet).

Language is set per room: a session created in the English room only admits students who join through the English room. If your group is mixed, choose one language for everyone.

Price Competition (Bertrand)

Cournot's twin on the same market (demand $130 - p$, unit cost 10):
each firm posts a price and all demand goes to the cheapest one.
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
price competition
Bertrand paradox
collusion

industrial organization

JEL C72 · C92 · D43 · L13

Address: bertrand.beer-lab.org

Español

English

Español · extendido

English · extended

☒ Show extended version

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 posts a whole-number price, $p_i \in \{0, 1, \dots, 130\}$. All the demand goes to the firm with the lowest price:

$$Q = \max(0, 130 - p_{\min}), \quad \pi_i = (p_i - 10) q_i,$$

$$q_i = \begin{cases} Q/k & \text{if } p_i = p_{\min} \text{ (} k \text{ firms tied),} \\ 0 & \text{if } p_i > p_{\min}. \end{cases}$$

Pricing a single ECU below the rival turns selling nothing into selling everything. That discontinuity is what sets this game apart from Cournot: in Cournot, producing a little more changes profit a little; here, charging a little less can double it.

For the instructor

Before playing, ask for two predictions: which price maximizes the market's *joint* profit?, and which price would each firm choose if it believes the rival will charge 70? The second answer (69), and what happens when it is repeated, structure the discussion.

3.2 Cover page, instructions and comprehension

The cover page introduces the BEER Lab and the rules of conduct. The participant confirms having read them. The instructions describe only the action: they do not mention “Bertrand”, “Nash” or “collusion”, nor do they suggest which price to choose.



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: each one posts a price at the same time, without knowing what the other posts. All the demand in the market goes to the firm (or firms) with the lowest price. If two or more tie for the lowest price, they split the demand equally. The other firms sell nothing.

Price, quantity and earnings

If you have the lowest price, how much the market sells depends on that price: **total market quantity = $\max(0, 130 - \text{lowest price})$** , split equally if there is a tie. If your price is not the lowest, you sell nothing.

Producing each unit costs 10 ECU.

Your earnings = (your price – 10) × the quantity you sell. If you sell nothing, your earnings are 0.

Example: if you charge 55 and the lowest price among the other firms is 80 (higher than yours), you have the lowest price: you sell 75 units and earn 3375 ECU. But if you charge 80 and another firm charges 55 (lower than yours), you do not have the lowest price: you sell nothing and your earnings are 0.

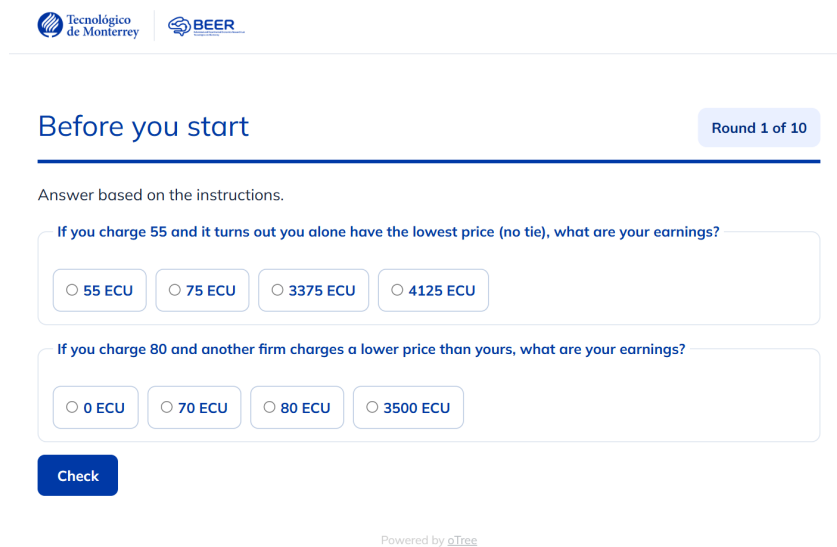
- There will be 10 rounds. Your earnings from all rounds are added up.
- You will stay in the same market, with the same firms, in every round.
- The decision screen has a calculator to try out prices before deciding.
- At the end of each round you will see the lowest price in the market, whether your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

Continue

Powered by [oTree](#)

Figure 3.2: Instructions: lowest-price rule, cost, earnings and a numerical example.

The example has two parts: with price 55 and a rival at 80, the firm has the lowest price, sells $130 - 55 = 75$ units and earns $(55 - 10) \times 75 = 3375$ ECU; with price 80 and a rival at 55, it sells nothing and earns 0. Neither 55 nor 80 coincides with the theoretical benchmarks (70 and 10), so the example does not act as an anchor. The check asks for the earnings in those two cases. The wrong options correspond to typical mistakes: confusing profit with revenue ($55 \times 75 = 4125$), with the price or with the quantity; and believing that a firm without the lowest price still sells ($70 \times 50 = 3500$). After a mistake, the screen restates the rule and allows another attempt. 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 charge 55 and it turns out you alone have the lowest price (no tie), what are your earnings?

