



Instructor Guide to Armaments, Security Competition, and Inspections

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 a two-participant security competition. It is intended for instructors in international relations, political economy, and experimental economics who want to connect an individual decision with its joint consequences. The activity compares capacity spending, limits, voluntary joining, inspections, accumulation, offense and defense, and private valuations.

Five substantive chapters provide a complete teaching sequence. The first organizes the class and explains access. The second develops reference accounts and predictions. The third presents the six extensions and their comparison limits. The fourth explains the private instructor report and data downloads. The fifth provides solved exercises, discussion questions, an assessment rubric, and operational troubleshooting. Common instructions are explained once; each extension identifies the actual changes in rules, information, and incentives.

All amounts are Experimental Currency Units (ECU). ECU are an experimental unit of account and are not automatically pesos, dollars, or course points. This is an original teaching adaptation informed by academic literature. Technical verification supports an instructor preview; use with students still requires a classroom pilot and prior explanation of any real incentive. A numerical choice should never be treated as evidence about a student's nationality, political beliefs, or suitability for a public role.

Author

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For the instructor

This guide follows the English interface. Spanish configurations implement the same accounts. Keep aggregates hidden during decisions and reveal the report after the relevant stage closes. Do not connect results with names, student records, or classroom seats.

Contents

How to use this guide	i
1 Preparation and implementation	1
1.1 Access links	1
1.2 Teaching question and scope	2
1.3 Class sequence	2
1.4 Navigation and routes	2
1.5 Choosing an edition and parameters	3
1.6 Participants and matching	3
1.7 Resources, comprehension, and closing	3
2 Mechanism and theory	8
2.1 Endowment, capacity, and resource	8
2.2 Three solved symmetric outcomes	8
2.3 Asymmetric spending and relative position	8
2.4 Best response and equilibrium	9
2.5 Efficiency and agreement stability	9
2.6 Repetition and expectations	9
2.7 Precision and limits of the benchmark	10
3 Institutions and information	17
3.1 Binding limit	17
3.2 Joining and voluntary compliance	17
3.3 Imperfect inspection and costs	18
3.4 Accumulation and depreciation	18
3.5 Offense and defense as different technologies	18
3.6 Private valuations and uncertain preferences	19
3.7 Comparisons that preserve interpretation	19
4 Report, data, and debriefing	27
4.1 Revelation and progress	27
4.2 Units and denominators	27
4.3 Spending distribution	28
4.4 Trajectories and joint payoff	28
4.5 Wide download and round-level file	28
4.6 Reconstructing payments	29
4.7 Selection, order, and inference	29
5 Cases, assessment, and teaching use	31
5.1 A debrief that starts from observations	31
5.2 Worked case: limit and deviation	31
5.3 Worked case: inspection and randomness	31

5.4	Worked case: inherited capacity	32
5.5	Worked case: defense without offense	32
5.6	Worked case: valuation and resource	32
5.7	Calculation exercises	33
5.8	Answers and reasoning	33
5.9	Written assessment and rubric	33
5.10	Troubleshooting and recovery	34
5.11	Privacy, literature, and adaptation	34
5.12	Pilot and teaching success	35

List of Figures

1.1	Institutional website: access through CLASSROOM.	4
1.2	Teaching catalog: search by title, topic, and JEL.	5
1.3	Isolated Demo with twenty bilingual configurations.	6
1.4	The four family rooms.	6
1.5	Basic room: three configurations in the selected language.	7
2.1	Welcome, purpose, and laboratory rules.	11
2.2	Budget, resource, sequence, and example.	12
2.3	Comprehension questions before decisions.	13
2.4	Field-specific correction preserves correct answers.	14
2.5	Position and matching at round start.	15
2.6	Simultaneous capacity-spending decision.	15
2.7	Allocation and payment for a completed round.	16
2.8	Persistent final page with the sum of payments.	16
3.1	Binding limit applied to the form.	20
3.2	Simultaneous joining of the voluntary agreement.	20
3.3	Decision after the joining stage.	21
3.4	Joining informed by inspection rules and costs.	22
3.5	Spending under the effective agreement state.	23
3.6	Results with separate monitoring and fine charges.	23
3.7	Third round: prior stock of 18 after two investments of 10.	24
3.8	Separate offense and defense fields with one budget.	25
3.9	Results under directional-transfer technology.	25
3.10	Private own valuation before the decision.	26
4.1	Private report: visible progress and hidden aggregates.	29
4.2	Aggregates after deliberate revelation.	30
4.3	Spending distribution by position, with denominators.	30

Preparation and implementation

Purpose	Connect relative position, joint costs, and control institutions.
Experimental unit	One pair of real participants with symmetric positions A and B.
Basic edition	One encounter, ten fixed-pair rounds, or ten rematched rounds.
Extended edition	Reference plus six extensions: limit, agreement, inspection, stock, offense and defense, private valuations.
Resources	40 ECU budget per person; joint resource of 60; base capacity of 1.
Decision	Integer spending from 0 to 40; binding limit 10; two fields with a maximum combined cost of 40 in offense and defense.
Payoff	Remaining budget plus allocated benefit, less applicable monitoring costs and fines.
Participants	A multiple of two; at least four for rematching; four in the demonstration.
Topics	Arms races, security dilemma, arms control, inspections, offense and defense, private information.
JEL	A22, C72, C92, D74, F52, F53.
Suggested duration	45–60 minutes for reference; 60–90 for repetition and discussion. Confirm through a pilot.
Availability	Validated local instance. Proposed public domain; deployment pending.

1.1 Access links

Institutional site: <https://beer-lab.org/>. Teaching catalog: <https://teaching.beer-lab.org/>.

Validated local preview: <http://localhost:8198/demo> and <http://localhost:8198/rooms>.

Proposed host, deployment pending: <https://armssecurity.beer-lab.org/>.

- https://armssecurity.beer-lab.org/room/armamentos_es
- https://armssecurity.beer-lab.org/room/arms_security_en
- https://armssecurity.beer-lab.org/room/armamentos_extendido
- https://armssecurity.beer-lab.org/room/arms_security_extended

1.2 Teaching question and scope

This activity studies an international-relations tension: two actors can improve their relative position through capacity spending while reducing the resources available to both. Positions A and B are symmetric and do not represent nationalities, governments, or personal characteristics. Security competition is interpreted during the debrief. Participant instructions describe decisions and accounts so that people can act without being given a hypothesis about how they should behave.

The family covers one encounter, repetition with fixed counterparts, and randomly rematched repetition. Extensions introduce a binding limit, voluntary joining, imperfect inspection, persistent capacity, separate offense and defense, and private valuations. These institutions compare economic mechanisms. The program does not reproduce every dimension of an arms race, and a classroom choice cannot be read as foreign policy. Its teaching value is to make visible the costs, incentives, and information that can sustain socially costly competition. Begin with the common accounting environment and introduce institutions only after students can reconstruct an individual outcome.

1.3 Class sequence

A reference class can use 45 to 60 minutes: ten for entry and rules, five for comprehension, ten for decisions, twenty for reading and discussion, and five for closing. With ten rounds or several institutions, reserve 60 to 90 minutes and check timing with your own class. These intervals are preparation suggestions, not measurements from a student pilot. A round may take longer when a private valuation or a two-component choice needs explanation.

Before play, ask students to identify what each person controls and what depends on the counterpart. Avoid announcing equilibrium spending or recommending a division. After the encounter, show accounting first and compare outcomes with theoretical benchmarks second. If you run another condition, use different groups or discuss the effect of learning the first environment. Leave time for a written exit question: what changed, which mechanism could explain the result, and what additional comparison would be needed? Close with a conclusion about incentives and institutions rather than a classification of students as cooperative or conflict-prone.

