



CredGuild

STUDY NOTES

CFA® Program Level I

Portfolio Construction

2027 curriculum · 6 readings · 27 practice questions

credguild.com

Version v2027.1 · October 2026

ABOUT THIS EDITION

CredGuild · CFA® Program Level I · Portfolio Construction
2027 curriculum · Version v2027.1 · Generated October 4, 2026

SHARING

© 2026 CredGuild. You may share this file freely, complete and unchanged. Do not sell it, and do not republish it with the CredGuild name, links or watermark removed.

USING THIS BOOK

These notes are a study aid. Use them alongside the CFA Institute curriculum. The latest version is free at credguild.com.

FOUND A MISTAKE?

Email hello@credguild.com, or use "Report an issue with this question" under any question on credguild.com.

TRADEMARKS

CFA Institute does not endorse, promote, review, or warrant the accuracy or quality of the products or services offered by CredGuild. CFA®, Chartered Financial Analyst® and CFA Institute® are trademarks owned by CFA Institute.

Contents

How to use this book	1
Portfolio Construction	2
87. Modern Portfolio Theory	3
88. Systematic vs Unsystematic Risk	20
89. Defined Benefit vs Defined Contribution	39
90. Basics of Portfolio Planning and Construction	49
91. The Behavioral Biases of Individuals	58
92. Value At Risk	67
Keep going at credguild.com	75

How to use this book

These are the CredGuild notes for the 2027 CFA® Program Level I curriculum, Portfolio Construction: 6 readings. They are the same notes as on credguild.com, set out for reading on paper or offline.

What each reading contains

- **What you'll learn:** the learning outcome statements the reading covers.
- **The notes, module by module:** worked examples, key concepts, common exam traps, exam shortcuts and a bottom line.
- **A quick check after each module:** one question with its answer and the full explanation.
- **Practice questions at the end, with the answers.** The full explanation for each one is free on the reading's page at credguild.com; the link is under the answers.

The coloured boxes

KEY CONCEPT

Definitions and formulas to know.

Example. A worked problem, step by step. Try it before you read the working.

COMMON EXAM TRAPS

Mistakes that cost marks.

EXAM SHORTCUTS

Faster ways through a question.

BOTTOM LINE

What to remember from the module.

Using it with the website

Paper is good for reading. Practice works better on the site: it scores each answer as you go, explains every option, keeps a list of the questions you got wrong and spreads the readings across the weeks before your exam. If you are not sure where to start, the free diagnostic test (credguild.com/cfa/level-1/diagnostic/) gives you a score in each topic.

If this book helps you, pass it on to someone else who is studying.

CFA® PROGRAM LEVEL I · TOPIC

Portfolio Construction

Exam weight 8–12% · 6 readings

Portfolio risk and return and the benefit of diversification, the capital market line and the CAPM, the portfolio management process and the investment policy statement, behavioral biases and an introduction to risk management.

Reading 87 Modern Portfolio Theory

Reading 88 Systematic vs Unsystematic Risk

Reading 89 Defined Benefit vs Defined Contribution

Reading 90 Basics of Portfolio Planning and Construction

Reading 91 The Behavioral Biases of Individuals

Reading 92 Value At Risk

credguild.com

PORTFOLIO CONSTRUCTION · READING 87

Modern Portfolio Theory

What you'll learn

LOS 87.a Describe the major asset classes (small- and large-cap stocks, corporate and government bonds, T-bills), their historical risk–return tradeoff, non-normal returns and liquidity.

LOS 87.b Explain risk aversion (versus risk neutrality and risk seeking) and what it implies for choosing among portfolios.

LOS 87.c Explain how an investor's utility function and indifference curves, combined with the capital allocation line, determine her optimal portfolio.

LOS 87.d Calculate and interpret the mean, variance, covariance and correlation of asset returns from historical data.

LOS 87.e Calculate and interpret the variance and standard deviation of a two-asset portfolio.

LOS 87.f Describe how combining assets whose returns are less than perfectly correlated reduces portfolio risk.

LOS 87.g Describe and interpret the minimum-variance frontier, the efficient frontier and the global minimum-variance portfolio.

MODULE 87.1

Historical Risk and Return

This reading describes the risk and return history of the major asset classes and explains risk aversion, utility, indifference curves, the capital allocation line and the choice of an optimal portfolio. It shows how to calculate mean, variance, covariance and correlation from historical returns and the standard deviation of a two-asset portfolio, how correlation drives diversification, and how the minimum-variance frontier, the global minimum-variance portfolio and the efficient frontier are defined.

LOS 87.a — Characteristics of the major asset classes

Portfolio construction starts with the **asset classes** an investor can combine. The classic building blocks are **small-capitalization stocks**, **large-capitalization stocks**, **long-term corporate bonds**, **long-term government bonds** (Treasury bonds) and **Treasury bills** (T-bills).

Risk and return go together

Long histories of market data (US data from 1926 onward, and similar data for other markets around the world) show a clear **risk–return tradeoff**: the asset classes with the highest **average annual returns** also have the highest **standard deviation of returns**.

KEY CONCEPT

US asset class, 1926–2017	Average annual return (geometric mean)	Standard deviation (annualized monthly)
Small-cap stocks	12.1%	31.7%
Large-cap stocks	10.2%	19.8%

US asset class, 1926–2017	Average annual return (geometric mean)	Standard deviation (annualized monthly)
Long-term corporate bonds	6.1%	8.3%
Long-term government bonds	5.5%	9.9%
Treasury bills	3.4%	3.1%
Inflation	2.9%	4.0%

The pattern holds broadly rather than pair by pair: over this period long-term government bonds were slightly more volatile than long-term corporate bonds while earning a little less.

Over long periods, equities have earned higher average returns than fixed-income securities, but with a higher standard deviation of returns. Small-cap stocks have had the highest average return and the highest standard deviation, and T-bills the lowest of both.

Why the pattern makes sense

Theory predicts this pattern. Investors are risk averse, so they hold a riskier asset class only if they expect a higher average return as compensation for the extra risk (LOS 87.b).

Nominal versus real returns

Year-by-year nominal returns on US equities have swung widely, from losses above 40% to gains above 50%. Subtracting inflation gives an approximate **real return**. On the 1926–2017 figures, T-bills earned a real return of only about $3.4\% - 2.9\% = 0.5\%$, while large-cap stocks earned about $10.2\% - 2.9\% = 7.3\%$. Because inflation itself moved around a lot over the period, real returns have been more stable than nominal returns.

Example. Suppose a fund's nominal return last year was 9.0% and inflation was 3.5%. The approximate real return is $9.0\% - 3.5\% = 5.5\%$. If the same fund had returned 1.0% in a year of 6.0% inflation, its approximate real return would be -5.0% . Nominal returns can hide the effect of inflation.

Beyond mean and variance

KEY CONCEPT

Describing an investment only by its **expected return** and **variance** (or standard deviation) is a simplification, because actual return distributions are not normal:

- **Negative skewness:** returns show a tendency toward large downside surprises.
- **Excess kurtosis** (fatter tails; kurtosis above 3): extreme outcomes, both up and down, happen more often than a normal distribution predicts.

These non-normal features (skewness $\neq 0$, kurtosis $\neq 3$) should be considered when analyzing investments.

Liquidity is another characteristic. Illiquidity can depress a security's price and so raise its expected return. It matters most in **emerging markets** and for thinly traded securities, for example **low-quality corporate bonds**; developed-market government securities are highly liquid.

COMMON EXAM TRAPS

- An option giving equities a higher average return *and* a lower standard deviation than bonds contradicts the historical record.
- Long-term government bonds are not the lowest-risk asset class: their prices move with interest rates, so they are more volatile than T-bills.
- Negative skewness describes the shape of the distribution (a long left tail), not a negative average return.

BOTTOM LINE

- Over long periods the asset classes with the highest average returns have also had the highest standard deviations, small-cap stocks being highest on both and T-bills lowest, although the pattern holds broadly and not for every pair.
- Over long periods equities have earned higher average returns than fixed-income securities with a higher standard deviation, which fits risk-averse investors holding riskier asset classes only for a higher expected return.
- The approximate real return is the nominal return minus inflation, and over 1926–2017 real returns were more stable than nominal returns because inflation itself varied a lot.
- Return distributions are not normal: negative skewness means a tendency toward large downside surprises, and excess kurtosis (kurtosis above 3) means extreme outcomes occur more often than a normal distribution predicts.
- Illiquidity can depress a security's price and so raise its expected return, which matters most in emerging markets and for thinly traded securities such as low-quality corporate bonds.

QUICK CHECK**Question 1**

A pension trustee reviews close to a century of capital market history for the United States and other developed markets, comparing equity asset classes with fixed-income asset classes. Relative to fixed-income securities, equities have *most likely* shown:

- A** higher average annual returns and higher standard deviation of returns.
- B** lower average annual returns and higher standard deviation of returns.
- C** higher average annual returns and lower standard deviation of returns.

Answer: A

Long-run data show a positive risk–return tradeoff across asset classes. Both small-cap and large-cap stocks have earned higher average annual returns than long-term corporate and government bonds, and they have done so with a larger standard deviation of returns. Results in other developed markets are similar.

Why the other options are wrong

- **B.** Equities have earned higher average returns than bonds over long periods. The extra return is the reward for their extra volatility.

- **C.** Equities have been more volatile than bonds; higher return with lower risk would contradict the risk–return tradeoff.

Key takeaway Over long periods: more average return has come with more standard deviation (small caps > large caps > bonds > T-bills).

MODULE 87.2

Risk Aversion

LOS 87.b — Risk aversion and portfolio selection

A **risk-averse** investor dislikes risk: given two investments with the **same expected return**, she chooses the one with the **lower risk** (standard deviation). She will hold riskier assets if the extra expected return is adequate compensation for the extra risk. Financial models assume investors are risk averse, and the market prices of financial assets reflect the preferences of risk-averse investors, so **riskier assets must offer higher expected returns**.

KEY CONCEPT

Investor type	Choice between two investments with equal expected return
Risk averse	Picks the less risky one
Risk neutral	Indifferent (cares only about expected return)
Risk seeking (risk loving)	Picks the riskier one

Illustration. A game pays \$200 or \$0 with equal probability (expected payoff \$100). A risk-averse investor prefers a sure \$100 to the game; a risk-seeking investor prefers the game; a risk-neutral investor is indifferent.

Dominance. A risk-averse investor never picks a portfolio that is beaten on both counts, that is, when another available portfolio has a higher (or equal) expected return and lower (or equal) risk, with at least one strictly better. Between a low-return/low-risk portfolio and a high-return/high-risk one, either can be a rational choice; which one depends on the investor's degree of risk aversion.

LOS 87.c — Utility, indifference curves and the optimal portfolio

Utility function

An investor's **utility function** expresses her trade-off between risk and return:

KEY CONCEPT

$$U = E(r) - \frac{1}{2}A\sigma^2$$

where $E(r)$ is expected return and σ^2 the variance of returns (both in decimals), and A is the investor's **degree of risk aversion**, also called the **risk aversion coefficient**. The larger A , the more utility the investor gives up for each unit of variance. A risk-averse investor has $A > 0$, a risk-neutral investor $A = 0$ and a risk-seeking investor $A < 0$.

Example. With $A = 2$, a portfolio with $E(r) = 8\%$ and $\sigma = 10\%$ gives $U = 0.08 - 0.5 \times 2 \times 0.10^2 = 0.08 - 0.01 = 0.07$.

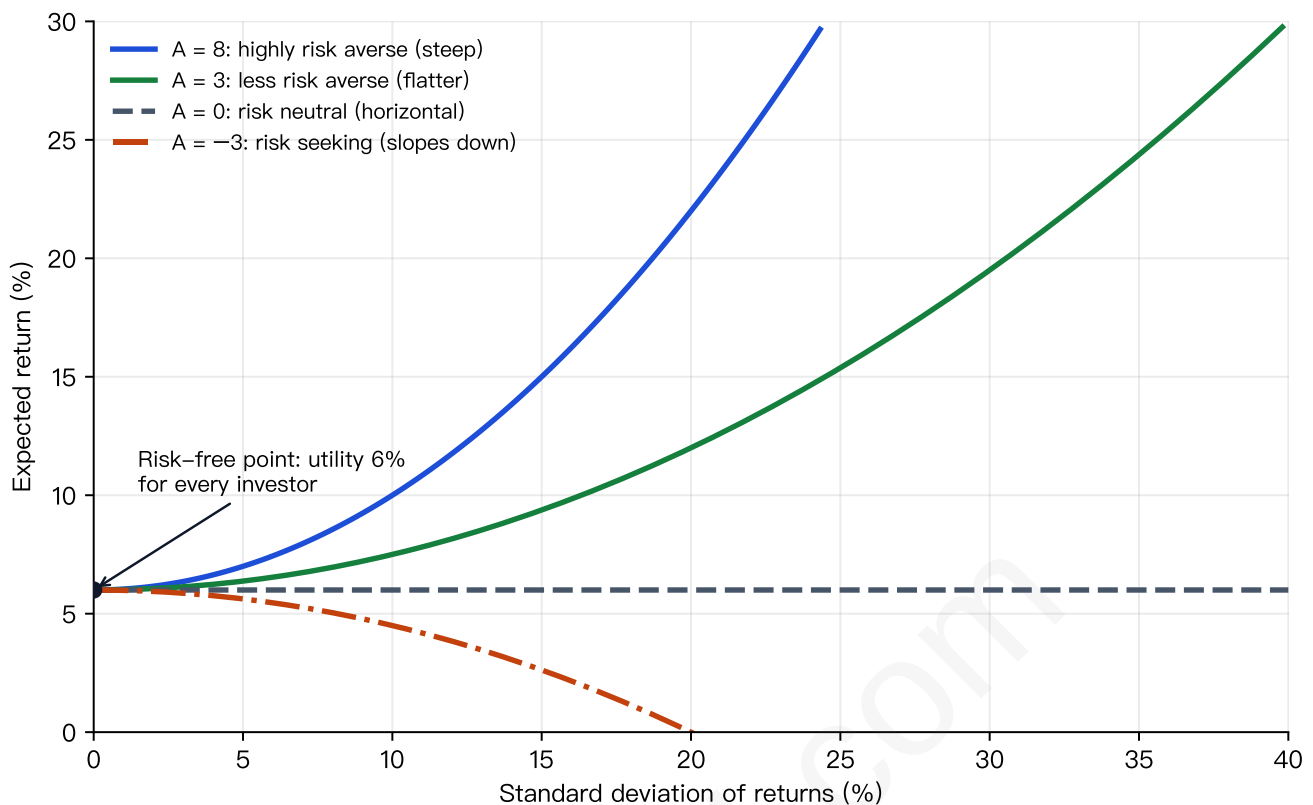
Two results follow directly from the formula. A risk-free asset has $\sigma = 0$, so its utility equals its return for every investor, whatever the value of A . A risky portfolio, by contrast, is worth less to a more risk-averse investor: with the same 8% and 10%, an investor with $A = 6$ gets $U = 0.08 - 0.03 = 0.05$, below the 0.07 of the investor with $A = 2$.

Indifference curves

An **indifference curve** plots the risk–return combinations that give an investor the **same expected utility**. Drawing the curves from expected return and standard deviation alone assumes that these two are the only portfolio characteristics the investor cares about. For a risk-averse investor the curves **slope upward** (more risk must be paid for with more expected return) and curves higher up and to the left give more utility.

- A more risk-averse investor needs more extra return per unit of extra risk, so her indifference curves are **steeper** (a higher A).
- A less risk-averse investor has **flatter** indifference curves.

Solving the utility function for expected return gives $E(r) = U + \frac{1}{2}A\sigma^2$, so the slope follows the sign of A : upward when $A > 0$, flat when $A = 0$ (risk neutral) and downward when $A < 0$ (risk seeking). The figure draws each kind with the same utility of 6%.



Indifference curves with a utility of 6% for investors with different risk aversion coefficients (illustrative numbers)

Adding the risk-free asset: the capital allocation line

Combine a risky portfolio (weight w) with a **risk-free asset** (weight $1 - w$). The risk-free asset's standard deviation is zero, and so is its correlation with the risky portfolio. In the two-asset portfolio formulas (LOS 87.e), every term involving the risk-free asset's risk therefore drops out, leaving

KEY CONCEPT

$$E(R_p) = w E(R_{\text{risky}}) + (1 - w)R_f \quad \sigma_p = w \sigma_{\text{risky}}$$

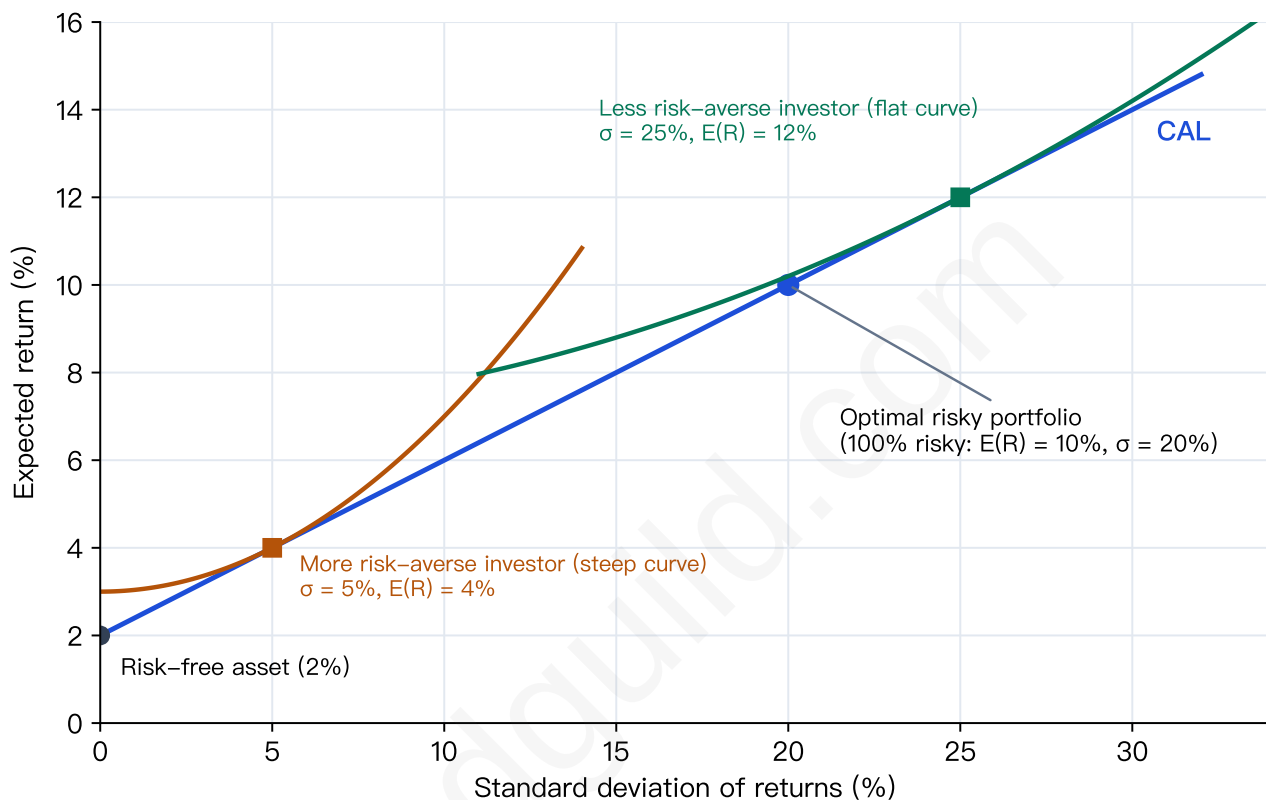
Portfolio risk is just the fraction w of the risky portfolio's risk, so all combinations lie on a **straight line**. The line from the risk-free rate through the **optimal risky portfolio** is the **capital allocation line** (CAL). $w > 1$ means borrowing at the risk-free rate to invest more than 100% of equity in the risky portfolio (a leveraged position, beyond the risky portfolio on the CAL).

The **two-fund separation theorem** says that every investor's optimal portfolio is some combination of the same two "funds": the **optimal risky portfolio** and the **risk-free asset**. Investors differ only in how much they put in each.

Example. $R_f = 2\%$; optimal risky portfolio $E(R) = 10\%$, $\sigma = 20\%$. With 30% in the risky portfolio: $E(R_p) = 0.30(10\%) + 0.70(2\%) = 4.4\%$ and $\sigma_p = 0.30 \times 20\% = 6\%$.

Choosing the optimal portfolio

The investor's **optimal portfolio** is the attainable portfolio that gives her the **highest utility**: the point where her **highest attainable indifference curve is tangent** to the CAL. With risky assets only, the tangency is with the **efficient frontier**, the set of risky portfolios with the highest expected return for each level of risk (LOS 87.g). Curves above it cannot be reached; curves below it are reachable but give less utility. The optimal portfolio is therefore not simply the one with the highest return, and it differs across investors because their indifference curves differ.



Capital allocation line and the optimal portfolios of two investors

The steep-curve (more risk-averse) investor is tangent near the risk-free end of the CAL: mostly T-bills, with low risk and low expected return. The flat-curve (less risk-averse) investor is tangent further out, with more in the risky portfolio (possibly borrowing) and higher risk and higher expected return.

COMMON EXAM TRAPS

- Risk aversion does not mean always choosing the least risky asset; it means choosing the less risky of two assets with the same expected return.
- Do not reverse the slopes: a steep curve belongs to the more risk-averse investor, a flat curve to the less risk-averse one.
- A leveraged investor (more than 100% in the risky portfolio) can still be risk averse, only less so, with flatter curves.
- The line joining the risk-free asset and a risky portfolio is the **capital allocation line**; the capital market line is the special case where the risky portfolio is the market portfolio (Reading 88).
- The optimum is the tangency with the highest attainable indifference curve. The lowest curve, or any point where a curve crosses the frontier, is wrong.

