



Instructor guide to Diversification and Portfolio Choice

Laboratory implementation, theoretical foundations,
experimental evidence, and variants

Behavioral and Experimental Economics Research Lab
Department of Economics



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How to use this guide

This guide supports the preparation, implementation, and classroom discussion of the Diversification and Portfolio Choice family available through the Behavioral and Experimental Economics Research Lab (BEER Lab) at the Department of Economics of Tecnológico de Monterrey. It is intended for instructors with different levels of familiarity with experimental and behavioral economics.

The document offers three reading paths. The **quick guide** is enough to launch a session. The operational chapters explain each screen used by instructors and students. The conceptual chapters present the theories, predictions, and empirical findings needed to lead the post-game discussion.

Access instructions and common screens are explained once. Each variant then focuses only on what changes relative to the basic game: configuration, group size, decisions, predictions, relevant outcomes, and academic literature.

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 class with portfolios

1.1 Learning objectives and scope

The central question is simple: why can spreading an investment reduce risk when none of the available investments is safe? Each student allocates an entire budget across instruments whose outcomes depend on a joint state. The class then compares chosen exposures, expected wealth and the dispersion of possible outcomes. An abstract concept, covariance, becomes a relationship that students can see in a table and verify through their own choice. The purpose is to make the economic mechanism understandable before introducing a more general optimization problem.

By the end, students should distinguish a financial instrument from the economic exposure it contains, calculate portfolio wealth in each state, explain why marginal probabilities alone cannot identify joint risk, and separate a decision made before an outcome from luck observed afterward. They should also recognize that counting funds does not count independent sources of risk. Constraints, charges and information change the comparisons that are economically relevant. These objectives fit an introductory course in finance, financial economics or decision making under risk.

The basic edition offers two risky exposures with identical expected returns and identical individual volatility. Consequently, the first contrast can focus on dependence without simultaneously adding a safe investment or unequal risk premia. The basic battery changes correlation while holding other features constant. Extended editions examine unequal volatility and means, duplicate funds, overlapping exposures, charges, bounded short positions, fictional labels and the acquisition of information about the joint distribution. Each comparison has a specific teaching question rather than merely a different title.

This is an individual activity. Nobody changes another person's opportunities, outcome or points. There are no buyers, sellers, endogenous prices or trading. This curricular boundary keeps diversification distinct from hedging through derivatives and from an asset market. The earlier safe-versus-risky allocation activity provides a useful introduction, but portfolio choice adds the composition of several risks that the participant actively chooses. The two activities can be taught in sequence without treating either as a replacement for the other.

For the instructor

For a first class, use one portfolio or the three-correlation battery. Save overlapping funds and information for a subsequent discussion. Having sixteen extensions available does not mean that every extension should be run in one session.

1.2 Family at a glance

Purpose	Connect composition, correlation and portfolio risk.
Experimental unit	Individual; any positive number of participants is allowed.
Basic edition	One portfolio; three correlations in fixed or random order.
Extended edition	Reference and sixteen economic and information contrasts.
Decision	ECU allocations that sum to the entire budget.
Payoff	Net wealth from one randomly selected opportunity.
Topics	diversification; portfolio choice; correlation; overlapping exposures; investment costs; financial information.
Suggested duration	8–15 min. one portfolio; 15–25 min. battery; 45–60 min. including discussion.
Participants	Any positive count; no matching required.
JEL	A22, C91, D81, G11, G41.

The ordinary endowment is 100 ECU per opportunity. ECU means Experimental Currency Units. The activity records points in that unit and does not announce a conversion into pesos, dollars or another currency. If an instructor arranges real incentives, a separately approved, consistent rule must be communicated before participants choose. A numerical amount on screen should never be interpreted as an implicit promise of a cash payment. The experimental accounting rule and any external incentive arrangement serve different purposes.

A session accepts any positive participant count; neither pairs nor complete groups are required. The reference visual walkthrough uses four people, and technical checks also include odd counts. Choices usually take eight to fifteen minutes for one opportunity and fifteen to twenty-five minutes for a battery. Including introduction and discussion, a forty-five-to-sixty-minute class is sufficient for the core material. These estimates depend on students' familiarity with percentages and state tables, so leave time for comprehension corrections rather than rushing the final choice.

Forty configurations are divided into twenty Spanish and twenty English options. Each language has three basic modes and seventeen extended conditions, including the reference. All use the same application and calculations. Session language is set at creation; it does not depend on browser language or on other sessions running concurrently. Select the option whose descriptive title matches the comparison you want to teach. The larger menu is a resource for course design, not a requirement to present every treatment at once.

1.3 Access, rooms and preparation

Start at <https://beer-lab.org/> and select **CLASE** in the top navigation. This opens <https://teaching.beer-lab.org/>. The catalogue supports searches by title, topic and JEL code. Locate Diversification and Portfolio Choice, confirm the language, and enable Show extended version when appropriate. Catalogue language and activity language are separate selections. If the new card is not yet visible, ask the laboratory coordination team about this delivery's publication status. A local package is not automatically a published website.

The Spanish basic room is https://portfolio.beer-lab.org/room/cartera_es; the English basic room is https://portfolio.beer-lab.org/room/portfolio_en. Extended rooms are https://portfolio.beer-lab.org/room/cartera_extendida and https://portfolio.beer-lab.org/room/portfolio_extended. Instructors use <https://portfolio.beer-lab.org/demo> for demonstrations and <https://portfolio.beer-lab.org/rooms> to prepare a session through a room. These are the stable addresses proposed for publication; public operation requires deployment

and DNS configuration. The delivered local instance is accessible at <http://localhost:8094/demo> on this computer.

Demo should show only this family's forty configurations. Rooms should show four rooms. A basic room offers three configurations in its language and initially selects a basic option. An extended room offers seventeen options. If another game appears, do not create a student session; contact the laboratory coordination team. Family isolation includes a separate instance and database. Filtering configuration options alone does not isolate historical sessions from other activities. Check both the selection menu and the session list when preparing a classroom demonstration.

Before class, create a test session, confirm the treatment, enter the participant count and open an individual link. Check the effective budget, returns and charges. Each individual link identifies one participant within that session and must not be projected alongside that person's choices. The room is a shared entry point; the individual link is a private continuation. The report is an authenticated instructor resource. Keep these three functions distinct when distributing access instructions, and use a fresh session for students after your rehearsal.

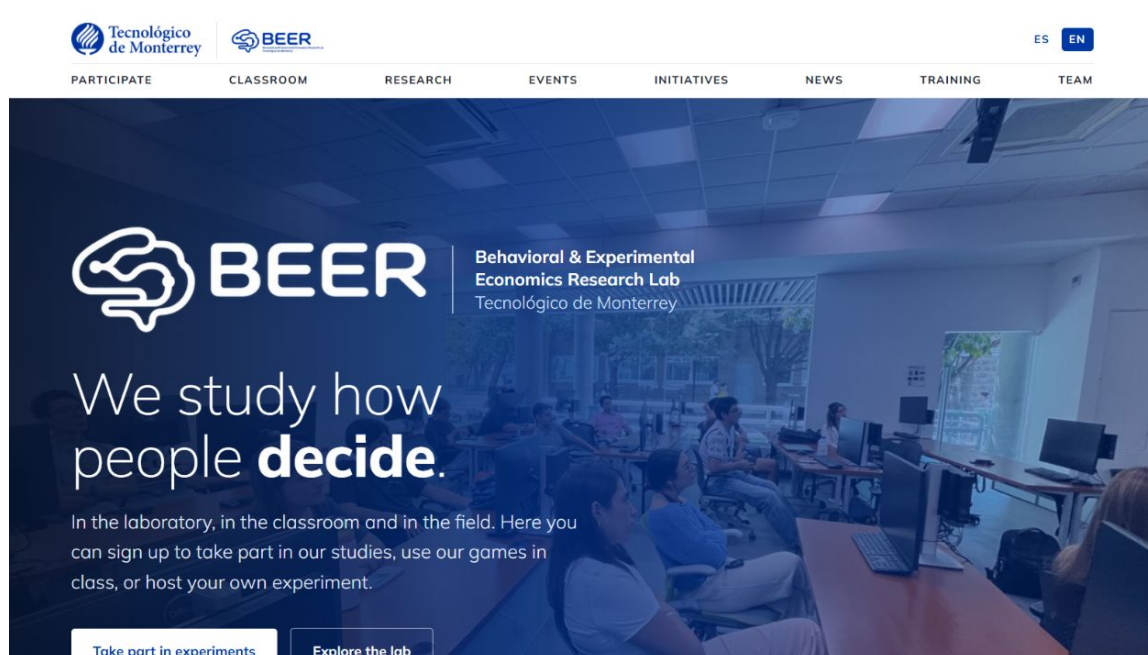


Figure 1.1: Select CLASE to reach the teaching catalogue.

