

Quantitative Methods

Present Value

$$PV = FV / (1 + r)^n$$

Future Value

$$FV = PV (1 + r)^n$$

Frequency of compounding

$$EFF = (1 + r)^n - 1$$

Perpetuity

$$PV = \frac{PMT}{(r/n)}$$

$$EFF = \left(1 + \frac{APR}{n}\right)^n - 1$$

Geometric Mean

$$\left[(1 + r_1)(1 + r_2)(1 + r_n) \right]^{1/n} - 1$$

$$APR = r \times n$$

Harmonic Mean

$$\frac{n}{\frac{1}{x_1} + \frac{1}{x_2} + \frac{1}{x_n}}$$

Position of an observation at a given percentile

$$(n+1) \times \frac{y}{100}$$

Population Variance

$$\frac{\sum_{i=1}^n |x_i - \mu|^2}{n}$$

Population stdev.

$$\sqrt{\text{Pop. variance}}$$

Mean Abs. Deviation (MAD)

$$\frac{\sum_{i=1}^n |x_i - \bar{x}|}{n}$$

Sample Variance

$$\frac{\sum_{i=1}^n |x_i - \bar{x}|^2}{n-1}$$

Population stdev.

$$\sqrt{\text{Sample variance}}$$

Quantitative Methods

Coefficient of Variation

$$\frac{\text{Standard Deviation}}{\text{Mean}}$$

Correlation of x & y

$$\frac{\text{covariance (xy)}}{(\sigma_x)(\sigma_y)}$$

Multiplication Rule (Joint Probs.)

$$P(AB) = P(A | B) \times P(B)$$

Addition Rule

$$P(A \text{ or } B) = P(A) + P(B) - P(AB)$$

Total Probability Rule *

$$P(A) = P(A | B_1) \times P(B_1) + P(A | B_2) \times P(B_2) + \dots + P(A | B_n) \times P(B_n)$$

Expected Value

$$EV = (X_1)P(X_1) + (X_2)P(X_2) \dots + (X_n)P(X_n)$$

Variance of 2-Stock Portfolio

$$w_A^2 \sigma_A^2 + w_B^2 \sigma_B^2 + 2w_A w_B \text{ covariance}_{AB}$$

FOR BINOMIAL RANDOM VARIABLE

Probability of "x" successes in "n" trials

$$p(x) = \frac{n!}{(n-x)! x!} p^x (1-p)^{n-x}$$

Expected value

$$E(x) = (n)(p)$$

Variance

$$\text{Var}(x) = (n)(p)(1-p)$$

Quantitative Methods

Normal Distributions

68% of observations fall within $\pm 1\sigma$

90% fall within $\pm 1.65\sigma$

95% fall within $\pm 1.96\sigma$

99% fall within $\pm 2.58\sigma$

Z-score (number of σ a given observation is from the population mean)

$$\text{Z-score} = \frac{x - \mu}{\sigma} = \frac{\text{observed value} - \text{population mean}}{\text{standard deviation}}$$

Roy's Safety-First Ratio (SFR)

$$\text{SFR} = \frac{E(R_p) - R_L}{\sigma} = \frac{\text{Expected return} - \text{Threshold level}}{\text{Standard deviation}}$$

Continuously Compounded Rate Equalities

$$\underbrace{\frac{\text{final price}}{\text{initial price}}}_{\text{price relative}} = \underbrace{(1 + \text{HPR})}_{\text{Holding period return}} = \underbrace{e^{\text{RCC}}}_{\text{Continuously compounded rate}}$$

Standard Error

Known population variance $\rightarrow \sigma / \sqrt{n}$

Unknown population variance $\rightarrow s / \sqrt{n}$

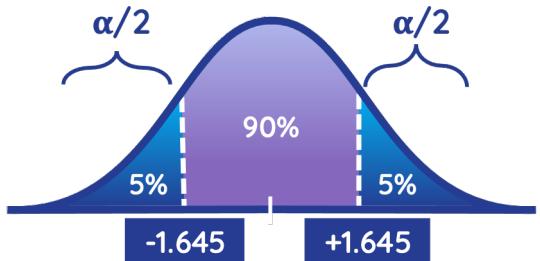
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Common Z-values for confidence intervals