- In the utility formula, enter returns and standard deviations as decimals (0.08, not 8) and keep the $\frac{1}{2}$. With $A = 2$, $E(r) = 8\%$ and $\sigma = 10\%$, dropping the $\frac{1}{2}$ gives 0.06 and entering 8 and 10 gives -92, instead of 0.07.

EXAM SHORTCUTS

- A risk-free asset has $\sigma = 0$, so its utility equals its return for every investor whatever the value of A , and no utility calculation is needed to rank it.

BOTTOM LINE

- Given two investments with the same expected return, a risk-averse investor picks the less risky one, a risk-neutral investor is indifferent and a risk-seeking investor picks the riskier one.
- Utility is $U = E(r) - \frac{1}{2}A\sigma^2$ with returns in decimals, where A is positive for a risk-averse investor, zero for a risk-neutral one and negative for a risk seeker, and a risky portfolio is worth less to a more risk-averse investor.
- An indifference curve joins risk-return combinations with the same expected utility; for a risk-averse investor it slopes upward, a more risk-averse investor has steeper curves, and curves higher and to the left give more utility.
- Combining a risky portfolio with the risk-free asset gives $E(R_p) = wE(R_{risky}) + (1 - w)R_f$ and $\sigma_p = w\sigma_{risky}$, a straight capital allocation line, with $w > 1$ meaning borrowing at the risk-free rate.
- Under two-fund separation every investor's optimal portfolio combines the same optimal risky portfolio with the risk-free asset, and investors differ only in how much they put in each.
- The optimal portfolio is where the investor's highest attainable indifference curve is tangent to the CAL, or to the efficient frontier when only risky assets are available, so a more risk-averse investor sits nearer the risk-free end.

QUICK CHECK

Question 2

Priya Nair and Tomas Ekberg share the same capital market expectations. Ekberg's risk-return indifference curves are flatter than Nair's. Compared with Nair, Ekberg is *most likely*:

- A** less risk averse and will choose an optimal portfolio with a higher expected return.
- B** more risk averse and will choose an optimal portfolio with a higher expected return.
- C** less risk averse and will choose an optimal portfolio with a lower expected return.

Answer: A

Flatter indifference curves mean Ekberg requires less extra expected return for each additional unit of risk, so he is less risk averse than Nair. Facing the same set of portfolios, his flatter curve is tangent further out along the frontier (or CAL), so his optimal portfolio has more risk and a higher expected return.

Why the other options are wrong

- **B.** Flatter curves indicate lower risk aversion; a more risk-averse investor has steeper curves.

- **C.** The degree of risk aversion is right, but a less risk-averse investor's tangency point lies further out, at a higher expected return.

Key takeaway Flatter curves mean less risk aversion and an optimal portfolio with more risk and higher expected return.

MODULE 87.3

Portfolio Standard Deviation

LOS 87.d — Mean, variance, covariance and correlation from historical data

One asset

The **mean return** is the average of the period returns. **Variance** and **standard deviation** measure how widely returns spread around that mean. They are the usual measures of investment risk.

$$\sigma^2 = \frac{\sum_{t=1}^T (R_t - \mu)^2}{T} \quad (\text{population}) \quad s^2 = \frac{\sum_{t=1}^T (R_t - \bar{R})^2}{T - 1} \quad (\text{sample})$$

Historical returns are a sample, so the **sample variance** (divide by $T - 1$) is normally used. Standard deviation is the square root of variance.

Two assets: covariance

Covariance measures how two variables move together over time.

$$\text{Cov}_{1,2} = \frac{\sum_{t=1}^T (R_{1,t} - \bar{R}_1)(R_{2,t} - \bar{R}_2)}{T - 1}$$

- **Positive covariance:** the returns tend to be above (or below) their means in the same periods, so they tend to move together.
- **Negative covariance:** when one return is above its mean, the other tends to be below its mean. It does not mean they always move in opposite directions.
- **Zero covariance:** no linear relationship, so knowing one return says nothing about the other in a linear sense.

Covariance is an absolute measure in squared return units. Its size depends on the assets' volatilities, so on its own it says little about the strength of the relationship.

Correlation

Standardizing covariance by the two standard deviations gives the **correlation coefficient**:

KEY CONCEPT

$$\rho_{1,2} = \frac{\text{Cov}_{1,2}}{\sigma_1 \sigma_2} \quad \Longleftrightarrow \quad \text{Cov}_{1,2} = \rho_{1,2} \sigma_1 \sigma_2$$

Correlation has no units and always lies between -1 and $+1$.

KEY CONCEPT**Correlation****Meaning**

$\rho = +1$

Perfectly positively correlated: deviations from the means are always proportional and in the same direction

$\rho = -1$

Perfectly negatively correlated: deviations always proportional and in opposite directions

$\rho = 0$

Uncorrelated: no linear relationship*Example.* Three annual returns: Asset A 4%, 10%, 1%; Asset B 6%, 12%, 0%.

- Means: $\bar{R}_A = 15/3 = 5\%$, $\bar{R}_B = 18/3 = 6\%$.
- Deviations: A $-1, +5, -4$; B $0, +6, -6$.
- $s_A^2 = (1 + 25 + 16)/2 = 21$, so $s_A = 4.58\%$; $s_B^2 = (0 + 36 + 36)/2 = 36$, so $s_B = 6\%$.
- $\text{Cov}_{A,B} = [(-1)(0) + (5)(6) + (-4)(-6)]/2 = 54/2 = 27$ (in $\%^2$).
- $\rho_{A,B} = 27/(4.58 \times 6) = 0.98$.

LOS 87.e — Portfolio standard deviationFor a two-asset portfolio with weights w_1 and $w_2 = 1 - w_1$:

$$E(R_p) = w_1 E(R_1) + w_2 E(R_2)$$

KEY CONCEPT

$$\sigma_p^2 = w_1^2 \sigma_1^2 + w_2^2 \sigma_2^2 + 2w_1 w_2 \text{Cov}_{1,2} = w_1^2 \sigma_1^2 + w_2^2 \sigma_2^2 + 2w_1 w_2 \rho_{1,2} \sigma_1 \sigma_2$$

$$\sigma_p = \sqrt{\sigma_p^2}$$

The inputs are the **weights**, each asset's **standard deviation** (or **variance**) and the **covariance** (or correlation). Expected returns are needed for $E(R_p)$ but not for σ_p . Beta, which measures an asset's systematic risk relative to the market (Reading 88), is not an input.

Example. 60% in an equity fund ($\sigma = 18\%$) and 40% in a bond fund ($\sigma = 10\%$), $\rho = 0.20$:

$$\sigma_p^2 = 0.36(0.0324) + 0.16(0.0100) + 2(0.6)(0.4)(0.2)(0.18)(0.10) = 0.011664 + 0.0016 + 0.001728 = 0.014992$$

$\sigma_p = \sqrt{0.014992} = 12.24\%$. With $\rho = +1$ the answer would be the weighted average $0.6(18\%) + 0.4(10\%) = 14.8\%$.

COMMON EXAM TRAPS

- When variances are given, take square roots before dividing the covariance by $\sigma_1\sigma_2$.
- Correlation outside -1 to $+1$ means an arithmetic error (e.g., dividing the wrong way).
- Sample statistics divide by $T - 1$, not T . Dividing by $T = 3$ in the three-year example gives a variance of 14 for Asset A and a covariance of 18 instead of 21 and 27.
- Portfolio variance or standard deviation: read which one is asked.
- Square the weights and the standard deviations (in decimals) in the first two terms, and keep the factor 2 on the covariance term. In the 60/40 example, dropping the 2 gives 11.89% and leaving the weights unsquared gives 15.86%, instead of 12.24%.

BOTTOM LINE

- Historical returns are a sample, so the sample variance divides the squared deviations by $T - 1$, and the standard deviation is its square root.
- Covariance measures how two returns move together: positive when they tend to be above or below their means in the same periods, negative when one tends to be above its mean while the other is below, and zero when there is no linear relationship.
- Covariance is in squared return units and depends on the assets' volatilities, whereas the correlation $\rho_{1,2} = \text{Cov}_{1,2}/(\sigma_1\sigma_2)$ has no units and lies between -1 and $+1$.
- Two-asset portfolio variance is $w_1^2\sigma_1^2 + w_2^2\sigma_2^2 + 2w_1w_2\rho_{1,2}\sigma_1\sigma_2$, so its inputs are the weights, the standard deviations and the covariance or correlation, with expected returns and beta not needed for σ_p .

QUICK CHECK**Question 3**

An analyst collects four years of returns for two stocks:

Annual returns on two stocks (%)

Year	Stock P	Stock Q
1	9	14
2	3	6
3	12	10
4	8	10

Using the sample formula, the covariance between the returns of Stock P and Stock Q (in percent squared) is *closest* to:

A

B

C

Answer: A

Sample covariance is the sum of the products of the two stocks' deviations from their own means, divided by $T - 1$. The products sum to 24 over four observations, so the covariance is $24/3 = 8$.

Means: $\bar{R}_P = (9 + 3 + 12 + 8)/4 = 8\%$; $\bar{R}_Q = (14 + 6 + 10 + 10)/4 = 10\%$

Year $R_P - \bar{R}_P$ $R_Q - \bar{R}_Q$ **Product**

1	1	4	4
2	-5	-4	20
3	4	0	0
4	0	0	0

$$\text{Cov}_{P,Q} = \frac{4 + 20 + 0 + 0}{4 - 1} = \frac{24}{3} = 8$$

Why the other options are wrong

- **B.** 14 is the sample variance of Stock P $(1 + 25 + 16 + 0)/3$. The question asks for the covariance between P and Q.
- **C.** 24 is the sum of the cross-products before dividing by $T - 1 = 3$.

Key takeaway Covariance: multiply paired deviations, sum, divide by $T - 1$. Don't confuse it with one stock's variance.

MODULE 87.4

The Efficient Frontier**LOS 87.f — Investing in assets that are less than perfectly correlated**

When $\rho_{1,2} = +1$, the portfolio variance formula collapses to a perfect square:

$$\sigma_p^2 = (w_1\sigma_1 + w_2\sigma_2)^2 \Rightarrow \sigma_p = w_1\sigma_1 + w_2\sigma_2$$

With **perfect positive correlation**, portfolio standard deviation is simply the **weighted average** of the assets' standard deviations: there is **no diversification benefit**. The lowest-risk (long-only) portfolio is then 100% in the asset with the lower standard deviation.

For any correlation below +1, the covariance term is smaller, so portfolio standard deviation is less than the weighted average of the individual standard deviations. That reduction is the **diversification benefit**, and the lower the correlation, the larger it is. At $\rho = 0$ the covariance term vanishes; for negative ρ it becomes negative and cuts risk further. At $\rho = -1$ the variance is again a perfect square, $(w_1\sigma_1 - w_2\sigma_2)^2$, so $\sigma_p = |w_1\sigma_1 - w_2\sigma_2|$. Choosing the weights so that $w_1\sigma_1 = (1 - w_1)\sigma_2$ sets this to zero and gives a **zero-variance** portfolio:

KEY CONCEPT

$$w_1 = \frac{\sigma_2}{\sigma_1 + \sigma_2}$$

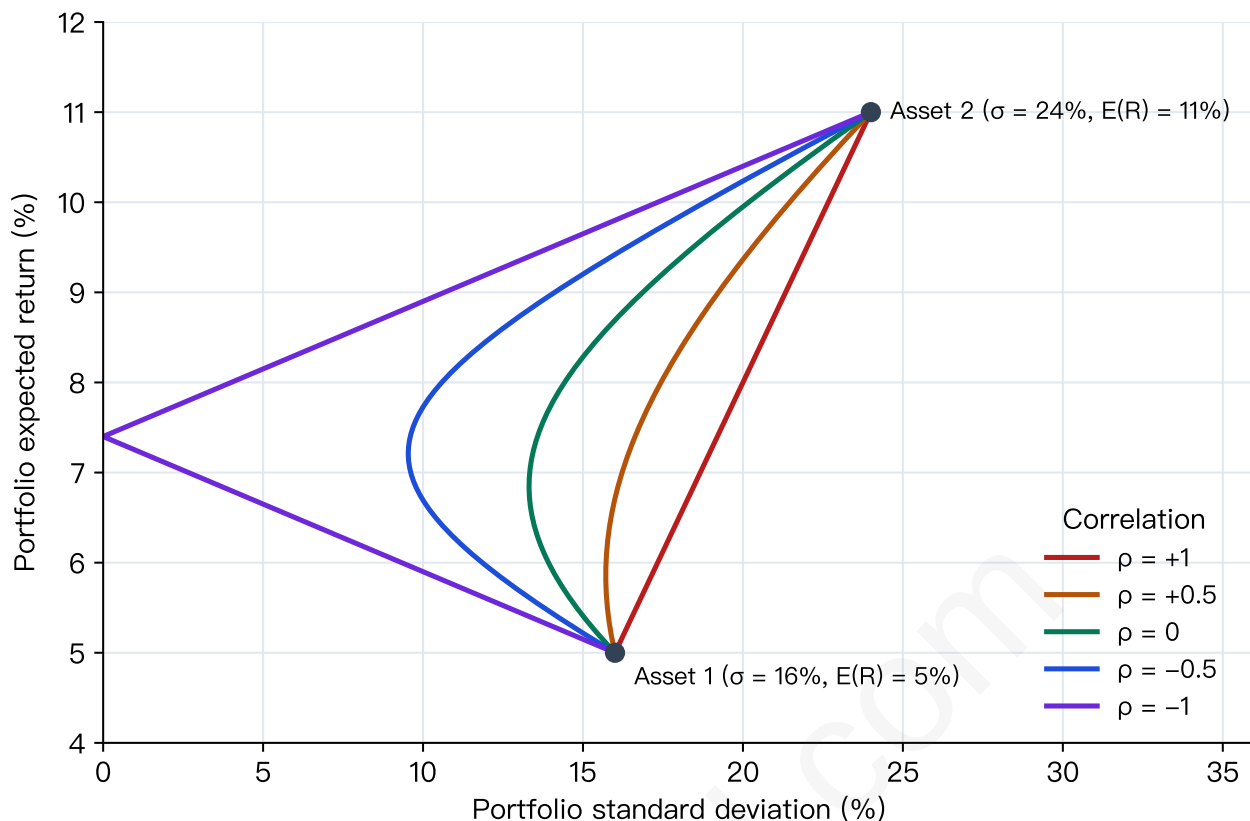
With long positions only, a zero-variance portfolio of two risky assets is possible only when $\rho = -1$; at $\rho = 0$ risk falls but cannot reach zero.

Example. Two assets with $\sigma_1 = 16\%$, $\sigma_2 = 24\%$, equally weighted:

KEY CONCEPT

ρ	Portfolio variance	Portfolio σ
+1	0.0400	20.00%
+0.5	0.0304	17.44%
0	0.0208	14.42%
-0.5	0.0112	10.58%
-1	0.0016	4.00%

At $\rho = -1$ the zero-variance mix is $w_1 = 24/40 = 60\%$; the equal-weighted mix still has 4.00% risk. The figure shows all long-only combinations of two assets ($E(R_1) = 5\%$, $E(R_2) = 11\%$) for several correlations. Correlation does not enter $E(R_p) = w_1E(R_1) + w_2E(R_2)$, so a given mix of weights has the same expected return on every curve. A lower correlation only cuts the risk of that mix, which is why the curve bulges further to the left. The $\rho = -1$ curve reaches the vertical axis at $0.60(5\%) + 0.40(11\%) = 7.4\%$, the expected return of the zero-variance mix.



Two-asset portfolio risk and return for different correlations

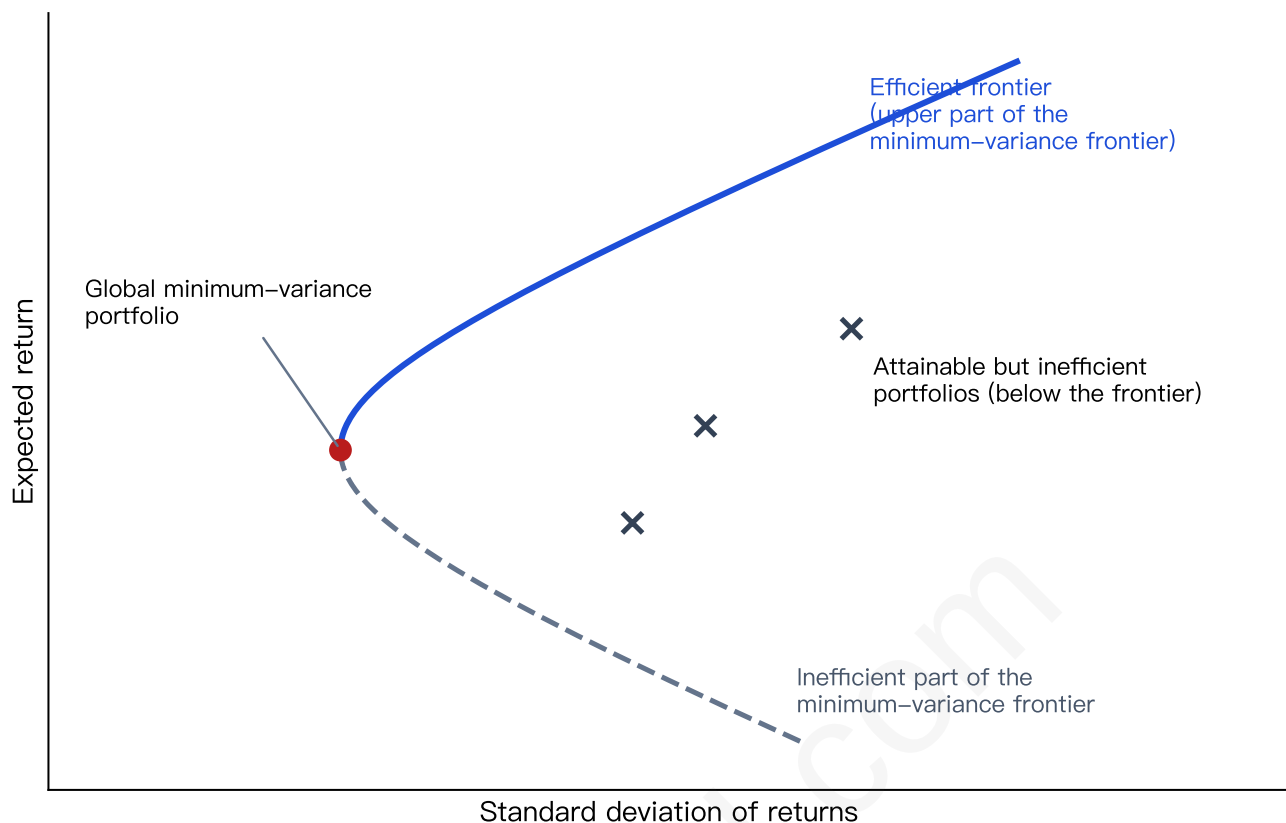
Adding an asset. If a new asset has the same standard deviation as the existing portfolio and a correlation with it below +1, adding it reduces portfolio standard deviation. With equal risk and return, the candidate with the lowest covariance (correlation) with the portfolio reduces risk the most. For the same reason investors add other asset classes, such as bonds, real estate and foreign stocks, to their domestic stocks.

LOS 87.g — Minimum-variance frontier, efficient frontier and the global minimum-variance portfolio

For each level of expected return, the portfolio with the lowest standard deviation is a **minimum-variance portfolio**; together they form the **minimum-variance frontier**. The minimum-variance portfolio farthest to the left, which is the lowest-risk risky portfolio of all, is the **global minimum-variance portfolio**.

KEY CONCEPT

Risk-averse investors want the highest expected return for each level of risk. The portfolios that offer it form the **efficient frontier**: the **upper part of the minimum-variance frontier**, starting at the global minimum-variance portfolio. Equivalently, an efficient portfolio is **not dominated** by any other attainable portfolio: no attainable portfolio offers a higher expected return with the same or lower risk. Efficient portfolios do not dominate one another, because moving along the frontier trades more risk for more expected return.



Minimum-variance frontier, efficient frontier and global minimum-variance portfolio

- A portfolio below the efficient frontier is **inefficient**: another attainable portfolio offers a higher expected return for the same risk (or the same return with lower risk). Risk-averse investors will not choose it.
- A portfolio above the efficient frontier is **not attainable**.
- The frontier is **concave**: its slope decreases as risk increases (each extra unit of risk buys less extra return).
- Lower correlations among assets move the frontier to the left (up and to the left, the "northwest"): the same returns with less risk.

Inputs (Markowitz). Risk is measured by the **variance (standard deviation) of returns**. Building the efficient frontier requires each security's **expected return**, **variance** and the **covariances** between all pairs of securities. Investors' risk aversion is not an input; it matters only when choosing a portfolio on the frontier (Module 87.2).

Spotting an inefficient portfolio. Portfolio K: $E(R) = 9\%$, $\sigma = 17\%$; Portfolio L: $E(R) = 10\%$, $\sigma = 15\%$. L has the higher return and the lower risk, so K cannot be on the efficient frontier.

When investors can lend and borrow at a risk-free rate below the expected returns on the efficient frontier, they combine the risk-free asset with the optimal risky portfolio (two-fund separation). The capital allocation line touches the concave efficient frontier only at the optimal risky portfolio, so every other frontier portfolio, including the global minimum-variance portfolio, lies below the line and is not an optimal holding for a rational investor. That includes the frontier portfolios beyond the tangency point. For an investor who wants more expected return than the optimal risky portfolio offers, borrowing at the risk-free rate to move further out along the line gives a higher expected return for the same standard deviation.