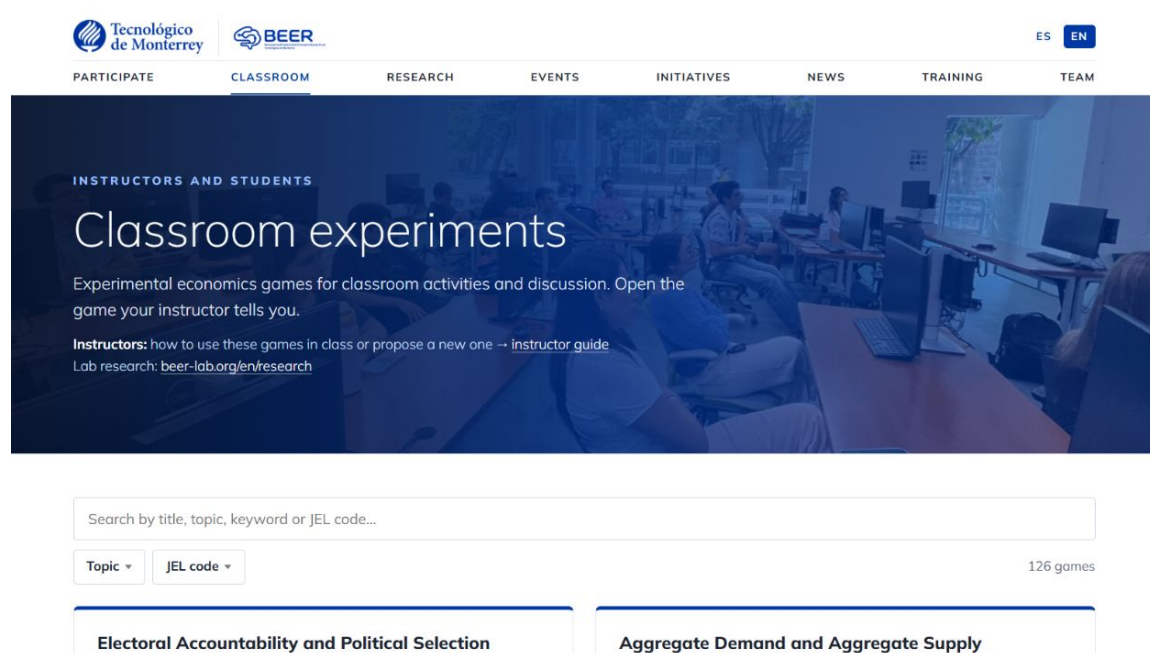


Figure 1.2: Search by title or topic and confirm language and edition. The new card appears after the family is published.

Diversification and Portfolio Choice · Basic · EN · One portfolio
Diversification and Portfolio Choice · Basic · EN · Three correlations in fixed order
Diversification and Portfolio Choice · Basic · EN · Three correlations in random order
Diversification and Portfolio Choice · Extended · EN · Reference: independent exposures
Diversification and Portfolio Choice · Extended · EN · Positive correlation
Diversification and Portfolio Choice · Extended · EN · Identical movement
Diversification and Portfolio Choice · Extended · EN · Negative correlation
Diversification and Portfolio Choice · Extended · EN · Exact offset
Diversification and Portfolio Choice · Extended · EN · Unequal volatility
Diversification and Portfolio Choice · Extended · EN · Unequal expected return
Diversification and Portfolio Choice · Extended · EN · Calculation aid
Diversification and Portfolio Choice · Extended · EN · Charge for two exposures
Diversification and Portfolio Choice · Extended · EN · Duplicate funds
Diversification and Portfolio Choice · Extended · EN · Mixed fund and overlapping exposures
Diversification and Portfolio Choice · Extended · EN · Bounded short positions
Diversification and Portfolio Choice · Extended · EN · Domestic and foreign labels
Diversification and Portfolio Choice · Extended · EN · Swapped labels
Diversification and Portfolio Choice · Extended · EN · Cost of access to B
Diversification and Portfolio Choice · Extended · EN · Purchase of joint information
Diversification and Portfolio Choice · Extended · EN · Free joint information

Figure 1.3: Demo contains only this language's twenty configurations: three basic and seventeen extended.

Rooms

Current rooms:

Diversificación y cartera · Básica
Diversification and Portfolio Choice · Basic
Diversificación y cartera · Extendida
Diversification and Portfolio Choice · Extended

Figure 1.4: Rooms contains the four family rooms; select the language and edition for your class.

Room: Diversification and Portfolio Choice · Basic

Create a new session

Session Config

Diversification and Portfolio Choice · Basic · EN · One portfolio

Number of participants

Individual decisions: any positive participant count is allowed.

Create

[Configure session](#) 

App sequence

portfolio_game (3 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://localhost:8094/room/portfolio_en

Figure 1.5: A basic room initially selects a basic configuration in its language and offers three modes.

Room: Diversification and Portfolio Choice · Basic

Create a new session

Session Config

Diversification and Portfolio Choice · Basic · EN · One portfolio

Number of participants

4

Individual decisions: any positive participant count is allowed.

Create

[Configure session](#) 

App sequence

portfolio_game (3 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://localhost:8094/room/portfolio_en

Figure 1.6: Enter the participant count and select Create. This individual activity accepts odd counts.

 Edit  Links  Monitor  Data  Payments  Report  Description

Figure 1.7: Use Links for private continuation links, Monitor for progress and Report for aggregate discussion.

The mechanism and a worked example

2.1 Budget, states and wealth

Every opportunity begins with a budget of 100 ECU. In the core activity, the participant chooses allocations to A and B. Both amounts must be nonnegative and sum exactly to 100. Cents are allowed: 33.33 and 66.67 are valid, whereas 33.333 is not. There is no separate cash reserve outside the offered instruments. Each multiplier includes invested principal. Receiving 0.70 for one ECU means ending with seventy cents of that unit, rather than earning an additional seventy cents on top of principal.

The states of A and B are represented by signs. A positive sign denotes an exposure's high return and a negative sign its low return. In the reference, each exposure pays 1.50 in its high state and 0.70 in its low state, each with a marginal probability of one half. Four combinations are possible: high-high, high-low, low-high and low-low. Under independence, each combination has probability one quarter. A single row determines all returns in the portfolio. Funds are not assigned independently drawn outcomes after allocations are submitted.

Let x_A and x_B denote allocations, $R_A(s)$ and $R_B(s)$ the state- s multipliers, and c the announced charges. Terminal wealth is

$$Y(s) = x_A R_A(s) + x_B R_B(s) - c, \quad x_A + x_B = W.$$

Here W is the budget, ordinarily 100 ECU. The formula measures terminal wealth rather than the gain relative to the starting budget. Subtract W from $Y(s)$ to obtain a gain or loss. Charges are deducted at settlement and do not reduce the amount to allocate. This convention makes the budget constraint explicit and keeps the treatment comparison easy to follow.

What participants will see

An institutional box inside the instructions states the budget. The choice screen repeats the available amount and constraints. Its preview calculates wealth in each state using the entered amounts; it does not predict which state will be drawn.

2.2 Two portfolios with the same mean

First compare a concentrated portfolio of 100 ECU in A with a portfolio allocating 50 ECU to each exposure. The concentrated portfolio produces wealth of 150 when A is high and 70 when A is low. Each outcome has probability one half. Expected wealth is $0.5(150) + 0.5(70) = 110$ ECU. Half of the outcomes exceed the initial budget and half fall below it. An expected value of 110

does not guarantee a gain in a particular realization; it summarizes the distribution before that realization occurs.

With 50 ECU in each exposure, high–high yields $50(1.50) + 50(1.50) = 150$. High–low yields $75 + 35 = 110$, and low–high also yields 110. Low–low gives $35 + 35 = 70$. Under independence, the outcome probabilities are 25% for 150, 50% for 110 and 25% for 70, because two distinct state rows yield 110. Expected wealth remains 110. Changing composition preserves the mean while moving more probability toward the centre of the outcome distribution. That is the mechanism students should explain in their own words.

State	Probability	All in A	50 in A and 50 in B
High–high	25%	150	150
High–low	25%	150	110
Low–high	25%	70	110
Low–low	25%	70	70

The concentrated portfolio's standard deviation is 40 ECU: its outcomes lie forty units from the mean. For the balanced portfolio, variance is $0.25(40)^2 + 0.50(0)^2 + 0.25(-40)^2 = 800$, and standard deviation is $\sqrt{800} \simeq 28.28$. Risk falls without an increase in expected wealth. The probability of ending below the starting budget also falls from 50% to 25% in this example. Nevertheless, standard deviation and loss probability are not generally interchangeable measures, and neither alone describes every feature of a distribution.