1.4 Navigation and routes

Open the institutional laboratory site and select CLASSROOM. The teaching catalog lets instructors search the title, change language, and locate topics such as arms races, the security dilemma, and inspections. Its card should lead to this family's host. The public address in the summary table is proposed; before a real class, confirm with the laboratory that deployment and administrative access are available. The local preview works only on the computer running the instance.

Demo is the family's configuration catalog; Rooms lists its four rooms. A room organizes admission but does not determine every rule by itself. In its form, the instructor selects the configuration and participant count. Check that selection's language before distributing links. Keep the instructor report and administrative data on your own device. Share the room or participant link using the laboratory's procedure. Never project passwords, individual links, or a list that connects participant codes with names. A participant needs the current session's access, not the instructor's administrative account.

1.5 Choosing an edition and parameters

The basic room offers one encounter, ten fixed-pair rounds, and ten randomly rematched rounds. Extended rooms contain a reference and six institutions. Start with a comparison that answers a course question; running every version in one class can make interpretation harder. For enforceable limits, compare the reference with the binding cap. For compliance, compare voluntary joining and inspection while holding the limit fixed. For dynamics, contrast persistent stock with fixed-pair rounds without accumulation.

Reference parameters are a 40 ECU endowment, a 60-unit resource, base capacity of one, and a limit of ten. The form permits parameter changes, while the server checks compatibility. Record every change and review instructions and examples before admitting students. Do not alter amounts during play. Stock requires fixed counterparts; inspection requires admissible probabilities and charges. Changing several elements does not preserve a clean comparison. A difference in outcomes could reflect budgets, technology, information, or history as well as the institution being taught. Treat modifications as new classroom comparisons and keep their configuration with the exported data.

1.6 Participants and matching

The decision unit is a person and the interaction unit is a pair. Each outcome depends on both decisions. Participant counts must be even: two suffice for fixed pairing, while rematching requires at least four. With an odd count, assign the extra student an observation task outside the program or postpone admission. Do not share a link or invent a counterpart. Observers can solve examples and discuss them after play closes, without communicating with active participants.

Positions are randomly assigned when the session is created and remain fixed. In fixed pairing, the same two people interact throughout. In random matching, position B participants are independently shuffled each round and paired with position A. Previous counterparts can reappear by chance, especially with only two pairs. Do not describe the rule as guaranteed absence of repeat encounters. Accumulation uses ten rounds with fixed counterparts because its purpose is to observe a security relationship with shared history and persistent own stock. Position labels organize the report; they do not create different rights or imply unequal roles.

1.7 Resources, comprehension, and closing

ECU means Experimental Currency Units. It does not automatically mean pesos, dollars, or grade points. Individual endowments renew each round and spending is deducted from them. The common resource is divided, not duplicated into every account. In the reference, each allocated unit is worth one ECU. Under private valuation, physical units and ECU benefits differ: the allocated fraction is multiplied by the person's valuation of the entire resource.

Comprehension asks about the example payoff, the resource size, and the absence of a winner lottery. Each error explains the calculation while retaining other answers. Help students read the rule without recommending a strategy. High spending does not establish misunderstanding when comprehension answers are correct. The sequence then covers position, waiting, joining when applicable, spending, settlement, and results. After the last active round, a final screen stays open. Ask students to wait for discussion rather than submit another choice. If someone closes the browser, restore the same link instead of creating a new participant. Reconnection preserves the intended person and pair.

Checkpoint

Before admission, confirm language, treatment, active rounds, matching, and group size. Open a test link and keep the report hidden.

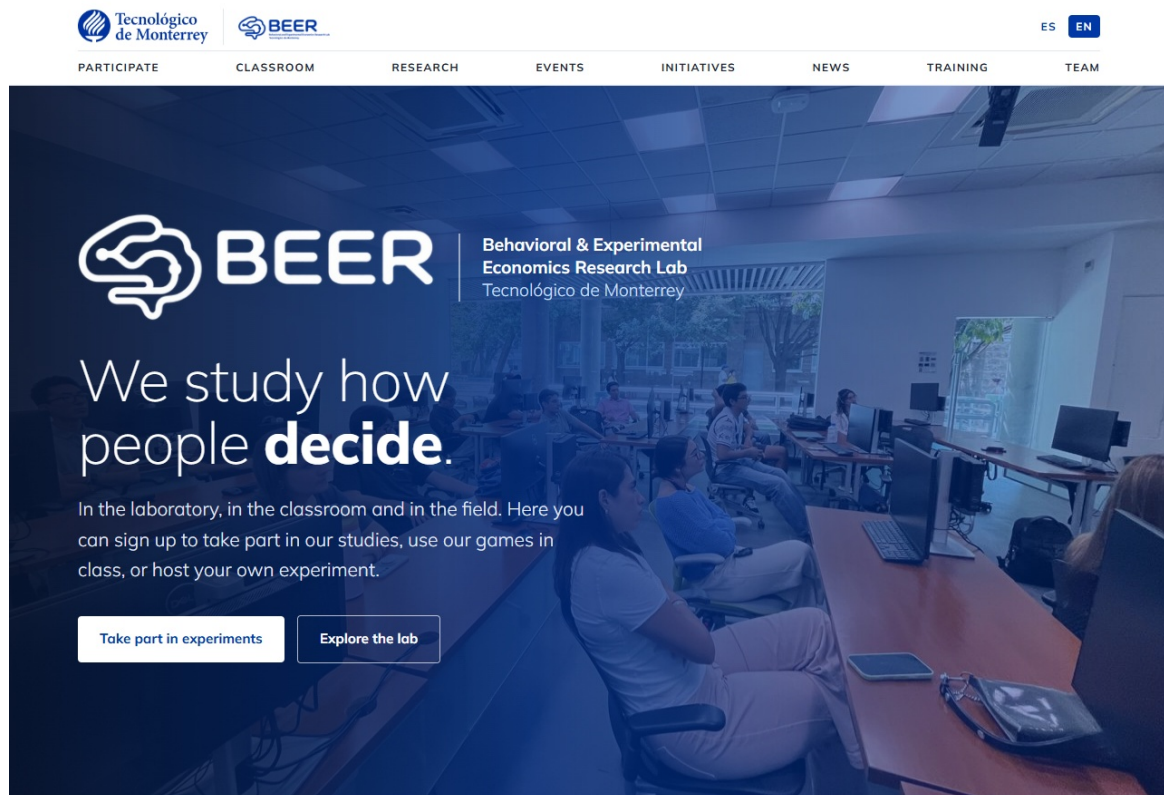


Figure 1.1: Institutional website: access through CLASSROOM.

Tecnológico de Monterrey **BEER** ES EN

PARTICIPATE CLASSROOM RESEARCH EVENTS INITIATIVES NEWS TRAINING TEAM

INSTRUCTORS AND STUDENTS

Classroom experiments

Experimental economics games for classroom activities and discussion. Open the game your instructor tells you.

Instructors: how to use these games in class or propose a new one → [instructor guide](#)
 Lab research: beer-lab.org/en/research

Search by title, topic, keyword or JEL code...

Topic ▾ JEL code ▾ 103 games

Electoral Accountability and Political Selection

Study how the prospect of remaining in office changes an officeholder's behavior and how information allows voters to choose between politicians with different types. Basic: One encounter or four encounters with fixed or reassigned groups. Extended: Eight treatments on continuation, information, types, office value, term limits, and audits.

electoral discipline political accountability political selection

Aggregate Demand and Aggregate Supply

Understand how spending choices aggregate into demand and how equilibrium with supply determines output and prices. Basic: One period, ten periods with the same economy, or ten periods with reassigned economies. Extended: Demand expansion and contraction, supply shock, fiscal stimulus, capacity, expectations, and coordination.

aggregate demand aggregate supply price level potential output

Figure 1.2: Teaching catalog: search by title, topic, and JEL.