COMMON EXAM TRAPS

- Efficient frontier = highest return for each level of **risk**. "Each level of risk tolerance" is a distractor.

- A covariance equal to $\sigma_1\sigma_2$ signals $\rho = +1$, even when no correlation is quoted.
- Diversification helps whenever $\rho < +1$, including positive correlations below +1.

EXAM SHORTCUTS

- With $\rho = +1$, portfolio standard deviation is the weighted average of the assets' standard deviations, so the full variance formula is not needed.
- A portfolio with a lower expected return and a higher standard deviation than another attainable portfolio is dominated, so it can be ruled out as efficient without plotting the frontier.

BOTTOM LINE

- For any correlation below +1, portfolio standard deviation is less than the weighted average of the assets' standard deviations, and the lower the correlation, the larger this diversification benefit.
- With long positions only, a zero-variance portfolio of two risky assets exists only when $\rho = -1$, with $w_1 = \sigma_2/(\sigma_1 + \sigma_2)$.
- Correlation does not affect a portfolio's expected return, only its risk, so a lower correlation moves each mix of weights to the left at the same expected return.
- Adding an asset with the same standard deviation as the portfolio and a correlation with it below +1 reduces portfolio risk, and among otherwise equal candidates the one with the lowest correlation reduces it most.
- The efficient frontier is the upper part of the minimum-variance frontier starting at the global minimum-variance portfolio; portfolios below it are inefficient, portfolios above it are not attainable, and it is concave.
- The Markowitz inputs are each security's expected return and variance and the covariances between all pairs, investors' risk aversion is not an input, and when investors can lend and borrow at a risk-free rate below the frontier's expected returns, the CAL touches the frontier only at the optimal risky portfolio.

QUICK CHECK

Question 4

Fund Lark has a standard deviation of returns of 7.4%, and Fund Wren has a standard deviation of returns of 5.2%. The two funds' returns are perfectly positively correlated. If short sales are not allowed, which allocation minimizes the standard deviation of a portfolio of the two funds?

- A Lark 0%, Wren 100%.
- B Lark 100%, Wren 0%.
- C Lark 41%, Wren 59%.

Answer: A

With a correlation of +1 there is no diversification benefit: portfolio standard deviation is just the weighted average of the two funds' standard deviations. The weighted average is lowest when everything is in the fund with the lower standard deviation, Wren (5.2%).

With $\rho = +1$: $\sigma_p = w_L(7.4\%) + w_W(5.2\%)$, a weighted average that is minimized at $w_W = 100\%$, giving $\sigma_p = 5.2\%$.

Why the other options are wrong

- **B.** Putting everything in Lark gives the highest possible portfolio risk (7.4%), because Lark is the more volatile fund.
- **C.** These weights ($w_{Lark} = 5.2/12.6 = 41\%$) would create a zero-risk portfolio only if the correlation were -1 . With $\rho = +1$, this mix has $\sigma_p = 0.41(7.4\%) + 0.59(5.2\%) = 6.1\%$, more than Wren alone.

Key takeaway With perfect positive correlation, hold only the lower- σ asset to minimize risk.

Practice questions

Question 5

Investors can borrow and lend at the risk-free rate, which is below the expected return of every portfolio on the efficient frontier of risky assets, and all investors hold the same expectations about risky assets. A rational, risk-averse investor is *least likely* to choose which of the following as her entire portfolio?

- A** 100% in the risk-free asset.
- B** The global minimum-variance portfolio.
- C** 140% in the optimal risky portfolio, financed by borrowing at the risk-free rate.

Answers: 5. B

Why each answer is right and why each other option is wrong: credguild.com/cfa/level-1/notes/portfolio-construction/modern-portfolio-theory/. The full bank has 75 questions on this reading.

PORTFOLIO CONSTRUCTION · READING 88

Systematic vs Unsystematic Risk

What you'll learn

LOS 88.a Describe what happens to risk and expected return when a risk-free asset is combined with a portfolio of risky assets.

LOS 88.b Explain the capital allocation line (CAL) and the capital market line (CML), including lending and borrowing portfolios and the market portfolio.

LOS 88.c Explain systematic and nonsystematic risk and why nonsystematic risk earns no additional expected return.

LOS 88.d Explain return generating models, including multifactor models and the market model, and their uses.

LOS 88.e Calculate and interpret beta from covariance, correlation and standard deviations, or from the CAPM relation.

LOS 88.f Explain the capital asset pricing model (CAPM), its assumptions, and the security market line (SML), and contrast the SML with the CML.

LOS 88.g Calculate and interpret an asset's expected (required) return using the CAPM.

LOS 88.h Describe and demonstrate applications of the CAPM and the SML, such as identifying undervalued and overvalued securities.

LOS 88.i Calculate and interpret the Sharpe ratio, Treynor measure, M-squared and Jensen's alpha.

MODULE 88.1

Systematic Risk and Beta

This reading adds a risk-free asset to a risky portfolio to derive the capital allocation line and the capital market line, separates systematic from unsystematic risk, and covers return generating models, the market model and the calculation of beta. It then derives the CAPM and the security market line, shows how to calculate required returns and identify mispriced securities, and how to compute and interpret the Sharpe ratio, M-squared, the Treynor measure and Jensen's alpha.

LOS 88.a — Adding a risk-free asset to a risky portfolio

A **risk-free asset** has a standard deviation of returns of zero, and its returns have **zero correlation** with the returns of any risky asset. When an investor puts a weight w in a risky portfolio P and $1 - w$ in the risk-free asset, the two-asset portfolio formulas reduce to two simple expressions:

$$E(R_C) = w E(R_P) + (1 - w) R_f$$

$$\sigma_C = w \sigma_P$$

- The **expected return** is a weighted average of the **risk-free rate** and the risky portfolio's expected return.
- The **standard deviation** is the risky weight times the risky portfolio's standard deviation, because the risk-free asset contributes no variance and no covariance.
- Both $E(R_C)$ and σ_C are linear in w , so every combination plots on a **straight line** that starts at R_f on the vertical axis and passes through P.

A single risky portfolio plus the risk-free asset therefore lets investors with very different degrees of risk aversion reach the level of risk they want. The resulting combinations can dominate risky portfolios that lie below the line.

Example. A risky fund has $E(R) = 9\%$ and $\sigma = 15\%$; $R_f = 3\%$.

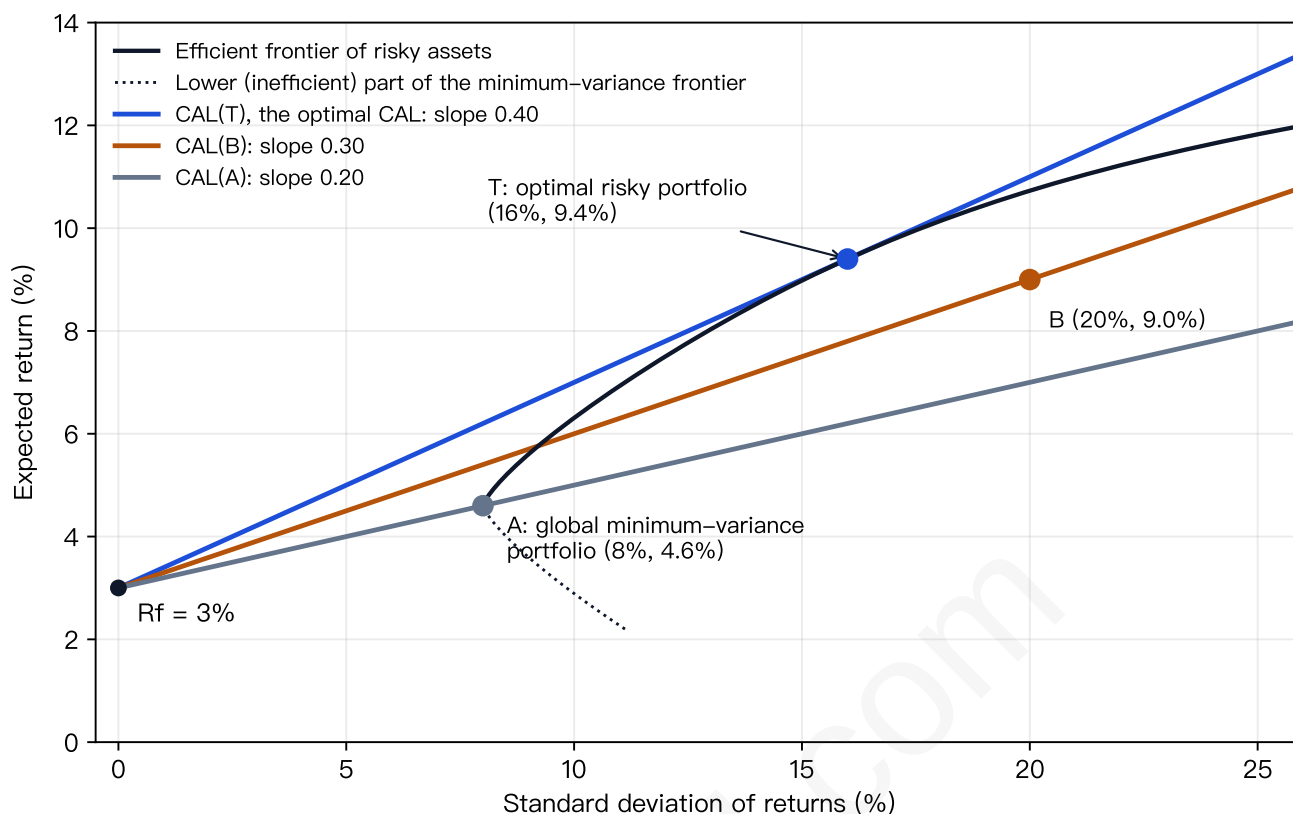
Weight in risky fund	Expected return	Standard deviation
0.70 (lending 30%)	$0.70(9) + 0.30(3) = 7.2\%$	$0.70(15) = 10.5\%$
1.00	9.0%	15.0%
1.25 (borrowing 25%)	$1.25(9) - 0.25(3) = 10.5\%$	$1.25(15) = 18.75\%$

Common exam traps

- A 50/50 mix has exactly half the risky portfolio's standard deviation. Expecting diversification to push it lower is the mistake: the risk-free return never varies, so it cannot offset any of P's swings.
- The variance is not a weighted average of the variances. The standard deviation is a weighted average of the standard deviations (one of which is zero). For the 0.70 weight in the example, averaging the variances gives a standard deviation of 12.55% instead of 10.5%.

LOS 88.b — The capital allocation line (CAL) and the capital market line (CML)

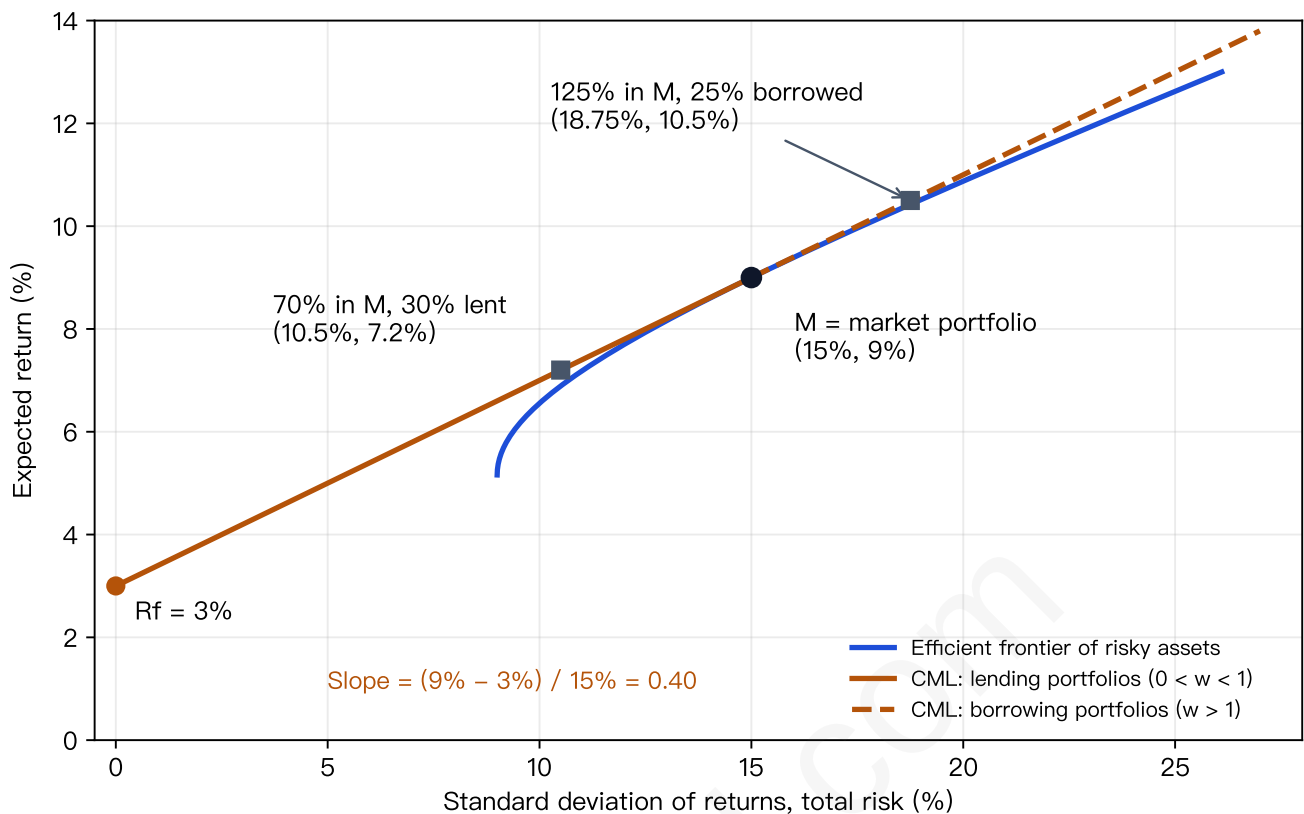
The **capital allocation line (CAL)** is the line of risk–return combinations available from the risk-free asset and one particular risky portfolio. Each risky portfolio produces its own CAL. Of all the CALs, the investor should use the one whose set of portfolios she prefers most. That is the steepest line from R_f , the one **tangent** to the efficient frontier, called the **optimal CAL**. The tangency point is the **optimal risky portfolio**: of all risky portfolios, it has the highest excess return per unit of standard deviation, $[E(R_P) - R_f]/\sigma_P$, which is the Sharpe ratio of LOS 88.i. Because every CAL starts at R_f , the optimal CAL offers a higher expected return than any other CAL at every level of risk above zero.



Three capital allocation lines from the same risk-free rate: the steepest one is tangent to the efficient frontier

In the figure, $R_f = 3\%$. B has a higher expected return than the global minimum-variance portfolio A and a steeper CAL: $(9.0 - 3)/20 = 0.30$ against $(4.6 - 3)/8 = 0.20$. T's CAL is steeper still, $(9.4 - 3)/16 = 0.40$, so T is the optimal risky portfolio. B lies inside the frontier, and T offers both less risk and more expected return than B. The investor then picks the point on the optimal CAL that maximizes her **expected utility**, where her highest indifference curve touches the line.

If investors had different forecasts, each would find a different tangency portfolio and a different CAL. Capital market theory assumes **homogeneous expectations**: everyone has the same estimates of expected returns, standard deviations and correlations. Everyone then faces the same efficient frontier and the same tangency portfolio, and that portfolio must be the **market portfolio**. The market portfolio is the portfolio of **all risky assets** in existence, held in market-value weights; it contains no risk-free asset. The common optimal CAL is called the **capital market line (CML)**.



The capital market line: lending and borrowing portfolios built from the risk-free asset and the market portfolio

KEY CONCEPT

$$E(R_P) = R_f + \left[\frac{E(R_M) - R_f}{\sigma_M} \right] \sigma_P$$

- The intercept is R_f . The slope, $\frac{E(R_M) - R_f}{\sigma_M}$, is the excess return per unit of total risk (standard deviation). It equals the Sharpe ratio of the market portfolio.
- $E(R_M) - R_f$ is the **market risk premium**. Writing the CML as $E(R_P) = R_f + [E(R_M) - R_f](\sigma_P / \sigma_M)$ shows that each unit of market risk σ_M an investor accepts adds one market risk premium to her expected return.
- Risk on the horizontal axis is **standard deviation (total risk)**. Beta is the risk measure of the security market line (LOS 88.f).
- Points between R_f and M are **lending portfolios**, with part of the money invested at R_f . Points beyond M, further up the line, are **borrowing portfolios**: the investor borrows at R_f and invests more than 100% of her equity in M (buying on margin). All portfolios on the CML hold the same risky portfolio (M), so their returns are **perfectly positively correlated** with each other and they carry no unsystematic risk.

Example. $R_f = 3\%$, $E(R_M) = 9\%$, $\sigma_M = 15\%$. Slope = $6/15 = 0.40$. A CML portfolio with $\sigma_P = 12\%$ has $E(R_P) = 3 + 0.40(12) = 7.8\%$; its weight in M is $12/15 = 0.80$. The risk-free asset has a beta of 0 and M has a beta of 1, so the beta of any CML portfolio equals its weight in M: 0.80 here, and 1.25 for an

investor who borrows a quarter of her equity and puts 125% of it in M.

Two-fund separation. Combining the CML with an investor's indifference curves splits portfolio choice into two separate decisions. Which risky assets to hold is the same decision for everyone: hold the market portfolio. How much risk to take, meaning how much to lend or borrow at R_f , depends on the investor's own risk aversion. This is the **two-fund separation theorem** (the **separation theorem**): every investor's optimal portfolio combines just two funds, the risk-free asset and the optimal risky portfolio. Security selection thereby reduces to building one well-diversified portfolio.

Passive vs. active. Investors who believe market prices are informationally efficient follow a **passive investment strategy**. They hold an index fund as a proxy for M and split their money between it and the risk-free asset. Investors who think they can identify mispriced securities use **active portfolio management**, overweighting securities they consider undervalued and underweighting those they consider overvalued.

Common exam traps

- Calling the market portfolio "all stocks", or a mix of risky assets and the risk-free asset, is wrong; a broad equity index is only a proxy for it.
- The market portfolio is found by drawing a line from the risk-free rate tangent to the efficient frontier. A line from some other point on the return axis, or the point where an investor's indifference curve touches the frontier, does not locate it.
- Reading capital market theory as "everyone holds exactly M" is a mistake; only the risky part of each investor's portfolio is the same.

LOS 88.c — Systematic and unsystematic risk

$$\text{total risk} = \text{systematic risk} + \text{unsystematic risk}$$

KEY CONCEPT

Systematic risk

Also called **market risk** or **nondiversifiable risk**

Caused by economy-wide factors (GDP growth, interest rates, inflation)

Cannot be removed by diversification

Priced: compensated with higher expected return

Unsystematic risk

Also called **unique risk**, **firm-specific risk** or **diversifiable risk**

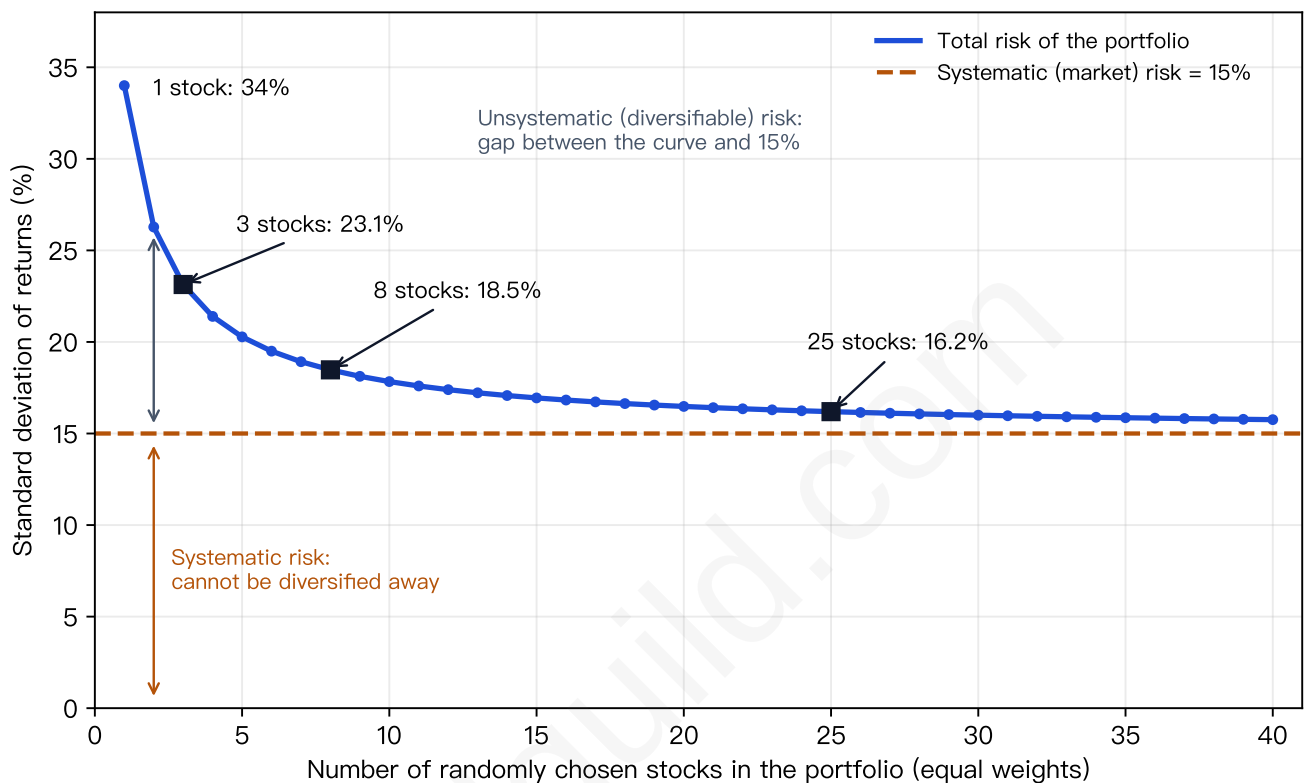
Caused by events specific to one company or industry

Falls as more (imperfectly correlated) securities are added

Not priced in equilibrium

Total risk is measured by the standard deviation (or variance) of returns. Exam convention: total risk = systematic risk + unsystematic risk is stated as a simple sum, with total risk measured by standard deviation. Current practice: the sum is exact for variances, as in the market model $\sigma_i^2 = \beta_i^2 \sigma_m^2 + \sigma_e^2$; the standard deviations of the two parts do not add up to the total standard deviation.