Feedback script

First ask what stayed constant. Then ask students to identify the two offsetting state rows. Introduce the term diversification afterward. Merely naming two different funds does not yet explain the reduction in risk.

2.3 What correlation changes

Correlation summarizes whether two deviations from their respective means tend to occur together. Positive correlation makes high A outcomes coincide with high B outcomes more often. Negative correlation increases the weight on opposite combinations. It does not mean that one exposure causes the other exposure's return. Both belong to an announced joint distribution. Because marginal probabilities remain unchanged, the treatment changes the composition of portfolio risk rather than the expected return of either underlying asset. This distinction is the main reason for using a joint-state table.

With correlation ρ , high–high and low–low each have probability $(1 + \rho)/4$, while high–low and low–high each have probability $(1 - \rho)/4$. At $\rho = 0.5$, the matching combinations receive 37.5% each and the opposite combinations 12.5% each. At $\rho = -0.5$, the probabilities are reversed. Adding rows in which A is high gives 50% in both cases, and the same check works for B. Thus individual probabilities cannot identify joint probabilities. Ask students to verify the sums before comparing portfolio risk.

The 50/50 portfolio keeps expected wealth of 110 ECU. Its standard deviation is 34.64 under positive correlation of 0.5, 28.28 under independence and 20 under negative correlation of -0.5. The basic battery contains precisely these three opportunities. Each has a fresh budget, with no feedback about the previous outcome. Fixed order therefore compares dependence without reinvestment. Random order helps distinguish position from opportunity, but it does not turn three choices by one person into observations from three independent people.

At the extremes, correlation one means identical movement. Every allocation between A and B yields the same outcome distribution, so spreading investments does not reduce dispersion. At correlation minus one, only opposite combinations are possible. The balanced portfolio produces 110 ECU in both feasible states. Individual instruments remain risky; offsetting occurs at portfolio level. Do not generalize this absence of risk to every allocation or to real assets whose dependence may change during a crisis. The result follows from the specific announced distribution and weights.

2.4 Payment selection and delayed feedback

One active choice is randomly selected to determine each participant's points. With one opportunity, selection is trivial; with a three-item battery, each position has probability one third. The application prepares the selection and state draws without showing them until every choice is complete. The final page identifies the selected opportunity, each position's portfolio, the effective correlation, charges and realized wealth. Total points equal only the net wealth from the selected opportunity. No other choice contributes to that total, even though other outcomes are available for audit.

Suppose a participant's three realized wealth amounts are 150, 70 and 110, and the second position is selected. Points are 70, not 330 and not the mean of 110. A dedicated comprehension question checks this rule. Random selection keeps each opportunity relevant without accumulating wealth from decisions that use independent budgets. It does not, by itself, establish that every participant psychologically evaluates the opportunities in isolation. Explain the accounting rule clearly and keep claims about behavioural interpretation separate from the implemented payment mechanism.

The application reveals no states, realized wealth or selected position between choices. The preview shows announced possibilities and probabilities, not the previously drawn outcome. This distinction prevents portfolio changes across the battery from mixing correlation effects with reactions to earlier gains or losses. Submitted allocations cannot be revised later. If the teaching objective concerns frequent revision or myopic loss aversion, use the separate family designed around that information calendar when it becomes available. The present battery is a comparison of fresh opportunities rather than a dynamic investment sequence.

State draws use equally likely tickets numbered one through ten thousand. Implemented probabilities match the announced values exactly. Wealth calculations use decimal amounts and round once to cents at settlement; theoretical means and standard deviations use values before final rounding. Students do not need an explanation of this infrastructure to participate. Instructors can nevertheless use the private export to verify that instructions, outcomes and points follow the same rule. This makes the classroom example reproducible without exposing hidden draws before choices are finished.

Theory, predictions and evidence

3.1 Mean, variance and covariance

The mean of a distribution is a probability-weighted average of possible outcomes. It is not a forecast of the single outcome a person will observe. Variance measures the average squared deviation from that mean, and standard deviation is its square root. Squaring makes both positive and negative deviations contribute to dispersion. Wealth variance is expressed in squared ECU; standard deviation returns to the unit of wealth and is easier to communicate. Keeping these units distinct helps students understand why a numerical variance cannot be directly compared with terminal wealth.

For a portfolio without random charges, expected wealth is $E[Y] = x_A\mu_A + x_B\mu_B - c$, where μ_A and μ_B are mean multipliers. Variance is

$$\text{Var}(Y) = x_A^2\sigma_A^2 + x_B^2\sigma_B^2 + 2x_Ax_B\rho\sigma_A\sigma_B.$$

The standard deviations σ_A and σ_B describe multipliers, not wealth from a 100-ECU position. Each equals 0.40 in the reference. Covariance is $\rho\sigma_A\sigma_B$. Adding individual risks without the cross term would miss their dependence. A charge that is fixed for a given portfolio changes its mean but not its variance, because it shifts every outcome by the same amount rather than changing their relative dispersion.

Define weights $w_A = x_A/W$ and $w_B = x_B/W$. Under long-only constraints, they sum to one and lie between zero and one. Portfolio-multiplier variance is $w_A^2\sigma_A^2 + w_B^2\sigma_B^2 + 2w_Aw_B\rho\sigma_A\sigma_B$. Multiplying its square root by W gives wealth standard deviation. This translation permits comparisons across budgets without confusing percentages with ECU. A participant with twice the budget may retain the same weights and have twice the standard deviation of terminal wealth. Percentage exposure and monetary risk therefore answer related but distinct questions.

Theoretical foundation

Markowitz's portfolio-selection contribution considers relationships among asset outcomes as well as individual characteristics (Markowitz, 1952). The tables, parameters and worked examples here are an original classroom adaptation of that mechanism, rather than a replication of a published experiment using these screens.

3.2 The minimum-variance portfolio

A minimum-variance portfolio is the feasible combination with the smallest dispersion under the announced opportunities. For two exposures with weights summing to one, the interior weight on

A is

$$w_A^{MV} = \frac{\sigma_B^2 - \rho\sigma_A\sigma_B}{\sigma_A^2 + \sigma_B^2 - 2\rho\sigma_A\sigma_B}.$$

If this value falls outside the permitted interval, the nearest feasible endpoint is used. The application then converts the weight into cent-feasible amounts. If the denominator is zero because exposures move identically, no unique allocation minimizes risk: every division is equivalent at the level of total exposure. The report explicitly identifies that nonuniqueness instead of treating the illustrative 50/50 allocation as uniquely correct.

With equal volatility and correlation below one, the minimizing weight is one half. This reference is especially useful in the core activity because expected wealth is unchanged. A person who prefers less dispersion when the mean stays constant has a natural reason to balance the portfolio. A risk-neutral person is indifferent among equal-mean portfolios, while someone who prefers dispersion may choose differently. Choosing 50% does not identify risk aversion, and every departure from the variance minimum should not automatically be labelled irrational.

The mean–variance criterion summarizes a distribution with two numbers. In a general distribution, people with different preferences may also care about asymmetry, loss probabilities and tails. Here the distributions are finite and fully specified. Return to the state rows whenever a formula threatens to replace understanding. If introducing expected utility, explain that each state’s wealth is evaluated through $u(Y)$ and weighted by that state’s probability. This differs from simply evaluating $u(E[Y])$, because averaging outcomes and evaluating their utility are not generally interchangeable operations.

Charges and unequal means distinguish minimum risk from preference-based optimal choice: lower dispersion can accompany lower expected net wealth. The report shows both for the reference. Concentration sums squared underlying weights: 0.50 at 50/50 and one at full exposure. With shorts it can exceed one and is neither a percentage nor a complete risk measure.

3.3 What prior research contributes

Benartzi and Thaler document that some allocations in defined-contribution plans follow an equal-division rule across offered options, allowing menu composition to affect final exposure ([Benartzi and Thaler, 2001](#)). The duplicate-fund extension asks this question while holding opportunities constant. Classroom results neither estimate actual savers’ behaviour nor reproduce the institutional environment of their study.

Huberman examines investment patterns connected with businesses familiar to customers and shareholders ([Huberman, 2001](#)); French and Poterba study domestic concentration in international equity portfolios ([French and Poterba, 1991](#)). These studies motivate the domestic-versus-foreign labels. Here the labels are explicitly fictional and distributions remain unchanged. A difference could be consistent with salience or familiarity, but it does not identify real-world home bias, which also involves information, taxes, currencies and institutional restrictions.

Blackwell studies the value of information structures in decision problems ([Blackwell, 1953](#)). Here the signal reveals correlation but leaves the terminal state unknown; its charge separates gross from net value. Theory does not establish that everyone will buy information or that every purchase will improve realized wealth.