Demo

[ES] Armamentos y competencia de seguridad — una interacción	Armamentos, competencia de seguridad e inspecciones / Armaments, Security Competition, and Inspections — BEER Lab Seleccione una variante de este juego. Select a version of this game.
[ES] Armamentos y competencia de seguridad — 10 rondas, pareja fija	
[ES] Armamentos y competencia de seguridad — 10 rondas, parejas aleatorias	
[ES] Extendido — Referencia proporcional	
[ES] Extendido — Límite vinculante	
[ES] Extendido — Acuerdo voluntario	
[ES] Extendido — Inspección imperfecta	
[ES] Extendido — Capacidad acumulada	
[ES] Extendido — Ofensa y defensa	
[ES] Extendido — Valoraciones privadas	
[EN] Armaments and security competition — one encounter	
[EN] Armaments and security competition — 10 rounds, fixed pair	
[EN] Armaments and security competition — 10 rounds, random pairs	
[EN] Extended — Proportional reference	
[EN] Extended — Binding limit	
[EN] Extended — Voluntary agreement	
[EN] Extended — Imperfect inspection	
[EN] Extended — Accumulated capacity	
[EN] Extended — Offense and defense	
[EN] Extended — Private valuations	

Figure 1.3: Isolated Demo with twenty bilingual configurations.

Rooms

Current rooms:

[ES] Armamentos y competencia de seguridad
[EN] Armaments and security competition
[ES] Armamentos y competencia de seguridad — Extendido
[EN] Armaments and security competition — Extended

Figure 1.4: The four family rooms.

Room: [EN] Armaments and security competition

Create a new session

Session Config

[EN] Armaments and security competition — one encounter

Number of participants

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

Create

[Configure session](#) 

App sequence

arms_security_game (10 rounds)

Armaments, Security Competition, and Inspections / Armamentos, competencia de seguridad e inspecciones.

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://127.0.0.1:8198/room/arms_security_en

Figure 1.5: Basic room: three configurations in the selected language.

Mechanism and theory

2.1 Endowment, capacity, and resource

Distinguish three objects. The endowment is a 40 ECU account that each person can keep or spend. Capacity is an index starting at one and increasing with spending. The 60-unit resource is divided between the two participants. A capacity unit is not additional resource production. Spending changes a person's relative allocation while reducing the unspent endowment. Positive base capacity prevents the formula from being undefined when neither person spends.

If A spends a and B spends b , A's fraction is $(1+a)/(2+a+b)$, while B's is $(1+b)/(2+a+b)$. These fractions sum to one. Multiplying each by 60 gives its resource allocation. Payoff adds this allocation to 40 minus own spending. Reference joint payoff is therefore 140 minus a minus b . This identity checks every outcome without calculating preferences or inferring intentions. If the sum differs, review units, rounds, and charges before interpreting behavior. Competition redistributes the resource; it does not create a separate 60-unit reserve for each actor.

2.2 Three solved symmetric outcomes

With zero spending, capacities are one and one. Each person receives 30 resource units and keeps 40 ECU, yielding an individual payoff of 70 and a joint payoff of 140. With spending of ten each, capacities are eleven and eleven. The resource still splits equally, but each person keeps only 30 of the endowment, so individual payoff is 60 and joint payoff is 120. Spending fourteen each produces capacities of fifteen and fifteen, allocation of thirty again, and payoff of 56 each. Equal shares do not establish equal efficiency across these scenarios.

Ask students why increasing both capacities does not increase either allocation. Then ask what changes when only one person raises spending. The tension need not arise from ignorance of an accounting identity: each person may want to avoid falling behind the other. Zero spending is a joint-resource benchmark, but it need not be stable against unilateral deviation. Keep distribution, efficiency, and the incentives for sustaining an agreement as separate questions.

2.3 Asymmetric spending and relative position

Suppose A spends ten and B spends zero. Their capacities are eleven and one. A receives 55 resource units and B receives five. Payoffs are forty minus ten plus fifty-five, or 85, and forty plus five, or 45. Their sum is 130, exactly ten below the 140 reference. A gains relative to zero spending while B loses more; spending explains the gap between private benefit and joint cost. No winner draw can turn a proportional allocation into the entire prize.

Hold A's spending fixed and allow B to respond. Increasing B's spending changes both shares even when A's choice is unchanged. This interdependence makes the activity a game. In a simultaneous round, B does not observe A's current spending before choosing and may use an expectation, a learned rule, or an equality preference. Do not attribute an observed strategic response to information the participant lacked. Later fixed-pair rounds provide shared history, but the current decision remains simultaneous and private. A sequence of outcomes is therefore not a sequence of publicly observed within-round moves.

2.4 Best response and equilibrium

For a continuous analytical reference, hold counterpart spending b fixed. A maximizes forty minus a plus $60(1+a)/(2+a+b)$. The marginal allocation benefit is $60(1+b)$ divided by the square of $(2+a+b)$, while marginal cost is one. Equating them gives a equal to the square root of $60(1+b)$, minus two, minus b , subject to the budget. Apply the zero and forty boundaries whenever the expression falls outside the interval. Because the program uses integers, compare neighboring choices before using a continuous solution as a decision benchmark.

At a symmetric equilibrium, a equals b and the condition reduces to $60/[4(1+a)]=1$, giving a equal to fourteen. No alternative integer spending raises individual payoff against a counterpart spending fourteen. Payoff is 56 each. The program does not require this choice; it provides a theoretical benchmark for discussion after play. A mean near fourteen does not demonstrate that everyone solved the model: it could combine very high and very low choices. This is why the report includes a spending distribution rather than averages alone.

2.5 Efficiency and agreement stability

Joint efficiency is maximized by zero spending from both, because it preserves all endowments while dividing the same resource. Against a counterpart spending zero, however, a unilateral increase can substantially raise own payoff. Joint efficiency and strategic stability are different concepts. An agreement needs an account of what prevents deviation: an enforceable restriction, a preference for compliance, future reciprocity, or an expected consequence. Stating that both sides can gain from lower spending identifies an opportunity without solving implementation.

A binding limit of ten changes the admissible choice set. Against spending of ten, the unrestricted continuous best response is about 13.69. Under a cap, the largest admissible choice is ten. Spending ten each is consequently a constrained equilibrium benchmark, yielding sixty each. A voluntary agreement with the same limit permits deviation: spending fourteen against ten pays approximately 60.62, compared with sixty from compliance. The monetary deviation gain is small but positive. The same written number can therefore create different incentives depending on whether it is enforceable.

2.6 Repetition and expectations

Ten fixed-pair rounds make learning, adaptation, and shared history observable. When low spending receives a low-spending response, a pair may try to sustain a less costly trajectory. If one person raises spending, the counterpart can react next round. The interface adds neither free messages nor separate threats; interpretations of reciprocity should remain hypotheses grounded in the observed sequence. A later response does not by itself establish what the participant believed while choosing.

Rematching reduces relationship continuity but does not remove general learning about the activity. Previous counterparts can reappear. Compare spending by round, dispersion, and payoffs, while explaining that one class cannot conclusively identify the causal effect of repeated relationships. If everyone first plays fixed pairs and then rematching, order and experience also change. Assign configurations across groups or vary order across classes for a more informative comparison. Do not treat all rounds as independent observations from people who never learned from previous interactions. The institution changes incentives within a continuing learning environment.

2.7 Precision and limits of the benchmark

A's resource allocation is rounded to two decimals; B receives the residual of the total resource. This prevents units from being created or lost by separately rounding both shares. Payoffs also use two decimals. A one-cent difference can reflect precision rather than a different economic rule. Reconstruct data from the stored allocation rather than repeatedly rounding a fraction. If parameters change, recompute examples and check that instructions display the actual amounts.

