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CFA® Program Level I

Quantitative Methods Formula Sheet

2027 curriculum · 11 readings · 133 formulas

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Version v2027.3 · October 2026

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CredGuild · CFA® Program Level I · Quantitative Methods Formula Sheet
2027 curriculum · Version v2027.3 · Generated October 6, 2026

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Every formula in the CredGuild notes for the 2027 CFA® Program Level I curriculum, Quantitative Methods, 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.

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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	$\text{Price return} = \dfrac{P_1 - P_0}{P_0}$ $\text{Capital distribution return} = \dfrac{D}{P_0}$ $\text{Total (holding period) return} = \dfrac{P_1 - P_0 + D}{P_0} = \text{price return} + \text{capital distribution return}$
Averaging returns over several periods	$\bar{R}_{\text{arith}} = \dfrac{R_1 + R_2 + \cdots + R_n}{n}$ $R_{\text{geo}} = \left[(1+R_1)(1+R_2)\cdots(1+R_n)\right]^{1/n} - 1$
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	$\text{Effective annual rate} = \left(1 + \dfrac{r_s}{m}\right)^{m} - 1$ $PV = \dfrac{FV}{(1 + r_s/m)^{m}}$ (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	$1 + r_{\text{real}} = \dfrac{1 + r_{\text{nominal}}}{1 + \pi}$ $\pi = \dfrac{1 + r_{\text{nominal}}}{1 + r_{\text{real}}} - 1$
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	$r_L = \dfrac{r_P(V_E + V_D) - r_D V_D}{V_E} = r_P + \dfrac{V_D}{V_E}(r_P - r_D)$

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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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