Systematic risk applies to single securities as well as to portfolios. Makers of luxury goods, such as sports cars and premium motorcycles, respond strongly to the business cycle and have high systematic risk. Utilities respond little to market-wide factors and have low systematic risk. As the number of randomly chosen stocks in a portfolio grows, total risk declines and approaches market risk. According to one study, about 12 to 18 stocks capture roughly 90% of the maximum diversification benefit; another put the number at about 30 stocks. Either figure is far smaller than the number of securities in the market.



Portfolio risk falls toward systematic risk as randomly chosen stocks are added (illustrative numbers)

As unsystematic risk is diversified away, the portfolio behaves more and more like the market, so its correlation with the market moves toward +1. The market portfolio is perfectly diversified, and all of its risk is systematic.

Bonds. The same reasoning applies to a bond portfolio. A surprise that hits one issuer, such as a downgrade, can be diversified away by holding bonds of many issuers, while economy-wide changes, such as a recession or a rise in interest rates or inflation, affect all bonds and cannot be diversified away.

Why unsystematic risk earns no premium. Capital market theory assumes diversification is costless; a low-cost index fund comes close. Investors will not be paid for bearing a risk they could remove for free, so in equilibrium the expected (required) return depends only on systematic risk. A single-drug biotech stock can have very high total risk yet low systematic risk, and therefore a low equilibrium return. A steady machine-tool maker with modest total risk but high sensitivity to the business cycle requires a higher return. A portfolio of 50 or 100 such biotech stocks would carry little of that firm-specific uncertainty, because the successes and failures offset one another. A security's systematic risk is measured by what it contributes to the risk of a well-diversified portfolio.

Common exam traps

- Individual securities carry both systematic and unsystematic risk. Only well-diversified portfolios are (approximately) free of unsystematic risk.
- Adding randomly chosen stocks reduces unsystematic risk and leaves the expected level of systematic risk unchanged. Deliberately adding high-beta (low-beta) stocks does raise (lower) the portfolio's systematic risk.
- Rejecting total risk = systematic risk + unsystematic risk because standard deviations do not add is the mistake; under the exam convention above, that identity is the expected answer.

LOS 88.d — Return generating models and the market model

A **return generating model** estimates an asset's expected return from its exposure to one or more factors. Factors may be **macroeconomic** (GDP growth, inflation, consumer confidence), **fundamental** (earnings, earnings growth, firm size, research spending) or **statistical**. In practice, most models rely mainly on macroeconomic and fundamental factors. Statistical factors frequently lack any grounding in finance theory. They may capture a pattern specific to one sample period that was found by **data mining** (testing one data set over and over).

The **multifactor model** in excess-return form is:

$$E(R_i) - R_f = \beta_{i,1}E(F_1) + \beta_{i,2}E(F_2) + \cdots + \beta_{i,k}E(F_k)$$

Each β is a **factor sensitivity (factor loading)**. The first factor is often the market's excess return.

- The **Fama and French** model uses three factors: the market's excess return, **firm size**, and the **book-to-market** (book value to market value) ratio.
- **Carhart** adds a fourth factor, **price momentum**, based on prior-period returns. The four factors explain a good share of the differences in US equity returns over the period in which the model was estimated.

A **single-factor model** uses just one factor, whatever that factor is (for example, only the book-to-market ratio, or only the earnings growth rate). The single-factor model whose factor is the market's excess return is the **single-index model**: $E(R_i) - R_f = \beta_i[E(R_m) - R_f]$.

The **market model** is a simplified single-index model estimated by regressing the asset's return on the market's **rate of return**:

$$R_i = \alpha_i + \beta_i R_m + e_i$$

- α_i and β_i are estimated from historical returns. The expected return is $\alpha_i + \beta_i E(R_m)$.
- It is used to estimate β_i and to measure **abnormal return**, $e_i = R_i - (\alpha_i + \beta_i R_m)$: the actual return minus the return expected given the actual market return.
- For consistency with the single-index model, α_i can be set to $R_f(1 - \beta_i)$.

Example. A stock's market model is $R_i = 0.4\% + 1.1R_m$. The market returns 6%, so the expected return is $0.4 + 1.1(6) = 7.0\%$. If the stock actually returned 8.5%, its abnormal return is $8.5 - 7.0 = 1.5\%$.

Common exam traps

- The market model regresses on the market's rate of return (R_m), not on its excess return or a risk-adjusted return.

- The number of factors decides "single-factor" versus "multifactor"; the type of factor does not.

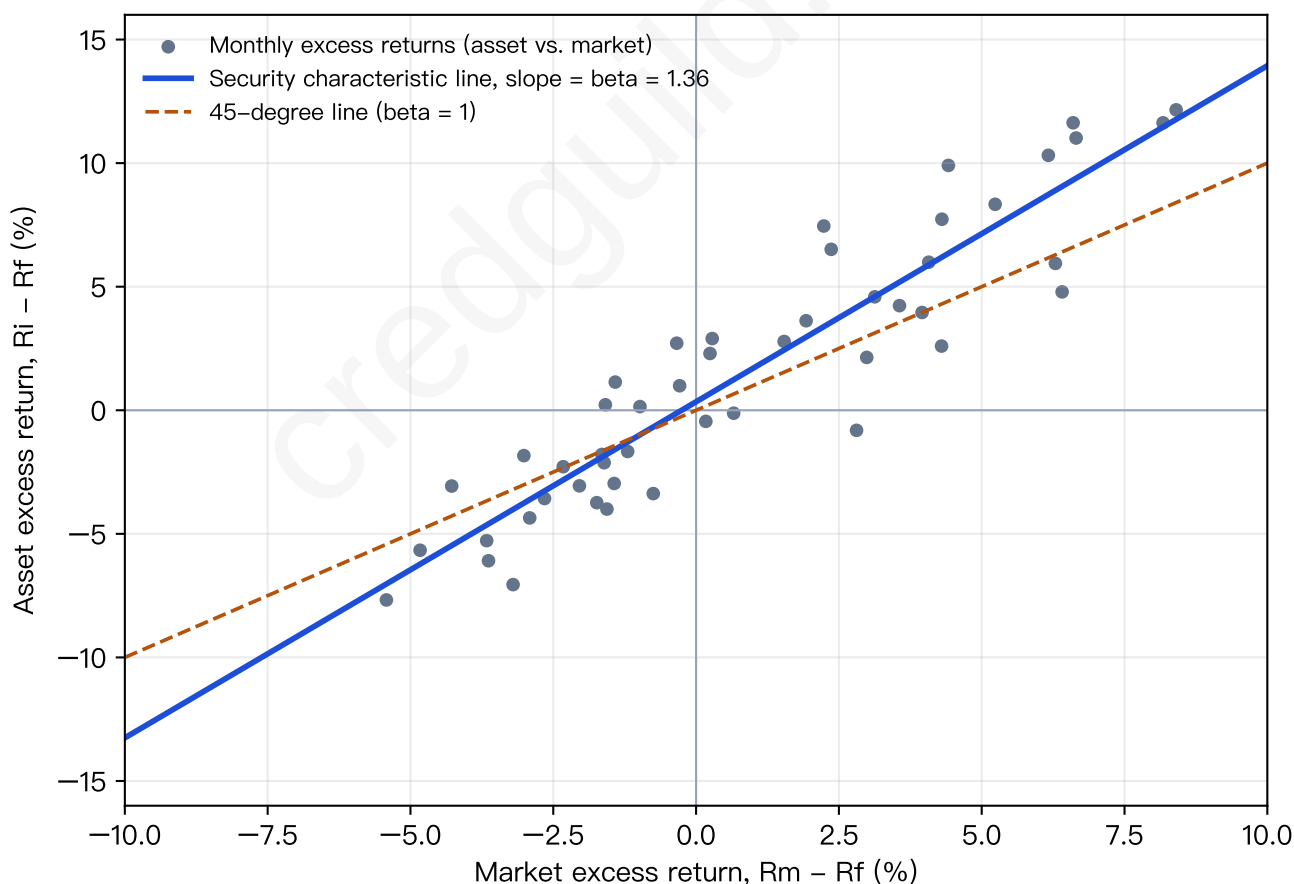
LOS 88.e — Calculating and interpreting beta

Beta is a standardized measure of the covariance of an asset's return with the market's return. It measures **systematic risk** only:

KEY CONCEPT

$$\beta_i = \frac{\text{Cov}(R_i, R_m)}{\sigma_m^2} = \frac{\rho_{i,m} \sigma_i \sigma_m}{\sigma_m^2} = \rho_{i,m} \frac{\sigma_i}{\sigma_m}$$

- The market's beta is 1, because the covariance of the market's return with itself is its variance: $\text{Cov}(R_m, R_m)/\sigma_m^2 = 1$. The (value-weighted) average beta of all stocks is also 1. A beta of 0 means the asset's return is uncorrelated with the market. Negative betas are possible.
- In practice beta is estimated as the slope of a regression of the asset's excess returns on the market's excess returns. The least squares line, which minimizes the sum of squared vertical distances of the points from the line, is the **security characteristic line**. Its slope is $\text{Cov}_{i,m}/\sigma_m^2$. A slope steeper than 45° means $\beta > 1$: the asset's return reacts more strongly to systematic factors than the market's does.



Security characteristic line: asset excess returns regressed on market excess returns

Example. $\sigma_i = 28\%$, $\sigma_m = 14\%$, $\rho = 0.45$.

Covariance = $0.45 \times 0.28 \times 0.14 = 0.01764$; $\beta = 0.01764 / 0.14^2 = 0.90$. Equivalently, $\beta = 0.45 \times (28/14) = 0.90$.

Backing beta out of the CAPM. The CAPM (LOS 88.f) states $E(R_i) = R_f + \beta_i[E(R_m) - R_f]$. Rearranging it gives $\beta_i = [E(R_i) - R_f] / [E(R_m) - R_f]$. If a stock is expected to earn 12% with $R_f = 2\%$ and $E(R_m) = 7\%$, $\beta = 10/5 = 2.0$.

Common exam traps

- Divide the covariance by the market variance. Dividing by the market standard deviation is a common mistake. In the example, dividing 0.01764 by 0.14 gives 0.126 instead of 0.90.
- When given variances, take square roots before using $\rho \sigma_i / \sigma_m$.
- The ratio is σ_i / σ_m , the asset's standard deviation over the market's. Do not invert it, and do not forget to multiply by the correlation. In the example, inverting the ratio gives 0.225 and leaving out the correlation gives 2.0, instead of 0.90.
- When backing out beta, subtract R_f from both the asset's and the market's expected return. In the example, 12/7 gives 1.71 and 10/7 gives 1.43 instead of 2.0.

EXAM SHORTCUTS

- The risk-free asset has a beta of 0 and the market portfolio a beta of 1, so the beta of any portfolio on the CML equals its weight in M, with no covariance calculation needed.

BOTTOM LINE

- Combining a risky portfolio P with the risk-free asset gives $E(R_C) = wE(R_P) + (1 - w)R_f$ and $\sigma_C = w\sigma_P$, so every combination lies on a straight line from R_f through P.
- The optimal CAL is the steepest line from R_f , tangent to the efficient frontier at the optimal risky portfolio, which has the highest excess return per unit of standard deviation of all risky portfolios.
- Under homogeneous expectations every investor's tangency portfolio is the market portfolio of all risky assets in market-value weights, and the CML, $E(R_P) = R_f + [(E(R_M) - R_f) / \sigma_M] \sigma_P$, measures risk by standard deviation, with investors differing only in how much they lend or borrow at R_f .
- Exam convention: total risk = systematic risk + unsystematic risk, with total risk measured by standard deviation; current practice: the sum is exact for variances only; in either case only systematic risk is priced, because capital market theory assumes unsystematic risk can be diversified away at no cost.
- The market model $R_i = \alpha_i + \beta_i R_m + e_i$ regresses an asset's return on the market's rate of return and gives the abnormal return $R_i - (\alpha_i + \beta_i R_m)$, while multifactor models such as Fama and French (market, size, book-to-market) and Carhart (adding momentum) use several factors.
- Beta is $Cov(R_i, R_m) / \sigma_m^2 = \rho_{i,m} \sigma_i / \sigma_m$, measures systematic risk only, and equals 1 for the market.

QUICK CHECK

Question 1

An investor combines a risk-free asset with a portfolio of risky assets. Which statement about the new portfolio is *least accurate*?

- A Its variance equals the weighted average of the variances of the risk-free asset and the risky portfolio.
- B Its expected return is a weighted average of the risk-free rate and the risky portfolio's expected return.
- C Its standard deviation equals the risky portfolio's weight multiplied by the risky portfolio's standard deviation.

Answer: A

The variance of the new portfolio is $w^2\sigma_P^2$, not $w\sigma_P^2 + (1-w)(0)$. The standard deviation, rather than the variance, is the weighted average of the two assets' standard deviations (zero for the risk-free asset and σ_P for the risky portfolio).

Example with $w = 0.5$, $\sigma_P = 20\%$: variance = $0.5^2 \times 0.04 = 0.01$ (standard deviation 10%), whereas a weighted average of variances would give $0.5 \times 0.04 = 0.02$ (standard deviation 14.1%).

Why the other options are wrong

- B. Accurate: $E(R_C) = wE(R_P) + (1-w)R_f$.
- C. Accurate: because the risk-free asset has zero standard deviation and zero correlation, $\sigma_C = w\sigma_P$.

Key takeaway Standard deviation is linear in the risky weight; variance is not.

MODULE 88.2

The CAPM and the SML

LOS 88.f — The CAPM, its assumptions, and the security market line (SML)

Only systematic risk is priced, so the relevant risk of any asset is its covariance with the market. Plotting expected return against $Cov(R_i, R_m)$, or against **beta** after standardizing by the market variance, gives the **security market line (SML)**. The equation of the SML is the **capital asset pricing model (CAPM)**:

$$E(R_i) = R_f + \beta_i [E(R_m) - R_f], \quad \beta_i = \frac{Cov(R_i, R_m)}{\sigma_m^2}$$

The intercept is R_f (beta 0), the market plots at $\beta = 1$, and the slope is the **market risk premium** $E(R_m) - R_f$. With a positive market risk premium, expected return rises **linearly** with systematic risk.

Assumptions of the CAPM

Assumption	Meaning
Risk aversion	Investors demand a higher expected return to accept more risk

Assumption	Meaning
Utility maximizing investors	Rational investors each choose the risk–return combination that maximizes their own expected utility
Frictionless markets	No taxes, no transaction costs and no other impediments to trading
One-period horizon	All investors share the same single-period time horizon
Homogeneous expectations	All investors have the same estimates of expected returns, standard deviations and correlations
Divisible assets	All investments are infinitely divisible
Competitive markets	Investors are price takers ; no single investor's trades can influence prices

Comparing the CML and the SML

KEY CONCEPT

	Capital market line (CML)	Security market line (SML)
Risk measure (x-axis)	Standard deviation (total risk)	Beta (systematic risk)
What plots on it in equilibrium	Only efficient portfolios (R_f combined with M)	All properly priced securities and portfolios, diversified or not
Slope	$[E(R_m) - R_f]/\sigma_m$	$E(R_m) - R_f$
Diversification of points on it	Always well diversified; only systematic risk	Can be single stocks or concentrated portfolios; any unsystematic risk they carry is not priced

The two lines are drawn against different risk measures, so there is no point at which they "converge". In equilibrium an inefficient portfolio or a single stock plots below the CML but on the SML. Every asset with a beta of 1 plots at the same point on the SML as the market, whatever its total risk.

Common exam traps

- Picking the stock with the highest standard deviation as the one with the highest equilibrium return is the classic mistake; the CAPM prices beta only.
- Risk aversion does not require holding the risk-free asset. A risk-averse investor may still borrow to buy more of M.
- The security characteristic line (LOS 88.e) is not the SML. Its slope is one asset's beta, while the slope of the SML is the market risk premium.

LOS 88.g — Expected (required) return with the CAPM

Substitute the inputs into $E(R_i) = R_f + \beta_i[E(R_m) - R_f]$. Check whether the question gives the **expected market return** $E(R_m)$ or the market risk premium $E(R_m) - R_f$.

Example. $R_f = 2.5\%$, $E(R_m) = 7.5\%$, $\beta = 1.4$: $E(R_i) = 2.5 + 1.4(7.5 - 2.5) = 9.5\%$. Because $\beta > 1$, the stock's expected return exceeds the market's.

Useful rearrangements and relationships:

- Market risk premium: $E(R_m) - R_f = [E(R_i) - R_f]/\beta_i$. The same equation solved for beta is shown under LOS 88.e.
- Nominal risk-free rate $\approx$ real risk-free rate + expected inflation.
- With a **positive market risk premium** ($E(R_m) > R_f$), a **negative beta** gives a required return below R_f . If $E(R_m) < R_f$, a negative beta gives a required return above R_f . For example, with $\beta = -0.5$, $R_f = 4\%$ and $E(R_m) = 2\%$, the required return is $4 - 0.5(-2) = 5\%$.
- Holding everything else constant and assuming a positive market risk premium, a higher beta raises the required return, so the price investors will pay today falls. With a negative market risk premium the beta ranking reverses.

Common exam traps

- If the premium is given, do not subtract R_f again.
- If the market return is given, subtract R_f before multiplying by beta. In the example, $2.5 + 1.4(7.5)$ gives 13.0% instead of 9.5%.
- Do not use the real risk-free rate when a nominal required return is asked for.

LOS 88.h — Applying the CAPM and the SML: finding mispriced securities

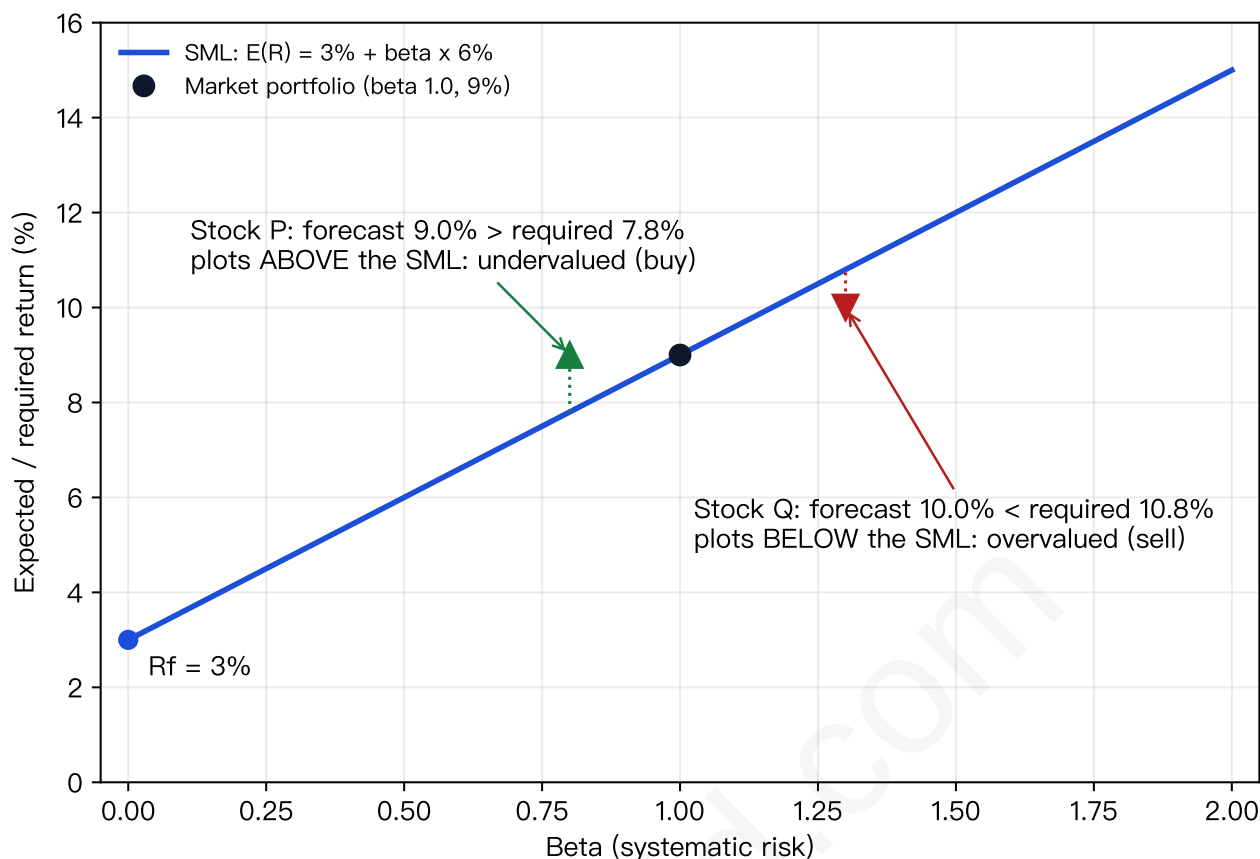
In equilibrium, a security's expected return equals its **required return** from the SML. An analyst compares her own forecast with the CAPM required return:

$$\text{forecast return} = \frac{P_1 - P_0 + D_1}{P_0} \quad \text{required return} = R_f + \beta[E(R_m) - R_f]$$

KEY CONCEPT

Comparison	Position vs. SML	Valuation	Action
Forecast > required	Plots above the SML	Undervalued	Buy
Forecast < required	Plots below the SML	Overvalued	Sell or sell short
Forecast = required	Plots on the SML	Properly valued	Indifferent

The forecast minus the required return is the security's expected **alpha**, the size of the mispricing. When forced to sell one of two undervalued holdings, sell the one with the smaller alpha.



