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FORMULA SHEET

CFA® Program Level I

Formula Sheet

2027 curriculum · 92 readings · 9 topics · 501 formulas

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Contents

Quantitative Methods 1

1. Returns of Financial Assets and Instruments 1
2. Types of Financial Returns 2
3. Benchmarking Returns 2
4. The Time Value of Money in Finance 2
5. Statistical Characteristics of Asset Returns 3
6. Statistical Distributions for Financial Asset Prices and Returns 4
7. Estimation and Hypothesis Testing 5
8. The Return and Risk of a Financial Portfolio 6
9. Simulation of Financial Asset Prices and Returns 7
10. Applications of Simple Linear Regression in Finance 7

Economics 9

12. The Firm and Market Structures 9
14. Fiscal Policy 9
15. Monetary Policy 9
17. International Trade 9
18. Capital Flows and the FX Market 9
19. Exchange Rate Calculations 10

Corporate Finance 11

20. Organizational Forms, Corporate Issuer Features, and Ownership 11
23. Working Capital and Liquidity 11
24. Capital Investments and Capital Allocation 11
25. Capital Structure 12

Financial Statement Analysis 13

28. Analyzing Income Statements 13
29. Analyzing Balance Sheets 13
30. Analyzing Statements of Cash Flows I 14
31. Analyzing Statements of Cash Flows II 15
32. Analysis of Inventories 15
33. Analysis of Long-Term Assets 15
34. Topics in Long-Term Liabilities and Equity 15
35. Analysis of Income Taxes 16
36. Financial Reporting Quality 16
37. Financial Analysis Techniques 16

Equities 19

39. Equity Instrument Features 19
41. Equity Issuance and Trading 19
42. Sources of Equity Returns 19
43. Introduction to Equity Valuation 19
44. Discounted Cash Flow (DCF) and Growth Models 20

45. Relative Value Equity Valuation Approaches 21
46. Financial Statement Forecasting in Equity Valuation 21
47. Industry and Competitive Analysis 22
48. Company Analysis: Past, Present, and Future 22
49. Equity Analyst Research Reports 23
50. The Capital Asset Pricing Model, Market Model, and Other Factor-Based Equity Models 23
Fixed Income 24
54. Fixed-Income Markets for Corporate Issuers 24
56. Fixed-Income Bond Valuation: Prices and Yields 24
57. Yield and Yield Spread Measures for Fixed-Rate Bonds 24
58. Yield and Yield Spread Measures for Floating-Rate Instruments 25
59. The Term Structure of Interest Rates: Spot, Par, and Forward Curves 25
60. Interest Rate Risk and Return 25
61. Yield-Based Bond Duration Measures and Properties 26
62. Yield-Based Bond Convexity and Portfolio Properties 26
63. Curve-Based and Empirical Fixed-Income Risk Measures 26
64. Credit Risk 27
69. Mortgage-Backed Security (MBS) Instrument and Market Features 27
Derivatives 28
70. Derivative Instrument and Derivative Market Features 28
71. Forward Commitment and Contingent Claim Features and Instruments 28
72. Derivative Benefits, Risks, and Issuer and Investor Uses 28
73. Arbitrage, Replication, and the Cost of Carry in Pricing Derivatives 28
74. Pricing and Valuation of Forward Contracts and for an Underlying With Varying Maturities 28
75. Pricing and Valuation of Futures Contracts 29
76. Pricing and Valuation of Interest Rates and Other Swaps 29
77. Pricing and Valuation of Options 29
78. Option Replication Using Put-Call Parity 29
79. Valuing a Derivative Using a One-Period Binomial Model 30
Alternative Investments 31
80. Alternative Investment Features, Methods, and Structures 31
81. Alternative Investment Performance and Returns 31
84. Natural Resources 31
85. Hedge Funds 31
Portfolio Construction 32
87. Portfolio Risk and Return: Part I 32
88. Portfolio Risk and Return: Part II 32
89. Portfolio Management: An Overview 33
Keep going at credguild.com 34

Every formula in the CredGuild notes for the 2027 CFA® Program Level I curriculum, reading by reading, each with what it is for. Worked numbers are left out. Use it for a last check of the equations; the notes explain where each one comes from. One topic has no formulas and is not listed.

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CFA® PROGRAM LEVEL I · FORMULA SHEET

Quantitative Methods

Exam weight 11–14% · 10 readings · 133 formulas

1 Returns of Financial Assets and Instruments

Return over a single period	$\text{Price return} = \frac{P_1 - P_0}{P_0}$ $\text{Capital distribution return} = \frac{D}{P_0}$ $\text{Total (holding period) return} = \frac{P_1 - P_0 + D}{P_0} = \text{price return} + \text{capital distribution return}$
Averaging returns over several periods	$\bar{R}_{\text{arith}} = \frac{R_1 + R_2 + \cdots + R_n}{n}$ $R_{\text{geo}} = \left[(1+R_1)(1+R_2)\cdots(1+R_n)\right]^{1/n} - 1$
Annualizing a holding period return	$\text{Annualized return} = (1 + HPR)^{365/\text{days}} - 1$ $(1 + R_{\text{period}})^{c} - 1$
Compounding frequency and continuous compounding	$\text{Effective annual rate} = \left(1 + \frac{r_s}{m}\right)^{m} - 1$ $PV = \frac{FV}{(1 + r_s/m)^{m}} \text{ (one year ahead)}$ $r_{cc} = \ln(1 + HPR)$ $HPR = e^{r_{cc}} - 1$
Building blocks of a required return	$\text{Required return} = \underbrace{\text{real risk-free rate} + \text{expected inflation}}_{\text{nominal risk-free rate}} + \text{risk premium(s)}$
Real return	$1 + r_{\text{real}} = \frac{1 + r_{\text{nominal}}}{1 + \pi}$ $\pi = \frac{1 + r_{\text{nominal}}}{1 + r_{\text{real}}} - 1$
Pretax vs. after-tax nominal return	$r_{\text{after-tax}} = \text{price return} \times (1 - t_{cg}) + \text{distribution return} \times (1 - t_d)$
Leveraged return	$r_L = \frac{r_P(V_E + V_D) - r_D V_D}{V_E} = r_P + \frac{V_D}{V_E}(r_P - r_D)$

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2 Types of Financial Returns

Two sources of return	$\text{Total return} = \text{capital appreciation return} + \text{capital distribution return}$
Interest rates and the risk-free rate	$HPR = \frac{\text{Face value} - \text{Price}}{\text{Price}}$ $r_{\text{annual}} = (1 + HPR)^{365/t} - 1$
Foreign exchange rates	$1 + r_{\text{domestic}} = (1 + r_{\text{local}})(1 + r_{FX})$
The risk-return tradeoff	$\text{short-term government bills} < \text{government bonds} < \text{corporate bonds} < \text{large-cap equities} < \text{small-cap equities}$
Portfolio expected return	$E(R_p) = \sum_i w_i E(R_i)$ $\text{total return} = \text{capital appreciation return} + \text{capital distribution return}$

3 Benchmarking Returns

Money-weighted rate of return (MWR)	$\sum_{t=0}^{T} \frac{CF_t}{(1 + MWR)^t} = 0$
Time-weighted rate of return (TWR)	$HPR_i = \frac{V_{end,i} - V_{begin,i} + D_i}{V_{begin,i}}$ $TWR_{annual} = [(1 + HPR_1)(1 + HPR_2) \cdots (1 + HPR_n)]^{1/\text{years}} - 1$
What an index is and how its return is measured	$R_{\text{period}} = (1 + R_1)(1 + R_2) \cdots (1 + R_n) - 1$ $V_n = V_0(1 + R_1)(1 + R_2) \cdots (1 + R_n)$
Price-weighted index	$\text{Index} = \frac{\sum P_i}{D}$ $w_i = \frac{P_i}{\sum P_j}$
Market-capitalization-weighted (value-weighted) index	$w_i = \frac{P_i N_i}{\sum P_j N_j}$ $\text{Index} = \frac{\sum P_i N_i}{D}, \quad D = \frac{\text{base-period market cap}}{\text{base value}}$

4 The Time Value of Money in Finance

The time value of money	$FV = PV(1 + r)^t$ $PV = \frac{FV}{(1 + r)^t}$
Fixed-coupon bonds	$P = \sum_{t=1}^{N} \frac{C}{(1 + YTM)^t} + \frac{F}{(1 + YTM)^N}$