The standard equilibrium assumes people maximize their monetary accounts, know the rule, and expect consistent decisions from the counterpart. Behavior can differ because of expectations, reciprocity, dislike of falling behind, attention, experience, or distributional preferences. These are alternative explanations, not diagnoses the program automatically establishes. Spending above fourteen is an observation relative to a benchmark; calling it irrational would require additional knowledge of objectives and information. The activity distinguishes a conditional prediction from a description of people. Preserve this distinction when translating capacity and spending into examples of international policy, especially when historical actors had objectives absent from the classroom model.

Theoretical foundation

Proportional allocation is deterministic. Greater capacity improves the relative share, while its cost reduces joint surplus. Inspection introduces a separate, explicit lottery.



BEER LAB · TEACHING GAMES

Resources, capacity, and decisions

The BEER Lab in the Department of Economics at Tecnológico de Monterrey is a place to learn about economic decisions through controlled activities.

You will interact with another participant. Both participants' decisions determine the resources and payoffs for the round.

Participation rules

- Remain silent and decide individually.
- Do not communicate with other participants during the activity.
- Follow the instructions; do not refresh or close the page.
- If you have a problem, raise your hand and ask privately.
- Wait for the instructor's directions after finishing.

I have read the rules and agree to participate.

- ☐ Yes
☒ No

Start

Figure 2.1: Welcome, purpose, and laboratory rules.



RESOURCES AND CAPACITY · ROUND 1 OF 1



Instructions

Resources and unit of account

Each participant receives 40 ECU per round. The common resource contains 60 units. Initial capacity is 1; spending is deducted from your own endowment. The endowment renews each round.

ECU stands for Experimental Currency Units. It is the unit of account for this activity.

This session does not convert ECU into real money.

Your budget

40 ECU

Common resource

60

Both participants decide privately and simultaneously. Your share of the resource is calculated from both decisions; there is no winner lottery. You then see the round outcome.

In the reference, $\text{capacity} = \text{base} + \text{spending}$. $\text{Allocation} = \text{resource} \times \text{own capacity} / \text{total capacity}$. $\text{Payoff} = \text{endowment} - \text{spending} + \text{benefit from the allocation}$.

Proportional capacity

Choose integer spending within your budget. Each unit raises your capacity by one unit.

Example: if both spend 10, each receives half the resource. Your example payoff is 60 ECU.

One encounter

Continue

Figure 2.2: Budget, resource, sequence, and example.

Comprehension check

Resources and unit of account

ECU stands for Experimental Currency Units. It is the unit of account for this activity.

This session does not convert ECU into real money.

Use the example in the instructions. Incorrect answers receive feedback beside each question; you can correct them without losing payoffs.

Example: if both spend 10, each receives half the resource. Your example payoff is 60 ECU.

What is your payoff in ECU in the displayed example?

How many units does the common resource contain in total?

Is a winner randomly drawn to allocate the common resource?

Continue

Figure 2.3: Comprehension questions before decisions.

Comprehension check

Resources and unit of account

ECU stands for Experimental Currency Units. It is the unit of account for this activity.

This session does not convert ECU into real money.

Use the example in the instructions. Incorrect answers receive feedback beside each question; you can correct them without losing payoffs.

Example: if both spend 10, each receives half the resource. Your example payoff is 60 ECU.

What is your payoff in ECU in the displayed example?

Your answer: 0. The correct answer is 60. The calculation is $40 - 10 + 30 - 0 = 60$ ECU. Monitoring is deducted only in the inspection example.

How many units does the common resource contain in total?

Is a winner randomly drawn to allocate the common resource?

Continue

Figure 2.4: Field-specific correction preserves correct answers.

Your position in this round

B

Your position remains fixed within the session. Both positions have the same decision options.

One encounter

Your budget

40 ECU

Common resource

60

Choose integer spending within your budget. Each unit raises your capacity by one unit.

Continue

Figure 2.5: Position and matching at round start.

Your spending decision

Your budget

40 ECU

Common resource

60

Choose integer spending within your budget. Each unit raises your capacity by one unit.

Spending on capacity

Confirm decision

Figure 2.6: Simultaneous capacity-spending decision.

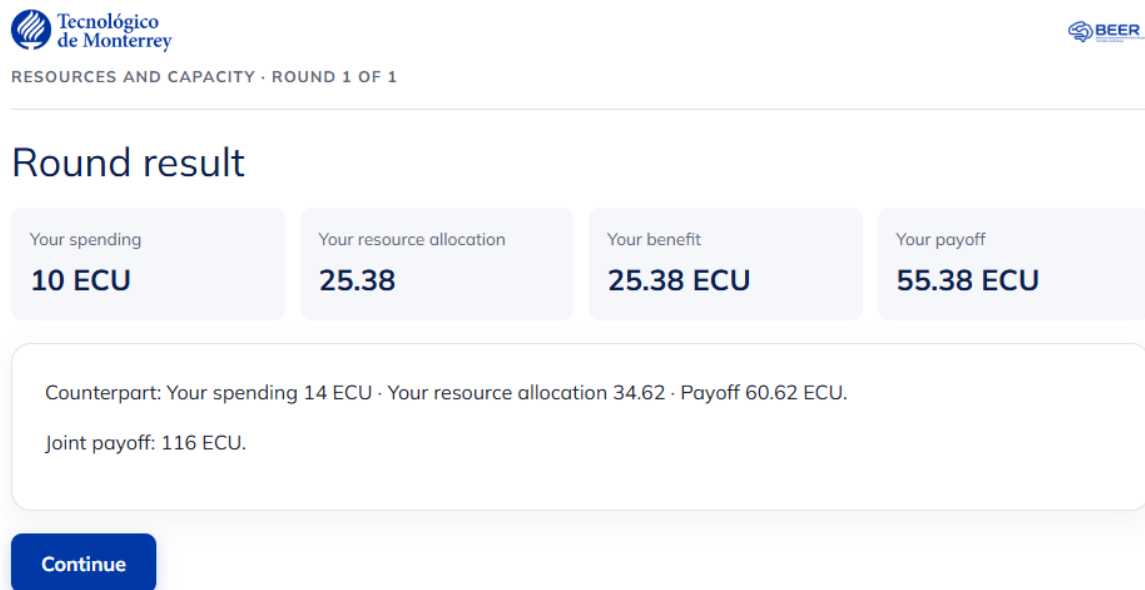


Figure 2.7: Allocation and payment for a completed round.

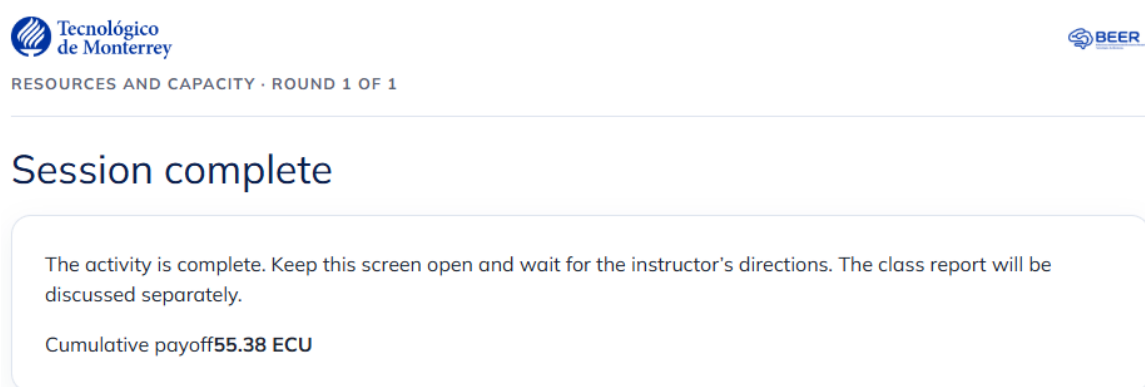


Figure 2.8: Persistent final page with the sum of payments.

