



Instructor guide: exchange and general equilibrium

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 supports preparation, implementation and discussion of the BEER Lab Exchange and General Equilibrium family. It serves microeconomics and related courses without assuming programming or laboratory experience.

The operational route explains access and preparation; the foundations develop bundles, budgets and references. Screens, treatments and exercises help instructors select a comparison and use classroom results in their debrief.

Both languages cover the basic edition and sixteen extensions. Bilateral bargaining and four-person markets are explicitly distinguished. Common elements appear once, while each treatment develops the rules and interpretations that change.

Author

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For the instructor

This guide follows the English-language interface. Spanish configurations use the same logic. Never project individual codes or connect outcomes to names, student identification numbers, or seats in the room.

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Preparing a session

1.1 Purpose and choice of experience

This family lets a class observe how an initial distribution of goods changes, or remains unchanged, when people can exchange. The starting point is a pure exchange economy: available resources are given and nothing new is produced. The classroom question is how individual opportunities change when ownership of goods is reorganized. This connects consumer choice to general equilibrium: someone's purchase requires someone else to deliver goods and receive a counterpart. Drawing a demand curve in isolation is insufficient; budgets and aggregate resources must be checked together.

Bilateral bargaining is the recommended entry point. Each participant receives a bundle, a rule converting final consumption into points, and a role in the sequence. One person proposes how much of each good to keep and the other accepts or rejects. An instructor can discuss the outcome before introducing formal equilibrium conditions. The report then places endowment, outcome and competitive reference in an Edgeworth box. Participants are not shown an optimal solution before making their decisions, and the interface does not announce a hypothesis they are expected to confirm.

The second route uses four-person markets with a posted price. Participants request purchases or sales of X, using Y as payment. A disclosed rationing rule makes orders compatible with available counterparties. Some treatments keep the price fixed; others update it between rounds using submitted excess demand. This institution differs from bargaining because both the decision space and the coordination rule change. A competitive reference helps interpret the two routes, but the program does not force people to select that allocation. The distinction should remain explicit throughout the debrief.

Item	Description
Purpose	Connect exchange, resource constraints, distribution and price coordination.
Experimental unit	A bargaining pair; a four-person market in posted-price treatments.
Basic edition	One interaction, ten rounds with fixed partners, or ten with random reassignment.
Extended edition	Sixteen treatments varying endowments, preferences, information, fees, constraints, proposal rights and prices.
Decision	Proposed own bundle and acceptance or rejection; a net X order in posted-price markets.
Outcome	ECU score calculated from the final bundle, less an exchange fee where applicable.

Topics	pure exchange, general equilibrium, Edgeworth box, Pareto efficiency, endowments and distribution, price adjustment.
JEL	A22, C92, D31, D51, D61.
Participants	At least two, multiples of two for bargaining; at least four, multiples of four for posted-price markets.
Suggested duration	50–75 minutes with discussion. Instructional estimate awaiting classroom validation.

1.2 Access through the laboratory website

Start at <https://beer-lab.org/en/>. The current CLASSROOM navigation leads to teaching resources; the catalog is <https://teaching.beer-lab.org/en/>. Spanish navigation uses CLASE and <https://teaching.beer-lab.org/>. Find Exchange and General Equilibrium. The card identifies the family rather than a particular session configuration. After entering, select language, edition and mode. The screenshots document navigation when this guide was prepared. News and other cards may change without changing the game's stable routes. Familiarity with GitHub or oTree programming is not required to run a prepared classroom session.

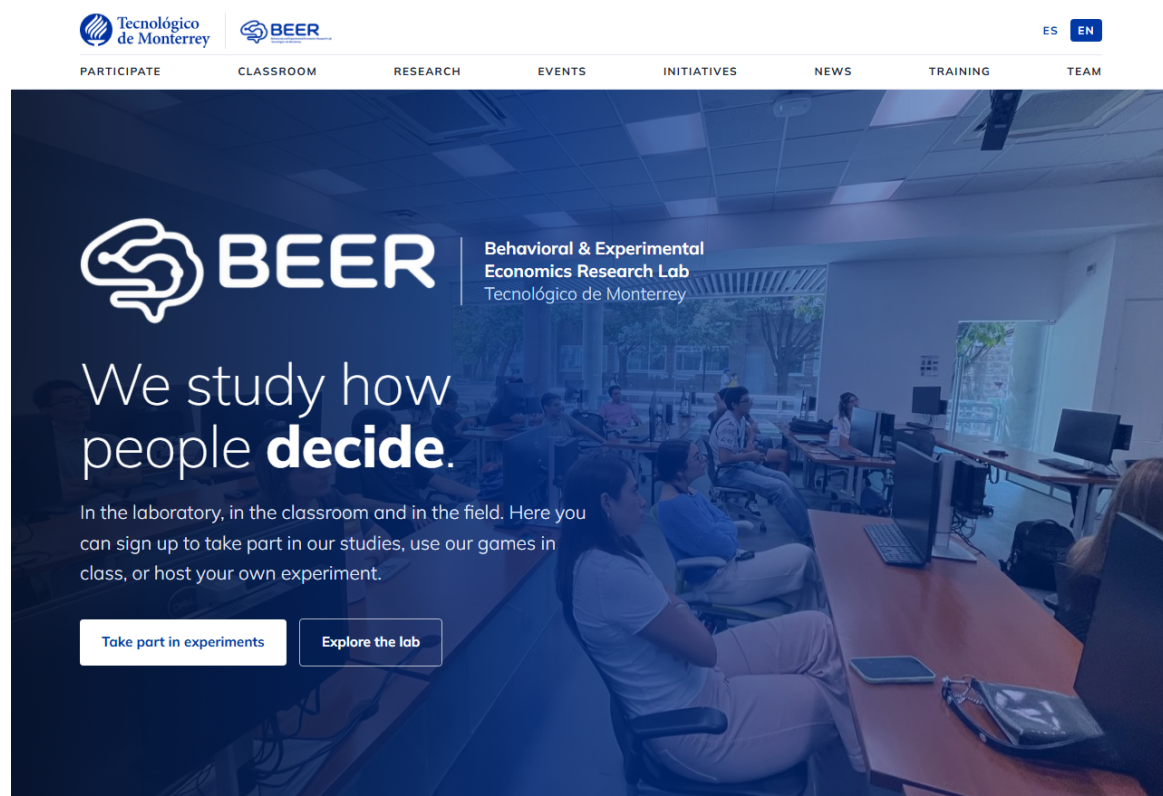


Figure 1.1: CLASSROOM provides the entry point from the institutional website.

Instructor access is <https://exchange.beer-lab.org/demo>. This family domain should show only its own basic and extended configurations in both languages. Demo supports exploration and demonstration sessions. For a class using a room, select Rooms and open the appropriate one. Administrative access requires credentials provided by the coordinator. Do not confuse the administrative password with a participant link or project it to solve an access problem. Participants should receive only their intended entry route, while the instructor retains access to monitoring and data.

