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CFA LEVEL I

Detailed Formula Sheet



Portfolio Management

Topic 9 of 10 • Fully Explained

💡 Plain-English explanations • 📊 Worked examples • 🧠 Memory hooks • ⚠️ Exam traps

Portfolio Process

Risk & Return

Diversification

Efficient Frontier & CML

CAPM & SML

Performance Measures

Behavioral Biases

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★ Mentored by Deepak Goyal — CFA, FRM ★

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👋 **Topic 9 — Portfolio Management!** The heart of modern finance: how combining assets **reduces risk without sacrificing return**. You'll meet diversification, the efficient frontier, the CAPM, and the performance ratios. Each card has the formula, a **plain-English meaning**, a worked example, and **memory hooks**. 📁

💡 **In Plain English** 📊 **Worked Example** 🧠 **Memory Hook** ⚠️ **Watch Out** 📌 **Key Fact**

1 🎯 The Portfolio Approach & Process

🔗 The Portfolio Management Process

Planning → Execution → Feedback (a continuous cycle)

💡 In Plain English

Planning: understand the client and write the **Investment Policy Statement (IPS)**. **Execution:** allocate assets and select securities. **Feedback:** monitor, rebalance, and measure performance. The **portfolio perspective** means judging each asset by its contribution to overall risk/return, not in isolation.

📌 Key Fact

The **IPS** is the roadmap — it captures the client's **objectives** (return & risk tolerance) and **constraints** (Liquidity, Time horizon, Taxes, Legal, Unique circumstances → "L-T-T-L-U").

2 📊 Risk & Return Measures

💰 Returns: Holding Period, Arithmetic & Geometric

$$\text{HPR} = \frac{P_1 - P_0 + \text{Income}}{P_0}$$

$$\text{Geometric mean} = [(1 + R_1)(1 + R_2) \dots (1 + R_n)]^{1/n} - 1$$

💡 In Plain English

The **arithmetic mean** is the simple average (good for a single expected period). The **geometric mean** compounds returns over time — it's the true multi-period growth rate and is **always ≤ arithmetic mean**.

📊 Worked Example

Returns 10%, -5%, 15%: Arithmetic = $20/3 = 6.67\%$; Geometric = $(1.10 \times 0.95 \times 1.15)^{1/3} - 1 = 6.32\%$.

📐 Variance, Covariance & Correlation

$$\text{Cov}(R_1, R_2) = \rho_{12} \sigma_1 \sigma_2 \implies \rho_{12} = \frac{\text{Cov}(R_1, R_2)}{\sigma_1 \sigma_2}$$

💡 In Plain English

Standard deviation measures an asset's total risk. **Covariance** measures how two assets move together; **correlation** standardizes it onto a -1 to +1 scale — the key ingredient for diversification.

📌 Key Fact

Correlation ranges from -1 to +1. +1 = move perfectly together (no diversification); -1 = perfectly opposite (risk can be eliminated); 0 = unrelated.

3 Portfolio Risk & Diversification

Two-Asset Portfolio: Return & Risk

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

$$\sigma_p = \sqrt{(w_1^2 \sigma_1^2 + w_2^2 \sigma_2^2 + 2w_1 w_2 \rho_{12} \sigma_1 \sigma_2)}$$

In Plain English

Portfolio return is just the weighted average of the assets' returns. Portfolio **risk is NOT** a simple weighted average — the correlation term pulls it **below** the average whenever $\rho < 1$. That gap is the diversification benefit.

Worked Example

w_1 60% (σ_1 20%), w_2 40% (σ_2 30%), ρ 0.3:

$\sigma_p = \sqrt{(0.36 \times 0.04 + 0.16 \times 0.09 + 2 \times 0.6 \times 0.4 \times 0.3 \times 0.06)} = \sqrt{0.03744} = \mathbf{19.35\%}$ (below the 24% weighted average!).

The Power of Diversification

Lower correlation → greater risk reduction. At $\rho = +1$ there is NO benefit.

In Plain English

The lower the correlation between assets, the more the portfolio's risk falls below the weighted-average risk. Combining imperfectly correlated assets is the closest thing to a "free lunch" in finance.