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Perpetual bonds	$PV_{\text{perpetuity}} = \dfrac{PMT}{r}$
Amortizing bonds and annuities	$PV_{\text{annuity}} = PMT \times \dfrac{1-(1+r)^{-N}}{r}$ $PMT = \dfrac{r \times PV}{1-(1+r)^{-N}}$
Equity instruments	$V_{\text{preferred}} = \dfrac{D_p}{r_p}$ $V_0 = \dfrac{D_1}{r_e - g_c}$ $D_1 = D_0(1+g_c)$
Zero-coupon bond	$r = \left(\dfrac{FV}{PV}\right)^{1/N} - 1$
Equity: implied required return	$r_e = \dfrac{D_1}{P_0} + g_c = \text{dividend yield} + \text{constant growth rate}$
Equity: implied growth rate	$g_c = r_e - \dfrac{D_1}{P_0} = \text{required return} - \text{dividend yield}$
Forward interest rates	$(1+S_2)^2 = (1+S_1)(1+1y1y) \quad \Rightarrow \quad 1y1y = \dfrac{(1+S_2)^2}{1+S_1} - 1$ $(1+S_3)^3 = (1+S_1)(1+1y1y)(1+2y1y)$
Forward exchange rates	$\dfrac{\text{Forward}}{\text{Spot}} = \dfrac{(1+r_{\text{price}})^T}{(1+r_{\text{base}})^T}$ $\dfrac{\text{Forward}}{\text{Spot}} = \dfrac{1+r_{\text{price, period}}}{1+r_{\text{base, period}}}$
Option values: one-period binomial model	$h = \dfrac{c_u - c_d}{S_u - S_d}$

5 Statistical Characteristics of Asset Returns

Population vs. sample	$\text{Sample mean: } \bar{X} = \dfrac{\sum_{i=1}^{n} X_i}{n}$ $\text{Population mean: } \mu = \dfrac{\sum_{i=1}^{N} X_i}{N}$
Range and mean absolute deviation	$\text{range} = \text{maximum value} - \text{minimum value}$ $\text{MAD} = \dfrac{\sum_{i=1}^{n} \lvert X_i - \bar{X} \rvert}{n}$
Skewness	$\text{skewness} = \dfrac{1}{n}\sum_{i=1}^{n}\left(\dfrac{X_i - \bar{X}}{s}\right)^3$

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Kurtosis	$\text{kurtosis} = \frac{1}{n}\sum_{i=1}^{n}\left(\frac{X_i - \bar{X}}{s}\right)^4$ $\text{excess kurtosis} = \text{kurtosis} - 3$
Covariance	$\text{Cov}_{XY} = \frac{\sum_{i=1}^{n}(X_i - \bar{X})(Y_i - \bar{Y})}{n-1} \quad \text{(sample)}$
Correlation	$\rho_{XY} = \frac{\text{Cov}_{XY}}{s_X s_Y}$ $\text{Cov}_{XY} = \rho_{XY}\, s_X\, s_Y$
Semivariance and target downside deviation	$\sigma^2_{\text{semi}} = \frac{\sum_{X_i<\bar{X}}(X_i - \bar{X})^2}{n}$ $s_{\text{target}} = \sqrt{\frac{\sum_{X_i<B}(X_i - B)^2}{n-1}}$
Coefficient of variation	$CV = \frac{s}{\bar{X}}$ $\left(\text{or } \frac{\sigma}{\mu}\right)$

6 Statistical Distributions for Financial Asset Prices and Returns

Cumulative distribution function (CDF)	$F(x) = P(X \le x)$ $P(a < X \le b) = F(b) - F(a)$
Unconditional expected value (mean)	$E(X) = \sum_{i=1}^{n} P(x_i)\, x_i$
Unconditional variance and standard deviation	$\sigma^2(X) = \sum_{i=1}^{n} P(x_i)\,[x_i - E(X)]^2$ $\sigma(X) = \sqrt{\sigma^2(X)}$
Unconditional covariance	$\text{Cov}(X,Y) = \sum_{i=1}^{n} P(x_i, y_i)\,[x_i - E(X)]\,[y_i - E(Y)]$
Discrete distributions	$E(X) = np$ $\sigma^2(X) = np(1-p)$ $P(k \text{ events in interval } t) = \frac{(\lambda t)^k e^{-\lambda t}}{k!}$ $\text{mean} = \text{variance} = \lambda \text{ (for one unit of time, } t = 1)$

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Continuous distributions	$P(x_1 \le X \le x_2) = \dfrac{x_2 - x_1}{b - a}$ $\text{mean} = \dfrac{a + b}{2}$ $\sigma^2 = \dfrac{(b - a)^2}{12}$
Conditional mean, variance and covariance	$E(X \mid S) = \sum_i P(x_i \mid S)\, x_i$ $\text{Var}(X \mid S) = \sum_i P(x_i \mid S)\,[x_i - E(X \mid S)]^2 = E(X^2 \mid S) - [E(X \mid S)]^2$
Updating probabilities with Bayes' formula	$P(E \mid I) = \dfrac{P(I \mid E)}{P(I)} \times P(E) = \dfrac{P(I \mid E)\,P(E)}{P(I \mid E)P(E) + P(I \mid E^c)P(E^c)}$

7 Estimation and Hypothesis Testing

The central limit theorem (CLT)	$\bar{X} \dot{\sim} N\left(\mu,\ \dfrac{\sigma^2}{n}\right)$ for large n (rule of thumb: $n \ge 30$)
Standard error and sampling error	$\sigma_{\bar{X}} = \dfrac{\sigma}{\sqrt{n}}$ (σ known) $s_{\bar{X}} = \dfrac{s}{\sqrt{n}}$ (σ unknown, the usual case)
Confidence intervals	$\text{point estimate} \pm \underbrace{(\text{reliability factor} \times \text{standard error})}_{\text{margin of error}}$
Value at risk (VaR) — a one-tailed interval	$\text{VaR}_\alpha = z_\alpha \times \sigma \times \text{portfolio value}$
Test statistic for a mean	$\text{test statistic} = \dfrac{\bar{X} - \mu_0}{s/\sqrt{n}}$ (use $\sigma/\sqrt{n}$ if σ is known)
Spearman rank correlation test	$r_s = 1 - \dfrac{6 \sum d_i^2}{n(n^2 - 1)}$
Test of independence using a contingency table	$E_{i,j} = \dfrac{(\text{total for row } i) \times (\text{total for column } j)}{\text{total number of observations}}$ $\chi^2 = \sum_i \sum_j \dfrac{(O_{i,j} - E_{i,j})^2}{E_{i,j}}$ $\text{df} = (r - 1)(c - 1)$

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8 The Return and Risk of a Financial Portfolio

Expected return of a portfolio	$E(R_P) = \sum_{i=1}^{N} w_i \, E(R_i)$ $\sum_{i=1}^{N} w_i = 1$ $R_{P,t} = \sum_{i=1}^{N} w_{i,t-1} \, R_{i,t}$
Portfolio variance	$\sigma_P^2 = \sum_{i=1}^{N} \sum_{j=1}^{N} w_i w_j \, \mathrm{Cov}(R_i, R_j)$ $\sigma_P^2 = w_1^2 \sigma_1^2 + w_2^2 \sigma_2^2 + 2 w_1 w_2 \, \mathrm{Cov}_{1,2}$ $\sigma_P = \sqrt{\sigma_P^2}$
Covariance and correlation	$\mathrm{Cov}_{1,2} = \rho_{1,2} \, \sigma_1 \, \sigma_2 \quad \Longrightarrow \quad \sigma_P^2 = w_1^2 \sigma_1^2 + w_2^2 \sigma_2^2 + 2 w_1 w_2 \rho_{1,2} \sigma_1 \sigma_2$
More assets: the variance–covariance matrix	$\text{number of unique covariances} = \dfrac{N^2 - N}{2}$ $\sigma_P^2 = \sum_{i=1}^{N} \sum_{j=1}^{N} w_i w_j \rho_{i,j} \sigma_i \sigma_j$ $\rho_{i,i} = 1$
Large portfolios: variance approaches average covariance	$\sigma_P^2 = \dfrac{\bar{\sigma}^2}{N} + \dfrac{N-1}{N} \overline{\mathrm{Cov}}$ $\sigma_P^2 \approx \bar{\rho} \, \bar{\sigma}^2$
Minimum-variance portfolio of two risky assets	$w_A = \dfrac{\sigma_B^2 - \mathrm{Cov}_{A,B}}{\sigma_A^2 + \sigma_B^2 - 2 \, \mathrm{Cov}_{A,B}}$ $w_B = 1 - w_A$
Adding a risk-free asset	$\text{Sharpe ratio} = \dfrac{E(R_P) - R_f}{\sigma_P}$ $E(R_C) = w_P E(R_P) + (1 - w_P) R_f$ $\sigma_C = w_P \, \sigma_P$ $w_P = \dfrac{r_{\text{target}} - R_f}{E(R_P) - R_f}$
Utility function	$U = E(r) - \frac{1}{2} A \sigma^2$
The capital allocation line (CAL)	$E(R_C) = R_f + \left[\dfrac{E(R_P) - R_f}{\sigma_P} \right] \sigma_C$
The capital market line (CML)	$E(R_P) = R_f + \left[\dfrac{E(R_M) - R_f}{\sigma_M} \right] \sigma_P$