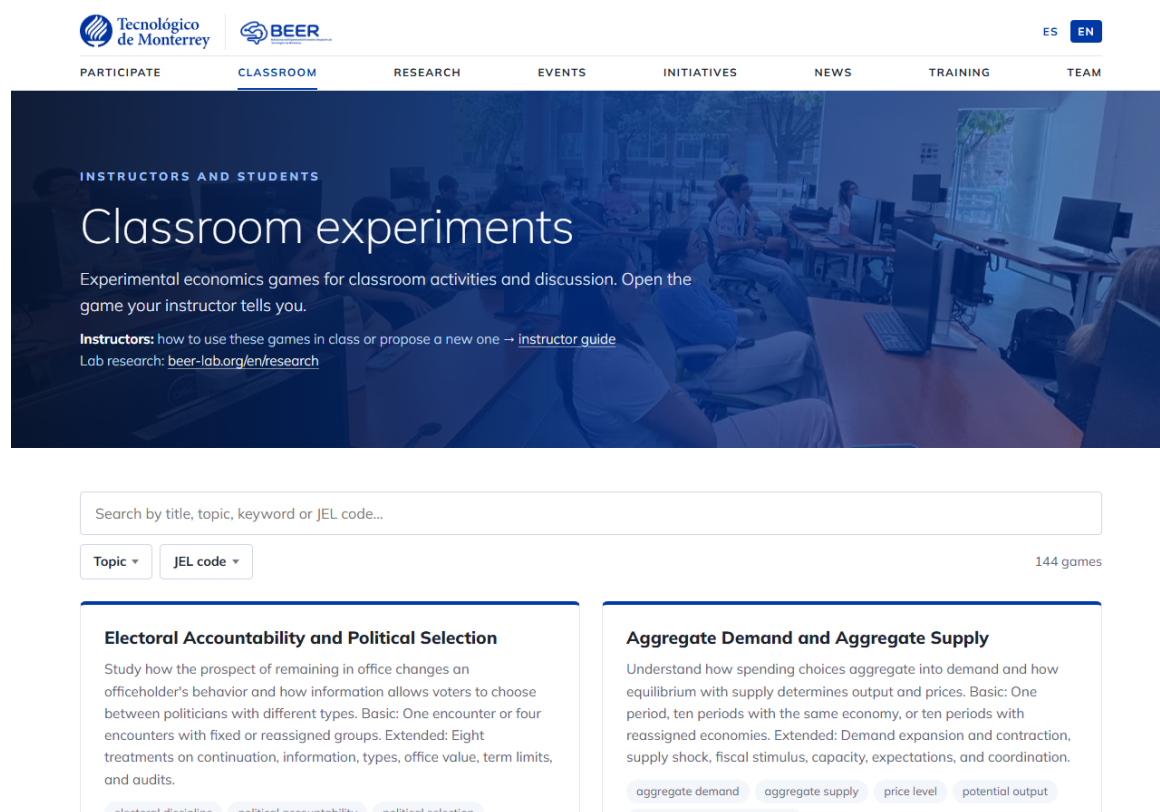


Figure 1.2: Select the family in the catalog before choosing a session mode.

The stable participant routes are https://exchange.beer-lab.org/room/intercambio_es, https://exchange.beer-lab.org/room/exchange_en, https://exchange.beer-lab.org/room/intercambio_extendido and https://exchange.beer-lab.org/room/exchange_extended. The first two are basic rooms; the others are extended. A room is not a separate treatment. It collects configurations for one language and edition, and the instructor selects one before activating the session. A participant entering an inactive room may need to wait until the intended session is available.

Each basic room offers three modes. Each extended room offers those reference modes plus sixteen additional treatments. The family therefore has 44 configurations. This counts ways of running a family, not 44 independent experimental paradigms. If other games appear, or an extended configuration is initially selected in a basic room, contact the laboratory before starting. Isolation also covers sessions and data: each family runs in its own instance and database even though the source repository contains other games. A filter in a room alone does not separate historical records.

1.3 Creating, distributing and monitoring a session

Before the group arrives, choose a teaching question and treatment. Write down what changes and what comparison remains fixed. An introductory class can compare basic bargaining and the competitive reference price. An advanced class might compare low and high prices or change endowments while holding preferences constant. Avoid varying several dimensions together and attributing every difference to one cause. Prepare separate sessions when you want distinct exports for the comparisons. Identify the announced horizon in advance instead of ending a ten-round activity unexpectedly after only a few decisions.

Demo

[ES] Intercambio y equilibrio general — Básico — Una interacción
[ES] Intercambio y equilibrio general — Básico — Mismas personas en cada ronda
[ES] Intercambio y equilibrio general — Básico — Reasignación aleatoria en cada ronda; puede repetirse una pareja
[ES] Intercambio y equilibrio general — Extendido — Una interacción
[ES] Intercambio y equilibrio general — Extendido — Mismas personas en cada ronda
[ES] Intercambio y equilibrio general — Extendido — Reasignación aleatoria en cada ronda; puede repetirse una pareja
[ES] Intercambio y equilibrio general — Extendido — Dotaciones iguales
[ES] Intercambio y equilibrio general — Extendido — Riqueza inicial desigual
[ES] Intercambio y equilibrio general — Extendido — Preferencias próximas a la dotación
[ES] Intercambio y equilibrio general — Extendido — Preferencias opuestas a la dotación
[ES] Intercambio y equilibrio general — Extendido — Escasez del bien X
[ES] Intercambio y equilibrio general — Extendido — Redistribución inicial
[ES] Intercambio y equilibrio general — Extendido — Preferencias privadas
[ES] Intercambio y equilibrio general — Extendido — Costo de intercambio
[ES] Intercambio y equilibrio general — Extendido — Límite a las transferencias
[ES] Intercambio y equilibrio general — Extendido — Proponente permanente

Figure 1.3: Check language, edition and mode in this family's Demo before beginning.

Rooms

Current rooms:

[ES] Intercambio y equilibrio general — Básico
[ES] Intercambio y equilibrio general — Extendido
[EN] Exchange and General Equilibrium — Basic
[EN] Exchange and General Equilibrium — Extended

Figure 1.4: Rooms contains four entry points distinguishing editions and languages.

Bargaining requires complete pairs: at least two, multiples of two. Posted-price markets require at least four, multiples of four. Twelve people form six pairs or three independent markets. References belong to each market, not the whole class. Incompatible counts are rejected; prepare a valid session rather than assigning a fictitious decision to an absent participant.

Assign a different link to each participant, or use the laboratory's room procedure. Opening one link twice does not create two people. Rehearse with fictitious records separate from the class. Participants receive entry links rather than administrative access; retain the report privately and project only the intended page.

Fixed matching preserves pairs and types; proposal rights alternate except under permanent proposer. Random reassignment may repeat partners and change A/B. Markets retain four members because adjustment uses that market's previous orders. Renew goods each round and announce the horizon. Identify new sessions clearly and do not unexpectedly truncate ten announced rounds.

Checkpoint

Confirm family, language, edition, treatment, horizon, group size, renewed goods, scoring and private report access. Keep aggregates hidden during decisions. Test a download and verify that it preserves all ten rounds in repeated modes.

Room: [EN] Exchange and General Equilibrium — Basic

Create a new session

Session Config

[EN] Exchange and General Equilibrium — Basic — One interaction

Number of participants

Complete groups of 2 participants. Use a multiple of 2; minimum 2.

Create

[Configure session](#) 

App sequence

exchange_equilibrium_game (10 rounds)

0 participants present

Start links

These URLs will stay constant for new sessions, even if the database is recreated.

Room-wide URL

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.

http://127.0.0.1:8187/room/exchange_en

Figure 1.5: The basic room filters its three configurations and lets the instructor check participant count and mode.

Create session

Tip: consider creating your session in a [Room](#), for more stable start links that are not opened accidentally.

Session Config

[ES] Intercambio y equilibrio general — Extendido — Ajuste de precios

Number of participants

4

Grupos completos de 4 participantes. Use un múltiplo de 4; mínimo 4.

Create

[Configure session](#) 

App sequence

exchange_equilibrium_game (10 rounds)

Figure 1.6: Respect the effective group multiple when switching from pairs to four-person markets.

oTree
Demo
Sessions
Rooms
Data
Server Check
Logout

[EN] Exchange and General Equilibrium — Basic — One interaction: session '7c41z6ca'

 Edit
 Links
 Monitor
 Data
 Payments
 Report
 Description

You can either use the session-wide link, persistent links, or single-use links.

Session-wide link

If it's not practical for you to use a Room, you can distribute the following link to participants.

<http://127.0.0.1:8187/join/detijuda>

Persistent links

For a real session, you should use a [room](#).

Single-use links

Below are single-use links.

P1	http://127.0.0.1:8187/InitializeParticipant/zivacw0m
P2	http://127.0.0.1:8187/InitializeParticipant/t3b3o6gt
P3	http://127.0.0.1:8187/InitializeParticipant/t3ej3z5n
P4	http://127.0.0.1:8187/InitializeParticipant/iszokyj1

Figure 1.7: Distribute separate slots and retain private access to the report and session data.