For each contrast, identify the changed feature, the formal prediction and alternative explanations. Charges, bounded shorts and calculation assistance are original teaching adaptations. A descriptive difference in a small class is insufficient to establish a causal effect of any of these mechanisms.

Basic modes and extended variants

4.1 One portfolio, fixed order and random order

The three basic modes share the same budget, marginal returns, selected-choice payment and absence of interim feedback. One portfolio presents only the independent reference. It is suitable for opening a class and contrasting concentrated with balanced exposure. The fixed battery presents independence, positive correlation of 0.5 and negative correlation of -0.5, in that order. Each position includes rules and a comprehension check, because the joint probabilities change while the individual characteristics of the underlying assets remain unchanged. Students must notice the altered table rather than assume every opportunity is identical.

The random battery contains the same three opportunities, exactly once each, but independently randomizes their order for each participant. Payment selection is uniform by position and, because every scenario appears once, also uniform across scenarios. The report groups choices by opportunity and by position in separate tables. A position effect may reflect task familiarity or a reference established by an earlier opportunity. It should not be called learning from outcomes, since no outcomes were disclosed between decisions. Sequence and scenario are separate descriptive variables.

For a causal comparison of modes, assign participants or class sections before observing choices and keep verbal instructions constant. Do not let early finishers explain the task to people still deciding. If battery and single sessions use different students, sample composition may partly explain observed differences. If the same students complete both, knowledge gained in the first session changes the second. State these limitations and treat the contrasts as teaching illustrations unless a separate research protocol is in place. The software supports comparisons, but does not itself create a valid experimental assignment.

Checkpoint

For a battery, the report must count three scheduled choices per participant. The final page identifies one selected position. Verify that the opportunity comparison contains all three scenarios and that the position table is not presented as accumulated wealth.

4.2 Four changes in dependence

Positive correlation and identical movement

The positive-correlation variant uses 0.5. Matching combinations have probability 37.5% each and opposite combinations 12.5% each. Each marginal mean remains 1.10. Minimum dispersion

still requires balanced exposure, but the reduction relative to full concentration is smaller than under independence. Compare 34.64 with 40 ECU, then with the core condition's 28.28 ECU. This sequence shows that having two assets does not by itself determine the quantitative benefit of combining them. Joint movement matters even when the separate return tables are unchanged.

Identical movement sets correlation to one. Only high-high and low-low have positive probability, 50% each. The displayed table retains zero-probability rows to show which combinations are no longer feasible. Every budget division has expected wealth of 110 and standard deviation of 40. The report identifies a nonunique minimum. An equal allocation could reflect a simple equality rule or convenience; it is not evidence of a diversification gain in this condition. Ask students whether a second label has created a second source of uncertainty.

Negative correlation and exact offset

The negative variant uses -0.5: opposite combinations receive 37.5% each and matching combinations 12.5% each. The balanced portfolio has standard deviation of 20 ECU, although wealth of 70 remains possible. Exact offset uses -1 and removes matching combinations. Equal allocations then produce 110 in every feasible state. Concentration retains individual risk. This distinguishes a distribution that eliminates portfolio risk from a single lucky realization. Students can verify the distinction without estimating correlation from a small sample of classroom outcomes.

The covariance formula in portfolio selection motivates these contrasts ([Markowitz, 1952](#)); the numerical values are a classroom calibration. Read the report through exposure A and standard deviation, not only drawn points. Ask which table information establishes the offset and what happens with weights of 75 and 25. The correct answer gives wealth of 130 in one opposite combination and 90 in the other. The same negative correlation therefore does not eliminate risk for every composition; the offset also depends on how much of each exposure is held.

4.3 Marginal moments and calculation assistance

Unequal volatility

B pays 1.30 or 0.90, with mean 1.10 and standard deviation 0.20; A retains 1.50 or 0.70. Under independence, the minimizing weight on A is $0.04/(0.16 + 0.04) = 0.20$. A portfolio of 20 ECU in A and 80 in B has expected wealth of 110 and standard deviation approximately 17.89 ECU. Equal division instead gives 22.36. The teaching question is why equal amounts no longer coincide with minimum dispersion. Observe whether exposure moves toward the less volatile asset, without declaring every other allocation erroneous before preferences are discussed.

Unequal expected return

B now pays 1.60 or 0.80. Its mean rises to 1.20 while its standard deviation stays at 0.40. A retains mean 1.10. Minimum variance still occurs at 50/50, but no longer preserves maximum expected wealth. Full investment in B gives expected wealth of 120; the balanced portfolio gives 115. The report displays risk and mean separately. Ask how much expected return is sacrificed to reduce dispersion and which preference might justify that sacrifice. This variant creates a trade-off rather than a single recommendation valid for everyone.

Calculation aid

Opportunities are exactly those of the independent core condition. The choice screen adds expected net wealth and standard deviation for the entered portfolio; other conditions display only state-contingent wealth. The aid neither preselects allocations nor ranks portfolios or identifies a best choice. It changes the cognitive cost of summarizing the same distribution. Its prediction depends on whether participants already calculated moments correctly. Convergence toward the reference could be compatible with improved understanding, but also with greater salience of the displayed statistic. The report cannot distinguish those explanations by itself.

These contrasts use the formal portfolio problem as support; they are not presented as previously established empirical effects of this interface. Keep available time constant and do not give one group an additional explanation of the formula. During feedback, compare opportunities first and choices second. This distinguishes an objective change in the problem from a presentation change in otherwise identical information. Ask a student to reconstruct 110 and 28.28 from the state rows before interpreting the calculator as an authority. The calculation aid should support reasoning, not replace it.



Choose your portfolio

Choice 1 of 1

Allocate 100.00 ECU. You can edit amounts before confirming. After submission, the choice is recorded.

Instruments A and B represent two distinct underlying exposures.

The joint distribution is known. Correlation between exposures A and B: 0.00.

Every allocation must be nonnegative, have at most two decimal places, and allocations must sum exactly to 100.00 ECU.

There are no charges in this opportunity.

A · Allocation (ECU)

B · Allocation (ECU)

State-contingent wealth preview

This preview calculates payoffs for your current amounts. The state is randomly drawn and is unknown before confirmation.

Joint state	Probability	Net wealth (ECU)
+ / +	25.00%	150.00
+ / -	25.00%	110.00
- / +	25.00%	110.00
- / -	25.00%	70.00

Calculation aid: the mean and standard deviation summarize this portfolio's distribution. They do not tell you which portfolio to choose.

Expected net wealth (ECU): **110.00**
Standard deviation (ECU): **28.28**

Continue

Figure 4.1: The aid calculates the entered portfolio's mean and deviation without recommending an allocation.

4.4 Duplicate funds and overlapping exposures

Duplicate funds

The menu contains A1, A2 and B. A1 and A2 are exact copies: they always pay A's same multiplier, and their positions are added to measure underlying exposure. An allocation of 25, 25 and 50 is equivalent to 50 in A and 50 in B. Dividing approximately one third across all funds instead creates roughly two-thirds exposure to A and one-third exposure to B. The number of input boxes increases, but the feasible set of underlying risks remains the same as before. Menu size and economic diversification are therefore distinct.

The comparison is motivated by naive menu diversification ([Benartzi and Thaler, 2001](#)). A tendency to divide by the number of offered options would be consistent with that rule, but one choice does not identify an individual's mental procedure. Inspect the report's underlying-exposure distribution. Do not calculate concentration from the three fund names: the application adds A1 and A2 before squaring weights. Ask students why three labels do not create three independent risks, and how they would change an equal-three-fund allocation while preserving its net budget.

Mixed fund and overlap

The menu contains A, B and C. C holds half of each underlying exposure and pays their state-by-state average. Effective weights are $w_A^{ef} = w_A + 0.5w_C$ and $w_B^{ef} = w_B + 0.5w_C$. Full investment in C and a direct 50/50 division have exactly the same distribution. Investing 50 in A and 50 in C instead creates effective exposure of 75% A and 25% B, despite an equal visual split across two instruments. The mixed fund's name cannot be treated as a separate independent source of risk.

The formal prediction depends on effective exposures rather than the number of instruments purchased. The mechanism is portfolio aggregation, and this condition is an original classroom construction. Compare exposure and dispersion in the report. Ask whether purchasing C after A adds a new risk or partly increases a risk already held. A diagram with two underlying boxes can trace every ECU, after which students verify wealth in the high–low state. This reveals the double counting that would result from mistakenly treating the mixed fund as independent. Equivalent exposure should imply equivalent wealth in every state.



Choose your portfolio

Choice 1 of 1

Allocate 100.00 ECU. You can edit amounts before confirming. After submission, the choice is recorded.

A1 and A2 are exact copies of exposure A. They always have the same outcome. Buying both does not add a new exposure. B represents the second exposure.