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Return-generating models and the CAPM	$E(R_i) = R_f + \beta_i \left[E(R_M) - R_f\right]$
Beta	$\beta_i = \dfrac{\text{Cov}(R_i, R_M)}{\sigma_M^2} = \dfrac{\rho_{i,M}\,\sigma_i\,\sigma_M}{\sigma_M^2} = \dfrac{\rho_{i,M}\,\sigma_i}{\sigma_M}$

9 Simulation of Financial Asset Prices and Returns

Multivariate simulation and the Cholesky decomposition	$X_1 = \sigma_1 Z_1$ $X_2 = \sigma_2 \left(\rho Z_1 + \sqrt{1-\rho^2}\, Z_2\right)$

10 Applications of Simple Linear Regression in Finance

The model and the regression line	$Y_i = b_0 + b_1 X_i + \varepsilon_i \quad \text{(population model)}$ $\hat{Y}_i = \hat{b}_0 + \hat{b}_1 X_i \quad \text{(estimated regression line, the line of best fit)}$
Least squares criterion	$\text{SSE} = \sum_{i=1}^{n} (Y_i - \hat{Y}_i)^2$ $\hat{b}_1 = \dfrac{\text{Cov}(X, Y)}{\sigma_X^2}$ $\hat{b}_0 = \bar{Y} - \hat{b}_1 \bar{X}$
Analysis of variance (ANOVA)	$\text{SST} = \text{SSR} + \text{SSE}$
Goodness-of-fit measures	$\text{SEE} = \sqrt{\text{MSE}} = \sqrt{\dfrac{\text{SSE}}{n-2}}$ $R^2 = \dfrac{\text{SSR}}{\text{SST}} = 1 - \dfrac{\text{SSE}}{\text{SST}}$
F-test	$F = \dfrac{\text{MSR}}{\text{MSE}}$ $df = 1 \text{ (numerator)},\ n-2 \text{ (denominator)}$
t-test of a regression coefficient	$t = \dfrac{\hat{b}_1 - b_1}{s_{\hat{b}_1}}$ $df = n - 2$
Predicted values	$\hat{Y} = \hat{b}_0 + \hat{b}_1 X_p$
Confidence (prediction) interval for a predicted value	$\hat{Y} \pm t_c\, s_f$ $df = n - 2$ $s_f^2 = \text{SEE}^2 \left[1 + \dfrac{1}{n} + \dfrac{(X_p - \bar{X})^2}{(n-1)s_X^2}\right]$

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$$E(R_i) = R_f + \beta_i \left[E(R_M) - R_f\right]$$

The CAPM as a one-factor regression

$$Z_{i,t} = b_0 + b_1 Z_{M,t} + \varepsilon_t$$

$$Z_{i,t} = R_{i,t} - R_{f,t}, \quad Z_{M,t} = R_{M,t} - R_{f,t}$$

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CFA® PROGRAM LEVEL I · FORMULA SHEET

Economics

Exam weight 6–9% · 6 readings · 23 formulas

12 The Firm and Market Structures

The two concentration measures

$$\text{N-firm concentration ratio} = \sum_{i=1}^{N} s_i$$

$$\text{HHI} = \sum_{i=1}^{N} s_i^2$$

14 Fiscal Policy

Fiscal policy tools: spending and revenue, advantages and disadvantages

$$\text{fiscal multiplier} = \frac{1}{1 - MPC(1-t)}$$

$$\Delta AD_{\text{tax}} = -\Delta T \times MPC \times \text{fiscal multiplier}$$

15 Monetary Policy

Effective central banks, targeting regimes and limits of policy

$$\text{neutral interest rate} = \text{real trend rate of economic growth} + \text{inflation target}$$

17 International Trade

Tariff welfare formulas (small country)

$$\text{Loss of consumer surplus} = \frac{Q_{D,0} + Q_{D,1}}{2}\Delta P$$

$$\text{Gain in producer surplus} = \frac{Q_{S,0} + Q_{S,1}}{2}\Delta P$$

$$\text{Tariff revenue} = M_1 \Delta P = (Q_{D,1} - Q_{S,1})\Delta P$$

$$\begin{aligned}\text{Deadweight loss} &= \text{consumer surplus loss} - \text{producer surplus gain} - \text{t}\\ &= \frac{1}{2}(Q_{S,1} - Q_{S,0})\Delta P + \frac{1}{2}(Q_{D,0} - Q_{D,1})\Delta P\end{aligned}$$

18 Capital Flows and the FX Market

Nominal and real exchange rates

$$\text{real P/B rate} = \text{nominal P/B rate} \times \frac{CPI_{\text{base currency}}}{CPI_{\text{price currency}}}$$

Percentage change in a currency's value

$$\%\Delta \text{ base} = \frac{\text{new P/B}}{\text{old P/B}} - 1$$

$$\%\Delta \text{ price} = \frac{1/\text{new P/B}}{1/\text{old P/B}} - 1 = \frac{\text{old P/B}}{\text{new P/B}} - 1$$

Exchange rates, trade and capital flows

$$(X - M) \equiv (S - I) + (T - G)$$

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19 Exchange Rate Calculations

Currency cross-rates	$\frac{A}{C} = \frac{A}{B} \times \frac{B}{C}$
The no-arbitrage (interest rate parity) relation	$(1 + r_d) = \frac{1}{S_{d/f}} (1 + r_f) F_{d/f}$ $\frac{F_{d/f}}{S_{d/f}} = \frac{1 + r_d}{1 + r_f}$ $F_{d/f} = S_{d/f} \frac{1 + r_d}{1 + r_f}$ $S_{d/f} = F_{d/f} \frac{1 + r_f}{1 + r_d}$ $\frac{F_{d/f}}{S_{d/f}} - 1 = \frac{r_d - r_f}{1 + r_f} \approx r_d - r_f$ $F = S \times \frac{1 + r_{\text{price}} (\text{days}/360)}{1 + r_{\text{base}} (\text{days}/360)}$
Forward quotes in points or percentages	$F = S + (\text{points} \times \text{point size})$ $F = S \times (1 + \text{percentage})$
Forward premium or discount	$\text{forward premium } (+) \text{ or discount } (\text{-}) = \frac{F}{S} - 1$

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Corporate Finance

Exam weight 6–9% · 4 readings · 18 formulas

20 Organizational Forms, Corporate Issuer Features, and Ownership

Key features of corporate issuers	$\text{effective tax rate on distributed profit} = t_c + t_d(1 - t_c)$
Public versus private companies	$\text{free float (\%)} = \frac{\text{shares outstanding} - \text{shares held by insiders, strategic investors and s}}{\text{shares outstanding}}$

23 Working Capital and Liquidity

The cash conversion cycle	$\text{CCC} = \text{DOH} + \text{DSO} - \text{DPO}$
Trade credit and its cost	$\text{EAR of supplier financing} = \left(1 + \frac{a}{1-a}\right)^{365/(c-b)} - 1$
Comparing CCCs	$\text{total working capital} = \text{current assets} - \text{current liabilities}$ $\text{net working capital} = (\text{current assets} - \text{cash and marketable securities}) - (\text{current liabilities} - \text{short-term and current debt})$
Liquidity ratios	$\text{current ratio} = \frac{\text{current assets}}{\text{current liabilities}}$ $\text{quick ratio} = \frac{\text{cash and marketable securities} + \text{receivables}}{\text{current liabilities}}$ $\text{cash ratio} = \frac{\text{cash and marketable securities}}{\text{current liabilities}}$

24 Capital Investments and Capital Allocation

Net present value (NPV)	$NPV = CF_0 + \frac{CF_1}{(1+r)^1} + \frac{CF_2}{(1+r)^2} + \cdots + \frac{CF_n}{(1+r)^n} = \sum_{t=0}^{n} \frac{CF_t}{(1+r)^t}$
Internal rate of return (IRR)	$0 = \sum_{t=0}^{n} \frac{CF_t}{(1+IRR)^t}$
Return on invested capital (ROIC)	$ROIC = \frac{\text{NOPAT}}{\text{average book value of invested capital}} = \underbrace{\frac{\text{NOPAT}}{\text{Sales}}}_{\text{operating margin after tax}} \times \underbrace{\frac{\text{Sales}}{\text{average invested capital}}}_{\text{capital turnover}}$
Real options	$\text{Project value} = NPV_{\text{without options}} + \text{value of options} - \text{cost of options}$

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25 Capital Structure

Calculating and interpreting the WACC	$WACC = w_d\, r_d(1-t) + w_e\, r_e$
MM Proposition II (no taxes): cost of equity and leverage	$r_e = r_0 + \frac{D}{E}(r_0 - r_d)$
MM with taxes	$V_L = V_U + tD$ $r_e = r_0 + \frac{D}{E}(r_0 - r_d)(1-t)$
Static trade-off theory	$V_L = V_U + tD - PV(\text{costs of financial distress})$