Economic foundations

2.1 Goods, points and opportunities to improve

In the basic reference, A receives 80 X units and 20 Y units; B receives 20 X and 80 Y. The economy contains 100 units of each good. There is no additional monetary account. Each person has 100 physical units when goods are added, but X and Y are not interchangeable one for one in scoring. A bundle with much of one good and little of the other can generate fewer points than a more balanced bundle. The endowment is therefore not an initial payment of 100 ECU, and the numerical coincidence should not obscure the different units.

Gross points are $U_i = 100(x_i/50)^{\alpha_i}(y_i/50)^{1-\alpha_i}$. Both basic parameters are $\alpha_i = 0.5$, giving $U_i = 2\sqrt{x_i y_i}$. Either initial bundle produces $2\sqrt{80 \times 20} = 80$ points. A bundle of fifty units of each good produces 100. Exchange can improve both people without producing physical resources: the gain comes from aligning consumption with the preferences induced by the scoring rule. Ask for a verbal explanation before checking the arithmetic. A valid explanation identifies the change in composition rather than claiming that trade created extra goods.

ECU means Experimental Currency Units and records the activity score. No conversion into pesos or real reward is announced. Points operationally represent preferences in this exercise; they do not establish a psychological utility function or permit interpersonal satisfaction comparisons outside it. Their sum is not reported as social welfare. The fee treatment deducts a charge from gross points. Elsewhere the score equals the announced transformation of final goods, rounded to two decimal places. A class can compare a person's own score before and after exchange without treating everyone's utility as a common cardinal welfare measure.

A Pareto improvement leaves everyone at least as well off and makes somebody strictly better off. A strict improvement for everyone requires each person to increase their score. The report uses the latter condition for its everyone-improves indicator. That percentage is not a complete efficiency measure. An outcome can improve everyone while leaving further improvements available; another can be efficient and unequal. Distribution and the use of available opportunities are separate questions. The guide treats both as important without replacing either one with an aggregate sum of points or an acceptance percentage.

2.2 Literature and limits of inference

Boháček (2002) develops a teaching experiment using two-good endowments, exchange and induced utility to study market clearing. This family retains that question but uses bilateral offers and round-based orders with explicit rationing. It does not reproduce the paper's open bargaining, random endowment distribution or hidden aggregate information. Calibration, posted prices and price adjustment are adaptations of the present implementation.

Murphy (n. d.) supports computational representation of Cobb–Douglas exchange, rather than validation of this rationing mechanism. The foundations in Arrow and Debreu (1954) are theoretical and do not imply that students always optimize or possess perfect information. Screenshots come from local verification sessions with fictitious data, not a class or published estimates. The guide invents no universal acceptance or convergence means. An observation can motivate hypotheses about expectations, fairness or calculation difficulty, but cannot distinguish those causes without additional evidence. Separate a conditional prediction, an observed pattern and an explanation that remains untested.

Attention

Do not equate acceptance with efficiency, a posted price with equilibrium, conservation with clearing of requested orders, or summed scores with social welfare. A trajectory may illustrate a mechanism without establishing general convergence or a psychological cause.

2.3 Reading the Edgeworth box

The box represents two bundles and a resource constraint simultaneously. A's origin is the lower-left corner; B's is the upper-right. Width is total X and height is total Y. A point (x_A, y_A) implies B receives $(X - x_A, Y - y_A)$. Moving right gives A more X and B less; moving up gives A more Y and B less. There is no third store of goods. Establish this reading before introducing curves. Students who read both origins from the lower-left corner may otherwise interpret a feasible allocation as a violation of conservation.

Indifference curves connect bundles generating the same individual points. With Cobb–Douglas preferences and positive quantities, the marginal rate of substitution is $MRS_i = \alpha_i y_i / [(1 - \alpha_i) x_i]$. It measures the local Y compensation for an additional X while points remain constant. Initially A's MRS is $20/80 = 0.25$ and B's is $80/20 = 4$. Different marginal valuations create scope for A to deliver X and receive Y on terms that improve both people. These are calculated marginal comparisons, not transaction prices observed in the activity. Finite trades require checking full bundles rather than relying only on a local derivative.

The contract curve collects interior allocations with equal marginal rates of substitution. Set $a = \alpha_A$, $b = \alpha_B$, and $k = b(1 - a) / [a(1 - b)]$. The curve is $y_A = kx_A Y / [X + (k - 1)x_A]$. Equal preferences and equal totals yield the diagonal $y_A = x_A$. This is a continuous reference without frictions. Its entire length is not voluntarily acceptable from a particular endowment, because some allocations make a person worse off. Preferences determine the curve's shape, whereas endowments determine starting points and outside options. Keep these roles separate when comparing treatments.

Giving each person (50, 50) increases both scores from 80 to 100. Giving A (70, 70) and B (30, 30) also places the allocation on the contract curve, yet B earns 60, below the initial 80. The second allocation can be efficient in goods and unattractive to the responder. Efficiency therefore does not guarantee agreement. The region of voluntary improvements is found by comparing curves through the endowment rather than selecting any efficient point. Ask students to draw both examples and explain why a change favorable to A does not automatically compensate B.

Theoretical foundation

The box combines feasibility, preferences and distribution. The contract curve equalizes marginal valuations; initial indifference curves delimit voluntary improvements. The competitive reference adds budgets at a common price. These constructions do not replace the actual proposal, response or rationing rule.

2.4 Budgets and competitive equilibrium

Let $p = p_X/p_Y$, measured in Y units per X, and normalize $p_Y = 1$. Wealth is $m_i = pw_{Xi} + w_{Yi}$, where w denotes the endowment. The budget is $px_i + y_i \leq m_i$. Under Cobb–Douglas preferences and price-taking choice, demands are $x_i = \alpha_i m_i / p$ and $y_i = (1 - \alpha_i) m_i$. No external money is added: wealth values goods already owned. A change in price also changes endowment wealth. Holding wealth incorrectly constant across price comparisons misses the endowment-income channel that distinguishes this economy from a demand exercise with an externally fixed cash budget.

The price making demands compatible with resources is $p^* = \sum_i \alpha_i w_{Yi} / \sum_i (1 - \alpha_i) w_{Xi}$. It equals one in the basic reference. Each person's wealth is one hundred Y and each demands fifty units of both goods. A sells thirty X for thirty Y and B makes the opposite exchange. With four people, two of each basic type, the price remains one while totals double. Price invariance is not volume invariance. Each executed transaction preserves individual value at that round's price as well as conserving the physical totals across the market.

Walras' law connects markets through budgets: aggregate excess demand satisfies $pz_X + z_Y = 0$ when everyone exhausts their budget. Both excess demands are zero at competitive equilibrium. In the application, recorded excess demand instead sums submitted net X orders before rationing. These need not equal optimal Cobb–Douglas demands. Rationing conserves goods even when requested orders fail to balance. Distinguishing desired demand, declared orders and executed allocations prevents interpreting a transaction accounting identity as evidence of equilibrium. The report deliberately retains requested excess demand after the execution has balanced the actual transfers.

The existence result of [Arrow and Debreu \(1954\)](#) supports studying prices consistent with choices under specified assumptions. It does not establish convergence of this bilateral protocol or adjustment rule. The application calculates an explicit reference for its Cobb–Douglas economy and compares it with human choices. Equilibrium is a benchmark rather than an outcome attributed to students by construction. The computational note by [Murphy \(n. d.\)](#) provides a reference for Cobb–Douglas economies and their graphical representation, without validating behavior in the present protocol. Instructors should identify both optimal choice and market compatibility before using the competitive interpretation.

Competitive efficiency also does not imply equality. With A endowed with (80, 80) and B with (20, 20) under equal preferences, the reference price remains one. Competitive demands equal those endowments: they are efficient and the score difference persists. An initial redistribution can change who reaches which bundle without changing box dimensions. When introducing the second welfare theorem, explain its conditions and distinguish an initial transfer from an external subsidy. The exercise does not create additional resources so that everyone can improve after any redistribution. It lets the class separate a distributive objective from voluntary exchange opportunities.