Using the SML to identify undervalued and overvalued stocks

Example ($R_f = 3\%$, $E(R_m) = 9\%$).

- Stock P: $\beta = 0.8$, bought at 50, forecast price 53 plus a 1.50 dividend. Forecast = $(53 - 50 + 1.50)/50 = 9.0\%$; required = $3 + 0.8(6) = 7.8\%$. P is undervalued by 1.2% and plots above the SML.
- Stock Q: $\beta = 1.3$, forecast 10.0%; required = $3 + 1.3(6) = 10.8\%$. Q is overvalued by 0.8% and plots below the SML.

The graph and the algebra always give the same conclusion, because the SML is the graph of the CAPM equation.

Common exam traps

- Include the dividend in the forecast holding period return. For Stock P, leaving out the 1.50 dividend gives a forecast of 6.0%, below the 7.8% required return, instead of 9.0%.
- Judging a stock against R_f instead of against its own required return is a mistake. With a positive market risk premium, a negative-beta stock can be undervalued even when its forecast return is below R_f .

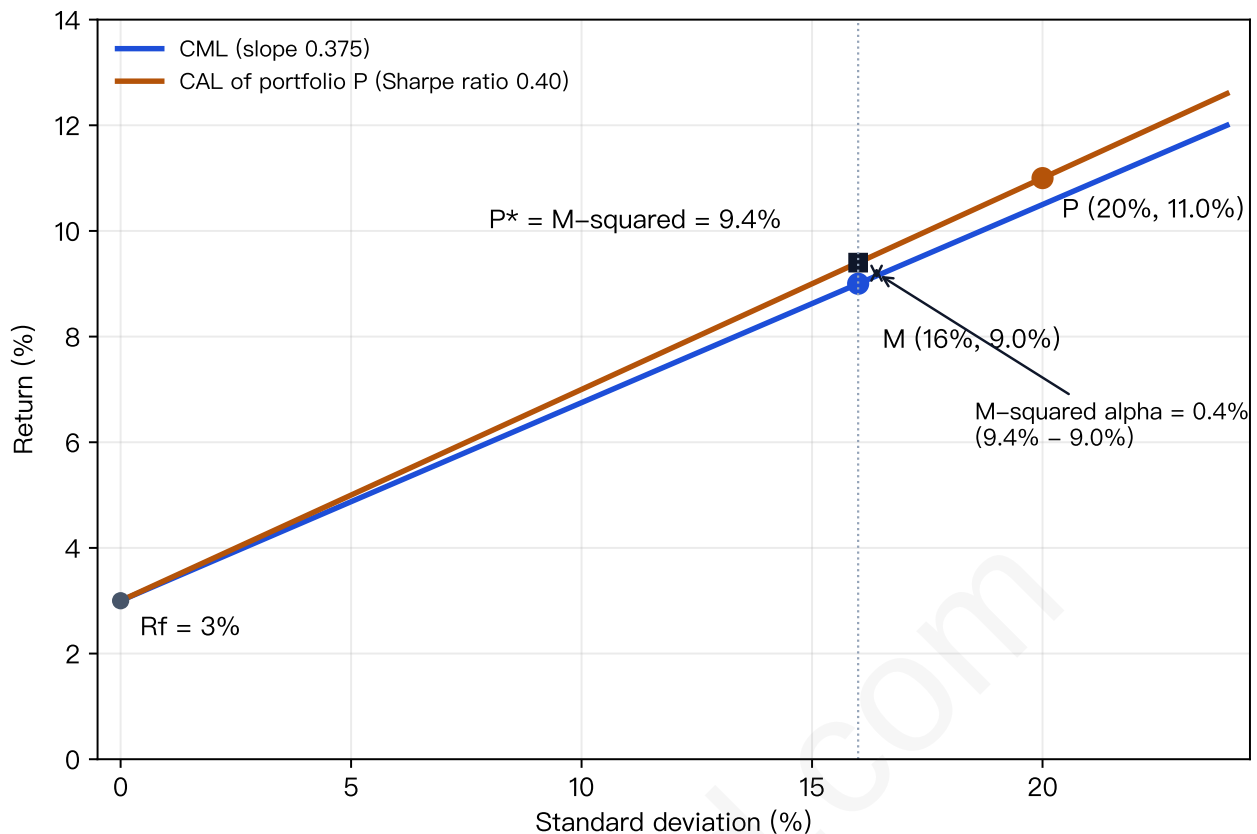
LOS 88.i — Sharpe ratio, Treynor measure, M-squared and Jensen's alpha

Performance evaluation analyzes the risk and return of an active manager's portfolio. **Attribution analysis**, part of performance evaluation, looks for the sources of the difference between the active portfolio's return and a passive benchmark's return. A higher return than the benchmark proves little on its own: a portfolio with more risk (especially more beta) than the benchmark should earn more over time, so returns must be adjusted for risk.

KEY CONCEPT

Measure	Formula	Risk used	Units / reading
Sharpe ratio	$\frac{R_P - R_f}{\sigma_P}$	Total risk	Slope of the portfolio's CAL; compare with other portfolios or the CML slope
M-squared (M²)	$R_f + \frac{R_P - R_f}{\sigma_P} \sigma_M$	Total risk	Percentage return of P leveraged/deleveraged to the market's σ
M² alpha	$M^2 - R_M$	Total risk	Positive if P plots above the CML
Treynor measure	$\frac{R_P - R_f}{\beta_P}$	Systematic risk	Excess return per unit of beta (a slope)
Jensen's alpha	$R_P - [R_f + \beta_P(R_M - R_f)]$	Systematic risk	Percentage return above the SML

- The Sharpe ratio can be used **ex ante** (expected values) or **ex post** (realized means and sample standard deviation). Its value is meaningful only in comparison with another portfolio's Sharpe ratio.
- M² produces the **same rankings as the Sharpe ratio** but is stated in percentage terms. Because $M^2 = SR_P \times \sigma_M + R_f$, M² exceeds R_M (M² alpha > 0) exactly when P's Sharpe ratio exceeds the CML slope. The Treynor measure and Jensen's alpha are the beta-based analogues: Treynor is a slope, and Jensen's alpha is a percentage.
- The choice of risk measure depends on whether the portfolio carries unsystematic risk. A single manager's portfolio or a concentrated holding should be judged with total-risk measures (Sharpe or M²). A well-diversified fund, such as one spread over many managers, can be judged with beta-based measures (Treynor or Jensen's alpha).
- Portfolios above the CML have higher Sharpe ratios than any CML portfolio and positive M² alphas. Portfolios above the SML have higher Treynor measures than any asset on the SML and positive Jensen's alphas.



M-squared: leveraging or deleveraging portfolio P to the market's standard deviation

Example. $R_P = 11\%$, $\sigma_P = 20\%$, $\beta_P = 1.1$; $R_f = 3\%$, $R_M = 9\%$, $\sigma_M = 16\%$.

- Sharpe = $8/20 = 0.40$, above the CML slope of $6/16 = 0.375$, so P beat the market on a total-risk basis.
- $M^2 = 3 + 0.40(16) = 9.4\%$; M^2 alpha = $9.4 - 9.0 = 0.4\%$.
- Treynor = $8/1.1 = 7.27\%$, against a market Treynor measure of 6% .
- Jensen's alpha = $11 - [3 + 1.1(6)] = 11 - 9.6 = 1.4\%$.

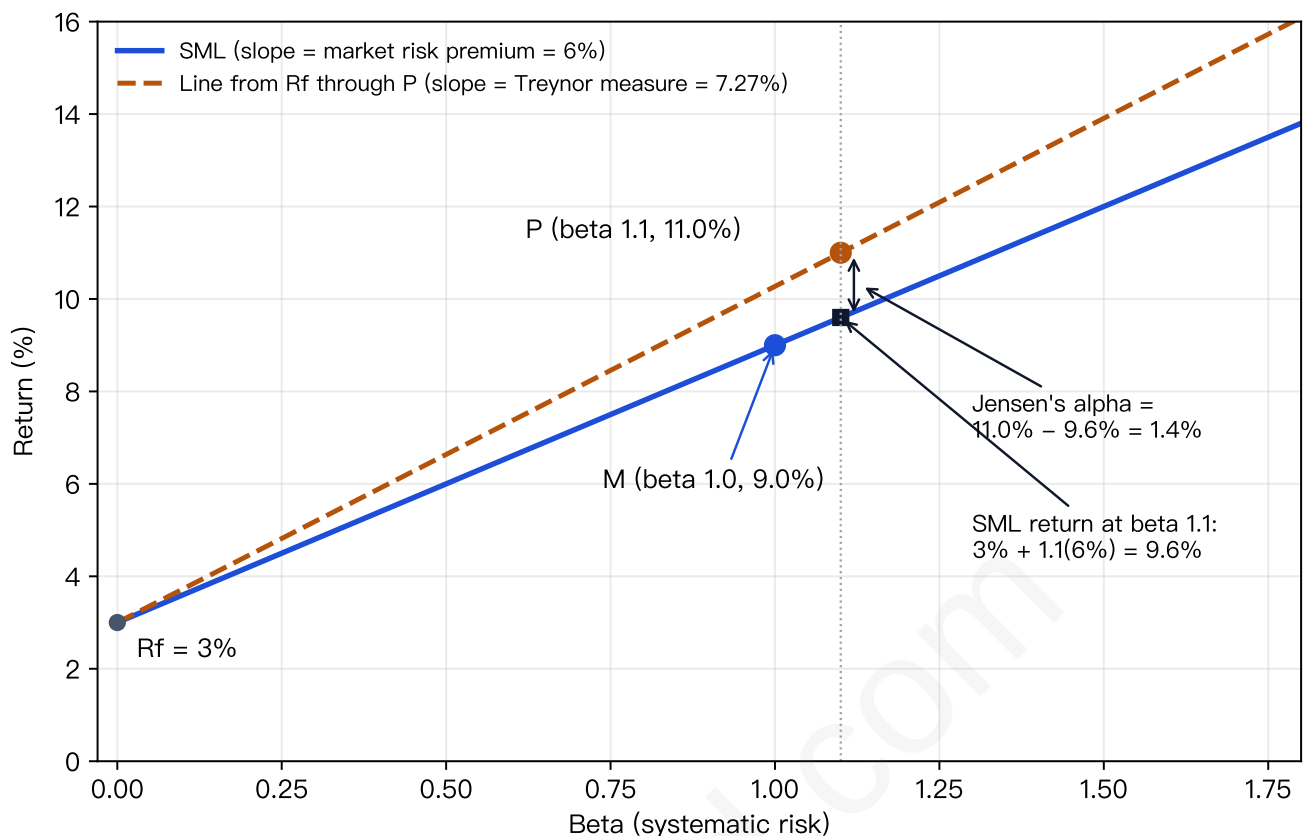
Example (the two families can rank funds differently). $R_f = 3\%$, $R_M = 9\%$, $\sigma_M = 16\%$.

Risk-adjusted performance of two funds and the market (illustrative numbers)

	Return	σ	β	Sharpe ratio	M ² alpha	Treynor measure	Jensen's alpha
Fund X	12%	24%	0.9	$9/24 = 0.375$	$3 + 0.375(16) - 9 = 0.0\%$	$9/0.9 = 10.0\%$	$12 - [3 + 0.9(6)] = +3.6\%$
Fund Y	10%	14%	1.2	$7/14 = 0.50$	$3 + 0.50(16) - 9 = +2.0\%$	$7/1.2 = 5.8\%$	$10 - [3 + 1.2(6)] = -0.2\%$
Market	9%	16%	1.0	$6/16 = 0.375$	0.0%	$6/1.0 = 6.0\%$	0.0%

Fund Y wins on the total-risk measures (Sharpe 0.50 against 0.375; M² alpha +2.0% against 0.0%). Fund X wins on the beta-based measures (Treynor 10.0% against 5.8%; Jensen's alpha +3.6% against -0.2%). X has a low beta but a high standard deviation, so much of its risk is unsystematic. If X is the investor's whole portfolio, that risk matters and Y is better. If X is one small part of a well-diversified fund, its unsystematic risk is diversified away and X is better. Sharpe and Treynor values are read by comparing them with another portfolio or with the market; M² alpha and Jensen's alpha are read directly, where a value above zero means the fund beat the market after adjusting for risk.

On a graph of return against beta, P's Treynor measure is the slope of the line from R_f through P, and its Jensen's alpha is the vertical gap between P and the SML at $\beta = 1.1$.



Treynor measure and Jensen's alpha for portfolio P, shown against the SML

The inputs to these measures, including the expected market return (and hence the market risk premium) and betas, are estimated with error. The expected market return need not equal its historical average. Results from the models are only as good as those estimates.

Common exam traps

- Sharpe and M^2 use standard deviation; Treynor and Jensen use beta. Distractors often use the wrong risk measure.
- When M^2 alpha is asked, subtract the market return from M^2 ; reporting M^2 itself is a common slip. In the example, reporting M^2 gives 9.4% instead of an M^2 alpha of 0.4%.
- Forgetting to subtract R_f in the numerator of the Sharpe or Treynor ratio. In the example, the Sharpe ratio becomes 0.55 instead of 0.40 and the Treynor measure 10.0% instead of 7.27%.

EXAM SHORTCUTS

- M^2 is above R_M exactly when the portfolio's Sharpe ratio is above the CML slope, so the sign of the M^2 alpha can be read from the Sharpe ratio comparison.
- Any asset with a beta of 1 has the market's required return under the CAPM whatever its total risk, so no calculation is needed for it.

BOTTOM LINE

- The CAPM, $E(R_i) = R_f + \beta_i[E(R_m) - R_f]$, is the equation of the security market line, whose intercept is R_f and whose slope is the market risk premium.
- The CAPM assumes risk-averse, utility-maximizing investors, frictionless markets, a single common period, homogeneous expectations, infinitely divisible assets and competitive markets in which investors are price takers.
- The CML measures risk by standard deviation and in equilibrium holds only efficient portfolios, while the SML measures risk by beta and holds all properly priced securities and portfolios, so a single stock plots below the CML but on the SML.
- A security whose forecast return exceeds its CAPM required return plots above the SML and is undervalued, one whose forecast is below plots below the SML and is overvalued, and the difference is its expected alpha.
- With a positive market risk premium a negative beta gives a required return below R_f , and when $E(R_m)$ is below R_f a negative beta gives a required return above R_f .
- The Sharpe ratio and M^2 use total risk and suit a single manager's or concentrated portfolio, M^2 ranking portfolios as the Sharpe ratio does, while the Treynor measure and Jensen's alpha use beta and suit a well-diversified fund.

QUICK CHECK**Question 2**

Denholm Freight shares have a beta of 1.15. The risk-free rate is 2.5% and the expected return on the market is 8.5%. According to the capital asset pricing model, the required return on Denholm shares is *closest* to:

- A 12.3%.
- B 9.8%.
- C 9.4%.

Answer: C

The CAPM adds a beta-adjusted market risk premium to the risk-free rate. The market risk premium is the expected market return minus the risk-free rate, 6.0%.

$$E(R_i) = R_f + \beta_i[E(R_m) - R_f] = 2.5\% + 1.15(8.5\% - 2.5\%) = 2.5\% + 6.9\% = 9.4\%$$

Why the other options are wrong

- **A.** 12.3% multiplies beta by the full market return instead of the market risk premium: $2.5\% + 1.15 \times 8.5\% = 12.3\%$.
- **B.** 9.8% is simply beta times the market return ($1.15 \times 8.5\%$), ignoring the risk-free rate and the premium structure of the CAPM.

Key takeaway CAPM: $E(R_i) = R_f + \beta_i[E(R_m) - R_f]$. Subtract R_f from the market return before multiplying by beta.

Practice questions

Question 3

A fixed-income manager holds bonds from many different issuers. After this diversification, the risk from which of the following events is *most likely* to remain in the portfolio?

- A A downgrade of one issuer after an accounting scandal.
- B A recession that lowers revenues at most companies.
- C A fire that shuts the main plant of one issuer.

Question 4

An analyst's CAPM-based expected return for Harwell Mining shares is 2.2 times the 10% return expected on the market portfolio. With a risk-free rate of 4%, the beta of Harwell Mining shares is *closest* to:

- A 3.0.
- B 2.2.
- C 1.8.

Question 5

About 60% of Mariela Cortez's wealth is in shares of the software company she founded; the rest is in a broad mix of bonds and equity index funds. Which of the following risk-adjusted performance measures is *least appropriate* for evaluating her overall portfolio?

- A Sharpe ratio.
- B Jensen's alpha.
- C M-squared.

Answers: 3. B · 4. A · 5. B

Why each answer is right and why each other option is wrong: credguild.com/cfa/level-1/notes/portfolio-construction/systematic-vs-unsystematic-risk/. The full bank has 105 questions on this reading.

PORTFOLIO CONSTRUCTION · READING 89

Defined Benefit vs Defined Contribution

What you'll learn

LOS 89.a Describe the portfolio approach: judge investments by their effect on total portfolio risk and return; diversification and the diversification ratio.

LOS 89.b Describe the planning, execution and feedback steps of the portfolio management process, including top-down and bottom-up analysis.

LOS 89.c Describe the main types of investors and their risk tolerance, horizon, liquidity and income needs.

LOS 89.d Describe and contrast defined contribution and defined benefit pension plans, including who bears investment risk.

LOS 89.e Describe the asset management industry: firm types, active vs passive management and industry trends.

LOS 89.f Describe mutual funds and compare them with ETFs, separately managed accounts, hedge funds, and private equity and venture capital funds.

MODULE 89.1

Portfolio Management Process

This reading introduces the portfolio approach, the three steps of the portfolio management process, the needs of different types of investors, the difference between defined contribution and defined benefit pension plans, and the asset management industry with its pooled investment vehicles.

LOS 89.a — The portfolio approach to investing

Under the **portfolio approach** (also called the **portfolio perspective**), every candidate investment is judged by what it adds to, or takes away from, the risk and return of the investor's whole portfolio. The alternative is to study the risk and return of each security on its own and to ignore how it fits with everything else the investor owns. An investor who puts all of her savings in the one stock she believes is "the best" is not using the portfolio perspective. She carries far more risk than someone holding a diversified mix of stocks.

- **Diversification** lets an investor cut portfolio risk without necessarily giving up expected return. It mainly narrows the spread of outcomes, making very high and very low returns both less likely. It is not a tool for raising expected return.
- **Modern portfolio theory (MPT)** concludes that the extra risk of holding a single security, which could have been diversified away, is not rewarded with a higher expected return.
- **Harry Markowitz** (early 1950s) used the **standard deviation of returns** as the measure of risk and showed how combining risky assets changes portfolio risk and expected return. His key result: unless the assets' returns are **perfectly positively correlated**, combining them reduces risk.
- In the 1960s, Treynor, Sharpe, Mossin and Lintner extended this work into MPT, in which equilibrium expected returns are a linear function of **market risk**, the part of risk that diversification cannot remove.

Measuring the benefit: the diversification ratio

KEY CONCEPT

$$\text{Diversification ratio} = \frac{\sigma \text{ of an equally weighted portfolio of the } n \text{ securities}}{\text{average } \sigma \text{ of the } n \text{ individual securities}}$$

The denominator is the average standalone risk of the securities in the group.

Ratio

Interpretation

= 1 No risk reduction at all from combining the securities

below 1 Some risk reduction; the lower the ratio, the greater the benefit

Example. A group of 12 stocks has an average standard deviation of 40%. An equally weighted portfolio of the 12 stocks has a standard deviation of 26%. The diversification ratio is $26/40 = 0.65$: the portfolio carries 65% of the risk of a typical single holding, a 35% reduction.

Two caveats apply. First, an equally weighted portfolio is only a convenient yardstick; optimization software can find the weights that give the lowest standard deviation for the group. Second, diversification works best in normal markets. In a financial crisis, such as the credit contagion of 2008, correlations tend to rise, so diversification protects less at the very time it is most wanted.

Common exam traps

- Judging a security by its own expected return, its excess-return potential, its fundamentals or its intrinsic value versus price is standalone analysis, not the portfolio approach.
- Do not invert the ratio. Portfolio risk goes in the numerator, and an equally weighted portfolio's standard deviation can never exceed the average standard deviation of its holdings, so a value above 1 means the ratio was turned upside down. In the 12-stock example, the inverted ratio is $40/26 = 1.54$ instead of 0.65.
- Low correlations measured in calm markets overstate the protection a portfolio will get in a crisis.