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CFA® PROGRAM LEVEL I · FORMULA SHEET

Financial Statement Analysis

Exam weight 11–14% · 10 readings · 95 formulas

28 Analyzing Income Statements

Revenue over time (long-term contracts)	$\text{Cumulative revenue}_t = \dfrac{\text{Cumulative cost to date}}{\text{Total expected cost}} \times \text{Transaction price}$
Depreciation methods	$\text{Straight-line} = \dfrac{\text{Cost} - \text{Salvage}}{\text{Useful life}}$
Capitalized interest	$\text{Adjusted coverage} = \dfrac{\text{EBIT} + \text{Depreciation of capitalized interest}}{\text{Interest expense} + \text{Interest capitalized}}$
Basic EPS	$\text{Basic EPS} = \dfrac{\text{Net income} - \text{Preferred dividends}}{\text{Weighted average number of common shares outstanding}}$
Diluted EPS and the if-converted method	$\text{Diluted EPS} = \dfrac{\text{NI} - \text{Pref. div.} + \text{Conv. pref. div.} + \text{Conv. debt int}}{\text{Wtd. avg. shares} + \text{Shares from conv. pref.} + \text{Shares from conv. debt}}$ $\text{Incremental shares} = N - \dfrac{N \times X}{\bar{P}} = \dfrac{\bar{P} - X}{\bar{P}} \times N$
Testing for dilution	$\text{Conv. preferred: } \dfrac{\text{Preferred dividends}}{\text{Shares on conversion}}$ $\text{Conv. bonds: } \dfrac{\text{Interest} \times (1 - t)}{\text{Shares on conversion}}$
Vertical common-size income statement	$\text{Common-size line item} = \dfrac{\text{Line item}}{\text{Revenue}}$ $\text{Effective tax rate} = \dfrac{\text{Income tax expense}}{\text{Pretax income}}$
Margin ratios	$\text{Gross profit margin} = \dfrac{\text{Revenue} - \text{COGS}}{\text{Revenue}}$ $\text{Operating profit margin} = \dfrac{\text{Operating profit (EBIT)}}{\text{Revenue}}$ $\text{Pretax margin} = \dfrac{\text{Earnings before tax}}{\text{Revenue}}$ $\text{Net profit margin} = \dfrac{\text{Net income}}{\text{Revenue}}$

29 Analyzing Balance Sheets

Goodwill	$\text{Goodwill} = \text{purchase price} - \text{fair value of identifiable net assets acquired}$

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Vertical common-size balance sheet	$\text{Common-size item} = \frac{\text{balance sheet item}}{\text{total assets}}$
Liquidity ratios (short-term obligations)	$\text{current ratio} = \frac{\text{current assets}}{\text{current liabilities}}$ $\text{quick ratio} = \frac{\text{cash} + \text{marketable securities} + \text{receivables}}{\text{current liabilities}}$ $\text{cash ratio} = \frac{\text{cash} + \text{marketable securities}}{\text{current liabilities}}$
Solvency ratios (long-term obligations)	$\text{long-term debt-to-equity} = \frac{\text{long-term debt}}{\text{total equity}}$ $\text{total debt-to-equity} = \frac{\text{total debt}}{\text{total equity}}$ $\text{debt ratio} = \frac{\text{total debt}}{\text{total assets}}$ $\text{financial leverage ratio} = \frac{\text{total assets}}{\text{total equity}}$

30 Analyzing Statements of Cash Flows I

Why a separate cash flow statement?	$\text{CFO} + \text{CFI} + \text{CFF} = \Delta\text{Cash}; \quad \text{Beginning cash} + \Delta\text{Cash} = \text{Ending cash}$
Timing differences show up on the balance sheet	$\text{Beginning AR} + \text{Sales} - \text{Cash collected} = \text{Ending AR}$
The direct method	$\text{Cash collected} = \text{Net sales} - \Delta\text{AR} + \Delta\text{Unearned revenue}$ $\text{Purchases} = \text{COGS} + \text{Ending inventory} - \text{Beginning inventory} = \text{COGS} + \Delta\text{Inventory}$ $\text{Cash paid to suppliers} = \text{Purchases} - \Delta\text{AP} = \text{COGS} + \Delta\text{Inventory} - \Delta\text{AP}$ $\text{Cash paid for wages} = \text{Wage expense} - \Delta\text{Wages payable}$ $\text{Cash paid for interest} = \text{Interest expense} - \Delta\text{Interest payable}$ $\text{Cash paid for insurance} = \text{Insurance expense} + \Delta\text{Prepaid insurance}$ $\text{Cash taxes paid} = \text{Tax expense} - \Delta\text{Taxes payable} - \Delta\text{Deferred tax liability} + \Delta\text{Deferred tax asset}$
Starting point: net income	$\text{CFO} = \text{NI} + \text{NCC} - \text{WC}_{\text{INV}}$
Investing activities (CFI)	$\text{Proceeds} = \text{Carrying value of asset sold} + \text{Gain (or} - \text{Loss)}$ $\text{Gross cost of disposals} = \text{Beginning gross PP\&E} + \text{Purchases} - \text{Ending gross PP\&E}$ $\text{Accumulated depreciation removed} = \text{Beginning AD} + \text{Depreciation expense} - \text{Ending AD}$ $\text{Carrying value disposed} = \text{Beginning net PP\&E} - \text{Depreciation} + \text{Purchases} - \text{Ending net PP\&E}$

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Financing activities (CFF)	$\text{CFF} = (\text{New borrowing} - \text{Principal repaid}) + (\text{Stock issued} - \text{Stock repurchased}) - \text{Cash dividends paid}$ $\text{Dividends declared} = \text{Beginning retained earnings} + \text{Net income} - \text{Ending retained earnings}$ $\text{Dividends paid} = \text{Dividends declared} - \Delta\text{Dividends payable}$

31 Analyzing Statements of Cash Flows II

Free cash flow to the firm (FCFF)	$FCFF = NI + NCC + [Int \times (1 - t)] - FC_{INV} - WC_{INV}$ $FCFF = CFO + [Int \times (1 - t)] - FC_{INV}$
Free cash flow to equity (FCFE)	$FCFE = CFO - FC_{INV} + \text{net borrowing}$ $FCFE = FCFF - [Int \times (1 - t)] + \text{net borrowing}$

32 Analysis of Inventories

Inventory ratios	$\text{Inventory turnover} = \dfrac{\text{COGS}}{\text{average inventory}}$ $\text{Days of inventory on hand (DOH)} = \dfrac{365}{\text{inventory turnover}}$

33 Analysis of Long-Term Assets

Goodwill	$\text{Goodwill} = \text{Purchase price} - \text{Fair value of identifiable net assets acquired}$
Impairment of assets held for use: IFRS and US GAAP	$\text{IFRS loss} = CV - \max(\text{FV} - \text{costs to sell},\ \text{VIU})$ $\text{US GAAP loss} = CV - \text{FV}\ \ (\text{only if } CV > \text{undiscounted CF})$
Ratios built from the disclosures	$\text{Fixed asset turnover} = \dfrac{\text{Revenue}}{\text{Average fixed assets}}$ $\text{Average age} \approx \dfrac{\text{Accumulated depreciation}}{\text{Annual depreciation expense}}$ $\text{Total useful life} \approx \dfrac{\text{Gross (historical cost) PP\&E}}{\text{Annual depreciation expense}}$ $\text{Remaining useful life} \approx \dfrac{\text{Net PP\&E}}{\text{Annual depreciation expense}} = \text{Total useful life} - \text{Average age}$

34 Topics in Long-Term Liabilities and Equity

Lessee accounting	$\text{Lease liability}_0 = \sum_{t=1}^{N} \dfrac{PMT}{(1+r)^t} = PMT \times \dfrac{1 - (1+r)^{-N}}{r}$
Defined contribution vs. defined benefit plans	$\text{Funded status} = \text{Fair value of plan assets} - \text{PV of the defined benefit obligation}$

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35 Analysis of Income Taxes

The income tax expense equation	$\text{income tax expense} = \text{taxes payable} + \Delta DTL - \Delta DTA$

36 Financial Reporting Quality

Depreciation, amortization and impairment	$\text{Annual depreciation (straight-line)} = \dfrac{\text{cost} - \text{salvage value}}{\text{useful life}}$
Linking the signs to what is being manipulated	$\text{Days payables} = \dfrac{\text{accounts payable}}{\text{COGS (or purchases)}/365}$
Cash flow versus earnings	$\text{CFO-to-net-income ratio} = \dfrac{\text{cash flow from operations}}{\text{net income}}$