☐ 55 ECU
 ☐ 75 ECU
 ☐ 3375 ECU
 ☐ 4125 ECU

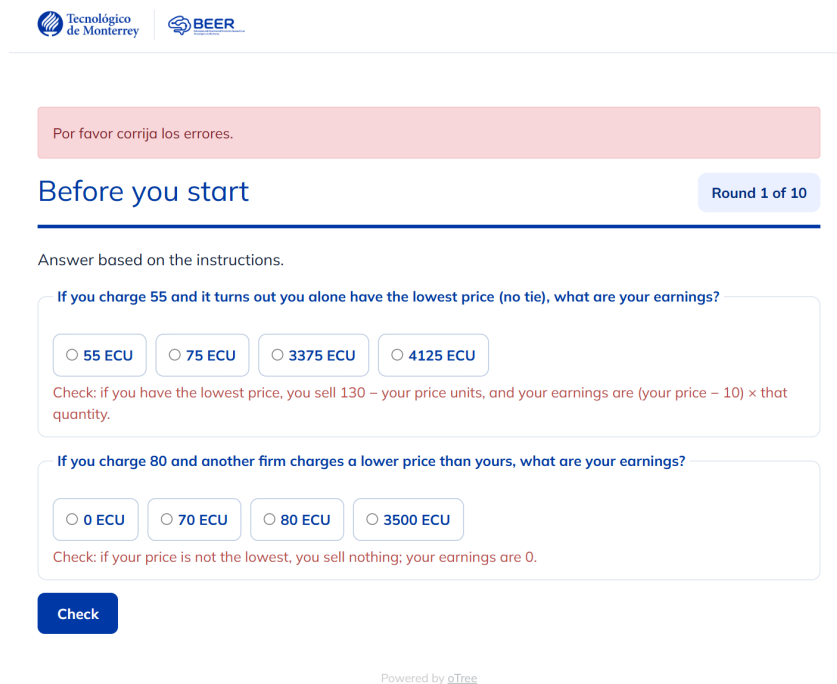
If you charge 80 and another firm charges a lower price than yours, what are your earnings?

☐ 0 ECU
 ☐ 70 ECU
 ☐ 80 ECU
 ☐ 3500 ECU

Check

Powered by oTree

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 charge 55 and it turns out you alone have the lowest price (no tie), what are your earnings?

☐ 55 ECU
 ☐ 75 ECU
 ☐ 3375 ECU
 ☐ 4125 ECU

Check: if you have the lowest price, you sell $130 - \text{your price}$ units, and your earnings are $(\text{your price} - 10) \times \text{that quantity}$.

If you charge 80 and another firm charges a lower price than yours, what are your earnings?

☐ 0 ECU
 ☐ 70 ECU
 ☐ 80 ECU
 ☐ 3500 ECU

Check: if your price is not the lowest, you sell nothing; your earnings are 0.

Check

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Figure 3.4: Wrong answers: the messages restate the rule without giving the answer.

Checkpoint

The second question is the important one: a firm without the lowest price *sells nothing*. This is the rule that surprises students who only know Cournot. If several people get it wrong, repeat it aloud before the first round.

3.3 Decision, waiting and result

The decision is simultaneous and private. Students type the price or use the slider. The **calculator** lets them try prices and shows quantity and earnings *assuming that price is the lowest in the market, with no tie*; if that box is unticked, it shows quantity and earnings of 0. It records nothing. The sliders start at 0 and the decision box starts empty; at price 0 the calculator shows a loss of 1300 ECU, which does not suggest any particular price.

Your price decision Round 1 of 10

This round there are 2 firms in your market.

Price your firm will charge (0 to 130)

If you have the lowest price, how much the market sells depends on that price: **total market quantity = $\max(0, 130 - \text{lowest price})$** , split equally if there is a tie. If your price is not the lowest, you sell nothing. Producing each unit costs 10 ECU.

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

My price 65

Assuming I have the lowest price in the market (no tie) ☒

Quantity I would sell: **65** My earnings: **3575 ECU**

Confirm price

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Figure 3.5: Price 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: Market waiting page.

What participants will see

“Please wait” means that decisions from other firms in the same market are still missing. It is not an error. Participants should not close or refresh the page.

The result shows the firm's own price, whether it was the lowest, the lowest price in the market, the quantity sold, the round's earnings and the cumulative earnings. In later rounds, the decision screen includes the history.