2.5 Bargaining and coordination through prices

Basic bargaining contains one proposal followed by one response per round. Rejection preserves endowments and does not trigger another offer. This is not an alternating-offers protocol within one negotiation or an implementation of Rubinstein equilibrium. Alternation across rounds changes who proposes a new reallocation of renewed goods. A score-oriented proposer can seek a favorable bundle subject to acceptance, but the program fixes neither response behavior nor tie-breaking at equal utility. Outcomes make those decisions discussable without building a predicted response into the software. Ten renewed rounds should not be described as ten revisions to one accumulating allocation.

Proposals are integer quantities, whereas the competitive model assumes divisible goods. This can prevent exact reproduction of a continuous allocation. At a boundary with zero of a good, the interior MRS formula does not apply. The report's contract curve excludes fees and transfer limits. With a fee, compare net gains; with a cap, identify reference allocations outside the permitted set. A difference from the reference is not sufficient evidence of irrationality. Institution, discreteness, information and expectations may matter, as may preferences not captured by the activity's scoring rule. A useful debrief establishes these alternatives before assigning a behavioral explanation.

A positive market order buys X by delivering Y , while a negative order sells X and receives Y . If requested purchases total sixty and sales twenty, only twenty are executed. Each buyer receives one third of the request and sellers execute all their requested sales. The short side determines volume and the long side faces proportional rationing. Executed quantities can be fractional although requests are integers. The posted price stays constant within a round. Rationing does not replace budgets: executed purchases are paid for with Y and all transfers respect initial inventories and the announced no-credit restriction.

Participant experience

3.1 Welcome and clear instructions

The first screen displays the laboratory logo and welcome. It explains the teaching purpose, requests silence and private decisions, and tells people how to ask for help. The no-conversation rule also applies to bargaining: proposals and responses use the interface, with no free-text messages. Instructions neither name a hypothesis nor announce that efficient behavior is expected. Participants need contractual information and their scoring formula, not a theoretical interpretation that steers their choices. The instructor may clarify rules while reserving predicted outcomes for the discussion after decisions are complete.

The resource panel distinguishes X and Y using different symbols and prominent quantities. Repeat that these are physical model goods rather than money or ECU. There is no independent monetary balance of one hundred. The body explains renewal each round and final scoring. Receiving eighty X and twenty Y does not mean receiving one hundred points: with symmetric preferences that bundle produces eighty. Ask someone to reconstruct the example and allow participants to review instructions. An endowment question must be answered from that person's assignment, rather than from the quantities assigned to another role.

Instruction tables specify types and parameters. Under private preferences only the person's own parameter appears; the counterpart's parameter is also excluded from the browser's preview calculation object. Privacy concerns that information in the exercise, not removal of administrative data access. Debrief using aggregates without publicly reconstructing who held each link. Market instructions announce the price, payment in Y and rationing before requesting orders. Do not treat missing counterpart information as a screen defect when it belongs to the treatment. Confirm the intended information condition before answering questions that might reveal a hidden parameter.

3.2 Comprehension with field-specific feedback

The check does not ask for an optimal strategy. It verifies endowments, conservation or conversion at the posted price, and the consequence of no exchange. The first question depends on type because A and B can receive different X quantities. The second asks how much X remains for B if A keeps ten, or how much Y an executed purchase of two X costs at the example's initial price. Participants should not substitute a later round's price or confuse a requested purchase with execution. The final question distinguishes retaining goods from losing them or receiving an invented counterparty.

Each incorrect response gets an explanation next to its field. Feedback states the correct quantity and relevant calculation while retaining the other submitted answers. With one hundred total X and ten retained by A, B receives $100 - 10 = 90$. At price 0.5, two executed X cost one Y.



Welcome to the laboratory

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

You will make individual, private decisions. At the end, the instructor will use aggregate results for classroom discussion.

General laboratory rules

- Remain silent throughout the activity.
- Do not talk or communicate with other participants.
- Make decisions individually and privately.
- Follow the instructions on screen.
- Do not close, refresh or leave the page.
- If you need help, raise your hand and ask for private assistance.

☐ I have read and agree to follow these rules.

Start

Figure 3.1: The cover identifies the laboratory and requests confirmation of its rules.

Your goods at the start of the round

● Good X **20**

■ Good Y **80**

You receive 20 units of X and 80 units of Y. These goods are renewed each round: they are neither money nor ECU and do not accumulate. The final score adds scores from all active rounds.

ECU means Experimental Currency Units. ECU are points calculated from your final goods: there is no additional 100 ECU account or real-money conversion.

With x final units of X and y of Y, your points before any fee are $U = 100 \times (x/50)^\alpha \times (y/50)^{(1-\alpha)}$. Your α is 0.5. Zero of either good gives zero points before any fee. Scores are rounded to two decimal places.

Score without exchange: 80 ECU

Figure 3.2: Goods appear within the body together with the formula and score without exchange.

There are two people, A and B. One proposes how many units of each good to keep for themselves. The other receives the remainder and accepts or rejects. Acceptance implements exactly those bundles; rejection leaves each person with their initial goods. There is no further offer within the round. Future transfers cannot be promised. The proposer alternates between A and B in successive rounds. Both people's endowments and α parameters are public information.

Conservation example: if A ends with 10 X units and 10 Y units, B receives 90 X and 90 Y. Each good's total must be conserved; this example does not recommend a choice.

Type	X	Y	α
A	80	20	0.5
B	20	80	0.5
One interaction			

Figure 3.3: Read the sequence, endowments and public information before making a choice.

Correction does not deduct points. Help with the particular rule without suggesting acceptance of a bundle or submission of a particular order. Delays often diminish once participants identify the unit being used, the parameter assigned to their role and the institutional consequence the question is checking.

How many X units do you receive at the start of each round?

0

Your answer: 0. The correct answer is 20. Your endowment is 20 X units; it is renewed every round.

If A keeps 10 X units, how many X units remain for B?

90

What happens if the proposal is rejected, or exchange is unavailable?

- ☒ Initial goods are retained.
- ☐ All goods are lost.
- ☐ The program invents a counterparty.

Figure 3.4: Feedback explains the correct endowment and retains the other completed fields.

What participants will see

Participants need initial goods, the scoring rule, the current decision and the consequence of no agreement or counterparty. The Edgeworth box, competitive reference and efficiency interpretations belong in the instructor report and subsequent discussion.

3.3 Making and responding to an offer

The proposer enters the quantities of X and Y to retain for themselves. This also applies when B proposes: controls always describe the proposer's own bundle. Internally the program converts this into a common allocation representation to record resources. The other person receives the remainder. Fields accept integers between zero and the total of each good. Any additional transfer cap is checked relative to the initial endowment. An invalid offer is not sent, and its values remain available for correction. This avoids requiring a participant to mentally reverse coordinates simply because proposal rights changed.

The preview calculates bundles and scores when these are public information. It supports arithmetic rather than recommending a choice. Under private preferences it calculates own points only and hides the counterpart's points. An applicable fee is deducted when an accepted allocation differs from the initial one. Entering quantities without continuing does not submit a definitive offer. After an error, correct the indicated field and check that the preview matches current entries. A useful distinction is between the bundle a person would like to retain and the bundle they expect their counterpart to accept.

The responder receives a table and accepts or rejects. Rejection preserves both endowments, creates no penalty, and does not trigger another offer within the round. The proposer waits for the response. Waiting is normal in an interactive game: identify who still has a decision before diagnosing a server failure. Refreshing or closing a page does not accelerate someone else's

X units you will keep

Y units you will keep

Bundle preview

	X	Y	ECU
You	50	50	100.00
The other person	50	50	100.00

Figure 3.5: The offer specifies the proposer's own bundle and the preview calculates the remainder.

response. Acceptance is recorded, but its motivation is not elicited. The instructor may ask about considerations afterwards while distinguishing that retrospective conversation from a formal measurement of preferences or beliefs. Do not infer a motive solely from the accept/reject field.

3.4 Orders, results and completion

The market asks for a net X order. Bounds depend on inventory and price: no person can sell more X than owned or buy more than initial Y can fund. Only one net order is submitted, with no credit. Zero is valid; negative values are sales. A new price changes maximum affordable purchases even when renewed endowments remain the same. The displayed range specifies the feasible order for that round.