The joint distribution is known. Correlation between exposures A and B: 0.00.

Every allocation must be nonnegative, have at most two decimal places, and allocations must sum exactly to 100.00 ECU.

There are no charges in this opportunity.

A1 · Allocation (ECU)

A2 · Allocation (ECU)

B · Allocation (ECU)

State-contingent wealth preview

This preview calculates payoffs for your current amounts. The state is randomly drawn and is unknown before confirmation.

Joint state	Probability	Net wealth (ECU)
+ / +	25.00%	150.00
+ / -	25.00%	110.00
- / +	25.00%	110.00
- / -	25.00%	70.00

Continue

Figure 4.2: Three instruments and two risks: A1 and A2 always share the same outcome.



Choose your portfolio

Choice 1 of 1

Allocate 100.00 ECU. You can edit amounts before confirming. After submission, the choice is recorded.

Mixed instrument C holds 50% in A and 50% in B. Its multiplier is their average in each state. Positions in C add to your direct exposures.

The joint distribution is known. Correlation between exposures A and B: 0.00.

Every allocation must be nonnegative, have at most two decimal places, and allocations must sum exactly to 100.00 ECU.

There are no charges in this opportunity.

A - Allocation (ECU)

B - Allocation (ECU)

C: A/B mix - Allocation (ECU)

State-contingent wealth preview

This preview calculates payoffs for your current amounts. The state is randomly drawn and is unknown before confirmation.

Joint state	Probability	Net wealth (ECU)
+ / +	25.00%	150.00
+ / -	25.00%	110.00
- / +	25.00%	110.00
- / -	25.00%	70.00

Continue

Figure 4.3: C holds halves of A and B. Add its components to direct exposures.

4.5 Charges and short positions

Charge for two exposures

A portfolio with nonzero exposure to both A and B pays a terminal charge of 2 ECU. A concentrated portfolio avoids it. A 50/50 division retains standard deviation of 28.28 but reduces expected net wealth to 108; full investment in A retains mean 110 and standard deviation 40. Minimum variance remains balanced, while the desirability of paying to reduce risk depends on preferences. The fixed charge creates a discontinuity at the endpoints: a very small B exposure triggers the entire charge, not a proportional fraction. This should be explained before interpreting corner choices.

Cost of access to B

A 3-ECU charge applies whenever exposure to B is nonzero, regardless of its size. Full A exposure gives mean wealth 110; full B exposure gives net mean 107, and equal division also gives 107. The teaching question distinguishes the cost of participating in an opportunity from a change in the asset's productivity. Inspect charges and mean in the report. Do not attribute movement toward A to familiarity when an objective asymmetric cost exists. Both charge conditions adapt a fixed-cost choice problem rather than claiming prior empirical estimates for these amounts.

Bounded short positions

Negative allocations are permitted. With a 100-ECU budget, each position lies between -50 and 150, net positions sum to 100 and absolute positions total at most 200. A position of -50 in A means selling borrowed exposure and owing its terminal value. With 150 in B, high-low and low-high yield wealth of 30 and 190. Receiving resources from an initial short sale does not create a guaranteed profit. With symmetric means and volatility, allowing shorts does not change the core variance minimum, but it expands the feasible range of risks.

There are no maintenance margins, collateral updates or forced sales. Obligations are netted at the end, and bounds guarantee nonnegative wealth in every state. This condition therefore does not replace the planned leverage-and-margin family. Exposure A may be negative or exceed 100%, and the histogram has dedicated bins. Ask students to calculate a repayment obligation before discussing speculation. Concentration can exceed one and should be interpreted alongside gross positions rather than as a bounded percentage. The extension teaches signed exposure, not the institutional dynamics of margin lending.



Choose your portfolio

Choice 1 of 1

Allocate 100.00 ECU. You can edit amounts before confirming. After submission, the choice is recorded.

Instruments A and B represent two distinct underlying exposures.

The joint distribution is known. Correlation between exposures A and B: 0.00.

Every allocation must be nonnegative, have at most two decimal places, and allocations must sum exactly to 100.00 ECU.

If your portfolio has nonzero exposure to both A and B, 2.00 ECU are deducted from terminal wealth. The charge does not reduce the budget you allocate.

A · Allocation (ECU)

B · Allocation (ECU)

State-contingent wealth preview

This preview calculates payoffs for your current amounts. The state is randomly drawn and is unknown before confirmation.

Joint state	Probability	Net wealth (ECU)
+ / +	25.00%	148.00
+ / -	25.00%	108.00
- / +	25.00%	108.00
- / -	25.00%	68.00

Continue

Figure 4.4: The two-exposure charge is deducted from every terminal-wealth state of a diversified portfolio.



Choose your portfolio

Choice 1 of 1

Allocate 100.00 ECU. You can edit amounts before confirming. After submission, the choice is recorded.

Instruments A and B represent two distinct underlying exposures.

The joint distribution is known. Correlation between exposures A and B: 0.00.

Every allocation must be nonnegative, have at most two decimal places, and allocations must sum exactly to 100.00 ECU.

If your exposure to B is nonzero, 3.00 ECU are deducted from terminal wealth. The charge does not reduce the budget you allocate.

A · Allocation (ECU)

B · Allocation (ECU)

State-contingent wealth preview

This preview calculates payoffs for your current amounts. The state is randomly drawn and is unknown before confirmation.

Joint state	Probability	Net wealth (ECU)
+ / +	25.00%	147.00
+ / -	25.00%	107.00
- / +	25.00%	107.00
- / -	25.00%	67.00

Continue

Figure 4.5: The cost of access to B is announced before choice and does not change the allocation budget.



Choose your portfolio

Choice 1 of 1

Allocate 100.00 ECU. You can edit amounts before confirming. After submission, the choice is recorded.

Instruments A and B represent two distinct underlying exposures.

The joint distribution is known. Correlation between exposures A and B: 0.00.

Negative positions are allowed: you sell borrowed exposure and must repay its terminal value. Each position is between -50.00 and 150.00 ECU; the net sum is 100.00 ECU and absolute positions total at most 200.00 ECU. Obligations are netted at settlement without a margin call.

There are no charges in this opportunity.

A · Allocation (ECU)

B · Allocation (ECU)

State-contingent wealth preview

This preview calculates payoffs for your current amounts. The state is randomly drawn and is unknown before confirmation.

Joint state	Probability	Net wealth (ECU)
+ / +	25.00%	150.00
+ / -	25.00%	30.00
- / +	25.00%	190.00
- / -	25.00%	70.00

Continue

Figure 4.6: A negative position creates a terminal obligation. The preview nets the two instruments.

4.6 Domestic and foreign labels

Two complementary variants are available. In the first, A is labelled domestic and B foreign. In the second, the labels are swapped. Returns, budget, probabilities and charges remain those of the independent reference. Instructions explicitly state that labels are fictional, convey no additional information and involve no exchange-rate differences. The activity asks no nationality, residence or other personal characteristics. It studies a response to an instrument description rather than the actual international exposure of identifiable students. Labels are treatment content, not demographic data.

A useful comparison considers the weight of the domestic-labelled exposure as well as the technical A weight in the private export. If A receives more investment in both conditions, screen position could explain the pattern without a domestic preference. If allocations shift when labels change, the pattern would be consistent with salience or familiarity. Interpretation requires comparable samples and presentation order. A mean allocation of 60% does not establish that everyone followed the same rule. Inspect the distribution and consider mixed behaviour before summarizing the result.

Huberman and French–Poterba motivate questions about familiar and domestic concentration ([Huberman, 2001](#); [French and Poterba, 1991](#)). This adaptation deliberately removes objective market differences to facilitate discussion. That also limits its scope: it does not reproduce countries, exchange rates, restrictions or information asymmetries in actual portfolios. Ask which mechanism could operate despite announced equivalence and which real-world features might make concentration reasonable. The aim is to distinguish a label from an additional economic reason, without ridiculing individual choices or claiming that classroom allocations estimate actual international investment patterns.



Choose your portfolio

Choice 1 of 1

Allocate 100.00 ECU. You can edit amounts before confirming. After submission, the choice is recorded.

Instruments A and B represent two distinct underlying exposures.

Domestic and foreign labels are fictional in this activity. They convey no extra information and do not change returns, probabilities or costs. There are no exchange-rate differences.

The joint distribution is known. Correlation between exposures A and B: 0.00.

Every allocation must be nonnegative, have at most two decimal places, and allocations must sum exactly to 100.00 ECU.

There are no charges in this opportunity.

A: domestic · Allocation (ECU)

B: foreign · Allocation (ECU)

State-contingent wealth preview

This preview calculates payoffs for your current amounts. The state is randomly drawn and is unknown before confirmation.