37 Financial Analysis Techniques

Activity ratios	$\text{receivables turnover} = \dfrac{\text{revenue}}{\text{average receivables}}$
	$\text{days of sales outstanding (DSO)} = \dfrac{365}{\text{receivables turnover}}$
	$\text{inventory turnover} = \dfrac{\text{cost of goods sold}}{\text{average inventory}}$
	$\text{days of inventory on hand (DOH)} = \dfrac{365}{\text{inventory turnover}}$
	$\text{payables turnover} = \dfrac{\text{cost of goods sold}}{\text{average trade payables}}$
	$\text{number of days of payables (DPO)} = \dfrac{365}{\text{payables turnover}}$
	$\text{purchases} = \text{ending inventory} - \text{beginning inventory} + \text{COGS}$
	$\text{total asset turnover} = \dfrac{\text{revenue}}{\text{average total assets}}$
	$\text{fixed asset turnover} = \dfrac{\text{revenue}}{\text{average net fixed assets}}$
	$\text{working capital turnover} = \dfrac{\text{revenue}}{\text{average working capital}}$

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Liquidity ratios	$\text{current ratio} = \frac{\text{current assets}}{\text{current liabilities}}$
	$\text{quick ratio} = \frac{\text{cash} + \text{marketable securities} + \text{receivables}}{\text{current liabilities}}$
	$\text{cash ratio} = \frac{\text{cash} + \text{marketable securities}}{\text{current liabilities}}$
	$\text{defensive interval} = \frac{\text{cash} + \text{marketable securities} + \text{receivables}}{\text{average daily expenditures}}$
	$\text{average daily expenditures} = \frac{\text{COGS} + \text{SG\&A} + \text{R\&D} - \text{noncash charges (e.g., depreciation, amort}}{365}$
	$\text{cash conversion cycle} = \text{DSO} + \text{DOH} - \text{number of days of payables}$
Solvency ratios	$\text{debt-to-equity} = \frac{\text{total debt}}{\text{total shareholders' equity}}$
	$\text{debt-to-capital} = \frac{\text{total debt}}{\text{total debt} + \text{total shareholders' equity}}$
	$\text{debt-to-assets} = \frac{\text{total debt}}{\text{total assets}}$
	$\text{financial leverage ratio} = \frac{\text{average total assets}}{\text{average total equity}}$
	$\text{interest coverage} = \frac{\text{EBIT}}{\text{interest payments}}$
	$\text{debt-to-EBITDA} = \frac{\text{total debt}}{\text{EBITDA}}$
	$\text{fixed charge coverage} = \frac{\text{EBIT} + \text{lease payments}}{\text{interest payments} + \text{lease payments}}$
Profitability ratios	$\text{gross profit margin} = \frac{\text{gross profit}}{\text{revenue}}$
	$\text{operating profit margin} = \frac{\text{operating income}}{\text{revenue}} \text{ or } \frac{\text{EBIT}}{\text{revenue}}$
	$\text{pretax margin} = \frac{\text{EBT}}{\text{revenue}}$
	$\text{net profit margin} = \frac{\text{net income}}{\text{revenue}}$
	$\text{ROA} = \frac{\text{net income}}{\text{average total assets}}$
	$\text{adjusted ROA} = \frac{\text{net income} + \text{interest expense}(1 - \text{tax rate})}{\text{average total assets}}$
	$\text{operating ROA} = \frac{\text{operating income (or EBIT)}}{\text{average total assets}}$
	$\text{ROE} = \frac{\text{net income}}{\text{average total equity}}$
	$\text{return on common equity} = \frac{\text{net income} - \text{preferred dividends}}{\text{average common equity}}$

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Two-part decomposition	$$\text{ROE} = \frac{\text{net income}}{\text{average total equity}} = \underbrace{\frac{\text{net income}}{\text{average total assets}}}_{\text{ROA}} \times \underbrace{\frac{\text{average total assets}}{\text{average total equity}}}_{\text{financial leverage}}$$
Original (three-part) DuPont equation	$$\text{ROE} = \underbrace{\frac{\text{net income}}{\text{revenue}}}_{\text{net profit margin}} \times \underbrace{\frac{\text{revenue}}{\text{average total assets}}}_{\text{total asset turnover}} \times \underbrace{\frac{\text{average total assets}}{\text{average total equity}}}_{\text{financial leverage}}$$
Extended (five-part) DuPont equation	$$\text{ROE} = \underbrace{\frac{\text{net income}}{\text{EBT}}}_{\text{tax burden}} \times \underbrace{\frac{\text{EBT}}{\text{EBIT}}}_{\text{interest burden}} \times \underbrace{\frac{\text{EBIT}}{\text{revenue}}}_{\text{EBIT margin}} \times \underbrace{\frac{\text{revenue}}{\text{average total assets}}}_{\text{total asset turnover}} \times \underbrace{\frac{\text{average total assets}}{\text{average total equity}}}_{\text{financial leverage}}$$
Business risk and the coefficient of variation	$$\text{CV} = \frac{\text{standard deviation of the item}}{\text{mean (expected value) of the item}}$$

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Equities

Exam weight 11–14% · 11 readings · 92 formulas

39 Equity Instrument Features

Preference shares (preferred stock)

$$\text{Annual preferred dividend} = \text{dividend rate} \times \text{par value}$$

41 Equity Issuance and Trading

Quotes and the spread

$$\text{bid-ask spread} = \text{lowest ask} - \text{highest bid}$$

$$\text{bid-ask spread}(\%) = \frac{\text{lowest ask} - \text{highest bid}}{\text{lowest ask}}$$

$$\text{mid-market price} = \frac{\text{lowest ask} + \text{highest bid}}{2}$$

VWAP

$$\text{VWAP} = \frac{\sum_i (\text{price}_i \times \text{volume}_i)}{\sum_i \text{volume}_i}$$

Float, trading volume and other liquidity measures

$$\text{market float} = \text{shares outstanding} - \text{restricted shares or shares not available for trading}$$

$$\text{average daily volume} = \frac{\sum_{i=1}^{n} (\text{shares traded on day } i)}{n}$$

$$\text{turnover ratio} = \frac{\text{average daily volume}}{\text{market float}}$$

42 Sources of Equity Returns

Price return and total return on equity

$$\text{price return} = \frac{P_1 - P_0}{P_0}$$

$$\text{total return} = \frac{P_1 - P_0 + D}{P_0}$$

Reinvested dividends

$$r_E = \frac{P_1 \left(1 + \frac{D}{P_{PD}}\right) - P_0}{P_0}$$

Equity value as a present value

$$P_0 = \frac{E(P_1) + E(D_1)}{1 + r_E}$$

43 Introduction to Equity Valuation

Book value, market capitalization and enterprise value

$$\text{book value} = \text{share capital} + \text{additional paid-in capital} + \text{retained earnings} + \text{accumulated other comprehensive income (and other reserves)} - \text{treasury stock}$$

$$\text{book value per share (BVPS)} = \frac{\text{book value of equity}}{\text{shares outstanding}}$$

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Limits of book value	$\text{P/B} = \dfrac{\text{market price per share}}{\text{BVPS}} = \dfrac{\text{market capitalization}}{\text{book value of equity}}$ $\text{EV} = \text{market value of common and preferred stock} + \text{market value of debt} - \text{cash and short-term investments}$

44 Discounted Cash Flow (DCF) and Growth Models

Cash flow measures for present value models and the valuation process	$V_0 = \sum_{t=1}^{n} \dfrac{E(CF_t)}{(1+r)^t} + \dfrac{E(TV_n)}{(1+r)^n}$
Free cash flow to equity	$FCFE = \text{net income} + \text{depreciation} - WCInv - CapEx + \text{net borrowing}$ $FCFE = CFO - FCInv + \text{net borrowing}$ $\text{net investment} = CapEx - \text{depreciation} + WCInv$ $FCFE = \text{net income} - \text{net investment} + \text{net borrowing}$ $\text{net borrowing} = DR \times \text{net investment}$ $FCFE = \text{net income} - \text{net investment} + DR \times \text{net investment} = \text{net income} - (1 - DR)(\text{net investment})$
Free cash flow to the firm	$FCFF = CFO - CapEx + \text{interest}(1-t)$ $FCFF = FCFE + \text{interest}(1-t) - \text{net borrowing}$
EBITDA	$FCFF = EBITDA(1-t) + (\text{depreciation} \times t) - FCInv - WCInv$
Residual income	$RI_t = EPS_t - r \times BVPS_{t-1}$
Constant growth (Gordon growth) model	$V_0 = \dfrac{D_1}{r-g} = \dfrac{D_0(1+g)}{r-g}$ $g = r - \dfrac{D_1}{P_0}$
Multistage (two-stage) models	$V_0 = \sum_{t=1}^{n} \dfrac{D_t}{(1+r)^t} + \dfrac{V_n}{(1+r)^n}$ $V_n = \dfrac{D_{n+1}}{r-g_L}$
Estimating the constant growth rate	$g = (1 - \text{dividend payout ratio}) \times ROE = b \times ROE$ $SGR_{FCFE} = \left(1 - \dfrac{FCFE}{\text{net income}}\right)\left(\dfrac{\text{net income}}{\text{beginning book value}}\right)$ $SGR_{FCFF} = \left(1 - \dfrac{FCFF}{NOPAT}\right)\left(\dfrac{NOPAT}{\text{beginning book value of total capital}}\right)$
Weighted average cost of capital	$WACC = \dfrac{MV_d}{MV_d + MV_e} r_d(1-t) + \dfrac{MV_e}{MV_d + MV_e} r_e$