LOS 89.b — The three steps of the portfolio management process

KEY CONCEPT

Step	What happens	Main output
Planning step	Analyze the investor's risk tolerance, return objectives, time horizon , tax exposure, liquidity needs , income needs and any unique circumstances or preferences	An investment policy statement (IPS) setting out objectives and constraints, plus an objective benchmark against which results will later be judged

Step	What happens	Main output
Execution step	Asset allocation (decide how funds are split among asset classes, often using top-down analysis), security analysis (often bottom-up analysis) and portfolio construction	The portfolio itself
Feedback step	Portfolio monitoring and rebalancing (restore target weights as prices, markets and client circumstances change); performance measurement and reporting against the IPS benchmark	Rebalanced portfolio; performance reports

The IPS is the foundation of the whole process, so writing the IPS comes first. It should be reviewed at least every few years and whenever the client's objectives or constraints change significantly. Recent portfolio performance is not a reason to revise it.

Top-down versus bottom-up analysis (both belong to execution)

- **Top-down analysis** works from the broad to the specific. It starts with the macroeconomic picture: forecasts of GDP growth, inflation and interest rates, and the stance of government policy such as **fiscal policy** (spending and taxes) and monetary policy. From this the manager decides which asset classes look most attractive. The resulting portfolio is usually spread across publicly traded equities, fixed-income securities, cash, private equity, hedge funds, real estate, and commodities and other real assets. Within an asset class the analysis then narrows to **industry analysis** and only after that to **company analysis**. Industry analysis comes first because an industry's outlook shapes the results of the firms in it.
- **Bottom-up analysis** starts with individual securities: analysts use valuation models to find securities that look undervalued.

Example (sorting activities). Over two months an adviser (1) interviews a new client about goals and constraints and drafts an IPS naming a 70/30 global equity/bond index as the benchmark; (2) uses macro forecasts to pick a 60% equity / 30% bond / 10% infrastructure mix and selects funds and securities; (3) after an equity rally, trims equities back to 60% and reports the quarter's return against the benchmark. Item (1) is planning, (2) is execution and (3) is feedback.

Common exam traps

- Choosing the benchmark is part of planning, because it is written into the IPS. Using it to judge results is feedback.
- Top-down analysis starts from the economy, yet it is an execution activity, not part of planning. Industry figures such as industry return on equity come after macro factors such as fiscal policy.
- Rebalancing involves trading, but it belongs to feedback, not execution.

LOS 89.c — Types of investors and their needs

- **Individual investors** save for goals such as a home, children's education or retirement. Many countries offer tax-deferred retirement accounts, and **defined contribution pension plans** are a popular vehicle. Their needs depend entirely on the individual.
- An **endowment** is a fund dedicated to supporting a specific purpose on an ongoing basis, such as a university's programs. A **foundation** is a fund set up for charitable purposes, such as supporting research on a disease. A typical aim is to fund the activity indefinitely without eroding the real (inflation-adjusted) value of its assets.
- A **bank** aims to earn more on its loans and investments than it pays on deposits. It keeps risk low and needs liquidity to meet depositor withdrawals.
- **Insurance companies** invest premiums to pay claims as they arise. **Life insurance companies** have a relatively long horizon. **Property and casualty (P&C) insurance companies** have a shorter one because their claims tend to come sooner.
- **Investment companies**, such as **mutual funds**, manage pooled money in a particular style or segment of the market.
- **Sovereign wealth funds** are pools of assets owned by a government.

Investor	Risk tolerance	Investment horizon	Liquidity needs	Income needs
Individuals	Depends on the individual	Depends on the individual	Depends on the individual	Depends on the individual
Banks	Low	Short	High	Pay interest
Endowments and foundations	High	Long	Low	Spending level
Insurance companies	Low	Long (life), short (P&C)	High	Low
Mutual funds	Depends on the fund	Depends on the fund	High	Depends on the fund
Defined benefit pension plans	High	Long	Low	Depends on participants' ages

A defined benefit plan's income need depends on its participants' ages: a plan whose members are mostly retired and drawing benefits needs more current income than one whose members are mostly young workers.

Common exam traps

- When a life insurer and a P&C insurer are compared, time horizon is the only difference in the profile.
- A long horizon alone does not identify the investor. A life insurer also has a long horizon, but unlike an endowment, a foundation or a DB plan it has low risk tolerance and high liquidity needs.

LOS 89.d — Defined contribution versus defined benefit pension plans

Feature	Defined contribution pension plan	Defined benefit pension plan
What the employer promises	A contribution each period into the employee's own account (based on, e.g., salary, service, age, profits or a match of the employee's contribution); no promise about the account's future value	Periodic payments after retirement , usually based on years of service and salary at or near retirement
Who makes the investment decisions	The employee	The employer / plan sponsor (through the plan's fund)
Who bears the investment risk	The employee	The employer (plan sponsor)
Effect of poor investment returns	Smaller retirement account for the employee	Employer must contribute more to the fund

Example (defined benefit). A plan pays 1.5% of final salary for each year of service. An employee retiring after 25 years with a final salary of \$80,000 receives $0.015 \times 25 \times \$80,000 = \$30,000$ per year for life. Because that amount is fixed by formula, weak fund returns are the employer's problem rather than the retiree's.

Common exam traps

- The fund manager bears the investment risk in neither plan. In a DC plan the employer's obligation ends once it has made its contribution, so a fall in the account's value is the employee's loss.
- A promised contribution is not a promised benefit. A stem that describes a promised retirement income describes a DB plan.

EXAM SHORTCUTS

- Sort a portfolio activity by its output: anything written into the IPS, including the benchmark, is planning; allocating, selecting and building is execution; monitoring, rebalancing and measuring performance is feedback.

BOTTOM LINE

- The portfolio approach judges each investment by its effect on the risk and return of the whole portfolio.
- Combining assets whose returns are not perfectly positively correlated reduces risk without necessarily giving up expected return.
- The diversification ratio is the standard deviation of an equally weighted portfolio $\div$ the average standard deviation of its securities; the lower the ratio, the greater the benefit.
- Planning produces the IPS and its benchmark; execution covers asset allocation, security analysis and portfolio construction; feedback covers monitoring, rebalancing and performance measurement.

- In a DC plan the employee makes the investment decisions and bears the investment risk; in a DB plan the employer promises the benefit and bears the risk.

QUICK CHECK

Question 1

An investor who applies modern portfolio theory in the tradition of Markowitz is deciding whether to add a utility stock to her holdings. She should *most appropriately* judge the stock by:

- A its expected return viewed on its own.
- B how it would change her portfolio's overall risk and return.
- C whether its intrinsic value exceeds its market price.

Answer: B

Markowitz's framework, the basis of modern portfolio theory, evaluates an investment by its effect on the risk and expected return of the portfolio as a whole. Because risk that can be diversified away is not rewarded, how the asset interacts with existing holdings matters more than its standalone characteristics.

Why the other options are wrong

- **A.** Looking only at expected return ignores risk and ignores how the stock combines with the rest of the portfolio.
- **C.** Comparing intrinsic value with market price is standalone security valuation (bottom-up analysis). The Markowitz framework calls for a portfolio-level evaluation.

Key takeaway Modern portfolio theory: no asset is judged in isolation.

MODULE 89.2

Asset Management and Pooled Investments

LOS 89.e — The asset management industry

The **asset management industry** consists of firms that manage investments for clients. They are **buy-side** firms. Broker-dealers and investment banks, by contrast, are **sell-side** firms. Asset managers may be independent or divisions of larger financial groups.

Type of firm	What it offers
Full-service asset manager	Many investment styles and asset classes under one firm
Specialist asset manager	Focus on one investment style or one asset class
Multi-boutique firm	A holding company that owns several different specialist asset managers
Traditional asset manager	Focus on equities and fixed-income securities

Type of firm	What it offers
Alternative asset manager	Focus on private equity, hedge funds, real estate, commodities and similar assets

Active versus passive management

- **Active management** tries to beat a chosen benchmark by relying on the manager's skill, using, for example, fundamental or technical analysis.
- **Passive management** tries to replicate a benchmark index, either by tracking a broad market index or through a **smart beta** approach that targets exposure to a particular risk factor.
- Passive management accounts for roughly one-fifth of **assets under management (AUM)**. Passive fees are lower, so passive management's share of industry revenue is smaller still than its share of AUM.

Industry trends

- The market share of passive management has been growing. Lower fees help, as do doubts about whether active managers add value after risk adjustment, especially in developed markets thought to be fairly efficient. Most AUM is still actively managed.
- Profit margins are higher in alternative asset classes, so many traditional managers have moved into alternatives, blurring the line between the two types.
- The volume of available data has grown enormously, pushing managers to spend on information technology and on data services bought from third parties.
- **Robo-advisors** use computer algorithms to give advice based on an investor's requirements and constraints. They appeal to younger investors and smaller accounts, and they have lowered barriers to entry into asset management, for example for insurance companies.

Common exam traps

- A holding company whose separate firms each specialize is a multi-boutique firm, even though the group as a whole covers many styles. Do not call it a full-service manager.
- Smart beta is passive management even though it tilts toward a risk factor. Reliance on fundamental or technical analysis signals active management.

LOS 89.f — Mutual funds and other pooled investments

A **pooled investment** is a single portfolio holding money from many investors; each investor owns shares in the pool. The **net asset value (NAV)** per share is

KEY CONCEPT

$$NAV = \frac{\text{fund assets} - \text{fund liabilities}}{\text{shares outstanding}}$$

Example. A fund holds assets worth \$412 million, owes \$12 million and has 16 million shares outstanding:
 $NAV = (412 - 12)/16 = \$25.00$ per share.

Open-end versus closed-end funds

- **Open-end fund:** investors buy newly issued shares at NAV and can **redeem** shares at NAV by selling them back to the fund, so the number of shares changes with investor demand. New cash is invested in more portfolio securities.
- **Closed-end fund:** a fixed number of shares. The fund neither takes new money nor redeems shares. The shares trade like stocks, on an exchange or over the counter. Because the price depends on supply and demand for the shares, the market price can differ significantly from NAV (a premium or discount).
- All mutual funds charge an ongoing **management fee** expressed as a percentage of NAV. **No-load funds** charge no purchase or redemption fees; **load funds** charge up-front fees, redemption fees or both.

Types of mutual funds

- **Money market funds** hold short-term debt securities. They pay interest income, and the chance that the share value changes is very small. NAV is typically held at one unit of currency per share, although some funds' NAVs have fallen in stressed markets.
- **Bond mutual funds** hold fixed-income securities and differ by maturity, credit rating, issuer and type (government, tax-exempt, high-yield, global).
- **Stock mutual funds** include **index funds**, which are passively managed to match an index, and **actively managed funds**, which select securities to beat their benchmarks. Actively managed funds charge higher fees and have higher **turnover**, which creates higher tax liabilities than index funds.
- **Balanced (hybrid) funds** hold both debt and equity securities.

Other pooled vehicles

Feature	Open-end fund	Closed-end fund	Exchange-traded fund (ETF)
Where investors trade	With the fund	In the market	In the market
Price versus NAV	Trades at NAV	Can differ significantly from NAV	Kept very close to NAV by special redemption provisions (arbitrage)
Typical management style	Active or index	Often active	Mostly passive (index); management fees generally low
Intraday trading, short sales, margin purchases	No (priced once a day at closing NAV)	Yes	Yes
Brokerage commission / bid-ask spread	No	Yes	Yes
Dividends	Can be reinvested in fund shares	Depends on the fund	Usually paid in cash

Feature	Open-end fund	Closed-end fund	Exchange-traded fund (ETF)
Capital gains tax from other investors' exits	Can arise when redemptions force sales of appreciated securities	No forced sales, because shares are never redeemed	May be lower: investor sales of ETF shares do not force the fund to sell securities

- A **separately managed account (SMA)** is a portfolio owned by a single investor and managed to that investor's needs; no shares are issued. It suits investors with substantial assets and carries an annual fee based on assets.
- **Hedge funds** are far less regulated than mutual funds. They limit the number of investors, often to **qualified (accredited) investors**, set high minimums (commonly \$250,000 to \$1 million) and are not offered to the general public. Typical fees are 2% of assets plus 20% of excess performance. They follow many strategies, often with **leverage**, short positions and derivatives. Examples are **global macro** funds and **event-driven** funds, which trade around corporate events such as mergers and acquisitions.
- **Private equity (buyout) funds** buy all the shares of a company, often a public one, and take it private, usually financing a large percentage of the purchase price with debt. They restructure the company to raise cash flow and typically exit within three to five years, for example through an initial public offering (IPO) or a sale.
- **Venture capital funds** resemble buyout funds but invest in start-up companies, usually taking equity stakes with little borrowed money and providing advice and expertise. Both buyout and venture capital managers take an active role in managing the companies they own.

Common exam traps

- ETFs and closed-end funds both trade in the market, but only a closed-end fund can sit at a large discount or premium to NAV for months. A persistent wide gap points to a closed-end fund, not an ETF.
- An exit through an IPO does not make a fund a venture capital fund. A fund that takes an established listed company private and later floats it again is a buyout fund; an event-driven hedge fund trades around mergers without running the companies.

BOTTOM LINE

- Asset managers are buy-side firms; a multi-boutique firm owns several specialist managers through one holding company.
- Active management tries to beat a benchmark; passive management, including smart beta, tracks one, and its share of AUM has been growing.
- $\text{NAV per share} = (\text{fund assets} - \text{fund liabilities}) \div \text{shares outstanding}$.
- Open-end funds issue and redeem shares at NAV; closed-end funds keep a fixed share count, and their market prices can differ significantly from NAV; ETFs trade in the market at prices kept close to NAV.
- Hedge funds are far less regulated than mutual funds, are often limited to qualified investors and typically charge 2% of assets plus 20% of excess performance.

QUICK CHECK

Question 2

Shares of the Norcastle Frontier Fund trade on a stock exchange and have been priced at a discount of about 14% to the fund's net asset value per share for several months. Norcastle is *most likely* a(n):

- A closed-end fund.
- B open-end fund.
- C exchange-traded fund.

Answer: A

Closed-end fund shares trade in the market at prices set by supply and demand for the shares, so they can sit at a large and persistent premium or discount to NAV.

Why the other options are wrong

- **B.** Open-end fund shares are bought from and redeemed by the fund at NAV, so they cannot trade at a discount to NAV (and they do not trade on an exchange).
- **C.** An ETF's special redemption provisions let arbitrageurs profit from any gap between price and NAV, which keeps ETF prices very close to NAV; a 14% gap lasting months is inconsistent with an ETF.

Key takeaway A large, lasting premium or discount to NAV points to a closed-end fund.

Practice questions

Question 3

An analyst using a top-down approach is evaluating the outlook for chemical company stocks. Which of the following factors should the analyst examine *first*?

- A Return on equity for the chemicals industry.
- B The outlook for fiscal policy.
- C Competitive risks within the chemicals industry.

Question 4

A pooled investment fund buys all of the outstanding shares of a listed industrial manufacturer, removing it from the stock exchange. The fund installs a new executive team and restructures the company's operations, and four years later it sells the company back to the public through an initial public offering. The fund is *most likely* a(n):

- A venture capital fund.
- B event-driven fund.
- C private equity fund.

Answers: 3. B · 4. C

Why each answer is right and why each other option is wrong: credguild.com/cfa/level-1/notes/portfolio-construction/defined-benefit-vs-defined-contribution/. The full bank has 34 questions on this reading.

PORTFOLIO CONSTRUCTION · READING 90

Basics of Portfolio Planning and Construction

What you'll learn

LOS 90.a Explain why a written investment policy statement is the starting point of the portfolio management process.

LOS 90.b Identify the main sections of an IPS and its minimum required content.

LOS 90.c Describe absolute and relative risk and return objectives and why they must be compatible.

LOS 90.d Distinguish willingness from ability (capacity) to take risk and combine them into overall risk tolerance.

LOS 90.e Classify liquidity, time horizon, tax, legal and regulatory, and unique-circumstance constraints and their portfolio implications.

LOS 90.f Specify asset classes for asset allocation (homogeneous within, low correlation between, covering the permitted universe).

LOS 90.g Describe portfolio construction: strategic vs tactical asset allocation, security selection, risk budgeting and core-satellite.

LOS 90.h Describe ESG approaches and how they affect benchmarks, voting and portfolio performance.

MODULE 90.1

Portfolio Planning and Construction

This reading explains why a written investment policy statement matters, what it contains, and how to set risk and return objectives and judge willingness and ability to take risk. It then covers the five investment constraints, the specification of asset classes, the roles of strategic and tactical asset allocation, security selection and risk budgeting, and ESG approaches in portfolio planning.

LOS 90.a — Why a written investment policy statement matters

The **investment policy statement (IPS)** is the written plan that starts the **portfolio management process**. Before any security is bought, the manager and client agree in writing on what the client needs, what the client can and will tolerate, and how results will be judged.

A written IPS is valuable for three main reasons:

- It forces discipline. The client must articulate circumstances, objectives and constraints instead of reacting to the market mood of the day.
- It keeps goals realistic. High return and low risk are popular wishes but usually incompatible, so the IPS makes the client reconcile return expectations with **risk tolerance**.
- It sets a yardstick. Performance is judged against a stated **benchmark** rather than with hindsight.

An IPS does not pick individual stocks or time the market. It works at the level of objectives, constraints, asset classes and policy.

Common exam traps

- The IPS comes first in the process; it is not a report card produced at the end.

LOS 90.b — Major components of an IPS

A typical IPS contains the following sections:

KEY CONCEPT

Section	What it covers
Client description / introduction	The client's circumstances and situation
Statement of purpose	What the IPS is meant to achieve
Statement of duties and responsibilities	Roles of the client, the custodian and the investment manager
Procedures	How the IPS is updated and how unforeseen events are handled
Investment objectives	Return objectives and risk objectives (risk tolerance)
Investment constraints	Liquidity, time horizon, taxes, legal and regulatory, unique circumstances
Investment guidelines	How the policy is executed: permitted asset types, use of leverage and derivatives
Evaluation and review	The benchmark and how results are assessed
Appendices	The strategic asset allocation (policy portfolio), permitted ranges and the rebalancing policy

The bare minimum. Even a short IPS must contain (1) a clear statement of the client's circumstances and constraints, (2) an investment strategy based on them and (3) a benchmark for evaluating performance. Detailed update procedures are common but are not part of that minimum. Nor is a precise annual target return, although return objectives may still be stated in the IPS, for example as a percentage.

The manager's fee schedule is not one of the IPS components listed above.

Common exam traps

- Permitted assets and leverage limits are investment guidelines. They are neither objectives nor constraints.

LOS 90.c — Risk and return objectives

Risk objectives translate the client's risk tolerance into specific limits on portfolio risk. **Return objectives** usually follow from a future financial goal, such as a target level of retirement income. Both can be stated in **absolute** or **relative** terms, and a return objective may be set as a percentage or as a currency amount.

KEY CONCEPT

	Absolute	Relative
Risk objective	"Portfolio value must not fall more than 8% in any 12-month period" or, in probability form, "no more than a 10% probability of losing more than 6% in a year"	"Return must not trail the benchmark index by more than 3% in any year", or a probability of underperforming a benchmark by a given margin
Return objective	A nominal figure ("at least 6.5% a year") or a real figure ("inflation plus 2.5%")	"Beat a stated equity index by 1% a year"; for a bank, a spread over its cost of funds

- Stating a risk objective as the **probability** of a given loss does not make it relative. It is relative only if it refers to a benchmark.
- A return of "inflation plus x%" is still an absolute (real) objective. A limit measured against a market interest rate, such as never earning less than the three-month Treasury bill rate over a calendar year, is a relative risk objective, because that rate serves as the benchmark.
- Very strict absolute risk objectives, such as no loss in any year, push the portfolio toward guaranteed instruments such as Treasury bills.
- **Peer-group benchmarks** (for example, "top quartile of endowments") are not **investable**: nobody can build that portfolio in advance.
- Risk and return objectives must be set together and must be compatible. The client's risk tolerance determines which returns are realistically attainable, and a return-only objective can push the client into far too much risk.

Example. A client wants 11% a year but says she cannot accept any calendar-year loss. Portfolios with an 11% expected return in her market carry a standard deviation near 16%. If returns are roughly normal, $P(R < 0) = N(-11/16) \approx 25\%$, so a losing year can be expected about one year in four. The objectives are inconsistent, and the adviser must either lower the return target or relax the risk limit.

LOS 90.d — Willingness versus ability (capacity) to take risk

An investor's overall risk tolerance combines two separate assessments: how much risk the investor wants to take and how much risk the investor's finances can bear.

KEY CONCEPT

	Willingness to take risk	Ability (capacity) to take risk
Driven by	Psychology: attitudes, beliefs, personality, financial knowledge	Financial circumstances
Measured by	Questionnaires, interviews (subjective)	Analysis of wealth, liabilities, income, horizon

Willingness to take risk

Higher when Investor is comfortable with volatility

Ability (capacity) to take risk

Long **time horizon**, large wealth relative to liabilities and spending needs, stable job and income, ample insurance, few dependents

Large near-term **spending needs** reduce the ability to bear risk, because the portfolio must reliably fund a fixed obligation. The expected rate of return, the level of inflation and the client's tax bracket are not inputs to risk tolerance. Expected return follows from risk tolerance, inflation matters for the return objective, and taxes are a constraint.

The table shows how the two assessments combine into overall risk tolerance.

Combining willingness and ability to take risk

Willingness \ Ability	Below-average ability	Above-average ability
Below-average willingness	Below-average risk tolerance (no conflict)	Conflict: educate the client; usually conform to the lower (below average)
Above-average willingness	Conflict: ability prevails (below average)	Above-average risk tolerance (no conflict)

When the two conflict, the lower assessment governs. With high willingness and low ability, ability prevails, and a portfolio tilted toward bonds rather than equities is appropriate. With low willingness and high ability, the adviser may educate the client and correct misconceptions but should not try to change the client's personality; a portfolio the client is clearly uncomfortable with is unlikely to end well.

Example. A 36-year-old client has a secure salaried job, no debt, savings well above her planned spending and 25 years until retirement. She also says she would sell all her equities if her account fell 10% in a year.