Institutions and information

3.1 Binding limit

The binding limit reduces maximum spending to ten. It is neither a promise nor a recommendation: the server rejects larger choices. The budget remains forty and the resource remains sixty. Relative to the reference, this comparison changes the choice set while preserving the allocation formula. If both spend the largest allowed amount, each receives thirty resource units and keeps thirty of the endowment. Payoffs are sixty each and total spending is twenty ECU. Zero spending by both would still yield 140 jointly.

Ask whether improving on the unrestricted equilibrium means achieving complete efficiency. It does not: a limit can reduce spending without eliminating every competitive incentive. The primary outcome is spending, accompanied by dispersion and payoffs. A concentration of choices at ten may mean the cap constrains a best response, but it could also reflect a focal number or interpretation of the rule. To distinguish these explanations, propose different limits or an information condition announcing ten without enforcing it. Such a proposal is an additional design, not an implemented option in this family.

3.2 Joining and voluntary compliance

In the voluntary condition, both participants choose whether to join the limit. An agreement is active only if both accept. If either declines, the next screen states that no agreement is active. When both accept, spending can still reach forty. Exceeding ten is recorded as a violation but generates no fine. Joining and compliance must remain distinct: accepting a rule does not establish that it was followed, and declining it does not mean the participant subsequently spends heavily.

Calculate three separate outcomes: the fraction of encounters with mutual joining, spending among participants with and without an agreement, and violations among those with an active agreement. The final denominator excludes people without an agreement. Spending fourteen without mutual joining is not an agreement violation, even though it exceeds the announced number. Discuss normative commitment, reciprocity expectations, and selection: acceptors may differ from those who decline. An association between agreement and lower spending does not establish that acceptance caused the reduction. Inspection preserves the same joining stage and adds material consequences, enabling a more precise institutional comparison.

3.3 Imperfect inspection and costs

Under mutual joining, inspection charges two ECU per participant to monitor the round. Each decision is inspected with a probability of seventy-five percent, independently of the other decision. Spending above ten incurs a ten ECU fine when inspected. Spending within the limit can be inspected without a fine. Without an agreement, there is no monitoring charge, inspection, or sanction. The program separates spending, violation, inspection, and detection; do not reconstruct one variable from another when its own field is available.

A violation has an expected fine of 7.5 ECU, while its realized fine can be zero or ten. Against spending of ten, raising own spending to fourteen improves the pre-fine account by approximately 0.62. The expected consequence exceeds that gain. Compliance at ten pays fifty-eight after monitoring. An absence of fines does not establish an absence of violations: some may escape inspection. Do not ignore monitoring costs when everyone complies. The institution can prevent additional spending while consuming resources that must be included when evaluating its joint performance. Expected incentives and realized enforcement outcomes answer different questions.

3.4 Accumulation and depreciation

Accumulated capacity starts with zero stock. Every round retains eighty percent of previous stock and adds current spending. Allocation capacity is one plus this new stock. The forty ECU endowment renews, but previous spending is not charged again: it persists through capacity rather than a second account deduction. Counterparts remain fixed for ten rounds. A high stock can sustain relative allocation even when new investment falls in a subsequent round.

If both spend ten in round one, each closes with stock ten. If both then spend zero, retained stock is eight and capacity is nine. Each receives thirty resource units and incurs no new spending, yielding seventy. If they continue spending ten, new stock is eighteen and capacity nineteen; shares remain equal and payoff remains sixty each. Higher stock does not itself expand the common resource. Observe new spending and accumulated stock separately. In the final round, future capacity within this session loses its continuation value, but capacity still affects current allocation. Do not automatically use the static equilibrium as the solution to this dynamic problem: an investment can influence several future rounds as well as the current one.

3.5 Offense and defense as different technologies

This extension replaces proportional allocation with two territorial transfers. Each participant starts with half the resource. Own offensive spending determines how much can be received from the counterpart's half, while the counterpart's defense reduces that transfer. The denominator contains base capacity, own offense, and twice the counterpart's defense. The reverse transfer uses the other components. Combined offense and defense spending cannot exceed forty. Transfers redistribute the same sixty units rather than destroying resource units through the allocation operation.

Without offense there are no transfers, even if someone spent on defense. This distinguishes protecting a position from acquiring the counterpart's resources. Defense can reduce a loss when the other participant invests in offense, yet consume endowment without changing allocation when that pressure is absent. Jervis motivates a security question about distinguishable postures and defensive advantage; this program's transfer technology is an original teaching adaptation. The comparison changes both technology and decision dimensions, so it is not the pure effect of increasing one defense parameter. Discuss spending composition, payoffs, and transfers before

summarizing outcomes as simply high or low total expenditure.

3.6 Private valuations and uncertain preferences

Each person receives a valuation of forty or eighty ECU for the entire resource, with equal and independent probabilities. They know their own value before choosing but do not know the counterpart's. Values are redrawn every round, so an earlier payoff does not determine the next valuation. The physical resource remains sixty units. A half-share produces a benefit of twenty for someone valuing the whole resource at forty, and forty for someone valuing it at eighty. Those benefits are added to the unspent endowment.

This introduces uncertainty about the counterpart's incentive to compete. It does not measure hostile intentions or turn a high value into political aggression. The same action can respond to different private incentives. Separate spending by own valuation and avoid diagnosing preferences from spending without information. The identity of 140 minus spending is no longer universal: allocation toward the higher-value participant can raise joint monetary value. The report supplies a no-spending reference using that round's valuations. Compare it with realized payoffs while distinguishing changes in allocation value, spending, and any applicable institutional charges. A resource quantity and the monetary value assigned to it are separate variables.

3.7 Comparisons that preserve interpretation

The extended reference reproduces the common formula and provides a comparison point. A binding limit changes choices. Voluntary joining introduces acceptance of a rule without enforcement. Inspection adds costs and consequences to that joining decision. Stock changes the time connection of investment. Offense and defense replace allocation technology and separate components. Private valuations change information and incentives about resource value. Do not automatically rank these variants as progressively better institutions: they address different questions and incur different costs.

Before comparing means, state what stayed constant: endowment, resource, counterparts, horizon, information, and order. Lower spending with inspection can coexist with a smaller joint payoff than under a costless binding limit. Higher stock can coexist with lower current investment. Agreements can be common yet frequently violated. These are distinct outcomes rather than contradictions. Require each conclusion to identify its outcome, denominator, and proposed mechanism. If a student wants to add free diplomacy, attacks, or coalitions, turn the suggestion into a subsequent design proposal. Those components are not part of the delivered program and should not be inferred from labels alone.

What participants will see

The participant sees the active rule, their budget, and permitted information. A private valuation is visible only to its recipient before the decision.

Your spending decision

Your budget

40 ECU

Common resource

60

The program only accepts spending from 0 to 10. This limit is binding.

Spending on capacity

Confirm decision

Figure 3.1: Binding limit applied to the form.

Joining the limit

Your budget

40 ECU

Common resource

60

First choose whether to join the limit of 10. An agreement exists only if both join. You may then spend any amount within your budget; violations are recorded, but there are no fines.

Do you join the announced limit for this round?

Joining

Confirm decision

Figure 3.2: Simultaneous joining of the voluntary agreement.

Your spending decision

Your budget

40 ECU

Common resource

60

First choose whether to join the limit of 10. An agreement exists only if both join. You may then spend any amount within your budget; violations are recorded, but there are no fines.

Both participants joined: the agreement is active.

This round's monitoring charge: 0 ECU.

Spending on capacity

Confirm decision

Figure 3.3: Decision after the joining stage.