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Non-callable, non-convertible preferred	$V_0 = \sum_{t=1}^{N} \frac{D_p}{(1+r_p)^t} + \frac{FV}{(1+r_p)^N}$ $V_0 = \frac{D_p}{r_p}$

45 Relative Value Equity Valuation Approaches

Method of forecasted fundamentals	$\frac{P_0}{E_1} = \frac{D_1/E_1}{r-g} = \frac{\text{payout ratio}}{r-g}$ $\frac{P_0}{B_0} = \frac{ROE-g}{r-g}$
Reconciling the two methods	$PEG = \frac{P/E}{g}$ (g in whole percentage points) $\widehat{P/B}_i = b_0 + b_1\, ROE_i + b_2\, g_i$
Value = assets in place + growth opportunities	$P_0 = \frac{E_1}{r} + PVGO$ $\frac{PVGO}{P_0} = 1 - \frac{E_1/P_0}{r}$
Price-to-sales (P/S)	$\frac{P_0}{S_0} = \frac{P_0}{E_0} \times \frac{E_0}{S_0} = \frac{\text{payout} \times (1+g)}{r-g} \times \text{profit margin}$
Enterprise value multiples	$EV = \text{market value of common and preferred stock} + \text{market value of debt} - \text{cash and short-term investments}$ $EV = \frac{FCFF_1}{WACC - g}$ $FCFF = EBITDA(1-t) + \text{Dep} \times t - \text{CapEx} - \text{WCInv}$
Balance-sheet multiples	$\frac{EV}{BV \text{ of capital}} = \frac{ROC \times (1 - \text{reinvestment rate})}{WACC - g}$
Cash-flow multiples and yields	$\frac{D_0}{P_0} = \frac{D_0}{E_0} \times \frac{E_0}{P_0}$ (payout × earnings yield) $\frac{D_0}{P_0} = \frac{r-g}{1+g}$
Using projected future values	$TV_n = \text{justified leading P/E}_n \times E_{n+1}$ $\text{justified leading P/E}_n = \frac{\text{payout}}{r-g}$

46 Financial Statement Forecasting in Equity Valuation

Revenue modeling	$g_{revenue} = g_{market} + \left(\frac{\text{new share}}{\text{old share}} - 1\right)$

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Expense (profit) modeling	$\Delta\text{Expense} = b_0 + b_1 \times \Delta\text{Revenue}$ $\text{COGS} = \text{forecast revenue} \times (1 - \text{gross margin})$
Financing modeling	$\text{financing needs} = \Delta\text{operating assets} - \Delta\text{non-debt liabilities} - \Delta\text{retained earnings}$
Start-up stage: venture capital arithmetic	$\text{ROI multiple} = (1+r)^n \quad \Longrightarrow \quad r = (\text{ROI multiple})^{1/n} - 1$ $\text{post-money value} = \dfrac{\text{expected revenue} \times (P/S)}{\text{ROI multiple}}$ $\text{pre-money value} = \text{post-money value} - \text{VC investment}$ $f = \dfrac{\text{VC investment}}{\text{post-money value}}$
Growth stage	$TV_n = NI_n \times P/E$ $V_0 = \dfrac{TV_n}{(1+r)^n}$ or $V_0 = \dfrac{TV_n}{\text{ROI multiple}}$
Decline stage	$\text{value} = P(\text{going concern}) \times \text{going-concern value} + P(\text{distress}) \times \text{distress sale value}$
Enterprise value and EV multiples	$\text{EV} = \text{market value of common and preferred stock} + \text{market value of debt} - \text{cash and short-term investments}$
Valuing equity from forecast model outputs	$SGR_{FCFF} = \left(1 - \dfrac{FCFF}{NOPAT}\right)\left(\dfrac{NOPAT}{\text{beginning book value of total capital}}\right)$

47 Industry and Competitive Analysis

Profitability	$\text{operating profit margin} = \dfrac{\text{operating income}}{\text{total revenue}}$ $\text{ROIC} = \dfrac{\text{NOPAT}_t}{\text{average invested capital}}$
Market share and concentration	$\text{market share} = \dfrac{\text{company sales}}{\text{industry size}}$ $HHI = \sum_{i=1}^{N} (\text{market share}_i)^2$

48 Company Analysis: Past, Present, and Future

Market potential for start-up and growth companies	$\text{Serviceable market} = \text{TAM} \times \text{technical fit (\%)} \times \text{geographic reach (\%)}$
Operating profitability	$\text{EBITDA} = \text{revenue} - \text{COGS} - \text{operating expenses (excluding D\&A)}$ $\text{EBIT} = \text{EBITDA} - \text{depreciation and amortization}$ $\text{Net income} = \text{EBIT} - \text{interest expense} - \text{taxes}$

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Operating leverage	$\text{Operating profit} = Q \times (P - VC) - FC$
Free cash flow to equity	$\text{FCFE} = \text{NI} + \text{D\&A} - \text{capital expenditures} - \Delta\text{working capital} + \text{net borrowing}$
Working capital management	$\text{CCC} = \text{DOH} + \text{DSO} - \text{DPO}$
Capital investments	$\text{Net capital expenditure} = \text{total capital expenditure} - \text{D\&A}$ $\text{ROIC} = \frac{\text{NOPAT}}{\text{average invested capital}}$ $\text{invested capital} \approx \text{total long-term liabilities} + \text{total equity}$
Capital structure	$\text{DFL} = \frac{\%\Delta \text{ net income}}{\%\Delta \text{ operating income}}$

49 Equity Analyst Research Reports

Two-stage FCFE valuation	$V_0 = \frac{FCFE_1}{1+r} + \frac{FCFE_2/(r-g)}{1+r}$

50 The Capital Asset Pricing Model, Market Model, and Other Factor-Based Equity Models

CAPM and the security market line	$E(R_i) = R_f + \beta_i\,[E(R_m) - R_f]$
Adjusted beta (mean reversion)	$\text{adjusted beta} = \omega \times \text{raw beta} + (1-\omega) \times 1.0$ ω commonly $2/3$
Beta from comparables (pure-play approach)	$\beta_U = \frac{\beta_{L,\text{peers}}}{1 + (1 - t_{\text{peers}})\,\frac{D}{E}_{\text{peers}}}$ $\beta_{L,\text{subject}} = \beta_U \left[1 + (1 - t_{\text{subject}})\,\frac{D}{E}_{\text{subject}}\right]$
Estimating the market risk premium	$E(R_m) = \frac{D_1}{P_0} + g$ $MRP = \frac{D_1}{P_0} + g - R_f$
Emerging markets: country risk premium	$CRP = \text{sovereign bond yield spread} \times \frac{\sigma_{\text{equity index}}}{\sigma_{\text{sovereign debt}}}$ $E(R_i) = R_f + \beta_i\,(MRP + CRP)$
Arbitrage pricing theory (APT)	$E(R_i) = R_f + \beta_{1i} f_1 + \beta_{2i} f_2 + \cdots + \beta_{ki} f_k$
The four-factor model	$E(R_i) = R_f + \beta_{mkt}\,[E(R_m) - R_f] + \beta_{SMB}\,E(SMB) + \beta_{HML}\,E(HML) + \beta_{UMD}\,E(UMD)$

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Fixed Income

Exam weight 11–14% · 11 readings · 62 formulas

54 Fixed-Income Markets for Corporate Issuers

Repurchase agreements

$$\text{purchase price} = \frac{\text{market value of collateral}}{\text{initial margin}}$$

$$\text{repurchase price} = \text{purchase price} \times \left(1 + \text{repo rate} \times \frac{\text{days}}{360}\right)$$

$$\text{haircut} = \frac{\text{market value} - \text{purchase price}}{\text{market value}} = 1 - \frac{1}{\text{initial margin}}$$

$$\text{variation margin} = \text{initial margin} \times \text{adjusted purchase price} - \text{market value of collateral}$$

56 Fixed-Income Bond Valuation: Prices and Yields

Price = present value of the promised cash flows

$$P = \frac{C}{(1+YTM)} + \frac{C}{(1+YTM)^2} + \cdots + \frac{C+FV}{(1+YTM)^N}$$

$$P = \sum_{t=1}^{2N} \frac{C/2}{(1+YTM/2)^t} + \frac{FV}{(1+YTM/2)^{2N}}$$

Accrued interest, flat price and full price

$$AI = \frac{t}{T} \times PMT$$

Matrix pricing

$$YTM_{target} = YTM_{short} + \frac{T_{target} - T_{short}}{T_{long} - T_{short}} (YTM_{long} - YTM_{short})$$