1. Sort the facts. Job security, wealth relative to needs and the long horizon are financial circumstances, so they bear on ability. Her reaction to a 10% fall is an attitude, so it bears on willingness.
2. Rate each dimension. Ability is high; willingness is low.
3. Combine them. The two conflict and willingness is the lower one. The adviser explains how a 25-year horizon can absorb short-term losses, but if her attitude does not change, the portfolio conforms to her low willingness and overall risk tolerance is below average.

Common exam traps

- Averaging a high willingness and a low ability to reach "moderate" or "average" risk tolerance is a mistake; the lower assessment governs.
- Re-administering the questionnaire does not fix a low ability to take risk.

LOS 90.e — Investment constraints

The five constraint categories are:

- **Liquidity:** the need to turn assets into spendable cash quickly without large price concessions, for example for regular withdrawals, tuition, a planned purchase or insurance claims. High liquidity needs call for cash and short-term bonds; illiquid hedge funds or private equity are unsuitable.
- **Time horizon:** often the period until withdrawals begin. Longer horizons allow more risk and less liquidity. A short horizon points to low-risk, liquid assets such as government securities or bank deposits. Short horizons and liquidity needs usually go together.
- **Tax concerns:** the investor's marginal tax rate, the different treatment of income and capital gains, and whether accounts are taxable, **tax-deferred** or **tax-exempt**. In a fully taxable account, an investor in a high tax bracket may prefer tax-exempt bonds (in the US) or equities whose return is expected to come mainly from capital gains, because gains are commonly taxed more lightly than income. Fully taxed income (corporate bond interest, for example) is best placed in tax-deferred accounts, while long-term capital gains, tax-exempt interest and (where they are taxed favorably) dividends suit accounts without tax deferral. Portfolio choices should compare expected after-tax returns with risk. Selling holdings to diversify can trigger capital gains tax.
- **Legal and regulatory factors:** constraints imposed by law or regulators, such as trust and pension rules, minimum payout requirements imposed by statute, limits on asset types or percentages, and restrictions on trading by corporate insiders.
- **Unique circumstances:** client-specific preferences or restrictions, often non-financial. Examples are **responsible investing** exclusions (tobacco, weapons, gambling), religious restrictions (for example, no interest-bearing securities), avoiding a competitor's shares, or diversifying away from an employer's industry.

A handy checklist for a whole IPS is **R-R-T-T-L-L-U**: Risk, Return, Time horizon, Tax, Liquidity, Legal, Unique.

The first two are **objectives**; the last five are **constraints**.

Common exam traps

- A rule the investor chooses is a unique circumstance. A rule imposed by law is legal and regulatory, even if it concerns payouts.
- A required minimum return is a return objective, even though it reads like a limit on the portfolio.
- The amount and timing of withdrawals are a liquidity matter. What the client spends the money on once it has left the portfolio is not a constraint at all.

LOS 90.f — Specifying asset classes

An **asset class** is a group of assets with similar risk and return behavior. For **strategic asset allocation** the classes should be defined so that:

- returns are **highly correlated within** each class, because its members behave alike;
- returns have **low correlation between** classes, which is what produces diversification benefits;
- taken together, the classes approximate the **universe of permissible investments** in the IPS.

Specify the type of security first, then subdivide. Equities can be split into domestic and foreign, large-cap and small-cap, developed and emerging; bonds into government and corporate, investment grade and high yield, or by maturity. A label such as "emerging markets" or "technology sector" alone is incomplete because it does not say whether the assets are equities or bonds. The traditional classes are equities, bonds, cash and real estate.

Alternative investments include hedge funds, private equity, commodities, artwork and intellectual property.

The manager then gathers expected returns, standard deviations and correlations for each class.

LOS 90.g — Portfolio construction and the role of asset allocation

1. Estimate return, risk and correlation for each asset class and build an **efficient frontier** of asset-class portfolios.
2. Choose the efficient portfolio that best matches the objectives and constraints in the IPS. Its weights are the **strategic asset allocation** (the policy portfolio), the long-term baseline. **Rebalancing** later moves drifted weights back to these targets; it is not an active strategy and not a tactical decision.
3. Decide how much **active management** to add:
 - **Tactical asset allocation** is a temporary deviation from strategic weights to exploit perceived short-term mispricing between asset classes. For example, a 10% real estate target might currently be held at 13% because property looks cheap.
 - **Security selection** is a deviation from the index weights of individual securities within a class. For classes without investable indexes (hedge funds, individual properties, art), selection is unavoidable.
4. Each active strategy may add return, but it also adds risk compared with a passive portfolio of asset-class indexes. **Risk budgeting** sets a total risk limit and allocates it among strategic allocation risk, tactical allocation risk and security selection risk.

Using several active managers against the same benchmark creates two problems:

- Their positions may offset, with one overweighting what another underweights. **Net active risk** is then below **gross active risk**, and the risk budget is underused.
- Combined trading may be excessive and tax-inefficient.

A **core-satellite approach** addresses both. Most of the portfolio (the core) is held passively in index funds, and a smaller satellite portion is actively managed. The success of tactical allocation and security selection depends on real opportunities and on manager skill.

Example (illustrative). A pension fund's strategic asset allocation, grouped by the role each asset class plays in the portfolio:

Role	Asset class	Target weight
Growth	Global equities	44%
	Private equity	10%
	High-yield credit	10%
Downturn hedging	Government bonds	18%
	Cash	6%
Inflation hedging	Inflation-linked bonds	7%
	Real estate	5%
Total		100% (growth 64%, downturn hedging 24%, inflation hedging 12%)

Common exam traps

- Setting target weights from the client's objectives is strategic asset allocation, even if the weights are aggressive.
- Changing a weight because the client's tax rate changed is an IPS (strategic) change. Tactical allocation responds to short-term valuation views.
- Market forecasts do matter, because the efficient frontier is built from expected returns and risks.

LOS 90.h — ESG considerations in portfolio planning

Environmental, social and governance (ESG) approaches:

Approach	What the investor does
Negative screening	Excludes specific companies or industries on ESG grounds
Positive screening	Invests in companies with good ESG practices
Thematic investing	Picks sectors or companies that advance a specific ESG goal
Impact investing	Seeks a financial return together with a positive ESG outcome
Engagement/active ownership	Uses shareholdings (votes, dialogue with management) to push for better ESG practices
ESG integration	Considers ESG factors throughout asset allocation and security selection

- A negatively screened portfolio should be judged against an index that excludes the same kinds of companies. A broad market index is not an appropriate benchmark for it.
- Positive screening, thematic and impact approaches need customized portfolios and benchmarks, and often specialist managers.
- Under active ownership, clarify whether clients will vote their own shares or have the manager vote according to specified ESG factors. Either arrangement is acceptable.
- The effect on returns is uncertain. A smaller universe and research costs may reduce returns, while good governance and lower ESG risks may raise them.

BOTTOM LINE

- The investment policy statement is the written plan that starts the portfolio management process: it forces the client to articulate circumstances, objectives and constraints, reconciles return expectations with risk tolerance, and sets a benchmark for judging results.
- At a minimum an IPS describes the client's circumstances and constraints, sets out a strategy built on them and names a benchmark for evaluating performance; permitted assets and leverage limits belong in the investment guidelines.
- Risk and return objectives can be absolute or relative, a risk objective being relative only when it refers to a benchmark, and the two objectives must be set together so that they are compatible.
- Willingness to take risk reflects the investor's psychology and ability to take risk reflects financial circumstances such as horizon, wealth relative to needs and income stability; when the two conflict the lower assessment governs, although with high ability and low willingness the adviser may educate the client.

- The constraints are liquidity, time horizon, taxes, legal and regulatory factors and unique circumstances, a rule imposed by law being a legal constraint and a rule the investor chooses a unique circumstance.
- Asset classes for strategic allocation should have highly correlated returns within each class, low correlations between classes, and together approximate the universe of permissible investments.
- The strategic asset allocation is the efficient asset-class portfolio that best fits the IPS, tactical asset allocation is a temporary deviation from it to exploit perceived short-term mispricing, and risk budgeting allocates a total risk limit among strategic, tactical and security selection risk.
- ESG approaches include negative and positive screening, thematic and impact investing, engagement and ESG integration, and a negatively screened portfolio should be judged against an index that excludes the same kinds of companies.

QUICK CHECK

Question 1

An adviser explains to a new client why they should agree on a written investment policy statement (IPS) before any money is invested. Which of the following is *least likely* to be one of the reasons she gives? A written IPS:

- A** names the individual securities the portfolio will buy first.
- B** makes the client spell out objectives, circumstances and constraints.
- C** helps keep return goals realistic given the client's risk tolerance.

Answer: A

An IPS works at the level of objectives, constraints, strategy and benchmark. It does not go down to the choice of particular securities, which is a later, implementation decision within the policy the IPS sets.

Why the other options are wrong

- **B.** Forcing the client to articulate needs, circumstances and constraints is a central purpose of a written IPS; it imposes discipline on both parties.
- **C.** The IPS makes the client reconcile return expectations with risk tolerance, so it does help keep goals realistic and makes the risks of investing explicit.

Key takeaway The IPS is the starting point of the portfolio management process. It sets policy; security selection comes later.

Practice questions

Question 2

A client's IPS lists several investment objectives. Which one is a relative return objective?

- A Achieve a nominal return of at least 7% per year.
- B Keep to 5% the probability of losing more than 7% in any 12-month period.
- C Outperform a global equity index by 1.5% per year.

Question 3

Holding everything else constant, which of the following changes would *most likely* reduce a client's ability to take investment risk?

- A A sharp rise in near-term spending needs.
- B A rise in the client's net worth.
- C The purchase of additional insurance coverage.

Question 4

Which of the following is a characteristic of a well-specified set of asset classes for strategic asset allocation?

- A Each class groups assets with widely differing risk and expected return.
- B Taken together, the classes cover roughly the whole universe the IPS permits.
- C Returns of each class are highly correlated with those of the other classes.

Question 5

Which of the following statements about integrating environmental, social and governance (ESG) considerations into portfolio construction is *most* accurate?

- A Adding ESG constraints to the investment process will most likely reduce portfolio returns.
- B Clients pursuing active ownership must vote their shares themselves instead of through the manager.
- C A broad market index is unlikely to be an appropriate benchmark for a negatively screened portfolio.

Answers: 2. C · 3. A · 4. B · 5. C

Why each answer is right and why each other option is wrong: credguild.com/cfa/level-1/notes/portfolio-construction/basics-of-portfolio-planning-and-construction/. The full bank has 38 questions on this reading.

PORTFOLIO CONSTRUCTION · READING 91

The Behavioral Biases of Individuals

What you'll learn

LOS 91.a Compare cognitive errors (faulty reasoning, can be mitigated) with emotional biases (feelings-based, often accommodated).

LOS 91.b Describe the six emotional biases and their implications for financial decision making.

LOS 91.c Explain how behavioral biases may contribute to bubbles, the value/growth anomaly and home bias.

MODULE 91.1

Cognitive Errors vs. Emotional Biases

This reading separates cognitive errors from emotional biases and explains why the first are usually mitigated and the second accommodated. It describes the belief perseverance and information-processing biases, the six emotional biases, and how behavioral biases may help explain bubbles and crashes, the value premium and home bias.

LOS 91.a — Cognitive errors versus emotional biases

Traditional finance assumes investors are fully rational and process all relevant information objectively.

Behavioral finance, pioneered by Kahneman and Tversky, shows that people depart from rationality in **systematic** ways. Because these departures are widespread rather than random, they are predictable.

Kahneman, Tversky and others suggest that if clients and their advisers understood these biases better, prices and returns would move closer to the efficient-market outcome of traditional theory.

Biases fall into two families:

KEY CONCEPT

	Cognitive errors	Emotional biases
Source	Faulty reasoning: misunderstanding statistics, information-processing mistakes, illogical reasoning, memory errors	Feelings, impulses or intuition; not the product of conscious thought
Nature	An attempt to reason that goes wrong	A spontaneous reaction
Fix	Can often be mitigated (reduced) through awareness, education, training or better information	Difficult to overcome; may have to be accommodated (the portfolio is adjusted to live with the bias)
Sub-groups	Belief perseverance biases and information-processing biases	Six biases (see Module 91.2)

Many biases have both cognitive and emotional elements. When they do, the adviser is more likely to succeed by working on the cognitive part. A useful test: if a simple change in thinking or better information would make the investor drop the bias, treat it as **cognitive**. If the view rests on emotion the investor is unwilling or unable to change, treat it as **emotional**.

Example. A client keeps too much money in low-yield deposits because he misreads a volatility chart. Once the adviser shows him the long-run return data, he rebalances. Better information changed his decision, so the problem was a cognitive error. Another client refuses to sell a family-business stake despite a clear case for diversifying, saying that selling "just feels wrong". Her view rests on feelings she will not change, so it is an emotional bias to be accommodated.

LOS 91.b — Cognitive errors: belief perseverance biases

Belief perseverance is the tendency to cling to prior beliefs. It is rooted in **cognitive dissonance**: holding conflicting beliefs, or receiving information that challenges a current belief, causes stress. A person can relieve it by dropping the old belief or by discounting the new information (questioning its truth, source, relevance or importance). When the second route is easier, the result is a bias toward existing beliefs.

Bias	Description	Typical consequence
Conservatism bias	Forms a reasonable initial view but fails to update it (or updates too slowly) when new information arrives; overweights prior probabilities	Holding positions too long; ignoring complex new data
Confirmation bias	Seeks and notices information that supports existing beliefs; avoids or discounts conflicting evidence, or distorts it to fit the prior view	Screens set up to confirm a view; overconfidence in a held belief. Remedy: deliberately seek contrary views
Representativeness bias	Classifies something by a few features and assumes it will behave like the category; treats two things that are alike in some respects as more alike in other respects than they are	Two forms: base-rate neglect (ignoring how common a trait is in the population) and sample-size neglect (generalizing from a small sample, e.g. three good years of a fund manager). Leads to overweighting a few characteristics and relying on simple rules and classifications instead of thorough analysis
Illusion of control bias	Believes one can control or influence outcomes that one cannot. Often linked with emotional biases: illusion of knowledge, self-attribution and overconfidence	Overweighting the employer's stock or other "controllable" holdings; poor diversification

Bias	Description	Typical consequence
Hindsight bias	Selective memory: sees past outcomes as predictable or even inevitable ("I knew it all along"), remembers correct forecasts and forgets wrong ones, overestimates what could have been known	Overconfidence; discarding sound methods that happened not to work

Example (representativeness). An analyst meets the founder of a young biotech company. The firm has a charismatic leader, a strong patent and fast hiring, the traits she associates with the best-known biotech successes, so she projects rapid growth. She ignores the base rate: only a small fraction of early-stage biotech firms ever bring a product to market. Judging the firm by how closely it resembles a few famous winners, rather than by how often firms like it succeed, is base-rate neglect.

LOS 91.b — Cognitive errors: information-processing biases

These biases concern how information is processed rather than the decision itself.

Bias	Description	Typical consequence
Anchoring and adjustment bias	Starts from an initial number (current price, last EPS, prior estimate) and adjusts too little as new data arrive	Underreacting to new information. Remedy: judge new data on its own merits rather than as an adjustment to the starting number
Mental accounting bias	Treats money differently depending on its source or the "account" it is in, instead of viewing the portfolio as a whole	Speculating with "found money" (bonuses, refunds), keeping an inheritance in low-risk bonds, treating income and capital gains differently, holding offsetting positions instead of considering correlations. New York taxi drivers who treat each day as a separate account and stop once a daily income target is met are a well-known case
Framing bias	Makes different choices depending on how the same facts are presented (as a gain or as a loss; over a short or a long horizon)	Overreacting to short-term volatility; mis-measured risk tolerance if questionnaire wording is biased
Availability bias	Judges probability by how easily examples come to mind; overweights recent, vivid, familiar or heavily publicized events	Choosing managers by advertising; limiting the universe to familiar firms; overreacting to recent news and ignoring long-run history

Example (framing). An investor is offered a choice for a \$30,000 position. Framed as gains, the choice is "keep \$20,000 for certain" or "a one-third chance of keeping all \$30,000 and a two-thirds chance of keeping \$15,000". Both have an expected value of \$20,000: one-third of 30,000 is 10,000, and two-thirds of 15,000 is 10,000. Most people take the sure amount. Framed as losses ("lose \$10,000 for certain" versus the equivalent gamble), many switch to the gamble, even though the outcomes are identical.

Classification summary

KEY CONCEPT

Belief perseverance (cognitive)	Information processing (cognitive)	Emotional
Conservatism	Anchoring and adjustment	Loss-aversion bias
Confirmation	Mental accounting	Overconfidence bias
Representativeness	Framing	Self-control bias
Illusion of control	Availability	Status quo bias
Hindsight		Endowment bias
		Regret-aversion bias

Common exam traps

- Conservatism and confirmation differ. Conservatism is failing to update a view; confirmation is selectively gathering or interpreting evidence to fit it.
- Conservatism and anchoring also differ, although both lead to underreaction. Anchoring starts from a specific number, such as a price or a prior EPS figure, and adjusts too little; conservatism is a belief perseverance bias in which a prior view or forecast is kept, or revised too slowly, as new information arrives.
- Availability is about ease of recall (recent, vivid, publicized events). Confirmation is about agreement with a prior view, and framing is about presentation.
- Mental accounting and framing are cognitive (information-processing) biases, even though they feel intuitive.

EXAM SHORTCUTS

- To classify a bias, ask whether better information or a simple change in thinking would make the investor drop it: if so, treat it as cognitive; if the view rests on emotion the investor will not or cannot change, treat it as emotional.

BOTTOM LINE

- Cognitive errors come from faulty reasoning and can often be mitigated through awareness, education, training or better information, while emotional biases arise from feelings or impulses and are hard to overcome, so the portfolio may have to accommodate them.

- Belief perseverance biases, rooted in cognitive dissonance, are conservatism, confirmation, representativeness, illusion of control and hindsight bias.
- Information-processing biases are anchoring and adjustment, mental accounting, framing and availability.
- Conservatism is failing to update a reasonable view, or updating it too slowly, confirmation bias is seeking and interpreting evidence to fit an existing view, and anchoring is adjusting too little from a specific starting number.
- Representativeness takes two forms, base-rate neglect (ignoring how common a trait is in the population) and sample-size neglect (generalizing from a small sample).
- Availability bias judges probability by how easily examples come to mind, and framing bias produces different choices from the same facts depending on how they are presented.

QUICK CHECK

Question 1

An adviser notes several tendencies in a client's behavior. Which one is *most likely* a cognitive error rather than an emotional bias? The client:

- A takes on more risk rather than selling a stock at a loss.
- B avoids buying stocks for fear of the regret she would feel if they fell.
- C assumes a new company will behave like others it seems to resemble.

Answer: C

Classifying something by a few features and assuming it will share the characteristics of that category is representativeness bias, a belief perseverance bias and therefore a cognitive error.

Why the other options are wrong

- A. Taking extra risk to avoid realizing a loss is loss-aversion bias, an emotional bias.
- B. Inaction driven by fear of regretting a wrong decision is regret-aversion bias, an emotional bias.

Key takeaway Representativeness (categorizing) is cognitive; loss aversion and regret aversion are emotional.

MODULE 91.2

Emotional Biases

LOS 91.b — Emotional biases

Six biases are generally classified as **emotional biases**. LOS 91.a compares them with cognitive errors and explains why they are usually accommodated rather than corrected.

KEY CONCEPT

Bias	Description	Typical consequence
Loss-aversion bias	Losses hurt more than equal gains please; decisions are judged against a reference point	Trading too much by selling winners for small gains (higher costs, lower returns); holding deteriorating losers and taking excess risk after a decline in the hope of getting back to breakeven; a position may be seen as a gain or a loss depending on how the reference point is framed
Overconfidence bias	Overestimating one's own knowledge, reasoning or forecasting ability; includes illusion of knowledge ; self-attribution bias , which is self-enhancing when it takes credit for successes and self-protecting when it blames others or circumstances for failures; prediction overconfidence (ranges too narrow); and certainty overconfidence (probability of being right overstated)	Underestimating risk, overestimating return, overtrading, too little diversification
Self-control bias	Lack of discipline: short-term satisfaction wins over long-term goals; hyperbolic discounting (preferring small payoffs now to larger ones later)	Undersaving for retirement, then taking excessive risk to catch up; overemphasis on income assets. Remedy: a formal plan and budget, reviewed regularly
Status quo bias	Comfort with the current situation; doing nothing is the default	Keeping an inappropriate allocation for years; ignoring better alternatives. Default options (e.g. automatic enrollment with opt-out) exploit it
Endowment bias	An asset feels more valuable simply because one owns it; owners tend to ask a higher price to sell it than they would pay to buy it	Holding inherited or familiar assets that no longer fit. Test: "Would you buy this today with new money?"
Regret-aversion bias	Fear that an action will turn out wrong leads to inaction; errors of commission weigh more than errors of omission . Herding is a form of regret aversion	Excess conservatism; following the crowd

Loss aversion and risk aversion. A **risk-averse** investor, faced with two choices with the same expected return, picks the less risky one. A **loss-averse** investor measures outcomes against a reference point and may take on more risk to avoid realizing a loss than to secure an equal gain.

Example (loss aversion). An investor holds a stock bought at €80 that now trades at €56, a 30% loss. His research no longer supports the stock, but he says he will sell "once it gets back to €80". He is using the purchase price as the reference point and refusing to realize the loss, which is typical loss-aversion behavior. The only relevant question is whether the stock is worth holding at €56.