RESOURCES AND CAPACITY · ROUND 1 OF 6



Joining the limit

Your budget

40 ECU

Common resource

60

First choose whether to accept the limit of 10. If both join, each pays a monitoring charge of 2 ECU. Each decision is inspected with probability 75%. Spending above the limit and being inspected leads to a fine of 10 ECU. If either declines, there is no agreement, monitoring charge, or fine.

Do you join the announced limit for this round?

Joining

Confirm decision

Figure 3.4: Joining informed by inspection rules and costs.

Your spending decision

Your budget

40 ECU

Common resource

60

First choose whether to accept the limit of 10. If both join, each pays a monitoring charge of 2 ECU. Each decision is inspected with probability 75%. Spending above the limit and being inspected leads to a fine of 10 ECU. If either declines, there is no agreement, monitoring charge, or fine.

Both participants did not join: there is no active agreement.

This round's monitoring charge: 0 ECU.

Spending on capacity

Confirm decision

Figure 3.5: Spending under the effective agreement state.

Round result

Your spending

10 ECU

Your resource allocation

25.38

Your benefit

25.38 ECU

Your payoff

55.38 ECU

Counterpart: Your spending 14 ECU · Your resource allocation 34.62 · Payoff 60.62 ECU.

Joint payoff: 116 ECU.

Both participants did not join: there is no active agreement.

This round's monitoring charge: 0 ECU · Fine: 0 ECU.

Continue

Figure 3.6: Results with separate monitoring and fine charges.

Your position in this round

A

Your position remains fixed within the session. Both positions have the same decision options.

Ten rounds with fixed counterparts

Your budget

40 ECU

Common resource

60

Starting stock

18

Counterparts remain fixed. Capacity includes 80% of previous stock plus current spending. New stock equals retained stock plus current spending. The budget renews, while stock persists.

Continue

Figure 3.7: Third round: prior stock of 18 after two investments of 10.

Your spending decision

Your budget

40 ECU

Common resource

60

Split spending between two components. Offense increases the transfer from your counterpart's initial half; defense reduces the transfer toward the counterpart. Defensive effectiveness is 2. Combined spending cannot exceed your budget.

Offense spending

Defense spending

Confirm decision

Figure 3.8: Separate offense and defense fields with one budget.

Round result

Your spending

14 ECU

Your resource allocation

30

Your benefit

30 ECU

Your payoff

56 ECU

Counterpart: Your spending 14 ECU · Your resource allocation 30 · Payoff 56 ECU.

Joint payoff: 112 ECU.

Continue

Figure 3.9: Results under directional-transfer technology.



RESOURCES AND CAPACITY · ROUND 1 OF 6



Your spending decision

Your budget

40 ECU

Common resource

60

Your private valuation

40 ECU

Your private valuation of the entire resource is 40 ECU. Each participant independently receives a valuation of 40 or 80 with equal probability before every round. Your counterpart does not know your valuation before deciding. Your benefit equals valuation $\times$ the fraction of the resource received.

Spending on capacity

Confirm decision

Figure 3.10: Private own valuation before the decision.

Report, data, and debriefing

4.1 Revelation and progress

The report initially shows participants, completed encounters, and pending encounters. Results stay hidden until the instructor selects Reveal results. Hide results closes the aggregates again, with the preference retained for that session in the browser. This prevents decisions from being projected while students are still choosing. Administrative authorization and revealing outcomes serve different purposes: logging in as instructor does not mean every aggregate should immediately be shown to the class.

An encounter completes when both decisions have been settled. Six rounds with four participants imply twelve encounters, rather than six or twenty-four. Individual decisions do generate twenty-four potential observations. During play, spending may be recorded without a completed encounter, joining may be recorded without spending, and future rounds may remain unanswered. Explicit denominators distinguish these states. If discussing only completed encounters, explain exclusions and close admission before displaying results. Do not replace pending answers with zero or interpret an initialized zero payoff as the outcome of an actual choice. Keep completion status with any extracted outcome.

4.2 Units and denominators

Mean spending is calculated per person among completed encounters. Mean joint payoff uses one observation per pair and round. Agreement rate uses completed encounters because mutual joining is a pair-level property. Violation rate uses participants with an active agreement; detection uses violations eligible for inspection. When there are no relevant observations, the report shows a dash instead of manufacturing a rate. Counts distinguish zero events from an absence of evaluable cases.

For example, two participants violate an agreement and only one is inspected. Realized detection is fifty percent among violations even though the technology has a seventy-five percent inspection probability for each decision. That difference can reflect sampling variation. If nobody violates, the realized detection rate cannot assess the mechanism's accuracy. Similarly, many individual joining choices need not produce many mutual agreements if they do not coincide within pairs. Identify the unit before answering what percentage complied: participants, pairs, and inspectable decisions answer different questions. Report both the numerator and denominator whenever a percentage is discussed.

4.3 Spending distribution

The histogram groups spending in five-ECU bins and separates A and B with colors and counts. This distinction organizes symmetric positions; it does not imply that one has greater authority. The final bin can contain only forty because the budget ends there. Examine mass at zero, near the limit, and at the entire budget, as well as the mean. A distribution concentrated near fourteen differs from one with the same mean made up of extreme choices.

Ask what comparison is needed to explain a concentration at ten. Under a binding cap, higher spending is unavailable; under voluntary agreement, it remains possible. A peak can reflect a restriction, commitment, a focal number, or a learned habit. The graph alone cannot choose among these explanations. Do not attribute A/B differences to unequal role incentives, since their rules are identical and small samples can separate by chance. If the instructor changed the budget, bins end at its actual value. Check that the labels and comparisons remain meaningful before using the figure as evidence for a behavioral mechanism.

4.4 Trajectories and joint payoff

The round table shows completed encounters, mean spending, joint payoff, and closing stock. Read the count beside each mean: an apparent trend can change because the set of completed observations changes. Fixed-pair outcomes connect the same relationship across rounds. Under rematching, individual learning still persists. Falling expenditure near the end might reflect learning, coordination, fatigue, or changes in continuation value. For stock, separate current investment from inherited state.

Program joint payoff is the sum of monetary accounts. In the reference, its loss from 140 equals total spending. Inspection additionally deducts monitoring and fines. With private valuations, allocation value can change, so the difference from equal division should not all be labeled dissipation. In international relations, these accounts omit many security benefits and harms. Use the indicator to analyze the programmed mechanism rather than evaluate military policy completely. A responsible conclusion states which resources enter the calculation and which remain outside it. A higher numerical payoff can answer an accounting question without resolving the normative question of which policy should be adopted.

4.5 Wide download and round-level file

The session Data page's CSV button downloads a wide file with one row per participant and rounds in columns. Its link includes the selected session, so it should not silently combine different classes. The file covers the application's ten technical periods; configurations with shorter horizons use only active rounds for decisions and aggregates. Future or unused periods may contain initialized fields. Retain completion status and do not interpret every numerical column as a played outcome.

The laboratory's authenticated custom export provides a long file: one row per person and active round. It includes configuration, language, treatment, position, pair, joining, spending components, valuation, stock, allocation, benefit, inspection, fine, payoff, and actual parameters. Each pair outcome appears in two individual rows. For joint-payoff analysis, build a single row per pair and round; adding a repeated pair field from both rows would double the result. Preserve the original download and work on a documented copy. A useful class approach starts with minimal columns and adds institutional variables only when they answer a specific question. Keep wide and long formats conceptually separate.

4.6 Reconstructing payments

For an individual audit, start with the actual endowment and subtract spending. Add the stored allocation benefit, then subtract monitoring and the fine. The result should match the round payoff. Reference benefit equals the received resource; private-value benefit equals valuation times the allocated fraction. In offense and defense, sum both components to obtain total spending. In stock, do not subtract earlier investments again.