Memory Hook

"Don't put all your eggs in one basket." Correlation is the magic dial: the lower it is, the safer the basket. 🍳

4 Efficient Frontier, CAL & CML

From the Efficient Frontier to the CML

Efficient Frontier: best return for each risk level | CAL/CML: risk-free asset + risky portfolio

$$\text{CML: } E(R_p) = R_f + \frac{E(R_m) - R_f}{\sigma_m} \times \sigma_p$$

In Plain English

The **efficient frontier** holds the best risky portfolios. Add a risk-free asset and the best line you can draw is the **Capital Allocation Line (CAL)**. When the risky portfolio is the **market portfolio**, that CAL becomes the **Capital Market Line (CML)** — and its slope is the market's Sharpe ratio.

Key Fact

Every investor holds a mix of the **risk-free asset + the same market portfolio**; only the proportions differ by risk tolerance. Borrowing to invest more in the market = a **leveraged** position on the CML.



Systematic vs Nonsystematic Risk

Total risk = Systematic (market) risk + Nonsystematic (diversifiable) risk

💡 In Plain English

Nonsystematic risk (company/industry-specific) can be **diversified away** for free. **Systematic risk** (market-wide) cannot — so it's the **only risk that earns a return**. This is why beta, not total risk, prices assets.

🧠 Memory Hook

"The market only pays you for risk you **CAN'T** avoid." Diversifiable risk = no reward. 💰

5

📌 CAPM & the Security Market Line



The Capital Asset Pricing Model

$$E(R_i) = R_f + \beta_i[E(R_m) - R_f]$$

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

💡 In Plain English

The CAPM says an asset's expected return = risk-free rate + a reward for its **systematic risk**. **Beta** measures that systematic risk: how much the asset moves relative to the market (market $\beta = 1$; risk-free $\beta = 0$).

📊 Worked Example

R_f 3%, β 1.2, market risk premium ($R_m - R_f$) 6% → $E(R_i) = 3\% + 1.2(6\%) = \mathbf{10.2\%}$.

Beta: ρ 0.7, σ_i 25%, σ_m 15% → $\beta = 0.7 \times 25/15 = \mathbf{1.17}$.

📌 SML vs CML

The **SML** plots expected return against **beta** (systematic risk) and prices **all** securities. The **CML** uses **total risk (σ)** and applies only to **efficient** portfolios.

6 🏆 Portfolio Performance Measures

The Four Appraisal Ratios

$$\text{Sharpe} = \frac{R_P - R_f}{\sigma_P} \quad | \quad \text{Treynor} = \frac{R_P - R_f}{\beta_P}$$

$$M^2 = (R_P - R_f) \frac{\sigma_m}{\sigma_P} + R_f \quad | \quad \text{Jensen's } \alpha = R_P - [R_f + \beta_P(R_m - R_f)]$$

💡 In Plain English

Sharpe & M² use **total risk (σ)** — best when the portfolio is your whole wealth. **Treynor & Jensen's alpha** use **beta** — best when the portfolio is one part of a diversified whole. Sharpe = the slope of the CAL.

Worked Example

R_P 12%, σ_P 18%, β_P 1.1, R_f 3%, R_m 9%, σ_m 15%:

Sharpe = 9/18 = **0.50**; Treynor = 9/1.1 = **8.2**; Jensen's α = 12 - [3 + 1.1(6)] = **2.4%**; M² = 0.50 × 15 + 3 = 10.5% → M² alpha = **1.5%**.

⚠️ Watch Out

Sharpe & Treynor only **rank** portfolios (a value like 0.5 isn't meaningful alone); **M²** and **Jensen's alpha** tell you the actual % out/under-performance vs the market.

7 🧠 Behavioral Biases

Cognitive Errors vs Emotional Biases

Cognitive Errors (faulty reasoning) | Emotional Biases (feelings & impulses)

💡 In Plain English

Real investors aren't perfectly rational. **Cognitive errors** come from flawed thinking and can be reduced with education & data. **Emotional biases** stem from feelings and are harder to correct — often best simply accommodated.

Common Biases

Cognitive: **anchoring, availability, representativeness, confirmation, framing, mental accounting**. Emotional: **loss aversion, overconfidence, self-control, status-quo, regret aversion, herding**.

Memory Hook

"Cognitive = you **THINK** wrong (fixable with facts); Emotional = you **FEEL** wrong (harder to fix)." 🧠🗨️