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CHEAT SHEET

CFA® Program Level I

Portfolio Construction Cheat Sheet

2027 curriculum · 6 readings · 26 formulas

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Version v2027.3 · October 2026

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CredGuild · CFA® Program Level I · Portfolio Construction Cheat Sheet
2027 curriculum · Version v2027.3 · Generated October 6, 2026

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The revision summary of the CredGuild notes for the 2027 CFA® Program Level I curriculum, Portfolio Construction: for each reading, the bottom line of every module, the exam shortcuts and the formulas. Use it in the last weeks before the exam, after you have studied the readings.

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CFA® PROGRAM LEVEL I · CHEAT SHEET

Portfolio Construction

Exam weight 8–12% · 6 readings · 26 formulas

87 Portfolio Risk and Return: Part I

MODULE 87.1 · HISTORICAL RISK AND RETURN

- 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.

MODULE 87.2 · RISK AVERSION

- 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.

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.

MODULE 87.3 · PORTFOLIO STANDARD DEVIATION

- 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.

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- Covariance is in squared return units and depends on the assets' volatilities, whereas the correlation $\rho_{1,2} = \mathrm{Cov}_{1,2}/(\sigma_1\sigma_2)$ 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.

MODULE 87.4 · THE EFFICIENT FRONTIER

- 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.

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.

FORMULAS

Utility function	$U = E(r) - \frac{1}{2}A\sigma^2$
Adding the risk-free asset: the capital allocation line	$E(R_p) = w\,E(R_{risky}) + (1-w)R_f$ $\sigma_p = w\,\sigma_{risky}$
One asset	$\sigma^2 = \frac{\sum_{t=1}^{T}(R_t-\mu)^2}{T}$ (population) $s^2 = \frac{\sum_{t=1}^{T}(R_t-\bar{R})^2}{T-1}$ (sample)
Two assets: covariance	$\mathrm{Cov}_{1,2} = \frac{\sum_{t=1}^{T}(R_{1,t}-\bar{R}_1)(R_{2,t}-\bar{R}_2)}{T-1}$
Correlation	$\rho_{1,2} = \frac{\mathrm{Cov}_{1,2}}{\sigma_1\sigma_2}$ $\mathrm{Cov}_{1,2} = \rho_{1,2}\,\sigma_1\,\sigma_2$
Portfolio standard deviation	$E(R_p) = w_1E(R_1) + w_2E(R_2)$ $\sigma_p^2 = w_1^2\sigma_1^2 + w_2^2\sigma_2^2 + 2w_1w_2\mathrm{Cov}_{1,2} = w_1^2\sigma_1^2 + w_2^2\sigma_2^2 + 2w_1w_2\rho_{1,2}\sigma_1\sigma_2$ $\sigma_p = \sqrt{\sigma_p^2}$

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Investing in assets that are less than perfectly correlated	$\sigma_p^2 = (w_1\sigma_1 + w_2\sigma_2)^2 \quad \Rightarrow \quad \sigma_p = w_1\sigma_1 + w_2\sigma_2$ $w_1 = \dfrac{\sigma_2}{\sigma_1 + \sigma_2}$

88 Portfolio Risk and Return: Part II

MODULE 88.1 · SYSTEMATIC RISK AND BETA

- 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.

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.

MODULE 88.2 · THE CAPM AND THE SML

- 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 M² use total risk and suit a single manager's or concentrated portfolio, M² ranking portfolios as the Sharpe ratio does, while the Treynor measure and Jensen's alpha use beta and suit a well-diversified fund.

EXAM SHORTCUTS

- M² is above R_M exactly when the portfolio's Sharpe ratio is above the CML slope, so the sign of the M² 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.

FORMULAS

Adding a risk-free asset to a risky portfolio	$E(R_C) = w\,E(R_P) + (1-w)\,R_f$ $\sigma_C = w\,\sigma_P$
The capital allocation line (CAL) and the capital market line (CML)	$E(R_P) = R_f + \left[\frac{E(R_M) - R_f}{\sigma_M}\right]\sigma_P$
Systematic and unsystematic risk	$\text{total risk} = \text{systematic risk} + \text{unsystematic risk}$
Return generating models and the market model	$E(R_i) - R_f = \beta_{i,1}E(F_1) + \beta_{i,2}E(F_2) + \cdots + \beta_{i,k}E(F_k)$ $R_i = \alpha_i + \beta_i R_m + e_i$
Calculating and interpreting beta	$\beta_i = \frac{Cov(R_i, R_m)}{\sigma_m^2} = \frac{\rho_{i,m}\,\sigma_i\,\sigma_m}{\sigma_m^2} = \rho_{i,m}\frac{\sigma_i}{\sigma_m}$
The CAPM, its assumptions, and the security market line (SML)	$E(R_i) = R_f + \beta_i\,[E(R_m) - R_f]$ $\beta_i = \frac{Cov(R_i, R_m)}{\sigma_m^2}$
Applying the CAPM and the SML: finding mispriced securities	$\text{forecast return} = \frac{P_1 - P_0 + D_1}{P_0}$ $\text{required return} = R_f + \beta[E(R_m) - R_f]$

89 Portfolio Management: An Overview

MODULE 89.1 · PORTFOLIO MANAGEMENT PROCESS

- 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 ÷ 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.

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.

MODULE 89.2 · ASSET MANAGEMENT AND POOLED INVESTMENTS

- 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.
- NAV per share = (fund assets − fund liabilities) ÷ 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.

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FORMULAS

Measuring the benefit: the diversification ratio	$$\text{Diversification ratio} = \frac{\sigma \text{ of an equally weighted portfolio of the } n \text{ securities}}{\text{average } \sigma \text{ of the } n \text{ individual securities}}$$
Mutual funds and other pooled investments	$$NAV = \frac{\text{fund assets} - \text{fund liabilities}}{\text{shares outstanding}}$$

90 Basics of Portfolio Planning and Construction

- 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.

91 The Behavioral Biases of Individuals

MODULE 91.1 · COGNITIVE ERRORS VS. EMOTIONAL BIASES

- 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.

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.

MODULE 91.2 · EMOTIONAL BIASES

- 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.

92 Introduction to Risk Management

- 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.

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