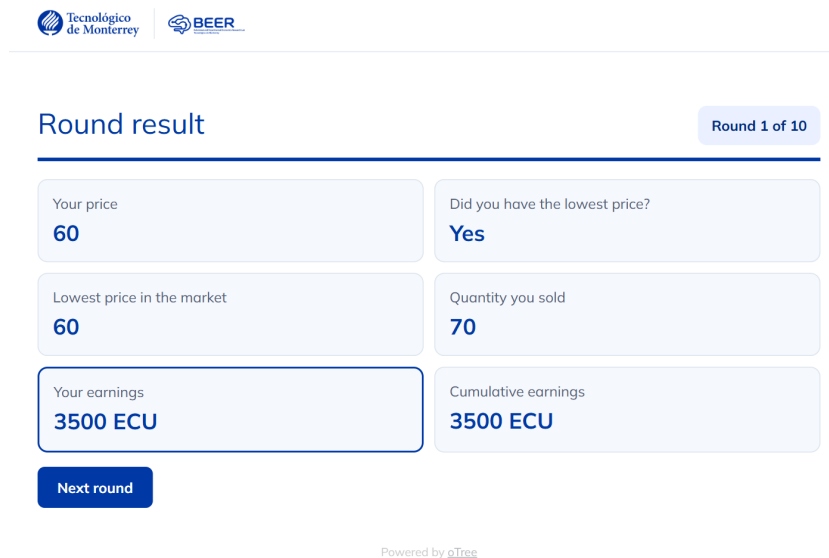


Figure 3.7: Round result when the firm had the lowest price.

With aggregate feedback the screen does not announce a tie explicitly: the firm sees “Yes” and a quantity equal to half the demand. In the example, both firms charged 60; demand is 70 and each sells 35 and earns $50 \times 35 = 1750$ ECU. When Q/k is not a whole number, each firm's quantity and earnings are rounded to the nearest integer.

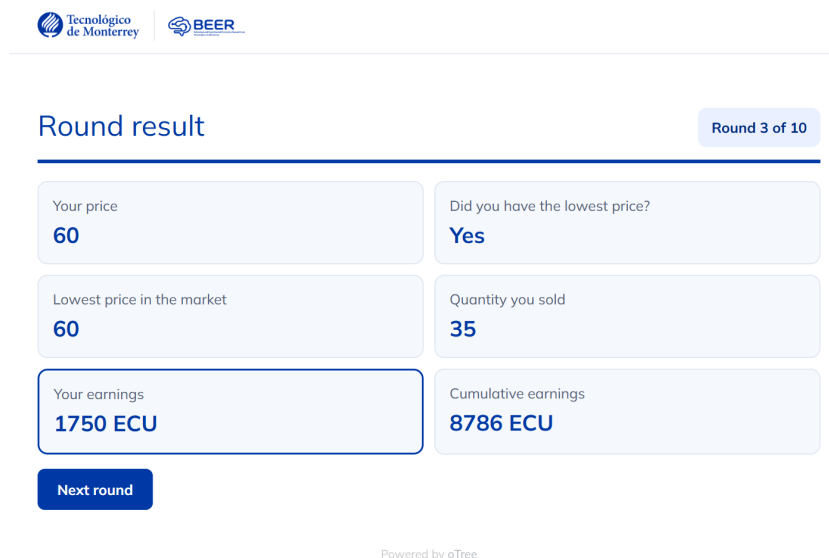


Figure 3.8: Result with a tie for the lowest price: demand is split equally.

Your price decision

Round 4 of 10

This round there are 2 firms in your market.

Price your firm will charge (0 to 130)

If you have the lowest price, how much the market sells depends on that price: **total market quantity = $\max(0, 130 - \text{lowest price})$** , split equally if there is a tie. If your price is not the lowest, you sell nothing. Producing each unit costs 10 ECU.

Calculator

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

My price



0

Assuming I have the lowest
price in the market (no tie)



Quantity I would sell: **130** My earnings: **-1300** ECU

Previous rounds

Round	Your price	Won?	Lowest price	Quantity sold	Your earnings
1	60	Yes	60	70	3500
2	62	Yes	62	68	3536
3	60	Yes	60	35	1750

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Figure 3.9: Decision in round 4, with the history of previous rounds.

End of the activity

Round 10 of 10

Your total earnings

13945 ECU

Round	Your price	Won?	Lowest price	Quantity sold	Your earnings
1	60	Yes	60	70	3500
2	62	Yes	62	68	3536
3	60	Yes	60	35	1750
4	55	No	52	0	0
5	49	Yes	49	81	3159
6	45	No	44	0	0
7	40	No	38	0	0
8	30	Yes	30	100	2000
9	25	No	22	0	0
10	20	No	18	0	0

Thank you for participating. Please wait for your instructor.

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Figure 3.10: Closing screen: total earnings, history and a request 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 has already ended. It opens with results hidden. At the top it shows participants, markets, completed rounds and markets 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.