Joint state	Probability	Net wealth (ECU)
+ / +	25.00%	150.00
+ / -	25.00%	110.00
- / +	25.00%	110.00
- / -	25.00%	70.00

Continue

Figure 4.7: Labels are fictional; their effect is compared while distributions remain identical.



Choose your portfolio

Choice 1 of 1

Allocate 100.00 ECU. You can edit amounts before confirming. After submission, the choice is recorded.

Instruments A and B represent two distinct underlying exposures.

Domestic and foreign labels are fictional in this activity. They convey no extra information and do not change returns, probabilities or costs. There are no exchange-rate differences.

The joint distribution is known. Correlation between exposures A and B: 0.00.

Every allocation must be nonnegative, have at most two decimal places, and allocations must sum exactly to 100.00 ECU.

There are no charges in this opportunity.

A: foreign · Allocation (ECU)

B: domestic · Allocation (ECU)

State-contingent wealth preview

This preview calculates payoffs for your current amounts. The state is randomly drawn and is unknown before confirmation.

Joint state	Probability	Net wealth (ECU)
+ / +	25.00%	150.00
+ / -	25.00%	110.00
- / +	25.00%	110.00
- / -	25.00%	70.00

Continue

Figure 4.8: Swapped labels distinguish a response to description from screen position.

4.7 Joint information: purchase and free access

In these two conditions, A retains multipliers 1.50 and 0.70 while B pays 1.30 and 0.90. Each marginal value has probability 50%. Before choice, each person is assigned a correlation regime of +0.5 or -0.5 with equal probability. In the purchase condition, the participant may pay 3 ECU to learn the regime. Without purchase, the table shows the initial mixture, assigning 25% to every combination. Effective correlation is not disclosed through another channel before the final page. Information changes knowledge of dependence, not marginal returns.

Free information displays the regime directly, with no charge or purchase choice. This is the relevant control for discussing adaptation to information, because it retains the same returns and the same distribution of regimes. Comparing with unequal volatility is also instructive, but that other condition has actual correlation zero rather than a mixture of regimes. The two structures give an uninformed choice the same prior distribution, although they differ in what can be learned before deciding. Explain the distinction before pooling observations across conditions.

Under positive correlation, the minimum-variance formula gives zero weight on A; under negative correlation, approximately 28.57%. Without information, the initial mixture gives 20%. The signal can therefore change a decision because individual volatilities differ. If volatilities were identical, the balanced minimum would be unchanged across regimes, weakening this teaching contrast. The charge is deducted from terminal wealth without reducing the 100-ECU budget. For a 50/50 example in high-high, wealth is 140 without purchase and 137 with purchase. Learning correlation never reveals which terminal state will occur.

Instrumental value depends on preferences and whether the portfolio adapts after the regime is observed. Blackwell motivates the information comparison ([Blackwell, 1953](#)); calibration and charges are original classroom choices. The report separates effective regime and purchase status and gives the purchase denominator. For a nonbuyer, excess risk relative to the conditional minimum is an ex post diagnostic using more information than was available at choice. It is not a measure of ex ante error. Ask what the participant would change in each regime and whether that expected benefit compensates for three certain units of wealth.



Information about correlation

Before allocating 100.00 ECU, you can learn this opportunity's correlation regime. A pays 1.50 or 0.70 per ECU; B pays 1.30 or 0.90. Each value has a marginal probability of 50%. The regime is $+0.50$ or -0.50 , initially equally likely. Purchasing reveals only the correlation and its table; it does not reveal the state that determines your payoff.

Information costs 3.00 ECU, deducted from terminal wealth. You will still allocate 100.00 ECU. If you do not buy it, you decide using the initial mixture. This choice is final; comprehension corrections do not cost points.

Would you like to purchase the information?

- ☐ Purchase information
- ☐ Continue with the initial information

Continue

Figure 4.9: Purchase reveals the correlation regime for three ECU; it does not reveal the terminal state.



Choose your portfolio

Choice 1 of 1

Allocate 100.00 ECU. You can edit amounts before confirming. After submission, the choice is recorded.

Instruments A and B represent two distinct underlying exposures.

You purchased information for 3.00 ECU. The effective correlation in this opportunity is -0.50. The table probabilities correspond to that regime.

Every allocation must be nonnegative, have at most two decimal places, and allocations must sum exactly to 100.00 ECU.

Information costs 3.00 ECU, deducted from terminal wealth. You will still allocate 100.00 ECU. If you do not buy it, you decide using the initial mixture. This choice is final; comprehension corrections do not cost points.

A · Allocation (ECU)

B · Allocation (ECU)

State-contingent wealth preview

This preview calculates payoffs for your current amounts. The state is randomly drawn and is unknown before confirmation.

Joint state	Probability	Net wealth (ECU)
+ / +	12.50%	137.00
+ / -	37.50%	117.00
- / +	37.50%	97.00
- / -	12.50%	77.00

Continue

Figure 4.10: After purchase, the table uses the effective regime and deducts the charge.



Choose your portfolio

Choice 1 of 1

Allocate 100.00 ECU. You can edit amounts before confirming. After submission, the choice is recorded.

Instruments A and B represent two distinct underlying exposures.

The effective correlation is $+0.50$ or -0.50 , initially equally likely. Without purchasing information, the table represents that initial mixture: each combination has 25%. It is not the conditional distribution of a known regime.

Every allocation must be nonnegative, have at most two decimal places, and allocations must sum exactly to 100.00 ECU.

There are no charges in this opportunity.

A · Allocation (ECU)

B · Allocation (ECU)

State-contingent wealth preview

This preview calculates payoffs for your current amounts. The state is randomly drawn and is unknown before confirmation.

Joint state	Probability	Net wealth (ECU)
+ / +	25.00%	140.00
+ / -	25.00%	120.00
- / +	25.00%	100.00
- / -	25.00%	80.00

Continue

Figure 4.11: Without purchase, the table retains the prior mixture of regimes; the effective regime remains hidden.



Choose your portfolio

Choice 1 of 1

Allocate 100.00 ECU. You can edit amounts before confirming. After submission, the choice is recorded.

Instruments A and B represent two distinct underlying exposures.

The joint distribution is known. Correlation between exposures A and B: -0.50.

Every allocation must be nonnegative, have at most two decimal places, and allocations must sum exactly to 100.00 ECU.

There are no charges in this opportunity.

A · Allocation (ECU)

B · Allocation (ECU)

State-contingent wealth preview

This preview calculates payoffs for your current amounts. The state is randomly drawn and is unknown before confirmation.

Joint state	Probability	Net wealth (ECU)
+ / +	12.50%	140.00
+ / -	37.50%	120.00
- / +	37.50%	100.00
- / -	12.50%	80.00

Continue

Figure 4.12: Free information retains the same regime distribution and removes the information charge.

Screens, report and data

5.1 Participant walkthrough

The welcome screen contains institutional logos, an explanation of the laboratory and general rules. Participants confirm that they have read them and select Start. Instructions state the effective budget inside the page body, define ECU, explain budget renewal and describe random payment selection. The joint distribution, instrument composition, charges and worked example follow. Ask participants to read the complete page before continuing, without suggesting a particular allocation. Institutional branding should support a clear entry into the activity rather than distract from its decision rules.

In the paid-information condition, an earlier screen explains the two equally likely regimes and the three-ECU charge. Participants choose whether to purchase or retain initial information. Subsequent instructions display the regime after purchase, or the prior mixture otherwise. Both paths reach comprehension and choice. Free information displays the regime directly. This flow difference serves a concrete economic question and creates no waiting between participants. The information decision is final, so students should understand the charge before confirming it.

Comprehension asks the required position sum, net wealth in the first example row, the payment-selection rule and whether a joint state determines all instruments. An error produces feedback beside that question, showing the submitted answer, correct answer and explanation. Other answers are retained. Corrections do not change points. If many students miss the same question, clarify the general rule without recommending a portfolio. The purpose is to verify knowledge of the mechanism, not to teach a preferred strategy before observing choices.

The decision page requests one amount per instrument. Once budget and bounds are satisfied, the preview shows wealth in every state. Only the calculation-aid variant adds mean and standard deviation. After confirmation, a battery continues to the next fresh opportunity; otherwise the final page appears. This page explicitly confirms completion and remains open while the participant waits for the instructor. There should be no continuation button leading to a technical message about there being no remaining pages. A clear ending is part of the participant experience.



Welcome to Diversification and Portfolio Choice

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

You will make private investment choices. No previous finance knowledge is required. Read the rules and ask for help privately if anything is unclear.

General rules

- Remain silent and do not communicate with other participants.
- Decide individually and privately.
- Follow the instructions on screen.
- Do not refresh, close or leave this page.
- Raise your hand or contact staff privately if you experience a problem.