Next check that the two allocations sum to the total resource and that joint payoffs satisfy the relevant accounting identity. Reconstruct fines from active agreement, spending above the limit, and realized inspection. The announced probability cannot replace the stored draw when checking a specific round. No fine can mean compliance, absence of agreement, or an undetected violation. Document which applies. These checks detect unit, duplication, and treatment errors before graphs are prepared. They are more informative than merely comparing a final mean with an expected number without reviewing its construction. Audit complete observations first, and preserve legitimate blanks when examining incomplete sessions.

4.7 Selection, order, and inference

A classroom report describes the session. Attributing a change to an institution requires a comparison that controls other differences. Joining and compliance are not randomly assigned within the voluntary condition: they are choices. Acceptors can have different expectations or preferences. Comparing acceptors with decliners can teach selection without independently identifying a commitment effect. In inspection, distinguish the behavioral response to the probability from random variation in realized detection among people who already violated.

Game order matters too. A class shown an explained equilibrium first may choose differently from one discovering the tension before theory. Record order, comprehension assistance, and connection incidents. Do not combine different parameter settings under a single treatment label. When proposing a formal study, define the assignment unit, primary outcome, and handling of dependence within pairs. Pedagogical discussion can state these limitations and compare hypotheses without promising causal identification that one class does not provide. A transparent description of what changed is more useful than an impressive causal label attached to a comparison confounded by experience or participant selection.

Attention

Pending rounds are not zero decisions. The report excludes incomplete pairs from payments and states its denominators. Use the selected-session download.

Instructor report: armaments and security competition

Proportional capacity · One encounter

Participants	Completed encounters	Pending encounters
4	2 / 2	0

Results are hidden. Reveal aggregates after the decisions you intend to discuss have closed.

Reveal results

Figure 4.1: Private report: visible progress and hidden aggregates.



Figure 4.2: Aggregates after deliberate revelation.

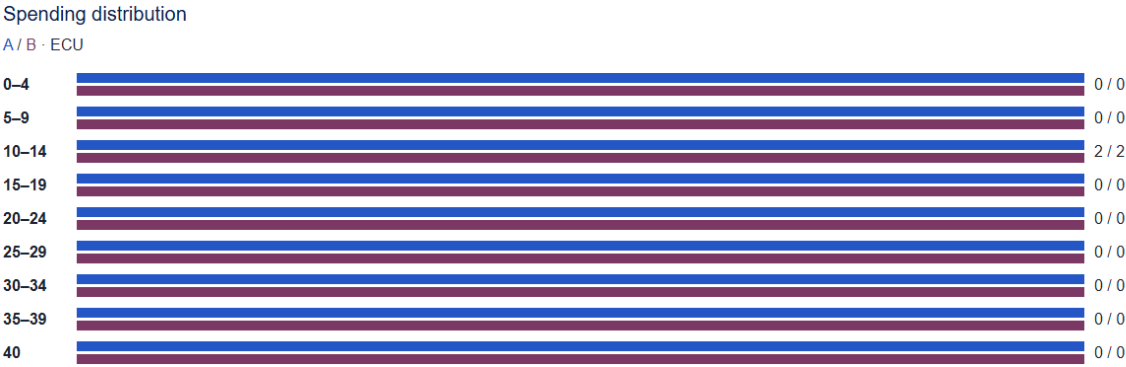


Figure 4.3: Spending distribution by position, with denominators.

Cases, assessment, and teaching use

5.1 A debrief that starts from observations

Begin by asking what happened without immediately offering an explanation. Identify one spending choice, allocation, and payoff, then reconstruct a complete pair. Ask whether both people's spending changed their relative shares or only consumed endowment. The first conceptual transition connects a visible identity with an incentive: why might someone spend even though joint spending reduces resources? Listen before introducing best response, equilibrium, or the security dilemma.

Next compare conditions through a specific question. Did the limit restrict choices or merely announce a number? Was there mutual joining followed by a violation? Did inspection change expected cost, realized cost, or both? Does little current spending imply little capacity when stock exists? End with the analogy's limits. Ask students to identify an international-security dimension absent from the game and explain how adding it would alter choices or payoffs. This sequence builds an explanation without presenting theory as a label that can retrospectively be attached to any outcome. Distinguish a useful analogy from an asserted explanation of a historical episode.

5.2 Worked case: limit and deviation

Consider spending of ten each under a binding cap. Capacity is eleven each, allocation is thirty each, and payoff is sixty each. Now hold B's spending at ten and allow A to deviate to fourteen, as under voluntary agreement. A's capacity is fifteen against B's eleven. A receives 60 times $15/26$, rounded to 34.62, while B receives the residual 25.38. Payoffs are 60.62 and 55.38, summing to 116: four below the earlier total because spending rose from twenty to twenty-four.

A improves by 0.62 while B loses 4.62. This asymmetry illustrates why private improvement does not measure joint performance. With mutual joining, A violated the agreement; without it, the same spending does not violate an agreement. Under a binding cap, fourteen would be rejected and never generate this outcome. Explain the three scenarios using the same numbers: enforceable restriction, unenforced commitment, and no agreement. Compliance when deviation is technically unavailable is not evidence of a moral preference for keeping promises. The institution changes what can be chosen before the analyst interprets why a particular action occurred.

5.3 Worked case: inspection and randomness

Keep A's spending at fourteen and B's at ten under mutual joining with inspection. Pre-charge payoffs are 60.62 and 55.38. Each pays two for monitoring. If A is not inspected, net payoffs are 58.62 and 53.38, summing to 112. If A is inspected, another ten is deducted: A receives 48.62, B

retains 53.38, and joint payoff is 102. Inspecting B produces no fine because B complied with the limit.

At an inspection probability of 0.75, A's expected payoff from violation is 0.75 times 48.62 plus 0.25 times 58.62, or 51.12. Complying at ten against ten yields fifty-eight. Expected incentives therefore favor compliance even though an undetected violation pays 58.62. The realized outcome does not contradict expected-payoff arithmetic. Distinguish the incentive known before choosing from randomness observed afterward. Also explain that fines leave the account instead of increasing B's payoff: this institution contains no compensation transfer. Identical rules can generate different realized fines across participants because the draw is independent.

5.4 Worked case: inherited capacity

In round one, A spends twenty and B zero. Closing stocks are twenty and zero, and capacities are twenty-one and one. A receives 57.27 and B 2.73. Payoffs are 77.27 and 42.73, summing to 120. In round two both spend zero. A retains stock sixteen while B retains zero, giving capacities seventeen and one. Allocations are 56.67 and 3.33, and payoffs are 96.67 and 43.33, summing to 140. Earlier investment changes future distribution without being charged again against renewed budgets.

The initial investment can look more attractive when several rounds are considered than when only its immediate payoff is examined. B's future response can change that advantage. This case does not solve the entire dynamic equilibrium; it shows why accumulation changes the problem. Compare observed stocks with current spending and consider what higher depreciation would do. Do not call stock an income amount added in full to every payoff. It modifies relative capacity in the formula, while the common resource remains sixty in each round.

5.5 Worked case: defense without offense

Suppose A chooses offense ten and defense zero, while B chooses offense zero and defense ten. The transfer to A is thirty times ten divided by (one plus ten plus twice ten), approximately 9.68. There is no transfer to B because B's offense is zero. Final resources are 39.68 and 20.32. Since both spent ten, payoffs are 69.68 and 50.32, summing to 120. B preserves more resource than without defense, but defense does not itself acquire a transfer from A.

Without B's defense, the transfer to A rises to thirty times ten divided by eleven, approximately 27.27. Allocations are 57.27 and 2.73, giving payoffs of 87.27 and 42.73. Compare defense's cost of ten with the reduction in loss, then consider no offense by either side: defense does not change the equal thirty-unit division. A component's usefulness depends on the counterpart's action. This dependence is the teaching objective; it does not automatically classify real defensive expenditure as efficient or real offensive expenditure as irrational. Technology and the opponent's behavior are part of any evaluation.