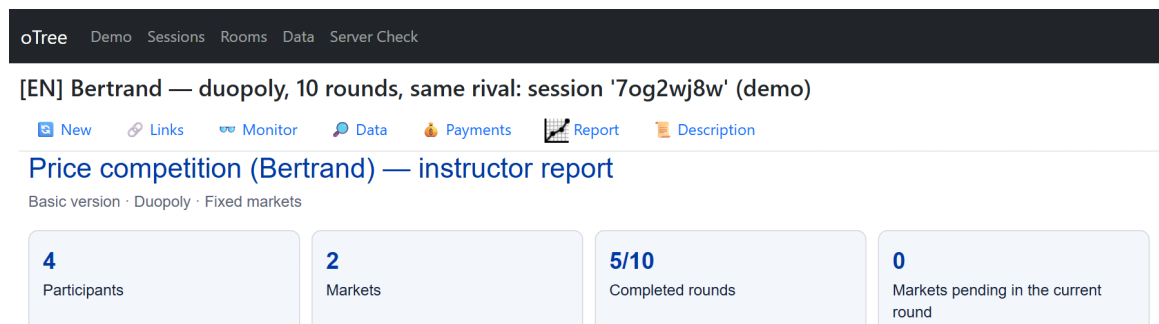


Figure 4.1: Report with results hidden and progress counters.