Common exam traps

- Status quo bias, regret aversion and endowment bias can all produce inaction. Status quo bias is comfort with the default; regret aversion is fear that acting will be a mistake; endowment bias makes an asset seem worth more because it is owned.
- Self-control bias concerns saving and spending discipline rather than trading decisions.
- Overconfidence has cognitive elements but is classified as an emotional bias, because it is hard to correct and rooted in the wish to feel good.

LOS 91.c — Behavioral biases and market characteristics

A **market anomaly** is a result that does not fit the prevailing model of risk and return. A **market inefficiency** is an anomaly that offers positive risk-adjusted returns. Many apparent anomalies disappear once small samples, time-period bias or a **misspecified risk model** are accounted for.

KEY CONCEPT

Bubbles and crashes. Behavioral finance does not offer an overall explanation of bubbles, but several biases may contribute:

- **Overconfidence** causes investors to trade too much, underestimate risk and diversify too little.
- **Self-attribution** and **hindsight bias** (taking credit for gains in a bull market) reinforce overconfidence.
- **Confirmation bias** leads investors to dismiss evidence that prices cannot keep rising and to treat early declines as buying opportunities.
- **Anchoring** leads investors to treat recent highs as rational prices even as prices fall.
- **Fear of regret** keeps even skeptical investors in the market.

Exploiting a bubble is hard. Leaving too early and staying too long are both costly, and short selling a rising market is risky and restricted.

Value vs growth. Value stocks (low market-to-book, low P/E, high dividend yield) have outperformed growth stocks over long periods. In Fama and French's (1992) tests, the apparent value premium disappeared once size and book-to-market factors were included in the return model, which suggests the extra return compensates for risk. A behavioral explanation is the **halo effect**, a form of representativeness in which a firm's good features (fast growth, a rising share price) are extended to the conclusion that it is a good stock. The result is overvaluation of growth stocks.

Home bias. Investors overweight domestic or local companies despite the benefits of global diversification, perhaps believing they have better information or simply feeling more comfortable. Investors also tend to overrate firms whose products they use or whose marketing they see often.

Common exam traps

- Under-diversification is linked to overconfidence, illusion of control and availability (a preference for familiar firms), not to anchoring.
- Anchoring and regret aversion tend to keep investors in a bubble; they do not deflate it.
- The halo effect overvalues growth stocks, not local or familiar ones. Overweighting companies close to home is home bias.

BOTTOM LINE

- The six emotional biases are loss aversion, overconfidence, self-control, status quo, endowment and regret aversion.
- A loss-averse investor feels losses more than equal gains and judges outcomes against a reference point, so may sell winners too early, hold losers and take on more risk to avoid realizing a loss, unlike a risk-averse investor, who picks the less risky of two choices with the same expected return.
- Overconfidence, which includes illusion of knowledge, self-attribution, prediction overconfidence and certainty overconfidence, leads investors to underestimate risk, overtrade and diversify too little, and it is classified as emotional although it has cognitive elements.
- Self-control bias puts short-term satisfaction ahead of long-term goals, status quo bias makes doing nothing the default, endowment bias values an asset more because it is owned, and regret aversion makes errors of commission weigh more than errors of omission.
- A market anomaly does not fit the prevailing risk-return model, and it is a market inefficiency only if it offers positive risk-adjusted returns; many apparent anomalies disappear once small samples, time-period bias or a misspecified risk model are accounted for.
- Biases such as overconfidence, confirmation, anchoring and fear of regret may contribute to bubbles, the halo effect may explain overvaluation of growth stocks, and home bias leads investors to overweight domestic or local companies.

QUICK CHECK

Question 2

Studies find that many investors hold far fewer securities than traditional portfolio theory would recommend. Which behavioral bias *best* explains this under-diversification?

- A Overconfidence.
- B Anchoring.
- C Fear of regret.

Answer: A

Overconfidence leads investors to overestimate their knowledge and underestimate risk, which results in overtrading and insufficient diversification.

Why the other options are wrong

- **B.** Anchoring may cause investors to treat recent highs as rational prices even as prices fall; it is not the usual explanation for under-diversification.
- **C.** Fear of regret (of missing gains) may keep skeptical investors in an overvalued market; it does not explain holding too few securities.

Key takeaway Under-diversification, overtrading and underestimating risk are hallmarks of overconfidence.

Practice questions

Question 3

Which of the following is classified as an information-processing bias?

- A** Regret aversion.
- B** Anchoring and adjustment.
- C** Status quo.

Question 4

Which of the following groups consists *only* of cognitive errors?

- A** Representativeness, framing, and overconfidence biases.
- B** Confirmation, anchoring and adjustment, and availability biases.
- C** Endowment, regret-aversion, and self-control biases.

Answers: 3. B · 4. B

Why each answer is right and why each other option is wrong: credguild.com/cfa/level-1/notes/portfolio-construction/the-behavioral-biases-of-individuals/. The full bank has 24 questions on this reading.

PORTFOLIO CONSTRUCTION · READING 92

Value At Risk

What you'll learn

- LOS 92.a** Define risk management as choosing and maintaining the optimal bundle of risks, not minimizing risk.
- LOS 92.b** Describe the features of a risk management framework.
- LOS 92.c** Define risk governance and describe what makes it effective.
- LOS 92.d** Explain how risk tolerance is set and how it shapes risk management.
- LOS 92.e** Describe risk budgeting and its role within risk governance.
- LOS 92.f** Identify financial and non-financial risks and describe how they interact.
- LOS 92.g** Describe methods for measuring (e.g., duration, beta, Greeks, VaR, CVaR, stress tests, scenarios) and modifying (avoid, prevent, accept, transfer, shift) risk exposures.

MODULE 92.1

Introduction to Risk Management

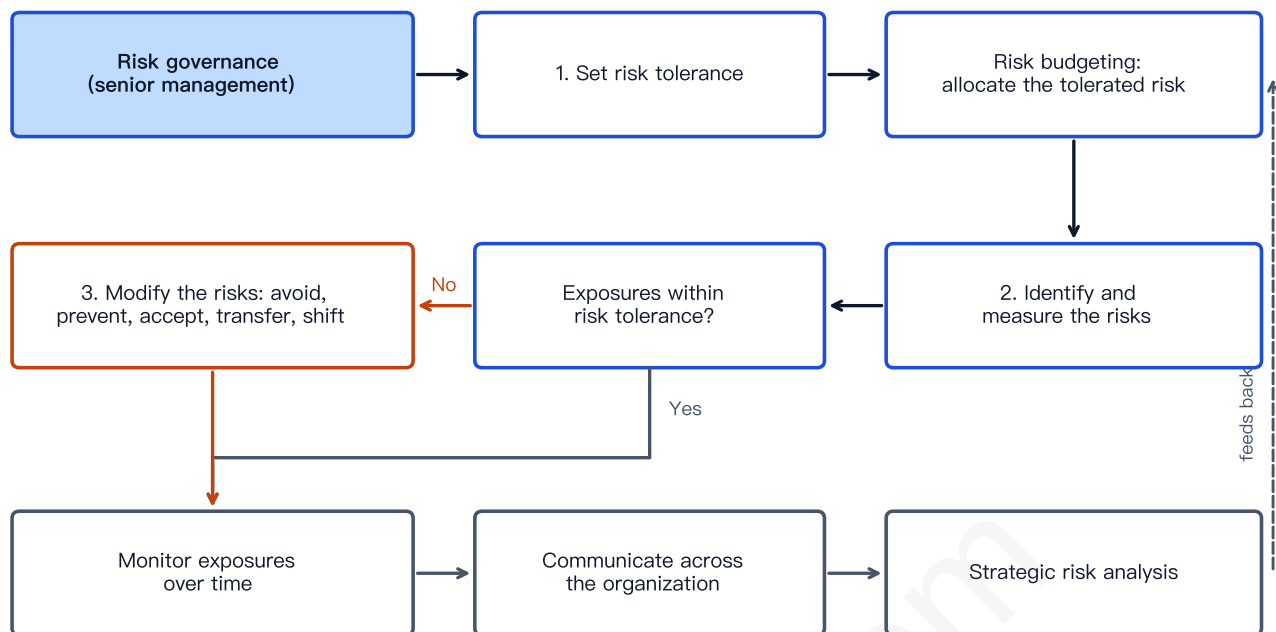
This reading defines risk management and the features of a risk management framework, and explains risk governance, risk tolerance and risk budgeting. It then classifies financial and non-financial risks and their interactions, and describes how risk exposures are measured (including VaR and CVaR) and modified.

LOS 92.a — What risk management is

Risk management is the process by which an organization, a portfolio manager or an individual (1) identifies its **risk tolerance**, (2) identifies and measures the risks it faces, and (3) modifies and monitors those risks, so that the bundle of risks it keeps is the one best suited to its goals.

- The goal is to hold the right risks. It is not to minimize or eliminate risk: returns above the risk-free rate come from bearing risk. An organization may deliberately increase its exposure to risks it is well placed to manage and reduce its exposure (through organizational changes, insurance or hedging) to risks it handles poorly.
- Managers cannot control the returns of any single period. They can control which risks they take and how much total risk they take. Risk management therefore means choosing the **optimal bundle of risks** and putting in place the strategies that achieve it.
- The same logic applies to individuals, who choose the bundle of risks that maximizes their expected utility.

The figure puts the steps in order. Risk governance sets the tolerance; the risks are then identified and measured; exposures are compared with the tolerance and modified when they are out of line; and the results are monitored, communicated and fed into strategic risk analysis.



The risk management process as a loop

LOS 92.b — Features of a risk management framework

A comprehensive **risk management framework** addresses all of the following:

1. Establishing processes and policies for risk governance.
2. Determining the organization's risk tolerance.
3. Identifying and measuring existing risks.
4. Managing and mitigating risks so that the organization ends up with its optimal bundle of risks.
5. Monitoring risk exposures over time.
6. Communicating across the organization.
7. Performing strategic risk analysis.

Disciplinary action against individual employees (for example, penalizing a trader who breached a limit) is not one of these features.

LOS 92.c — Risk governance

Risk governance is senior management's determination of the organization's risk tolerance, of the elements of its optimal risk exposure strategy, and of the framework for oversight of the risk management function. It is set at the enterprise level and aims to manage risk in a way that supports the organization's overall goals. It gives organization-wide guidance on which risks to pursue efficiently, which to limit, and which to reduce or avoid. A **risk management committee** gives different parts of the organization a forum to raise issues of risk measurement, integration of risks and mitigation.

Term	Meaning	Relationship
Risk governance	Senior management's overall oversight of risk management	The umbrella concept
Risk tolerance	How much overall risk the organization will take, and which risks	One element decided under risk governance
Risk budgeting	Allocating the acceptable risk across assets/investments	One element carried out within risk governance

LOS 92.d — How risk tolerance affects risk management

Risk tolerance is the overall amount of risk an organization will take in pursuing its goals. Top management sets it by identifying the risks the firm can take effectively and those it should reduce or avoid. The factors that determine it include:

- expertise in its lines of business;
- skill at responding to negative outside events;
- the regulatory environment;
- financial strength and the ability to withstand losses.

Management must examine risks that arise both inside and outside the organization and weigh each one against the expected benefit of bearing it. A low risk tolerance does not require cutting every identified risk. Some risks are worth keeping because they are consistent with the organization's objectives.

LOS 92.e — Risk budgeting

Risk budgeting allocates the organization's total acceptable risk (its risk tolerance) to assets or investments by considering their risk characteristics and how they combine. The aim is to place that risk where expected returns over time are greatest.

- The budget can be a single metric: return variance, portfolio beta, portfolio duration or value at risk.
- It can be split by investment category (e.g., domestic equities, domestic debt, international equities, international debt).
- It can be built from risk factors (interest rate risk, equity market risk, foreign exchange risk), which are estimated and aggregated to check that the total matches the risk tolerance.

LOS 92.f — Financial and non-financial risks and how they interact

Financial risks arise from exposure to financial markets. **Non-financial risks** arise from the organization's operations and from sources outside it.

KEY CONCEPT

Financial risks

Credit risk: the counterparty may not meet its contractual obligations

Non-financial risks

Operational risk: losses from human error, faulty processes, inadequate security or business interruption (includes **cyber risk**)

Financial risks

Liquidity risk: having to sell an asset below its fair value because of market conditions

Market risk: uncertainty about the prices of stocks, commodities and currencies, and about interest rates

Non-financial risks

Solvency risk: running out of cash and being unable to continue operating

Regulatory risk: the regulatory environment changes, adding costs or restricting activities

Governmental or political risk (includes **tax risk**): political action outside the regulatory framework, such as a tax increase, imposes costs

Legal risk: uncertainty about exposure to future legal action

Model risk: valuations from the organization's models are wrong

Tail risk: extreme outcomes are more likely than the organization's analysis indicates (e.g., from wrongly assuming normality)

Accounting risk: accounting policies or estimates are judged incorrect

Individuals also face **mortality risk** (dying before providing for dependents, usually addressed with life insurance) and **longevity risk** (outliving one's assets, which a lifetime annuity reduces), as well as the risk of health care expenses (health insurance). The approach is the same as for an organization: decide which risks to bear (self-insure), which to prevent or avoid, and which to take in order to maximize expected utility.

Interactions. Risks are not independent. Suppose a commodity producer hedges price risk with a swap arranged with a dealer. If commodity prices fall sharply, the dealer owes the producer a large payment under the swap, so the producer's credit risk rises. If the dealer disputes the contract, legal risk appears. Credit and legal losses may force the producer to sell assets in a weak market (liquidity risk), and those losses drain cash (solvency risk). Interactions like these are frequent and matter most in periods of market stress, so risks must be assessed together as well as one at a time.

LOS 92.g — Measuring and modifying risk exposures**Measures****KEY CONCEPT**

Measure	What it measures
Standard deviation	Volatility of asset prices or interest rates (stand-alone risk); can mislead for non-normal distributions (negative skew, fat tails)
Beta	Market risk of equities/equity portfolios; appropriate for securities held in a well-diversified portfolio

Measure	What it measures
Duration	Price sensitivity of debt securities to interest rate changes
Delta	Sensitivity of a derivative's value to the underlying's price
Gamma	Sensitivity of delta to the underlying's price
Vega	Sensitivity of a derivative's value to the underlying's volatility
Rho	Sensitivity of a derivative's value to the risk-free rate

Common measures of tail risk (also called downside risk) are:

- **Value at risk (VaR)** is the minimum loss over a given period that will occur with a stated probability, so a VaR figure always states an amount, a period and a probability. Equivalently, it is the maximum potential loss at the matching confidence level (95% for a 5% VaR), but larger losses still occur in the tail, so VaR is not the worst possible loss. Results depend heavily on the inputs and the model chosen, so VaR should be used together with other measures. Banks use it widely, including to set minimum capital requirements.
- **Conditional VaR (CVaR)** is the expected loss given that the loss exceeds the VaR threshold (the probability-weighted average of those losses). It is similar to the loss given default used for debt securities.

Example. A fund reports a one-week VaR of \$600,000 at 5%. In about 5% of weeks the fund should expect to lose at least \$600,000. If the losses in those worst weeks average \$850,000, the CVaR is \$850,000.

Two methods supplement VaR. **Stress testing** examines the effect of a specific (usually extreme) change in one key variable. **Scenario analysis** combines changes in several inputs at once. Rare events, operational risks and tax or regulatory changes often need subjective estimates. The market prices of insurance and derivatives also reveal market participants' estimates of expected losses, and operational risk can be estimated from large samples of firms (the overall probability of a large operational loss and the average size of such losses). A subjective estimate of a risk's probability and size is still better than ignoring the risk.

Modifying risk exposures

KEY CONCEPT

Method	How it works	Example
Avoid a risk	Do not engage in the activity	Not investing in a politically unstable country. Usually a top-management decision, made when the risk outweighs the activity's benefits
Prevent a risk	Take steps to prevent the loss or make it less likely	Stronger data security against breaches, when the benefit exceeds the cost
Accept (bear) a risk / self-insurance	Keep the risk, ideally efficiently (e.g., via diversification or a loss reserve)	Reserve account for small claims. Self-insurance only means bearing the losses; it can reflect inaction rather than a deliberate decision

Method	How it works	Example
Risk transfer	Another party takes on the risk	Insurance, surety bonds (pay if a third party fails to perform), fidelity bonds (employee theft or misconduct). Insurers diversify across risks that ideally are not highly correlated, and may buy reinsurance for concentrated risks
Risk shifting	Change the distribution of possible outcomes, mainly with derivatives	Forwards, futures or swaps to hedge currency risk; buying puts to set a floor; writing calls (gives up upside, and the premium reduces the downside)

The choice is always a cost-benefit comparison, and several methods may be combined for a single risk. An insurance policy with a deductible is an example: the insurer takes on losses above the deductible (risk transfer), while the insured bears the losses up to it (self-insurance). The aim is a risk profile consistent with the organization's risk tolerance.

Common exam traps

- A what-if run that moves interest rates and oil prices together is scenario analysis. A stress test looks at one key variable.
- Do not read VaR as the worst possible loss or as the average loss in the tail. The average of the losses beyond VaR is CVaR.
- Buying puts or writing calls reduces a loss by changing the distribution of outcomes, so it is risk shifting. Risk transfer means another party, such as an insurer, takes the risk on.
- Beta does not measure interest rate sensitivity. Duration and rho do.
- Solvency, model, tax and tail risk sound financial, yet they are classified as non-financial risks.

BOTTOM LINE

- Risk management identifies the risk tolerance, identifies and measures the risks faced, and modifies and monitors them, with the aim of holding the optimal bundle of risks rather than minimizing or eliminating risk.
- Risk governance is senior management's determination of risk tolerance, of the elements of the optimal risk exposure strategy and of the framework for overseeing risk management, set at the enterprise level.
- Risk tolerance depends on expertise in the lines of business, skill at responding to negative outside events, the regulatory environment and financial strength, and a low risk tolerance does not require cutting every identified risk.
- Risk budgeting allocates the total acceptable risk to assets or investments, using a single metric such as variance, beta, duration or VaR, a split by investment category, or aggregated risk factors.
- Financial risks are credit, liquidity and market risk, while operational, solvency, regulatory, political and tax, legal, model, tail and accounting risks are non-financial, and because risks interact, especially in periods of market stress, they must be assessed together as well as one at a time.
- VaR is the minimum loss over a stated period that will occur with a stated probability, so it is not the worst possible loss, and CVaR is the expected loss given that the loss exceeds the VaR threshold.

- A stress test examines a specific, usually extreme, change in one key variable, while scenario analysis changes several inputs at once.
- Risk can be avoided, prevented, accepted through self-insurance, transferred to another party such as an insurer, or shifted by changing the distribution of outcomes with derivatives, the choice being a cost-benefit comparison.

QUICK CHECK

Question 1

Which of the following is *most likely* one of the goals of an organization's risk management process?

- A Identifying the risks the organization faces.
- B Minimizing the risks the organization faces.
- C Eliminating the risks the organization faces.

Answer: A

The risk management process identifies the organization's risk tolerance, identifies and measures the risks it faces, and then modifies and monitors those risks. Its aim is the optimal bundle of risks rather than the smallest possible amount of risk.

Why the other options are wrong

- **B.** Minimizing risk is not the goal. Returns above the risk-free rate require bearing risk, and an organization may deliberately increase risks it manages well.
- **C.** Eliminating all risk would also eliminate the returns that come from bearing it; risk management keeps the risks that fit the organization's tolerance and goals.

Key takeaway Risk management chooses which risks to bear; it does not try to avoid all risk.

Practice questions

Question 2

Which statement about how an organization sets its risk tolerance is *most accurate*?

- A The organization's financial strength is one of the factors it should weigh.
- B An organization with low risk tolerance should cut every risk it identifies.
- C Only risks that come from outside the organization need to be considered.

Question 3

To protect its equity portfolio, the Ashcombe Teachers' Pension Fund buys over-the-counter put options from a single dealer. Over the next quarter, equity prices fall 25% and the puts move deep in the money. Which risk has *most likely* increased the most for the fund as a result of this move?

- A Market risk on the equity portfolio.
- B Credit risk on the put options.
- C Operational risk in the fund's trading.

Question 4

Westbury College buys a flood insurance policy for its campus buildings. For each flood claim, the college pays the first \$400,000 of damage itself, and the insurer pays the rest. Which description of this arrangement is *most accurate*?

- A Losses of any size are transferred to the insurer, so the college bears no flood risk.
- B The policy is a form of risk shifting, because it changes the distribution of the college's outcomes.
- C The first \$400,000 of each loss is self-insured, and the part above it is transferred.

Answers: 2. A · 3. B · 4. C

Why each answer is right and why each other option is wrong: credguild.com/cfa/level-1/notes/portfolio-construction/value-at-risk/. The full bank has 20 questions on this reading.

Keep going at credguild.com

The notes are the start. These are free on the site and do what a PDF cannot:

- **Diagnostic test:** 36 questions weighted like the exam, a score in each topic and the topics to start with.
credguild.com/cfa/level-1/diagnostic/
- **Practice questions:** 398 free questions with full explanations, scored as you answer. A free account answers any question in the bank, up to 50 new questions a day. credguild.com/cfa/level-1/practice/
- **Notes:** every reading of the 2027 curriculum, with worked examples and exam traps, on the site and as a PDF. credguild.com/cfa/level-1/notes/
- **Study plan:** pick your exam window and weekly hours and get a week-by-week schedule.
credguild.com/cfa/level-1/plan/
- **Mock exam:** 180 questions in two sessions, on the 2027 topic weights; the first one is free with an account.
credguild.com/cfa/level-1/mock/
- **Cheat sheet and formula sheet:** every reading's bottom line and every formula, by topic.
credguild.com/cfa/level-1/cheat-sheet/

Found a mistake? Email hello@credguild.com.