5.6 Worked case: valuation and resource

Take A's value as forty and B's as eighty, with zero spending. Both receive thirty physical units, but their benefits are twenty and forty ECU. Payoffs are sixty and eighty, summing to 140. Equal resource quantities do not yield equal payoffs when values differ. If A spends ten and B zero, allocations become fifty-five and five. Benefits are approximately 36.67 and 6.67, and payoffs are

66.67 and 46.67. Their sum of 113.34 reflects both spending and allocation toward the lower-value participant.

Reconstruct physical quantities first and monetary values second. Multiplying fifty-five directly by forty would confuse total value with value per unit. Correct conversion divides by the full resource quantity of sixty. The counterpart did not know the other person's value before choosing, so an efficient-allocation judgment uses information that may not have been available. The example teaches uncertainty about economic incentives. Connecting it to security intentions requires an explicit analogy and a reminder that the program does not observe political desires or the risk of war. Do not treat a programmed value category as a psychological classification.

5.7 Calculation exercises

Exercise one: for reference spending of six and eighteen, compute capacities, allocations, and payoffs. Check the joint total before rounding and explain who improves relative to zero spending. Exercise two: against spending of ten, compare own choices of nine, ten, and fourteen. Identify comparisons admissible under a binding cap and those available only under voluntary agreement. Exercise three: keep a violation at fourteen and calculate expected payoff at inspection probabilities zero, one-half, and one. Separate fixed monitoring charges from expected fines.

Exercise four: given previous stock twenty and eighty percent retention, calculate closing stock and capacity with current spending five, then compare zero current spending. Exercise five: explain why defense ten cannot generate an incoming own transfer when own offense is zero. Exercise six: a participant values the full resource at eighty and receives forty-five of its sixty units; compute the benefit before adding unspent endowment. Require every answer to state units, formula, result, and condition. A list of correct numbers without their meaning does not demonstrate understanding of the mechanism or the information available when choosing.

5.8 Answers and reasoning

In exercise one, capacities are seven and nineteen, totaling twenty-six. A's allocation rounds to 16.15 and B receives 43.85. Payoffs are 50.15 and 65.85, summing to 116 because spending totals twenty-four. Neither exceeds the payoff of seventy under mutual zero spending. Choices must nevertheless also be evaluated against available alternatives given expectations about the counterpart, rather than only against joint efficiency.

Against spending of ten, own spending of nine, ten, and fourteen produces approximately 59.57, sixty, and 60.62 before charges. The cap permits the first two and excludes the third. With inspection and own spending fourteen, expected net payoffs are 58.62, 53.62, and 48.62 at probabilities zero, one-half, and one while maintaining a monitoring charge of two. Exercise four's closing stock is sixteen plus five, or twenty-one, and capacity is twenty-two. With no new spending, stock is sixteen and capacity seventeen. Exercise six's benefit is eighty times forty-five divided by sixty, or sixty. Changing parameters changes these answers; reference numbers should not be memorized as universal rules. Correct reasoning must travel with the numerical result.

5.9 Written assessment and rubric

A short essay can ask why an agreement improving joint payoffs may be hard to sustain. Require a numerical example, a deviation mechanism, and an institution changing its incentives. Another essay can distinguish violating, detecting a violation, and sanctioning it. A third can ask whether

rising stock establishes an increasingly intense race when new spending declines. These questions require interpreting variables rather than repeating the game's name.

A useful rubric weights accurate accounting, conceptual distinctions, denominators, and inference quality. Reward recognizing that several explanations can fit the data. For a data assignment, require one pair-round table, a histogram, and a trajectory. Students must retain missing values and document exclusions. Do not grade a spending choice as correct or incorrect unless the exercise specifies a maximization objective and a known counterpart action. Separating academic assessment from experimental behavior lets students explore choices without guessing the instructor's preferred strategy. Assess the explanation of a decision and its consequences, not whether the individual chose the action that produces the most attractive class average.

5.10 Troubleshooting and recovery

When a pair waits, identify the administrative stage before intervening: rules, comprehension, joining, spending, or results. One unfinished participant can keep the counterpart waiting. Do not skip a choice or invent spending to release the pair. After disconnection, reopen the same link. A link from another session or a reset database may not identify the participant; check the current session with the laboratory. The local instance should preserve its database when the server restarts.

Record late entry, individual assistance, prohibited communication, and other incidents. Pedagogical discussion can continue with affected observations identified, while a formal analysis needs an explicit exclusion rule. If the report shows zero encounters, check that both people passed the settlement wait and that active rounds match the selected configuration. If a file appears to contain too many rounds, recall the distinction between technical and active periods. Do not resolve confusion by deleting data or creating duplicate sessions. First identify the unit, state, and access link. Recovery should preserve the intended participant and account rather than silently replace the interaction being studied.

5.11 Privacy, literature, and adaptation

Explain how the activity will be used and follow institutional course rules. Do not promise monetary conversion when the session uses hypothetical ECU. Never project names or connect choices with nationalities, identities, or personal traits. For uses beyond teaching, follow the relevant institutional procedures before collecting or reusing data. The software is not itself an approved research protocol. Symmetric positions support mechanism discussion without assigning students historical identities.

Literature motivates questions without making this design a replication. Skaperdas studies contest success functions; Garfinkel links military investment and cooperative equilibrium; Pilisuk presents an arms-race and disarmament experiment with inspection components; Sheremeta reviews overbidding and heterogeneity in contests. This game's deterministic allocation, amounts, fines, and depreciation are original teaching choices. Distinguish conceptual motivation from estimated evidence about the exact treatment. A hypothetical worked result demonstrates a programmed rule, not a finding obtained from participants. Students should be able to identify which statements are numerical consequences of this implementation and which are questions for empirical research.

5.12 Pilot and teaching success

Before general use, conduct a supervised pilot. Record duration, comprehension difficulties, access stability, actual group sizes, and debrief clarity. Software checks verify branches and accounts; they do not replace observing whether students understand the activity. Suggested timing and teaching effectiveness remain awaiting validation with students. A pilot can reveal that an institution needs more explanation even when its calculation is correct.

Teaching success does not mean obtaining low spending. High spending can support a precise discussion of best response, efficiency, and institutions; low spending can be poorly interpreted if automatically attributed to trust. Assess whether students distinguish resource and valuation, agreement and compliance, new spending and stock, probability and realized outcome. Keep a short record of which examples worked and which caused confusion. This supports adjustments to class sequence while retaining stable rules and comparability across future sessions. Production, pilot validation, and publication are separate milestones and should be documented separately. A working local preview is evidence of software availability on that computer, not evidence that the public host is deployed or that the lesson has been validated.

Feedback script

Start with the accounts. What did each position gain, and what did achieving it cost? Then ask whether the limit was binding, voluntary, or monitored. An answer should identify a rule and an observable result.

Bibliography

- Jervis, R. (1978). Cooperation under the Security Dilemma. *World Politics*, 30(2), 167–214. <https://doi.org/10.2307/2009958>.
- Garfinkel, M. R. (1990). Arming as a Strategic Investment in a Cooperative Equilibrium. *American Economic Review*, 80(1), 50–68. <https://sites.socsci.uci.edu/~mrgarfin/papers/aer-arming.pdf>.
- Skaperdas, S. (1996). Contest Success Functions. *Economic Theory*, 7, 283–290. <https://doi.org/10.1007/BF01213906>.
- Pilisuk, M. (1984). Experimenting with the Arms Race. *Journal of Conflict Resolution*, 28(2), 296–315. <https://doi.org/10.1177/0022002784028002005>.
- Sheremeta, R. M. (2013). Overbidding and Heterogeneous Behavior in Contest Experiments. *Journal of Economic Surveys*, 27(3), 491–514. <https://doi.org/10.1111/joes.12022>.