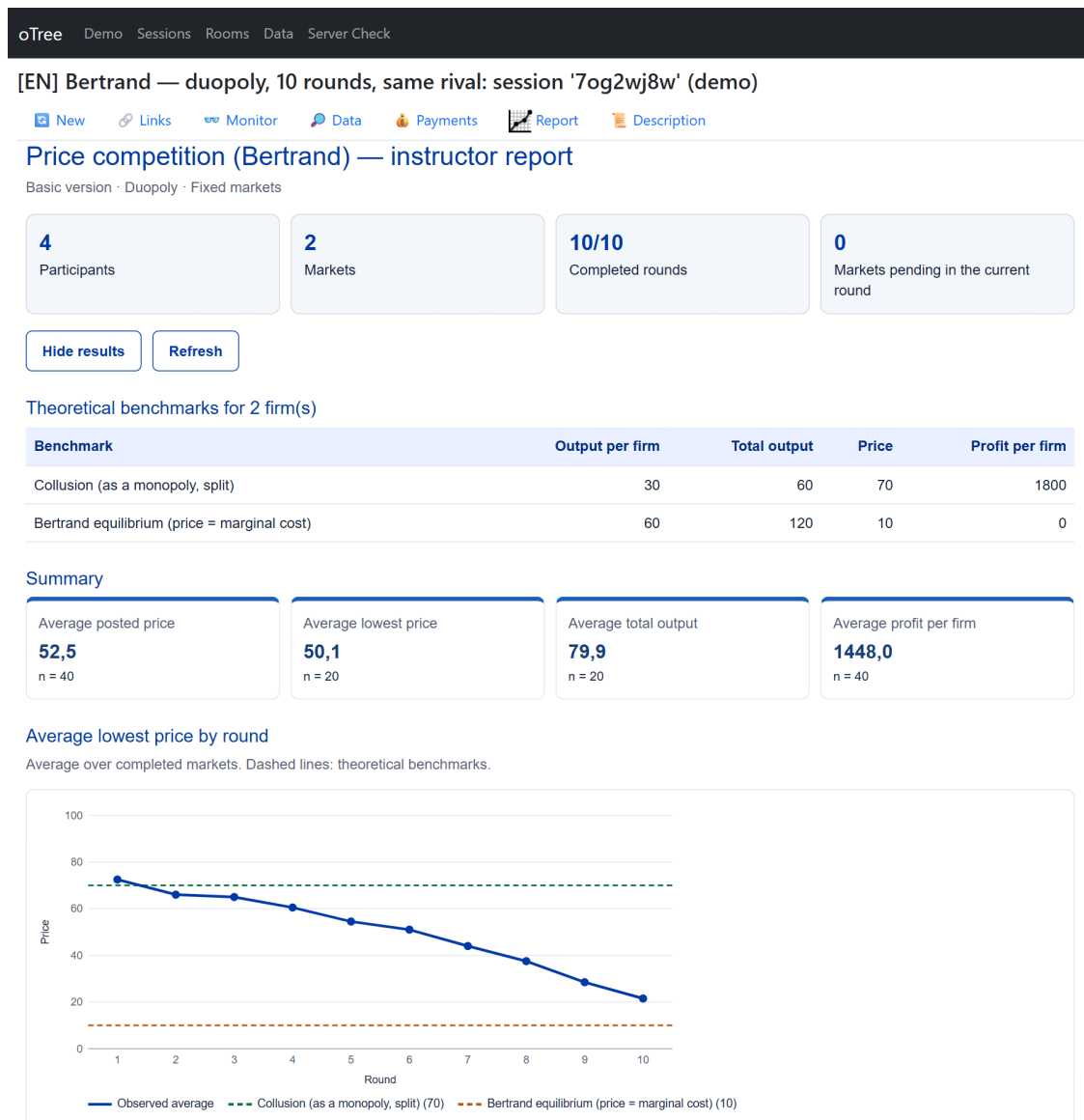


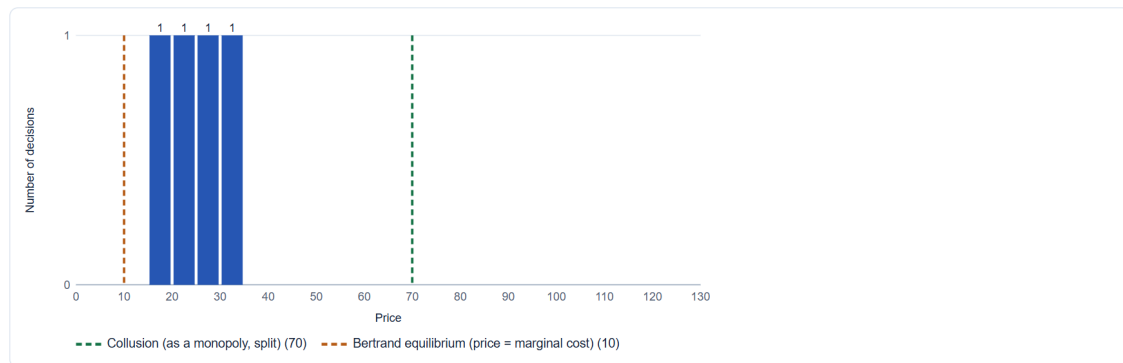
Figure 4.2: Revealed report: benchmarks, summary and lowest price by round (simulated decisions).

Early rounds versus late rounds (lowest price)

	Average lowest price
Rounds 1–3	67,8
Rounds 8–10	29,2

Distribution of posted prices

Decisions in the last completed round.



Markets in the last completed round (Round 10)

Market	Firms	Price	Lowest price in the market
Market 1	2	18 + 20	18
Market 2	2	25 + 30	25

Individual data: Data → Custom export (bertrand). 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; markets with an extra firm appear in the final table and in a notice.
2. Distinguish the two prices in the summary. The **average posted price** averages all decisions; the **average lowest price** averages, by market, the price at which the market actually sold. The latter is the one to compare with the benchmarks. Average profit per firm includes firms that sold nothing.
3. The central chart is the lowest price by round against two lines: collusion (70) and the Bertrand equilibrium (10). The fall towards 10 is the result worth showing.
4. With several rounds, look at the early-versus-late table (it appears once at least six rounds are complete) before talking about learning.
5. The histogram (last completed round, or all decisions in the one-round mode) includes all posted prices, not only the winning ones. Bars group prices in steps of 5: 10 and 11 fall in the same bar.
6. The markets table shows combinations such as “20 + 18”: useful for discussing who undercuts and by how much, without identifying anyone.

Debrief script

Ask first what the class expected. Then reveal the trend and the histogram. Ask those who charged high prices and those who charged low prices to explain their reasoning, without singling anyone out. Finish with the best response on the board: “if your rival charges p , you should charge $p - 1$ ”. Ask where that chain stops.

Theory and evidence

5.1 Theoretical benchmarks

Theoretical foundation

With $n \geq 2$ identical firms with constant marginal cost $c = 10$ and a homogeneous good, the unique Nash equilibrium with continuous prices is $p = c = 10$: at any common price above cost, each firm earns more by cutting its price slightly and taking the whole market. The result does not depend on n ; two firms are enough to reach the competitive price (the “Bertrand paradox”). Maximum joint profit is achieved by charging the monopoly price, which maximizes $(p - 10)(130 - p)$: $p^M = 70$, $Q = 60$, profit 3600 split among the n firms.

n	Collusion (all at 70)		Bertrand equilibrium ($p = 10$)	
	$q / Q / P$	π per firm	$q / Q / P$	π per firm
1	60 / 60 / 70	3600	= monopoly	
2	30 / 60 / 70	1800	60 / 120 / 10	0
3	20 / 60 / 70	1200	40 / 120 / 10	0
4	15 / 60 / 70	900	30 / 120 / 10	0

These are the figures shown in the report. With whole-number prices the monopoly price is still exactly 70 (69 and 71 give 3599).

The duopoly illustrates the dilemma: if both firms charge 70, each sells 30 and earns 1800 ECU; but if the rival charges 70, charging 69 yields $59 \times 61 = 3599$ ECU. In general, if the rival charges between 12 and 70, the best response is to charge one ECU less; if it charges more than 70, the best response is 70.