57 Yield and Yield Spread Measures for Fixed-Rate Bonds

Periodicity and the effective annual yield

$$EAY = \left(1 + \frac{\text{stated annual yield}}{n}\right)^n - 1$$

$$\text{stated yield}_m = m\left[(1+EAY)^{1/m} - 1\right]$$

Current yield and simple yield

$$\text{current yield} = \frac{\text{annual cash coupon}}{\text{flat price}}$$

$$\text{simple yield} = \frac{\text{annual coupon} \pm \text{straight-line amortization}}{\text{flat price}}$$

Option-adjusted price and option-adjusted yield

$$\text{callable bond value} = \text{straight bond value} - \text{call option value}$$

Z-spread

$$\text{price} = \sum_{t=1}^{N} \frac{CF_t}{(1+S_t+Z)^t}$$

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Option-adjusted spread (OAS)	$\text{OAS} = \text{Z-spread} - \text{option value (bp)}$ $\text{option value} = \text{Z-spread} - \text{OAS}$

58 Yield and Yield Spread Measures for Floating-Rate Instruments

Simplified valuation on a reset date	$V = \sum_{t=1}^{N} \frac{(\text{MRR} + \text{QM}) \times FV/m}{\left(1 + \frac{\text{MRR}+\text{DM}}{m}\right)^t} + \frac{FV}{\left(1 + \frac{\text{MRR}+\text{DM}}{m}\right)^N}$
Key formulas: money market yields	$\text{Add-on yield (365-day)} = HPY \times \frac{365}{\text{days}}$ $\text{Discount yield} = \frac{FV - P}{FV} \times \frac{360}{\text{days}}$ $P = FV \times \left(1 - \text{discount yield} \times \frac{\text{days}}{\text{year}}\right)$ $FV = PV \times \left(1 + \text{add-on yield} \times \frac{\text{days}}{\text{year}}\right)$
Comparing with a semiannual-pay bond	$EAY = (1 + HPY)^{365/\text{days}} - 1$ $\text{semiannual bond basis} = 2\left[(1 + EAY)^{1/2} - 1\right]$

59 The Term Structure of Interest Rates: Spot, Par, and Forward Curves

Pricing with spot rates	$P = \frac{PMT}{(1 + S_1)} + \frac{PMT}{(1 + S_2)^2} + \cdots + \frac{PMT + FV}{(1 + S_N)^N}$
Par rates	$100 = \frac{c}{1 + S_1} + \frac{c}{(1 + S_2)^2} + \cdots + \frac{c + 100}{(1 + S_N)^N} \Rightarrow c = \frac{100\left[1 - \frac{1}{(1+S_N)^N}\right]}{\sum_{t=1}^{N} \frac{1}{(1+S_t)^t}}$
Forward rates and notation	$(1 + S_3)^3 = (1 + S_1)(1 + {}_{1y1y})(1 + {}_{2y1y}) = (1 + S_2)^2(1 + {}_{2y1y})$ $S_N = \left[(1 + S_1)(1 + {}_{1y1y}) \cdots (1 + {}_{(N-1)y1y})\right]^{1/N} - 1$ ${}_{A\text{y}B\text{y}} = \left[\frac{(1 + S_{A+B})^{A+B}}{(1 + S_A)^A}\right]^{1/B} - 1$
Valuing a bond with forward rates	$P = \frac{PMT}{1 + S_1} + \frac{PMT}{(1 + S_1)(1 + {}_{1y1y})} + \frac{PMT + FV}{(1 + S_1)(1 + {}_{1y1y})(1 + {}_{2y1y})}$

60 Interest Rate Risk and Return

Horizon yield	$\text{Horizon yield} = \left(\frac{\text{sale price (or principal)} + \text{coupons} + \text{reinvestment income}}{\text{purchase price}}\right)^{1/H} - 1$
Holding period return, Macaulay duration and the investment horizon	$\text{Duration gap} = \text{Macaulay duration} - \text{investment horizon}$

Calculating and interpreting Macaulay duration	$\text{MacDur} = \sum_{t=1}^{N} t \times w_t$ $w_t = \frac{CF_t/(1+r)^t}{\text{full price}}$ $\sum_t w_t = 1$

61 Yield-Based Bond Duration Measures and Properties

Modified duration	$\text{ModDur} = \frac{\text{MacDur}}{1+r}$ (annual-pay: $r = \text{YTM}$) $\text{ModDur} = \frac{\text{MacDur}}{1+\text{YTM}/2}$ (semiannual-pay, YTM on a semiannual bond basis, du $\%\Delta P \approx -\text{ModDur} \times \Delta\text{YTM}$
Approximate modified duration	$\text{ApproxModDur} = \frac{V_- - V_+}{2 \times V_0 \times \Delta\text{YTM}}$
Money duration and PVBP	$\text{Money duration} = \text{ModDur} \times \text{full price of the position}$ $\text{Money duration per 100 of par} = \text{ModDur} \times \text{full price per 100}$ $\Delta V \approx -\text{Money duration} \times \Delta\text{YTM}$ $\text{PVBP} = \frac{V_- - V_+}{2}$ $\text{PVBP} \approx \text{Money duration} \times 0.0001$

62 Yield-Based Bond Convexity and Portfolio Properties

Convexity from the cash flows	$\text{convexity}_t = \frac{t(t+1)}{(1+r)^2}$
Approximate convexity	$\text{approximate convexity} = \frac{V_- + V_+ - 2V_0}{(\Delta YTM)^2 V_0}$
Price change using duration and convexity	$\%\Delta PV^{Full} \approx -\text{AnnModDur} \times \Delta YTM + \frac{1}{2} \times \text{AnnConvexity} \times (\Delta YTM)^2$
Money convexity	$\text{MoneyCon} = \text{AnnConvexity} \times PV^{Full}$ of the position $\Delta PV^{Full} \approx -(\text{MoneyDur} \times \Delta YTM) + \frac{1}{2} \times \text{MoneyCon} \times (\Delta YTM)^2$

63 Curve-Based and Empirical Fixed-Income Risk Measures

Why effective duration and effective convexity for bonds with embedded options	$\text{effective duration (EffDur)} = \frac{V_- - V_+}{2V_0\,\Delta\text{Curve}}$ $\text{effective convexity (EffCon)} = \frac{V_- + V_+ - 2V_0}{(\Delta\text{Curve})^2 V_0}$

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Percentage price change for a change in the benchmark yield	$\%\Delta PV^{Full} \approx -\text{EffDur} \times \Delta\text{Curve} + \frac{1}{2} \times \text{EffCon} \times (\Delta\text{Curve})^2$
Key rate duration and shaping risk	$\%\Delta V \approx -\sum_k \text{KeyRateDur}_k \times \Delta r_k$

64 Credit Risk

Measuring credit risk	$\text{expected loss} = \text{probability of default} \times \text{loss given default}$ $\text{LGD (in money)} = \text{expected exposure} \times (1 - \text{recovery rate})$ $\text{LGD\% (rate)} = \text{loss severity} = 1 - \text{recovery rate}$ $\text{credit spread} \approx \text{PD} \times \text{LGD\%} = \text{PD} \times (1 - \text{recovery rate})$
Market factors: liquidity	$\%\Delta P_{\text{full}} \approx -\text{ModDur} \times \Delta\text{Spread} + \frac{1}{2}\,\text{Convexity} \times (\Delta\text{Spread})^2$

69 Mortgage-Backed Security (MBS) Instrument and Market Features

Mortgage pass-throughs and CMOs	$\text{WAC} = \sum_i w_i \times \text{mortgage rate}_i$ $\text{WAM} = \sum_i w_i \times \text{remaining term}_i$ $\text{pass-through rate} = \text{WAC} - \text{fees}$
Commercial mortgage-backed securities	$\text{DSCR} = \dfrac{\text{net operating income}}{\text{debt service}}$ $\text{LTV} = \dfrac{\text{loan amount}}{\text{appraised value}}$

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Derivatives

Exam weight 6–9% · 10 readings · 41 formulas

70 Derivative Instrument and Derivative Market Features

Long and short exposure

$$\text{Payoff to long at settlement} = S_T - F$$

$$\text{Payoff to short} = F - S_T$$

71 Forward Commitment and Contingent Claim Features and Instruments

Value at expiration and profit for long and short option positions

$$c_T = \max(0,\ S_T - X)$$

$$p_T = \max(0,\ X - S_T)$$

$$\text{Profit to buyer} = \text{value at expiration} - \text{premium paid}$$

$$\text{Profit to writer} = \text{premium received} - \text{value at expiration}$$