Results show final goods, gross points, fee, score and change relative to retaining the endowment. Market results separate requested and executed X. A request for thirty that executes twenty reflects rationing rather than necessarily an arithmetic defect. Goods are conserved even when points increase. Results concern that person's market: other groups do not supply missing counterparties. Under reassignment, the initial comparison uses the type and endowment of the current round.

The final page requires no advance. Ten rounds add ten scores, not inventories. Later technical oTree periods are not unfinished tasks in a one-interaction configuration, and the report aggregates only active rounds. A new session should be announced as a rule and link change. Instructor reports remain available through private administration, without asking participants to click a nonexistent continuation button.

Review the received proposal

Good X
20

Good Y
80

Your role in this round
B

Round
1 / 1

Acceptance implements these bundles and any announced fees. Rejection preserves your initial endowment.

	X	Y	ECU
The other person	50	50	100
You	50	50	100

Your response

☐ Accept
☐ Reject

Continue

Figure 3.6: The responder compares the received proposal with retaining the initial endowment.




Please wait

Please wait for the proposal to be submitted.

Figure 3.7: Waiting allows the other person to finish preparing the proposal.

Submit an integer from -20 to 160. An order of 0 keeps your goods. Current price: 0.5 Y units per X.

Executed volume is the smaller of total requested purchases and sales. The larger side is reduced proportionally, so executed quantities may be fractional. Each executed X is paid for with p Y units. An order with no counterparty is not executed. Unexecuted goods stay in your bundle.

Net X order: positive buys, negative sells

Continue

Figure 3.8: The current range distinguishes buying, selling and no exchange at the posted price.

Final bundle

Good X **50**

Good Y **50**

Points before fee	100 ECU
Fee deducted in ECU	0 ECU
Round score	100 ECU
Change relative to keeping your endowment	20 ECU

Exchange response: Accepted

Figure 3.9: The individual results panel separates final goods, points, fees and changes relative to the endowment.

Activity completed

You have completed all active rounds. Remain quiet and wait for your instructor. You do not need to advance to another page.

Total score: 100 ECU

Round	ECU
1	100

Figure 3.10: The completion page confirms the active horizon and displays accumulated points.

Extended treatments

4.1 Endowments and distribution

Equal endowments give each person (50, 50) and retain symmetric preferences. The endowment coincides with the competitive allocation and lies on the contract curve. No feasible reallocation can make both strictly better off without additional resources. If different proposals appear, examine distribution and acceptance rather than counting any movement as a gain. This conceptual control shows that exchange does not help merely because an exchange occurred. Zero gains can be consistent with available opportunities rather than demonstrating inattention or misunderstanding. Contrast this with a basic outcome that remains at its initially inefficient endowment.

Unequal wealth gives A (80, 80) and B (20, 20). Identical proportions already equalize marginal rates of substitution. The competitive price remains one and initial scores are 160 and forty. Exchange availability does not eliminate inequality. Ask what an initial transfer would change and whether the poorer person can improve without hurting the other. Without production or external resources, voluntary transactions do not resolve every distributive difference. This reference also shows why an efficiency concept alone does not select a socially preferred distribution. Avoid describing a high score for one type as evidence that the market failed to conserve goods.

Initial redistribution gives A (60, 20) and B (40, 80). Totals remain one hundred of each good and the reference price stays at one. Wealth is eighty and one hundred twenty, giving competitive demands (40, 40) and (60, 60). Final distribution changes even without a price change. Distinguish an endowment transfer from altered preferences: the point transformation remains the same. Looking only at prices can conceal important differences in wealth, consumption and individual opportunities. This provides a manageable classroom introduction to distribution within equilibrium analysis without introducing production, taxation or an external monetary transfer account.

Scarce X gives A (50, 20) and B (10, 80). The box measures sixty by one hundred and the competitive price is $100/60 = 5/3$. A's wealth is $(5/3)50 + 20 = 103.333$, yielding $x_A = 31$ and $y_A = 51.667$. B demands $x_B = 29$ and $y_B = 48.333$. Quantities still sum to sixty and one hundred. When box dimensions change, do not compare coordinates without checking scales. A higher relative price reflects resources and preferences rather than creation of extra X units. Ask students to verify both budgets and both goods totals with the unrounded formulas.

4.2 Preferences and information

Preferences close to the endowment set $\alpha_A = 0.75$ and $\alpha_B = 0.25$. A weights X more heavily and B weights Y more heavily, matching the goods initially held in greater quantities. Aggregate symmetry keeps the competitive price at one, while demands become (75, 25) and (25, 75). Opportunities for improvement are smaller than with identical preferences. Less exchange need not indicate weaker

coordination: endowments may already fit preferences better. Keep that possibility visible before comparing only volume or average gains. The treatment separates the motivation to exchange from the institution's ability to coordinate people who want to exchange.

Opposed preferences set $\alpha_A = 0.25$ and $\alpha_B = 0.75$. The reference becomes A (25, 75) and B (75, 25), again at price one. Desirable exchange increases and the contract curve is no longer diagonal. Equal bundles are not a general efficiency rule. Compare marginal rates at the endowment and reference before discussing fairness. Curve shape depends on preferences; price also depends on their combination with resources. A common price can support different allocations in differently composed economies. The debrief should therefore identify parameters before interpreting a visually unusual point as an error or an inequitable choice.

Private preferences retain those opposed parameters but hide the counterpart's parameter. Offered quantities and own points remain visible, while the preview neither calculates the other person's points nor receives their parameter. There is no free messaging or strategic taste-reporting stage. Acceptance can reveal something about a particular bundle without identifying a complete utility function. Compare against public opposed preferences to isolate information. Comparing only against baseline would combine a preference change with an information change, preventing attribution to privacy. The instructor's data retain parameters for analysis, but those administrative records should not be projected to reveal individual assignments.

X units you will keep

Y units you will keep

Bundle preview

	X	Y	ECU
You	50	50	100.00
The other person	50	50	—

Figure 4.1: The private preview retains quantities and hides counterpart points without sending their parameter to the browser.

4.3 Fees, constraints and proposal rights

The exchange fee deducts five ECU from each person when an accepted allocation differs from the initial allocation. It changes no physical totals and is not charged after rejection or exact retention of endowments. A small gross improvement can become a net loss. Allocating (50, 50) to each generates one hundred gross and ninety-five net points, still above eighty. Box curves represent gross preferences without the friction; net gains evaluate whether a specific offer covers the fee. The charge is a points deduction, not a percentage of goods destroyed in transport. Keeping the units explicit prevents mixing this treatment with an iceberg trade cost.

The transfer cap permits changes of at most twenty units of each good relative to initial endowments. Basic (50, 50) requires a thirty-unit transfer and is inadmissible. A (60, 40) and B (40, 60) satisfy the cap and generate approximately 97.98 points each. Distance from the competitive reference

can therefore result from the restriction. Distinguish institutional from physical feasibility and constrained from unrestricted efficiency. An impossible proposal should not be recommended as a correct response to a participant facing a different feasible set. The application retains entries and explains the violated constraint so they can revise them.

X units you will keep

Transfer of either good cannot exceed 20 units relative to the initial endowment.

Y units you will keep

Transfer of either good cannot exceed 20 units relative to the initial endowment.

Bundle preview

	X	Y	ECU
You	50	50	100.00
The other person	50	50	100.00

Figure 4.2: Validation explains the cap and retains quantities for correction.

Permanent proposer assigns every offer to A and every response to B. Goods renew and preferences remain unchanged. The treatment concentrates an institutional right without forcing the proposer to earn more. Compare it with fixed pairs and alternating proposal rights. Remember that A also identifies an endowment: interpreting the causal effect of proposing requires separating those dimensions and using independent markets. Classroom results can motivate a discussion of bargaining power without establishing its causal magnitude. Repeated interaction may affect expectations even though there is no enforceable promise to compensate a counterpart in a future round.

No exchange preserves each person's endowment every round and introduces no artificial choice. It verifies the points reference rather than producing a new independent bargaining observation each repetition. Use it briefly or set the intended horizon before class. The report records observed zero gains, distinct from pending records. Absence of transactions is a treatment rule, not an estimate of rejection or missing counterparties. To study willingness to exchange, select a treatment that permits an actual choice. Ask students what can be learned from the controlled restriction and what requires comparison with an otherwise equivalent exchange session.