Whole-number prices: the equilibrium at 11

The game allows only whole-number prices, and that adds a nuance worth knowing before the discussion. In duopoly there are *two* pure-strategy Nash equilibria: both firms at 10 (profit 0) and both at 11. At 11, each sells $119/2 = 59.5$ and earns 59.5 ECU; cutting to 10 yields 0 and raising to 12 yields 0, so nobody wants to deviate. By contrast, both at 12 is not an equilibrium: each earns 118, and cutting to 11 earns 119. With three or four firms it is also an equilibrium for all to charge 11 (profits $119/3 \approx 39.7$ and $119/4 = 29.75$), and so is any profile in which at least two firms charge 10.

Two further useful observations: charging 10 is weakly dominated by charging 11 (11 never yields less and sometimes yields more), and any price above 70 is weakly dominated by 70. So, in class, prices of 11 or 12 are as much “equilibrium” as 10, and the gap between 11 and 12 is a single ECU. The game rounds each tied firm’s quantity and earnings to the nearest integer: with two firms at 11, each sees 60 units and 60 ECU.

5.2 Comparison with Cournot in the same market

The lab’s Cournot game uses the same inverse demand $P = \max(0, 130 - Q)$ and the same cost. With a single firm, choosing quantity or price is the same thing; the difference appears from two firms onward.

n	Cournot: $P / Q / \pi$ per firm	Bertrand: $P / Q / \pi$ per firm
1	70 / 60 / 3600	70 / 60 / 3600
2	50 / 80 / 1600	10 / 120 / 0
3	40 / 90 / 900	10 / 120 / 0
4	34 / 96 / 576	10 / 120 / 0

In Cournot the equilibrium price falls gradually towards cost as firms enter; in Bertrand it reaches cost with two. For the classroom comparison, run both games with the same market size and the same mode (for example, a ten-round duopoly with the same rival) and project both trends: Cournot’s in terms of price ($P = 130 - Q$) and Bertrand’s in terms of the lowest price. If you run both with the same group, order matters: the second session starts with experience from the first.

5.3 Experimental evidence

Price competition experiments with homogeneous goods have a long tradition; [Davis and Holt \(1993\)](#) and [Holt \(1995\)](#) present the early results, and [Potters and Suetens \(2013\)](#) review the more recent literature. The meta-analysis by [Engel \(2007\)](#) documents that collusion in oligopoly experiments decreases with the number of firms.

[Dufwenberg and Gneezy \(2000\)](#) study price-setting markets with 2, 3 and 4 sellers randomly rematched every round. With two sellers, prices stay clearly above the competitive level; with three and four, they approach it. The theoretical prediction does not depend on the number of firms, but observed behavior does.

[Suetens and Potters \(2007\)](#) compare price-setting and quantity-setting markets in comparable designs (with differentiated products) and find more tacit collusion under price competition, as their title says. Their design differs from this game, which uses a homogeneous good; treat it as a hypothesis to discuss, not as a prediction for your class.

Communication matters. [Fonseca and Normann \(2012\)](#) compare price-setting markets with and without the possibility of talking between rounds, with different numbers of firms, and find that communication raises prices and profits; without communication, collusion is harder the more firms there are.

5.4 Regularities worth discussing

- In duopoly, the lowest price usually stays above 10 in the first rounds, with much heterogeneity across markets.
- With the same rival and several rounds, attempts to sustain high prices appear, often interrupted by cuts of one or a few ECU; with a reassigned rival they are harder to sustain.
- As the number of firms rises, the lowest price falls further and faster.
- Final prices of 10, 11 or 12 are consistent with the theory under whole-number prices (section 5.1).

Attention

The results of a single class are descriptive. Without random assignment across treatments, enough markets and a research protocol, a difference between two sessions—including the comparison with Cournot—does not estimate a causal effect. With 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 lowest price in the market and whether it was its own, not each rival's price).

6.1 One round

`bertrand_en_1_round` removes the strategic history. It suits an introduction to best responses and the Bertrand paradox in a short class. The histogram includes all decisions.

6.2 Ten rounds with the same rival

`bertrand_en_10_fixed_partner` keeps markets fixed for all ten rounds. It lets you discuss tacit collusion, signaling through prices, and punishment (cutting the price after the rival undercuts). Do not announce aggregate results between rounds.

6.3 Ten rounds with a reassigned rival

`bertrand_en_10_random_partners` forms new markets at random every round. It reduces the scope for reputation and punishment within a pair, and is closer to the design of [Dufwenberg and Gneezy \(2000\)](#). Compare with the fixed-partner mode to discuss why repeated interaction with the same people makes high prices easier to sustain.

Extended variants

7.1 Map of treatments

All variants last ten rounds and use the same market ($Q = 130 - p_{\min}$, cost 10, $p \in [0, 130]$).