I have read the rules and am ready to start.

☐ Yes

☒ No

Start

Figure 5.1: The welcome presents the laboratory, rules and a clear start control.

Resources and unit of account

You control a budget of 100.00 ECU in each choice. You must allocate it entirely among the available instruments.

ECU means Experimental Currency Units. It is a unit of account; no conversion into real money is announced here.

Each opportunity has a fresh budget. Outcomes are not reinvested and your choices do not depend on other people.

At the end, one of your choices is randomly selected with equal probability. Its net terminal wealth determines your points. States and the selected choice are revealed after the entire activity.

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

This session does not convert ECU into real money.

Figure 5.2: The budget and ECU definition appear inside the instruction body.

Multipliers include principal: 1.50 means receiving 1.50 ECU for each ECU allocated. One joint state determines the returns of all instruments in your portfolio.

Each underlying exposure has a 50% probability of its high value and a 50% probability of its low value. Combinations and their probabilities are listed below.

The joint distribution is known. Correlation between exposures A and B: 0.00.

Instruments A and B represent two distinct underlying exposures.

Every allocation must be nonnegative, have at most two decimal places, and allocations must sum exactly to 100.00 ECU.

There are no charges in this opportunity.

Rule example: A: 50.00 ECU, B: 50.00 ECU. The table shows this portfolio's net terminal wealth in each state. This is an example, not a recommendation.

Joint state	A	B	Probability	Net wealth (ECU)
+ / +	1.50	1.50	25.00%	150.00
+ / -	1.50	0.70	25.00%	110.00
- / +	0.70	1.50	25.00%	110.00
- / -	0.70	0.70	25.00%	70.00

Figure 5.3: Review multipliers, joint probabilities and constraints before continuing.



Check the rules

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.

Correct any error before deciding; corrections do not reduce your points.

Rule example: A: 50.00 ECU, B: 50.00 ECU. The table shows this portfolio's net terminal wealth in each state. This is an example, not a recommendation.

Joint state	A	B	Probability	Net wealth (ECU)
+ / +	1.50	1.50	25.00%	150.00
+ / -	1.50	0.70	25.00%	110.00
- / +	0.70	1.50	25.00%	110.00
- / -	0.70	0.70	25.00%	70.00

How many ECU must allocations sum to?

According to the first example row, what is net terminal wealth in ECU?

Which choices determine final points?

- ☐ One randomly selected choice
☐ The sum of all choices

Are instrument outcomes determined by one joint state?

- ☐ Yes
☐ No, instruments are drawn separately

Continue

Figure 5.4: Comprehension checks example rules rather than evaluating an investment strategy.

How many ECU must allocations sum to?

1

Your answer: 1. The correct answer is 100. Net positions must sum to the entire budget: 100.00 ECU.

According to the first example row, what is net terminal wealth in ECU?

1

Your answer: 1. The correct answer is 150. Multiply each position by that row's multiplier, add the amounts and subtract announced charges: 150.00 ECU.

Which choices determine final points?

- ☐ One randomly selected choice
- ☒ The sum of all choices

Your answer: The sum of all choices. The correct answer is One randomly selected choice. One opportunity is selected with equal probability after all choices are complete. Wealth amounts are not added.

Are instrument outcomes determined by one joint state?

- ☐ Yes
- ☒ No, instruments are drawn separately

Your answer: No, instruments are drawn separately. The correct answer is Yes. One joint-state row determines all returns simultaneously. Drawing each instrument separately would destroy the announced correlation.

Figure 5.5: Each correction shows the submitted answer, correct answer and explanation, retaining other fields.



Choose your portfolio

Choice 1 of 1

Allocate 100.00 ECU. You can edit amounts before confirming. After submission, the choice is recorded.

Instruments A and B represent two distinct underlying exposures.

The joint distribution is known. Correlation between exposures A and B: 0.00.

Every allocation must be nonnegative, have at most two decimal places, and allocations must sum exactly to 100.00 ECU.

There are no charges in this opportunity.

A · Allocation (ECU)

B · Allocation (ECU)

State-contingent wealth preview

This preview calculates payoffs for your current amounts. The state is randomly drawn and is unknown before confirmation.

Joint state	Probability	Net wealth (ECU)
+ / +	25.00%	150.00
+ / -	25.00%	110.00
- / +	25.00%	110.00
- / -	25.00%	70.00

Continue

Figure 5.6: Allocate the entire budget and inspect state-contingent wealth before confirming.



The activity has ended

Your choices have been recorded. Wait for your instructor's directions and keep this page open.

Your final points: 70.00 ECU. Choice 1 was selected.

Opportunity	Allocation (ECU)	Net wealth (ECU)	Effective correlation	Charges (ECU)	Selected
1	A: 50.00, B: 50.00	70.00	0.00	0.00	Selected

Figure 5.7: The final page identifies the selected opportunity and confirms completion.

5.2 Reading the report without confusing choice and luck

Open Report from the session administration. It initially shows participant count and scheduled, completed and pending choices. Four people in a battery imply twelve scheduled choices; four people in one opportunity imply four. If a choice is missing, decision tables and distributions are not enabled yet. Private downloads still preserve the session's status. This policy prevents a faster-finishing subset from being presented as if it represented the complete class. Progress information and behavioural aggregates serve different purposes and are intentionally separated.

Once everything is complete, select Reveal aggregates for discussion. Every report load begins hidden, and a button can hide results again. The summary includes mean and median exposure A , underlying concentration, mean excess standard deviation and mean points. Mean exposure sums completed-choice percentages and divides by their count. Median exposure is the middle value of those ordered percentages. In a battery, both describe choices, not independent people or portfolios weighted by actual personal wealth. Keep the unit of observation visible when discussing the displayed averages.

Mean concentration is calculated after aggregating instruments that contain the same underlying risk. Its numerator sums choice-level concentration and its denominator counts completed choices. Excess standard deviation subtracts the feasible minimum from the chosen portfolio's deviation, in ECU. Zero means attaining that dispersion diagnostic, not maximizing utility or obtaining the best realized payoff. For nonpurchased information, the conditional reference uses the regime revealed later. Treat it as a subsequent diagnostic rather than labelling an uninformed decision erroneous for failing to use information that was unavailable at choice.

The histogram places net exposure A in intervals and counts choices as frequencies. Separate bins cover negative exposure, zero, positive intervals, one hundred and values above one hundred. Frequencies must sum to completed choices. Two participants can create a mean of 50% by each choosing fifty, or by choosing zero and one hundred respectively. The histogram distinguishes those situations. A balanced class mean is not proof that each individual portfolio was diversified. The distribution is necessary for understanding how the average was produced.

Opportunity and position tables identify the comparison being made. Information conditions additionally separate regime and purchase. Mean points uses one selected realization per participant, a denominator different from choice count. A lower-risk portfolio can produce fewer points than a concentrated portfolio by chance. Begin feedback with prospective distributions and choices, then introduce realized points to discuss decision quality versus one observed outcome. This order prevents students from treating luck as evidence that a portfolio's announced risk was miscalculated.

Instructor report: Diversification and Portfolio Choice

Private report for discussing portfolio choices and ex ante risk. No individual identifiers are displayed.

Reference: independent exposures · Basic · EN

Participants: 4

Scheduled choices: 4

Completed: 0

Pending: 4

A battery contains dependent choices by the same person. Percentages and averages use completed choices; points use one selected choice per person.

[Download this session's choices \(CSV\)](#)

[Download this session's wide data](#)

Aggregates become available after all scheduled choices are completed. Private downloads retain pending and inactive round rows with blank outcomes.

Choices are pending. Decisions and distributions are not displayed yet.

Figure 5.8: While choices are pending, the report displays progress and withholds aggregates.

Instructor report: Diversification and Portfolio Choice

Private report for discussing portfolio choices and ex ante risk. No individual identifiers are displayed.

Reference: independent exposures · Extended · EN

Participants: 4

Scheduled choices: 4

Completed: 4

Pending: 0

A battery contains dependent choices by the same person. Percentages and averages use completed choices; points use one selected choice per person.

[Download this session's choices \(CSV\)](#)

[Download this session's wide data](#)

Aggregates become available after all scheduled choices are completed. Private downloads retain pending and inactive round rows with blank outcomes.

[Reveal aggregates for discussion](#)

Figure 5.9: A complete session starts hidden and requires explicit instructor revelation.

Exposure A (% of budget)	50.00
Median exposure A (%)	50.00
Mean underlying concentration	0.50
Mean excess standard deviation (ECU)	0.00
Mean points per participant (ECU)	90.00
Completed choices	4.00
Participants with points	4.00

Figure 5.10: Distinguish choice count from participants with points when interpreting averages.