4.4 Posted-price markets

Low and high fixed prices are 0.5 and two Y per X, with four people and two of each basic type. A low price can generate more intended purchases than sales of X; a high price can reverse that pressure. This reference is conditional on choices guided by preferences and budgets, rather than orders generated by the software. Human orders determine recorded excess demand. Nobody receives an automatic counterparty and realized allocations incorporate rationing. Discuss why people might change a request when they expect only partial execution. Such behavior need not resemble an unconstrained price-taking demand schedule.

The competitive-reference treatment posts one. If both A participants sell thirty X and both B

participants buy thirty, sixty units execute and everyone ends at (50, 50). This reproduces the model's competitive allocation. Different orders can create rationing or no trade at the same price. A correctly calculated price alone does not establish equilibrium: check choices, budgets and compatibility. The treatment separates computing a supporting price from implementing an institution that coordinates actual individual plans. It also provides a concrete comparison with bilateral bargaining without claiming that a four-person strategic market literally contains infinitely many price-taking traders.

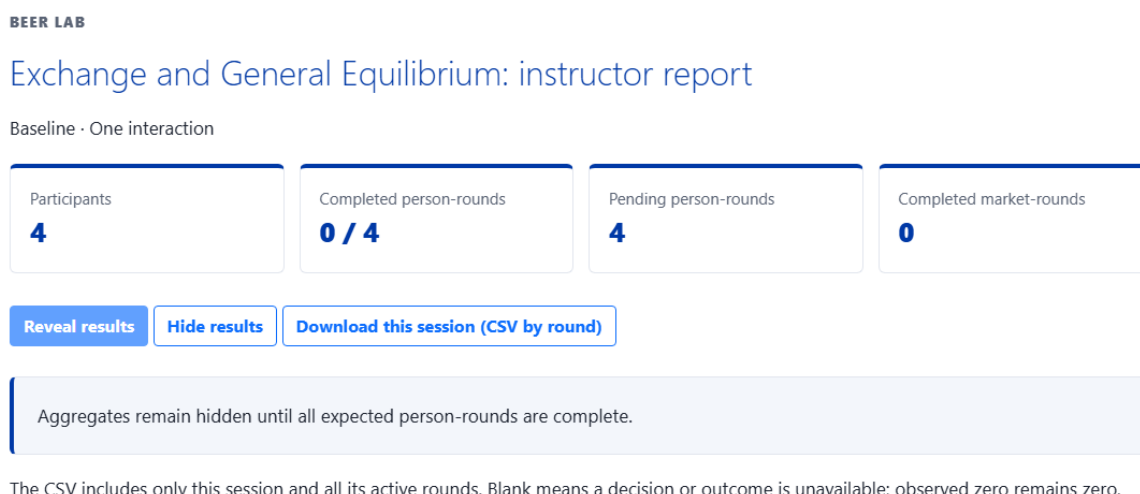
Price adjustment starts at 0.5 and calculates $p_{t+1} = p_t \exp(0.8z_{Xt}/X)$, bounded from 0.1 to ten. Here X is total market X endowment and z_{Xt} is requested purchases minus requested sales before rationing. Executed excess is not used because execution balances transfers by construction. The next round renews goods and retains the updated price. This is an explicit teaching adaptation rather than continuous trading or pure tâtonnement without off-equilibrium transactions. Price changes respond to declared orders, not an estimate of optimal demand or beliefs. The report allows those distinctions to be discussed directly.

Adjustment with scarce X uses (50, 20) and (10, 80) per pair of types. Four people have one hundred twenty X and two hundred Y; the competitive reference is 5/3 while the initial quote remains 0.5. Compare order pressure while holding preferences and adjustment fixed. Convergence is not guaranteed: the horizon is finite, requests are integers, execution is rationed, and people learn. Prices may approach, diverge from or settle away from the reference. Those trajectories invite questions about assumptions supporting an adjustment process rather than conversion of one observed classroom path into a universal dynamic prediction.

Report and evidence

5.1 Revealing completed results

The instructor report is private. Before completion it displays participants, expected person-rounds, pending records and completed market-rounds. Aggregates remain hidden and reveal is disabled while active decisions are pending. Four people over ten rounds generate forty person-rounds, not forty independent participants. Bargaining creates two markets per round for four people, while a posted-price treatment creates one. Establish these denominators before comparing percentages. A pair finishing earlier contributes a completed market, but its outcome is not revealed while the session still contains other pending active decisions. Progress and outcomes therefore serve different functions in the panel.



The CSV includes only this session and all its active rounds. Blank means a decision or outcome is unavailable; observed zero remains zero.

Figure 5.1: The initial report shows progress and permits a session download without revealing decisions.

Once complete, the instructor can reveal and hide aggregates again. Reloading restores the hidden presentation. The report does not display individual codes for projection. Administrative CSV records retain identifiers needed to organize observations and should remain off the classroom display. Downloads are available before completion, allowing backup of interrupted sessions without inventing decisions. If discussion must start early, use a conceptual question rather than forcing incomplete aggregates to appear. Confirm the report belongs to the intended session: identical treatments can have separate sessions for different groups or teaching occasions, and their records should not be confused.

5.2 Gains, distributions and endowment types

The overview shows mean score change, acceptance over completed offers, and markets in which everyone strictly improved. Denominators differ. Acceptance applies only to bargaining; a zero denominator under market or autarky does not mean universal rejection. The histogram uses completed person-rounds and retains losses, zeros and positive intervals. An average gain of twenty can conceal unequal gains or some losses. Examine distribution and types without automatically assigning psychological motivations. Recorded gains compare each outcome with its own endowment, rather than with another person's bundle or the average bundle across the entire class.



Figure 5.2: The distribution retains losses and observed zeros and states its sample size.

Type	n	X	Y	Round score	Change relative to keeping your endowment
A	2	50	50	100	20
B	2	50	50	100	20

Figure 5.3: A and B rows consistently distinguish quantities and score changes.

Tables report average bundles and points by type. Under reassignment a person may change type between rounds, so rows group current positions rather than permanent identities. A four-person market contains two of each type. Do not interpret an average bundle as someone's actual choice, or replace mean utility with utility of the mean: the transformation is nonlinear. Retain individual records for appropriate calculations without exposing participant links. For acceptance questions, distinguish proposer status from endowment type and observe how proposal rights alternate. The same label can identify physical resources while a separate institutional rule determines who acts first.

5.3 Geometry and evolution

The box shows the last completed bilateral market, with its round and sample size one. It does not plot all pairs. It distinguishes endowment, outcome, competitive reference, initial indifference curves and contract curve. Points can coincide: rejection places the outcome at the endowment, while an accepted competitive allocation can coincide with the theoretical reference. Such overlap has economic meaning rather than indicating missing data. State which objects are observed and which are computed from parameters. The reference budget line passes through A's endowment at the competitive price, although bargaining does not require exchanges to occur at that price.