Variant	What changes	Teaching question
Monopoly	$n = 1$	Do students find the monopoly price without rivals? Does it match the Cournot monopoly?
Three firms	$n = 3$	Does the price fall faster with more firms, even though the theory does not change?
Four firms	$n = 4$	Is there any room left for high prices?
Four firms, reassigned markets	$n = 4$, new markets every round	What happens without repeated interaction and with many rivals?
Communication	Duopoly with a 60 s chat before each round	Do explicit price cartels form? Are they stable?
No calculator	Duopoly without calculator	How much does a tool for computing earnings help?
Each rival shown	$n = 4$; at the end of each round each firm's price and earnings are shown	Does behavior change when students see who won and at what price?

7.2 Monopoly

Each participant is the only firm in their market: the instructions say “quantity = $\max(0, 130 - \text{your price})$ ”. There is no waiting and no interaction. The benchmark is $p = 70$, $Q = 60$, profit 3600 ECU, identical to the Cournot monopoly. It is useful as a baseline or to check that the class masters the “marginal revenue equals marginal cost” condition.

Your price decision

Round 1 of 10

Price your firm will charge (0 to 130)

How much you sell depends on your price: $\text{quantity} = \max(0, 130 - \text{your price})$. It is never below 0. Producing each unit costs 10 ECU.

Calculator

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

My price 50

Quantity I would sell: 80 My earnings: 3200 ECU

Confirm price

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Figure 7.1: Monopoly: the calculator only has the firm's own price.

Attention

In this variant the comprehension check is the same as in the duopoly: it asks about “the lowest price” and about “another firm” with a lower price, even though a monopoly has no other firms. Tell the class that it is a question about the general rule and that their market will have no rivals.

Debrief script

Compare the distribution of prices with 70. If there is dispersion, ask how they searched for the maximum: by trying prices with the calculator or by calculating? If the class has already played the Cournot monopoly, show that both reach the same outcome.

7.3 Three and four firms

Markets have 3 or 4 firms; the instructions and the decision screen state the size. The equilibrium is still $p = 10$ with zero profit; the only thing that changes with n is how much each firm would receive if all charged 70 (1200 or 900 ECU). The variant with reassigned markets forms new markets every round.

Debrief script

Project the lowest-price trend next to that of a duopoly session, if you have one. Ask why the theory does not change with n while behavior does: it takes only *one* firm cutting its price for the whole market to follow, and with more firms it is more likely that one will.

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”). Nothing written is binding. The evidence shows that communication

raises prices in price-setting oligopolies (Fonseca and Normann, 2012). In this game an agreement is especially fragile: whoever breaks it by charging one ECU less takes the whole market.

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Time left to complete this page: 0:52

Messages Round 1 of 10

You can write to the other firms in your market. You have 60 seconds. Do not write your name or any personal information.

Firm 1 (Me) Shall we both charge a high price?
Firm 2 OK, I will charge 70.

Send

Go to the decision

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

Debrief script

Compare the lowest price with that of the duopoly without chat. Then read aloud, without identifying markets, some agreements and whether they were kept (**Data** → **Chat**). Relate this to competition policy: why the law prosecutes communication between competitors and not just high prices.

7.5 No calculator

A duopoly identical to the baseline, but the decision screen has no calculator. In this game the calculation is simple (quantity = $130 - p$ if the firm has the lowest price), so the difference from the version with a calculator may be small; the direction of the effect in your class is an open question.

Debrief script

Ask how they decided without a tool. If dispersion is greater than in the duopoly with calculator, discuss the role of computation costs and bounded rationality.

7.6 Each rival shown

Four-firm markets. At the end of each round each participant sees, in addition to the lowest price, the price, whether it won, and the earnings of each firm in their market. In the other configurations they see only the lowest price and whether it was their own.

Round result

Round 1 of 10

Your price

45

Did you have the lowest price?

No

Lowest price in the market

38

Quantity you sold

0

Your earnings

0 ECU

Cumulative earnings

0 ECU

Firms in your market

Firm	Your price	Won?	Your earnings
Firm 1	38	Yes	2576
Firm 2	60	No	0
Firm 3	40	No	0
Firm 4 (your firm)	45	No	0

Next round

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Figure 7.3: Result with each firm's price and earnings in the market.

In this table the columns are headed “Your price” and “Your earnings” also in the rows of the other firms; tell the class that each row refers to the firm named in it. With this information, copying the firm that earned most in the previous round is a simple rule; in this game the firm that earns most is the one with the lowest price (if it was above cost), so imitating it pushes prices down. How much behavior changes relative to the four-firm variant without this information is an open question.

Debrief script

Compare the trend with the four-firm variant without this information. Ask: did anyone copy the winner?, what happens to the price if everyone copies the cheapest firm?