[-50,0)%	0	0%
0%	0	0%
(0,25]%	0	0%
(25,50]%	4	 100%
(50,75]%	0	0%
(75,100)%	0	0%
100%	0	0%
(100,150]%	0	0%

Figure 5.11: Each bar counts choices in an exposure-A interval; frequencies sum to the completed-choice total.

Opportunity	Minimum-variance exposure A (%)	Minimum standard deviation (ECU)	Mean wealth of that portfolio (ECU)	Minimum uniqueness
Reference: independent exposures · 0.00	50.00	28.28	110.00	Unique exposure minimum

Figure 5.12: Compare risk and mean with a feasible reference and check whether the minimum is unique.

5.3 Export and privacy

The report offers a session-specific choice CSV and a native wide export. The choice file retains one row per participant and technical round, including pending rows before response and inactive rows when fewer than three opportunities are used. The wide file retains one row per participant with rounds in columns. Download links contain the session identifier so a download does not silently combine all sessions created that day. Confirm scope before interpreting the number of rows or sharing any teaching extract.

The choice CSV records treatment, order, allocations, information purchase where applicable, realized states, wealth, mean, deviation, exposure, concentration, charges and selection. Audit data include the exact opportunity specification and its fingerprint. Pending rows leave draws, outcomes and potentially revealing hidden-regime specifications blank. Missing values are never converted into zero. Completed rows permit reconstruction of calculations. These are private technical records, not projection material, and their detail should not be confused with the anonymous aggregates shown during classroom discussion.

Participant identifiers connect choices within a session but do not appear in the aggregate report. The activity collects no names, student numbers, age, gender or nationality. When illustrating within-person relationships, retain the person as the relevant unit. Battery decisions must not artificially multiply the sample by being treated as separate independent subjects. A publishable comparison would need its own protocol, assignment and data-governance arrangements; the teaching application does not by itself authorize such a use. Classroom demonstration and research inference are different activities.

Before finishing, confirm that the download belongs to the displayed session, includes every active position and assigns one selected payoff per person. Do not distribute administrative links to students. Project only the revealed aggregate report. If explaining the export format, use a synthetic table or clearly identified test data. Guide screenshots show test screens and omit the monitoring table of identities. This preserves the pedagogical value of showing the actual interface while keeping individual continuation links out of projected teaching material.

Class plan and exercises

6.1 A fifty-minute class

Spend the first five minutes on the diversification question and the meaning of terminal wealth. Explain ECU and silence rules without identifying the reference portfolio. During the next fifteen minutes, students read and complete one opportunity or a short battery. Keep monitoring private. Answer rule questions individually and note which comprehension items were most difficult for future preparation. Do not verbally announce returns that differ from the selected configuration. The instructor's role is to make the mechanism clear without directing investment choices.

Reserve ten minutes to reconstruct the examples of 100 in A and 50 in each exposure. Write all four state rows before projecting aggregates. Ask students to identify marginal probabilities, combine the rows yielding 110 and explain the reduction in dispersion. Reveal the histogram afterward and discuss whether the class mean represents a typical individual portfolio. Use another ten minutes to compare correlations or one selected extension. Address one teaching question at a time: joint risk, fund composition or cost, rather than asking students to memorize the entire catalogue.

Use the final ten minutes for a short exercise and written reflection. A useful exit response explains why two funds may fail to diversify and which information is needed to calculate portfolio risk. Assess reasoning and calculation rather than randomly drawn points or closeness to an instructor's chosen weight. If the activity contributes to a grade, announce the reasoning criteria beforehand. Experimental payoff variation should remain an outcome realization rather than an indicator of academic ability. This distinction reinforces the conceptual separation between a decision and its observed consequence.

Feedback script

Discussion script: which outcomes were possible before choosing, what changed when investment was spread, what stayed constant, does the class mean represent everyone, and which charges or information would change the comparison? Finish with one statement about ex ante risk and one about the realized outcome, including their units and denominators.

6.2 Exercises with answer guidance

A portfolio of 75 and 25

Under independence, calculate wealth from 75 in A and 25 in B. The four rows give 150, 130, 90 and 70. Mean wealth is 110 and variance is $(1600 + 400 + 400 + 1600)/4 = 1000$, giving standard deviation 31.62. This portfolio is less dispersed than full A exposure and more dispersed than

50/50. An adequate answer identifies independence when assigning probability one quarter to each row, rather than mechanically taking an arithmetic average without explaining why equal probability weights are appropriate.

Three funds and two risks

A participant assigns 33.33 to A1, 33.33 to A2 and 33.34 to B. Effective exposure is 66.66 to A and 33.34 to B. Concentration is approximately $0.6666^2 + 0.3334^2 = 0.5555$, not one third. To restore balanced exposure without changing the total, the participant can use 25, 25 and 50. Other divisions between duplicate funds are equivalent. Verify one state to demonstrate that equivalence concerns actual payoffs rather than merely similar-looking percentages. The arbitrary split between exact copies should not be counted as a new risk dimension.

A mixed fund

With 60 in A, 20 in B and 20 in C, effective exposures are 70 in A and 30 in B. In high–low, C pays 1.10 and total wealth is $60(1.50) + 20(0.70) + 20(1.10) = 126$. The same value follows from $70(1.50) + 30(0.70)$. This equality checks aggregation. Treating C as a third independent exposure would instead produce a distribution different from the announced one. The student should correct the composition calculation, rather than interpreting the discrepancy as a malfunctioning state draw.

Paying to reduce risk

Compare full A exposure without a charge with 50/50 under the two-exposure charge. The first has mean 110 and deviation 40; the second has mean 108 and deviation 28.28. Under the illustrative criterion $E[Y] - \lambda \text{Var}(Y)/2$, the balanced portfolio beats concentration when $108 - 400\lambda > 110 - 800\lambda$, or $\lambda > 0.005$. Define the parameter's units and emphasize that this is an example of preferences, not an estimate for the class. The calculation establishes why paying a cost has no preference-independent answer, even when the reduction in risk is unambiguous.

Information that enables adaptation

With volatilities 0.40 and 0.20, reconstruct A's minimizing weight in each regime. At $\rho = 0.5$, the numerator is $0.04 - 0.04 = 0$, so the minimum uses zero A. At $\rho = -0.5$, the numerator is 0.08 and denominator 0.28, giving 28.57%. The prior mixture minimizes at 20%. To assess purchase, compare expected utility when decisions can adapt to both regimes with expected utility when choosing before learning the regime, deducting the charge in every state. Comparing three isolated deviations or selecting only the favourable regime after seeing it is insufficient.

Class mean and distribution

One class has four A exposures: zero, zero, one hundred and one hundred. Another has fifty, fifty, fifty and fifty. Both means and medians are fifty, but average individual concentration is one in the first class and 0.50 in the second. Under independence, their mean portfolio deviations are 40 and 28.28. The exercise shows why distributions and individual portfolio risk should accompany mean choices. There is also no jointly owned class portfolio that offsets risks across students: every budget belongs to a different person whose own payoff is settled separately.

6.3 Common problems and closing checklist

If the preview does not appear, check that every active field contains a number, no amount has more than two decimal places and the sum matches the budget exactly. A blank cell is not zero. In a three-instrument menu, an intended zero amount must be entered explicitly. Rejection of a negative amount outside the short-position variant is correct: only that variant allows negative positions. Effective bounds are shown in instructions and inputs, while the server additionally verifies the net sum and absolute exposure.

If a participant remains on comprehension, inspect the feedback for that particular question. The person may have omitted a charge or confused wealth with gain. Do not solve the difficulty by announcing which portfolio maximizes points. If the report remains pending, check counts and private monitoring. A participant may have reached the final choice without submitting it. Do not force progress to fabricate a portfolio or substitute zeros for missing responses. An incomplete session can still support discussion using the theoretical worked example while actual aggregates remain unavailable.

A link stating that the participant does not exist usually belongs to an earlier session whose database was recreated. Create a new session and distribute its current links. Restarting the server to update code does not require deleting the database. Preserve test and class sessions when only wording or styles change. If the data model changes, consult coordination before reusing an incompatible database. Do not stop other game-family instances to resolve a problem in this activity. Recovery should target the affected instance and preserve useful data.

Attention

Low points do not prove poor diversification. First inspect the announced distribution and chosen portfolio. A realized payoff belongs to one state, whereas risk and expected wealth describe opportunities before the draw.

Before opening the classroom, confirm family, language, edition, participant count and budget. Before revealing results, confirm that no choices are pending. Before downloading, confirm the session. Before closing, retain the needed export, hide results if projection remains active and remember that individual links are private. A short review of these steps keeps discussion focused on the economic mechanism and lets instructors reuse the activity confidently. The checklist complements understanding rather than replacing the substantive preparation of examples and comparisons.

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