A four-person market replaces the bilateral box with a table of requested orders, executed changes

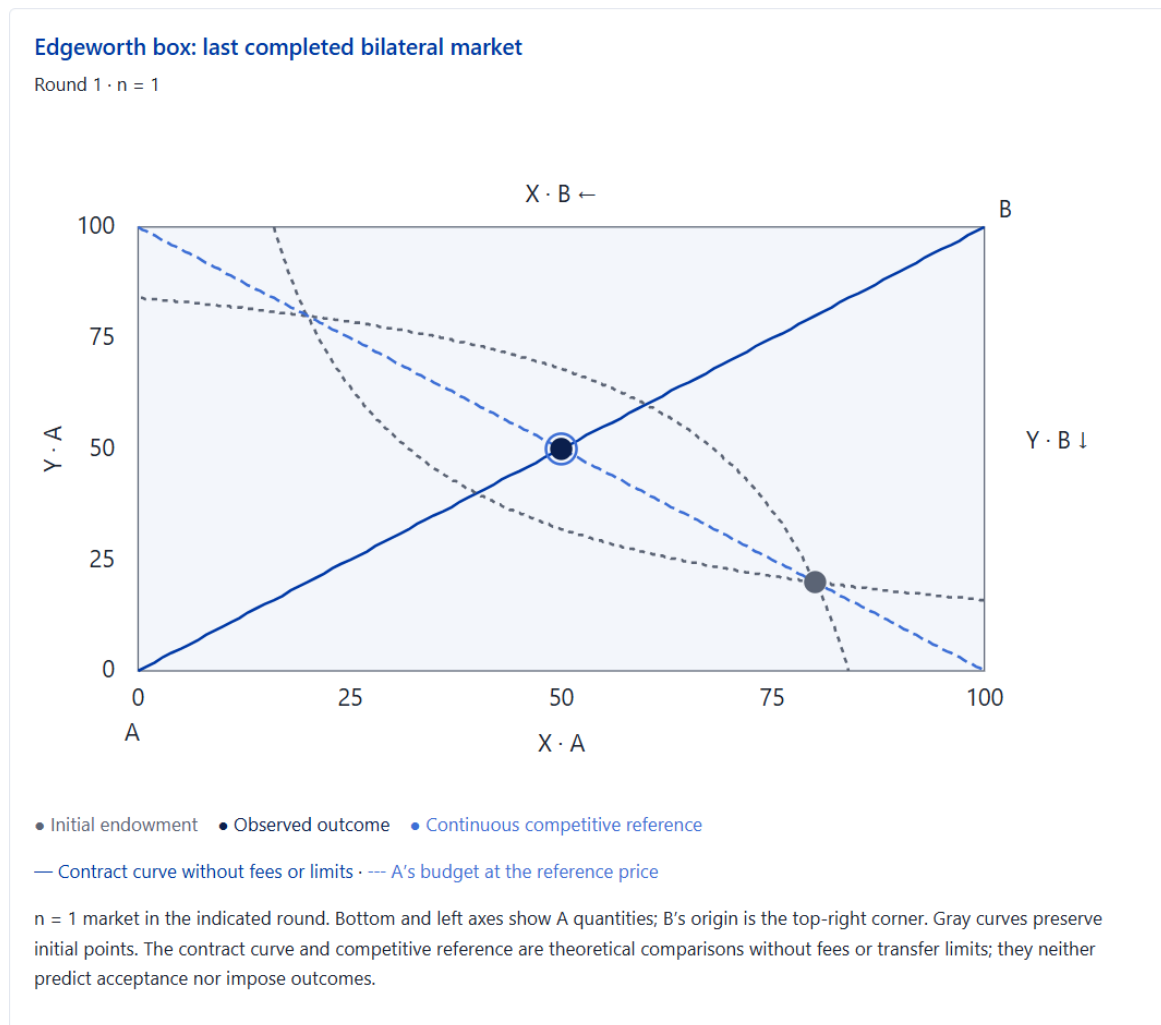


Figure 5.4: The box distinguishes endowment, outcome and reference, with B read from the opposite origin.

and bundles for the last completed market. Evolution separates gains in ECU, prices in Y per X, and requested excess demand in X units. These quantities do not share an axis. The round table adds completed markets and volume. Zero excess with zero volume can mean nobody submitted an order, without demonstrating exhaustion of exchange opportunities. A stable price can reflect balanced declared requests, a constraint or a choice pattern different from optimal demand. Read its associated volume and decisions before calling it equilibrium.

Orders and execution: last completed market

Round 10 · n = 1

Type	Requested X order	Executed change in X	X	Y	ECU
A	-20	-20	60	38.965	16.7
B	30	20	40	61.035	18.82
A	-20	-20	60	38.965	16.7
B	30	20	40	61.035	18.82

Figure 5.5: Reconstruct requests and execution before interpreting volume or final bundles.

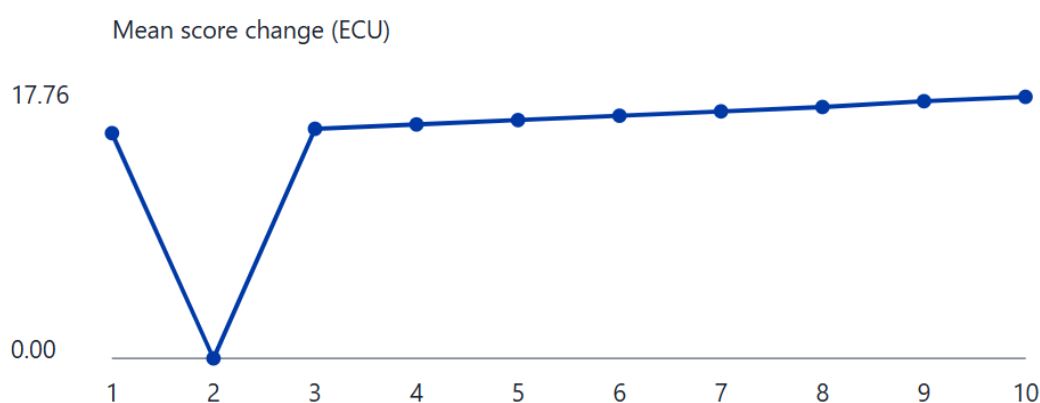


Figure 5.6: Score-change trajectories use ECU and completed person-rounds.

Compare fixed and random partners using separate sessions and retain the matching label. The report does not automatically combine unrelated databases. Use the same parameters and horizon and record treatment order. Ten observations from one market are not ten independent replications. A causal analysis needs appropriate randomization and attention to within-group dependence. A class may illustrate learning without estimating a causal effect. When comparing courses, document prior exposure, instructions and attendance before attributing differences to an institution. Those differences can matter even when the software and scoring formula are identical.

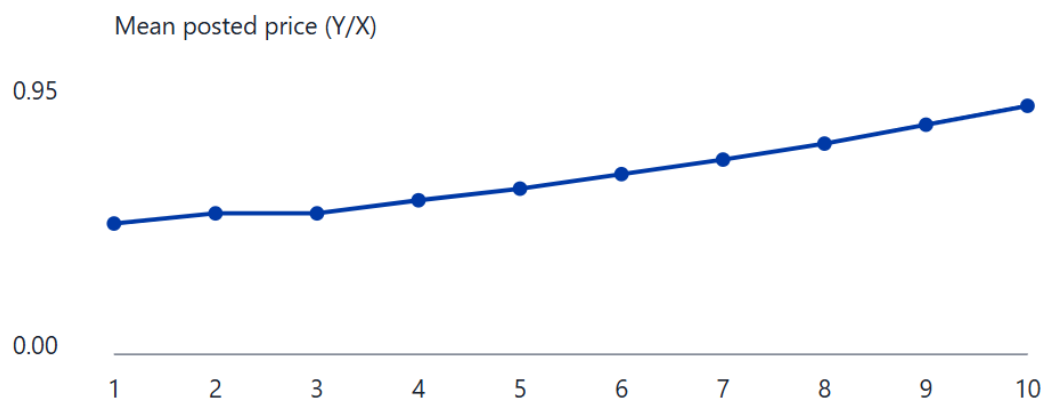


Figure 5.7: Prices use Y units per X and remain separate from points.

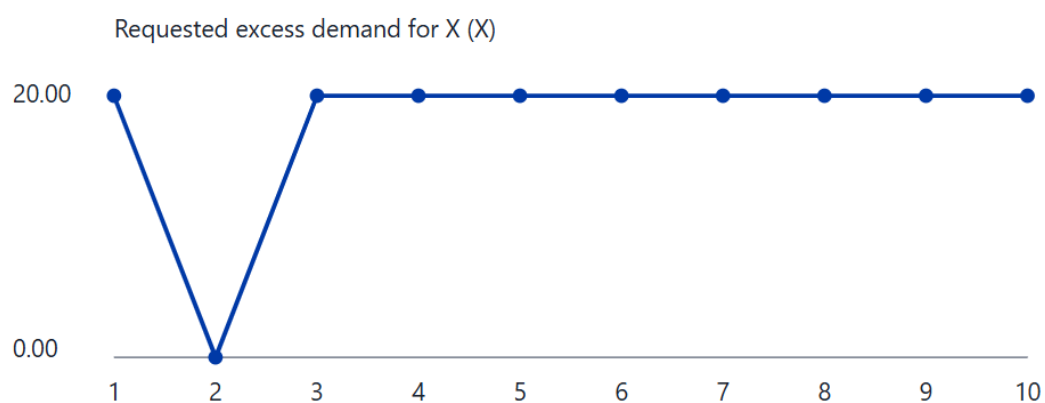


Figure 5.8: Requested excess X is retained before rationing; zero does not establish equilibrium.