Class plan and interpretation

8.1 Suggested 50-minute session

0–5 min	Joining the room, lab rules and market formation.
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: joint-profit-maximizing price and equilibrium price.
33–43 min	Lowest-price trend, histogram and table of markets.
43–48 min	Best response ($p - 1$), the Bertrand paradox and the comparison with Cournot; published evidence.
48–50 min	Applications: price wars, cartels, product differentiation and capacity constraints.

8.2 Questions to guide the discussion

1. Which price maximizes joint profit? Why does no firm want to stay there on its own?
2. If your rival charges 70, what should you charge? And if it charges 40? Where does the chain stop?
3. Why do two Cournot firms keep the price at 50 while here they do not?
4. Did behavior change with repetition? Were there “punishments” after a firm cut its price?
5. Why do we observe prices above cost in real markets with few firms? (Differentiated products, limited capacity, search costs, repeated interaction.)
6. Which real markets resemble this game: neighboring gas stations, online price-comparison sites, procurement auctions?

8.3 Common misreadings

Hasty reading	Correction
Charging a high price is irrational.	It may be an attempt at tacit collusion in the expectation of reciprocity, especially with a fixed partner.

Hasty reading	Correction
The equilibrium is exactly 10.	With whole-number prices, everyone at 11 is also an equilibrium, and 12 is a single ECU away from being one.
With more firms, the equilibrium falls.	In Bertrand the equilibrium is 10 for any $n \geq 2$; what changes with n is observed behavior and the collusive profit per firm.
Bertrand and Cournot are rival theories of the same market.	They are models with different choice variables; which one describes a market better depends on whether firms set prices and adjust quantities (or the reverse) and on their capacity.
The average describes every market.	Look at the histogram and the table: markets with high prices and markets in a price war often 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 on their decisions.
- Treat the session as a teaching activity, unless there is a research protocol with specific consent.

9.2 Troubleshooting

Situation	Action
I went to <code>teaching.beer-lab.org</code> and cannot see 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" (in Spanish) before starting	You have not created the session in that room yet, or the student opened another room (another language or edition). Once you create it, they are let in automatically.
"Please wait" for a long time during the game	Check Monitor : a firm in the market is missing. Ask the student to reopen the room in the same browser; if that is not possible, use Advance slowest participants : that firm is recorded with price 0, sells 130 units at a loss of 1300 ECU and its rivals earn 0 that round. Repeat every round or create a new session.
"La sesión está llena" (in Spanish, also in English rooms)	More students joined than were declared. Before starting: Close this room , a new session with the correct number, and everyone opens the link again.
A market with lowest price 0 in the report	Almost always a firm advanced from the Monitor. Mention it when projecting: it lowers the average lowest price and raises the average total output.
A market never completes	More participants were declared than joined. Close the room and create a new session with the correct number.
A market has one extra firm	This happens when the class size is not a multiple of the market size. It is intentional: the instructions mention it and the report sets it apart.
A student says they "won" but sold half	There was a tie for the lowest price; demand is split equally.
Several tabs of the same browser are the same participant	This is 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	No market is complete in the round yet. Wait and click Refresh .
Negative earnings	They occur when a firm sells at a price below 10. They are part of the game; ECU are not converted into money.

9.3 Data for later analysis

Data → **Custom export (bertrand)** 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, price, whether it had the

lowest price, quantity sold, lowest price in the market, profit, and comprehension attempts. Chat messages are in **Data** → **Chat**. Treat repeated decisions within the same market as dependent.

Annotated bibliography

- [Davis and Holt \(1993\)](#): textbook of experimental economics with chapters on markets and pricing institutions.
- [Holt \(1995\)](#): classic survey of industrial organization experiments.
- [Dufwenberg and Gneezy \(2000\)](#): price competition with 2, 3 and 4 sellers.
- [Engel \(2007\)](#): meta-analysis of collusion in oligopoly experiments.
- [Suetens and Potters \(2007\)](#): more tacit collusion with prices than with quantities.
- [Fonseca and Normann \(2012\)](#): communication and explicit versus tacit collusion in price-setting markets.
- [Potters and Suetens \(2013\)](#): survey of recent oligopoly experiments.

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Room QR codes

Project or print the page for the room you will use. Students scan it with their phone camera and click **Start**.

Price Competition

English room



`bertrand.beer-lab.org/room/bertrand_en`

Scan the code and press **Start**.

Price Competition

English room, extended version



`bertrand.beer-lab.org/room/bertrand_extended`

Scan the code and press **Start**.

Price Competition

Sala en español



`bertrand.beer-lab.org/room/bertrand_es`

Escanee el código y pulse **Comenzar**.

Price Competition

Sala en español, versión extendida



bertrand.beer-lab.org/room/bertrand_extendido

Escanee el código y pulse **Comenzar**.