72 Derivative Benefits, Risks, and Issuer and Investor Uses

Risks

$$\%\Delta\text{margin} = \frac{\Delta P\%}{m}$$

$$\text{leverage} = \frac{1}{m}$$

73 Arbitrage, Replication, and the Cost of Carry in Pricing Derivatives

Replicating forwards (underlying with no costs or benefits of holding)

$$F_0(T) = S_0(1 + R_f)^T$$

Spot versus expected future price, and the cost of carry

$$F_0(T) = [S_0 + PV_0(\text{cost}) - PV_0(\text{benefit})]\,(1 + R_f)^T$$

$$F_0(T) = S_0\, e^{rT}$$

$$F_0(T) = S_0\, e^{(r+c)T}$$

$$F_0(T) = S_0\, e^{(r+c-b)T}$$

Currency forwards

$$F = S_0 \times \left(\frac{1 + R_{\text{price}}}{1 + R_{\text{base}}}\right)^T$$

$$\text{or, continuously compounded,} \quad F = S_0\, e^{(r_{\text{price}} - r_{\text{base}})T}$$

74 Pricing and Valuation of Forward Contracts and for an Underlying With Varying Maturities

Value and price of a forward: at initiation, during its life, at expiration

$$V_t(T) = [S_t + PV_t(\text{cost}) - PV_t(\text{benefit})] - F_0(T)(1 + R_f)^{-(T-t)}$$

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Implied (no-arbitrage) forward rates	$(1+Z_{A+B})^{A+B} = (1+Z_A)^A\,(1+F_{A,B})^B \quad \text{so} \quad F_{A,B} = \left[\dfrac{(1+Z_{A+B})^{A+B}}{(1+Z_A)^A}\right]^{1/B} - 1$ $1 + Z_{\text{long}}\frac{d_{\text{long}}}{360} = \left(1 + Z_{\text{short}}\frac{d_{\text{short}}}{360}\right)\left(1 + F\frac{d_{\text{long}}-d_{\text{short}}}{360}\right)$
Forward rate agreements (FRAs)	$\text{Payment to long} = \dfrac{\text{Notional} \times (\text{MRR} - \text{FRA rate}) \times \frac{\text{days}}{360}}{1 + \text{MRR} \times \frac{\text{days}}{360}}$

75 Pricing and Valuation of Futures Contracts

Interest rate futures	$\text{futures price} = 100 - (100 \times \text{MRR}_{A,\,B-A})$ $\text{BPV} = \text{notional principal} \times \text{period (in years)} \times 0.0001$

76 Pricing and Valuation of Interest Rates and Other Swaps

Solving for the par swap rate	$\displaystyle\sum_{n=1}^{N}\frac{\text{MRR}_n}{(1+S_n)^n} = \sum_{n=1}^{N}\frac{F}{(1+S_n)^n}$ $F = \dfrac{1 - \dfrac{1}{(1+S_N)^N}}{\displaystyle\sum_{n=1}^{N}\frac{1}{(1+S_n)^n}}$
Value during the life	$\text{Value to fixed-rate payer} = PV(\text{expected floating payments}) - PV(\text{remaining fixed payments})$

77 Pricing and Valuation of Options

Moneyness, exercise value and time value	$\text{Call exercise value} = \max(0,\ S - X)$ $\text{Put exercise value} = \max(0,\ X - S)$ $\text{Option premium} = \text{exercise value} + \text{time value}, \quad \text{so} \quad \text{time value} = \text{premium} - \text{exercise value}$

78 Option Replication Using Put-Call Parity

Put–call parity	$c + X(1+R_f)^{-T} = S + p$
Put–call forward parity and options in corporate finance	$F_0(T)(1+R_f)^{-T} + p_0 = c_0 + X(1+R_f)^{-T}$ $p_0 - c_0 = [X - F_0(T)]\,(1+R_f)^{-T}$
Option view of a firm (equity and debt)	$V_0 = c_0 + PV(D) - p_0$ $\text{Equity}_T = \max(0,\ V_T - D)$ $\text{Debt}_T = \min(V_T,\ D) = D - \max(0,\ D - V_T)$

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79 Valuing a Derivative Using a One-Period Binomial Model

Call: long h shares, short one call	$h\,S_1^u - c_1^u = h\,S_1^d - c_1^d \quad \Rightarrow \quad h = \dfrac{c_1^u - c_1^d}{S_1^u - S_1^d}$ $c_0 = hS_0 - V_0$
Put: long h shares, long one put	$h = \dfrac{p_1^d - p_1^u}{S_1^u - S_1^d}$ $V_0 = hS_0 + p_0 \;\Rightarrow\; p_0 = V_0 - hS_0$
Risk neutrality	$\pi_U = \dfrac{1 + R_f - R^d}{R^u - R^d}$ $\pi_D = 1 - \pi_U$ $c_0 = \dfrac{\pi_U\,c_1^u + \pi_D\,c_1^d}{1 + R_f}$ $p_0 = \dfrac{\pi_U\,p_1^u + \pi_D\,p_1^d}{1 + R_f}$

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Alternative Investments

Exam weight 6–9% · 4 readings · 11 formulas

80 Alternative Investment Features, Methods, and Structures

Calculating the performance fee

$$\text{Fee}_{\text{soft hurdle}} = p \times R$$

$$\text{Fee}_{\text{hard hurdle}} = p \times (R - h)$$

$$\text{full catch-up reached at } R = \frac{h}{1-p}$$

81 Alternative Investment Performance and Returns

Life cycle and the J-curve

$$\text{MOIC} = \frac{\text{total capital returned} + \text{value of remaining assets}}{\text{total capital paid in}}$$

Leverage

$$\text{leveraged return} = \frac{r(V_0 + V_B) - r_B V_B}{V_0}$$

$$\text{leveraged return} = r + \frac{V_B}{V_0}(r - r_B)$$

After-fee return mechanics

$$\text{total fees} = mV_1 + \max\left[0,\ p(V_1 - V_0)\right]$$

$$r_{\text{after fees}} = \frac{V_1 - V_0 - \text{total fees}}{V_0}$$

84 Natural Resources

Commodity valuation: cost of carry

$$\text{futures price} \approx \text{spot price} \times (1 + r_f) + \text{storage costs} - \text{convenience yield}$$

85 Hedge Funds

Where returns come from, index biases and diversification

$$R_{\text{fund}} = \underbrace{\text{market beta}}_{\text{broad market}} + \underbrace{\text{strategy beta}}_{\text{sector/strategy exposure}} + \underbrace{\alpha}_{\text{manager skill}}$$

$$CV = \frac{\sigma}{\bar{R}}$$

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Portfolio Construction

Exam weight 8–12% · 3 readings · 26 formulas

87 Portfolio Risk and Return: Part I

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	$\text{Cov}_{1,2} = \frac{\sum_{t=1}^{T}(R_{1,t}-\bar{R}_1)(R_{2,t}-\bar{R}_2)}{T-1}$
Correlation	$\rho_{1,2} = \frac{\text{Cov}_{1,2}}{\sigma_1\sigma_2}$ $\text{Cov}_{1,2} = \rho_{1,2}\,\sigma_1\,\sigma_2$
Portfolio standard deviation	$E(R_p) = w_1E(R_1) + w_2E(R_2)$ $\sigma_p^2 = w_1^2\sigma_1^2 + w_2^2\sigma_2^2 + 2w_1w_2\text{Cov}_{1,2} = w_1^2\sigma_1^2 + w_2^2\sigma_2^2 + 2w_1w_2\rho_{1,2}\sigma_1\sigma_2$ $\sigma_p = \sqrt{\sigma_p^2}$
Investing in assets that are less than perfectly correlated	$\sigma_p^2 = (w_1\sigma_1 + w_2\sigma_2)^2 \quad \Rightarrow \quad \sigma_p = w_1\sigma_1 + w_2\sigma_2$ $w_1 = \frac{\sigma_2}{\sigma_1+\sigma_2}$

88 Portfolio Risk and Return: Part II

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

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Calculating and interpreting beta	$\beta_i = \dfrac{Cov(R_i, R_m)}{\sigma_m^2} = \dfrac{\rho_{i,m}\,\sigma_i\,\sigma_m}{\sigma_m^2} = \rho_{i,m}\dfrac{\sigma_i}{\sigma_m}$
The CAPM, its assumptions, and the security market line (SML)	$E(R_i) = R_f + \beta_i\,[E(R_m) - R_f]$ $\beta_i = \dfrac{Cov(R_i, R_m)}{\sigma_m^2}$
Applying the CAPM and the SML: finding mispriced securities	$\text{forecast return} = \dfrac{P_1 - P_0 + D_1}{P_0}$ $\text{required return} = R_f + \beta[E(R_m) - R_f]$

89 Portfolio Management: An Overview

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

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