Classroom practice and data

6.1 An introductory and an advanced class

For fifty minutes, allow eight for access and instructions, seven for comprehension and interaction, twelve for reconstruction, eighteen for the box and competitive reference, and five for an exit response. These are planning estimates rather than measured durations. Prepare links and sessions beforehand. Address the specific rule when someone corrects comprehension while retaining privacy. Prevent discussion between people who have finished and those still choosing, because it changes the experience. Waiting students can write an individual prediction without sharing it, provided they do not delay a decision needed by someone else to complete the market.

Before revealing theory, ask whether both people can improve while resources stay constant. Collect proposed bundles and check totals on the board. Then reconstruct an anonymous market, separating endowment, offer, response and outcome. Introduce the box afterwards. The graphic explains an understood experience rather than becoming a figure memorized in isolation. Ask where B reads their quantities and what an allocation outside the box would mean. A bundle with attractive points but nonexistent resources is not feasible, even if everyone prefers receiving it. This sequence establishes conservation as part of economic reasoning instead of a technical restriction hidden in software.

For seventy-five minutes, allocate fifteen to bargaining and conservation, fifteen to budgets, twenty to a low-price or adjustment market, fifteen to the report and ten to assessment. Compare separate sessions and announce rule changes. Low prices and private preferences are not one experimental variation. In an advanced class, derive optimal demand and compare its implied excess demand with declared orders. This connects optimization, institution and learning. It also identifies what additional information could separate arithmetic errors from a strategic response to expected rationing. A theory comparison becomes more productive when students can name the assumption that differs from actual classroom conditions.

Feedback script

Ask what was conserved and what changed. Reconstruct goods before points. Separate proposal, acceptance and allocation. In markets, write orders, the short side, rationing and Y payments. Present the competitive reference afterwards and ask for one assumption that could explain a difference from the observed outcome.

6.2 Worked exercises

Exercise 1: mutual improvement. Start from A (80, 20) and B (20, 80). *Guidance:* A delivers thirty X in return for thirty Y and both finish at (50, 50). Scores rise from eighty to one hundred, a gain of twenty ECU each. One hundred units of each good are conserved; the operation produces no physical resources. Adding quantities and calling them points omits the bundle transformation. Ask students to state the direction of both transfers and explain why final composition is more valuable under the reference preferences.

Exercise 2: efficiency and acceptance. A receives (70, 70). *Guidance:* B gets (30, 30) and scores are one hundred forty and sixty. The point lies on the diagonal contract curve, but B loses twenty relative to retaining the endowment. Rejection restores initial bundles. This identifies a material comparison rather than a universal response prediction. A's improvement does not automatically compensate B without a further transfer. Discuss what information about the curve and starting point supports each claim.

Exercise 3: competitive price. Derive the basic price. *Guidance:* the numerator is $0.5(20+80) = 50$ and denominator $0.5(80+20) = 50$, so $p^* = 1$. Each person's wealth equals one hundred Y, with half spent on each good. Demands are fifty of each. Check individual budgets and aggregate totals before calling the allocation equilibrium. Compatibility of only one market is insufficient without the budget reasoning connecting it to the other. The relative price is Y per X rather than ECU per unit.

Exercise 4: rationing. At price 0.5, two sellers request sales of ten X each and two buyers request thirty each. *Guidance:* supply is twenty, purchases sixty, excess forty and volume twenty. Each buyer receives ten X and pays five Y; each seller delivers ten X and receives five Y. Unexecuted goods remain in endowments. Aggregate Y payments are ten on each side. Requested excess remains informative even though executed transfers offset exactly. Compare the individual execution rate with aggregate volume and identify which side is rationed.

Exercise 5: next price. Apply adjustment to that market with total X of two hundred. *Guidance:* $p_{t+1} = 0.5 \exp(0.8 \times 40/200) \approx 0.5868$. Excess purchases raise the quote. The following round renews goods and uses that price without carrying previous bundles. Applying the formula to volume twenty confuses trading activity with imbalance. Using executed excess would always give zero and remove adjustment. Ask why the exponent is dimensionless and why the result retains Y-per-X units.

Exercise 6: observed zero. Every order equals zero. *Guidance:* excess and volume are zero, initial bundles and scores remain, and the quote does not change. These are observed outcomes rather than pending records. Mutual gains can still exist under basic endowments. Zero declared excess therefore does not prove competitive equilibrium. Ask what price-taking choices were expected and what information is missing to explain no orders. Someone might misunderstand, avoid an operation or respond to expectations, but the order field alone identifies none of those causes.

Exercise 7: fee versus cap. Compare (50, 50) with a fee of five and a cap of twenty. *Guidance:* under the fee the bundle is permitted and gives ninety-five net points each. Under the cap it is inadmissible because thirty units of each good must change hands. A (60, 40) and B (40, 60) satisfy the cap and yield $2\sqrt{2400} \approx 97.98$ without a fee. Do not combine institutions if only one is active. This separates a friction reducing points without changing physical resources from a rule directly restricting feasible reallocations.

Exercise 8: efficient inequality. With (80, 80) and (20, 20), calculate marginal rates and competitive demands. *Guidance:* both rates are one and demands match endowments at price one. Points are one hundred sixty and forty. No Pareto improvement helps the latter without hurting

the former given these resources and preferences. A distributive policy asks a different question from voluntary exchange. The Pareto criterion does not select a preferred distribution. Request an explanation recognizing this limitation without interpreting it as a normative endorsement of inequality.

6.3 Downloading and organizing data

The report downloads a long CSV for the open session: one row per person and active round, forty data rows for four people over ten rounds. It retains types, choices, agreements, endowments, parameters and outcomes. Pending results remain blank; observed zero remains zero. An inapplicable response differs from an unsubmitted choice. Retain completion and treatment fields to distinguish these cases.

The session-specific native Data download is wide, with one participant per row and columns for ten technical rounds. Inactive columns do not indicate dropout. Global exports can contain other sessions: select the session link or report CSV to isolate the class. Preserve an original and import UTF-8 comma-delimited data with the correct decimal convention. Protect participant codes because they can be linked to entry URLs.

Count one offer per market-round when analyzing acceptance, not one offer for each person's repeated CSV row. Gains use person-rounds. Aggregate orders within markets and retain identities privately to study dependence under reassignment. Record interruptions, attendance and treatment order. Compare per-round gains rather than accumulated points when horizons differ.

6.4 Troubleshooting and assessment

For a waiting screen, identify who must propose, respond or order. Check session and horizon before restarting processes. Updating does not require erasing a database. A link from a replaced database needs a valid current session. Localhost works only on the hosting computer; other computers need the server route configured by the laboratory. Preserve class records and document interruptions instead of replacing data to resolve uncertainty about a screen.

For surprising bundles or points, reconstruct conservation, type, price and fee. Distinguish requested from executed quantities and remember that B proposes their own retained bundle. Keep private parameters off the projector. An empty report may need completion or reveal; a decimal reference may differ from an integer choice. Zero gains can follow autarky, rejection or no counterparty. Decisions distinguish these cases without identifying motives.

Finish with an equation, an observation and an inference limit. Ask students to explain the budget in Y, rationing with its denominator, and why a trajectory does not prove convergence under other preferences. Assess the distinction among goods, points and prices rather than memorization of an allocation. A successful response identifies both resource constraints and one difference between the actual institution and the competitive reference.

Checkpoint

Confirm completion, session download, active horizon and protected identifiers. Record interruptions and retain announced rules with the data. Interpretation should be reconstructible from decisions and parameters without attributing outcomes to unmeasured mechanisms.

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