$Z_{\alpha/2} = 1.645$ for 90% confidence intervals
(level of significance is 10%, 5% in each tail)

$Z_{\alpha/2} = 1.960$ for 95% confidence intervals
(level of significance is 5%, 2.5% in each tail)

$Z_{\alpha/2} = 2.575$ for 99% confidence intervals
(level of significance is 1%, 0.5% in each tail)



Formulas to calculate confidence intervals *

$$\bar{x} \pm \left(Z_{\alpha/2} \right) \left(\frac{\sigma}{\sqrt{n}} \right) \quad \text{or} \quad \bar{x} \pm \left(t_{\alpha/2} \right) \left(\frac{s}{\sqrt{n}} \right)$$

Linear Regression

$$\text{Total Variation} = \text{Explained variation} + \text{Unexplained variation}$$



SST



SSR



SSE

$$F\text{-stat} = \frac{\frac{\text{MSR}}{\text{MSE}}}{\frac{\text{SSE}}{n - (k+1)}}$$

MSR SSE
MSE n - (k+1)

$$R^2 = \frac{\text{SSR}}{\text{SST}}$$

Quantitative Methods

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Economics

Elasticity Formulas

$$\text{Own-price Elasticity} = \frac{\% \Delta \text{ Qty}}{\% \Delta \text{ Price}}$$

$$\text{Cross-price Elasticity} = \frac{\% \Delta \text{ Qty}}{\% \Delta \text{ Price (related good)}}$$

$$\text{Income Elasticity} = \frac{\% \Delta \text{ Qty}}{\% \Delta \text{ Income}}$$

Marginal Product

$$\text{Marginal Product} = \frac{\Delta \text{ output}}{\Delta \text{ labor}}$$

N-firm Concentration Ratio

Sum of mkt shares of N largest firms

HHI Ratio

Sum of SQUARED market shares of N largest firms

Gross Domestic Product

Saving, investment, Fiscal and Trade Balance *

$$\text{GDP} = C + I + G + (X - M)$$

$$S = I + (G - T) + (X - M)$$

GDP Deflator

$$\frac{\text{Nominal GDP}}{\text{Real GDP}} \times 100$$

Solow Growth Model

$$\text{Growth in potential GDP} = \text{Growth in tech} + WL \left[\begin{matrix} \text{Growth} \\ \text{in labor} \end{matrix} \right] + Wc \left[\begin{matrix} \text{Growth} \\ \text{in capital} \end{matrix} \right]$$

Economics

Unemployment Ratios

$$\text{Unemployment rate} = \frac{\text{Unemployed}}{\text{Labor force}}$$

$$\text{Participation ratio} = \frac{\text{Labor force}}{\text{Working age population}}$$

Money Creation

$$\text{Money created} = \frac{\text{Initial deposit}}{\text{Reserve requirement}}$$

Quantity Theory of Money

$$(M) \times (V) = (P) \times (Y)$$

Money supply Velocity of \$ in circulation Price level Real output

Neutral Interest Rate

$$\text{Neutral interest rate} = \text{trend growth rate} + \text{inflation}$$

Balance of Payments

$$\text{Current account} = \text{Capital account} + \text{Financial account}$$

Real Exchange Rates

$$\text{Real exchange rate} = \frac{\text{Nominal exchange rate}}{\text{(spot rate)}} \times \frac{\text{CPI base currency}}{\text{CPI price currency}}$$

Economics

No Arbitrage Forward Exchange Rates*

$$\text{Forward } \frac{\text{price}}{\text{base}} = \text{Spot } \frac{\text{price}}{\text{base}} \times \frac{(1 + r \text{ price})}{(1 + r \text{ base})}$$

Rate of Change

$$\text{Rate of change} = \frac{\text{final value}}{\text{initial value}} - 1$$

Marshall-Lerner Condition

$$(Wx)(Ex) + (WM)(EM - 1) > 0$$

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Financial Statement Analysis

Basic EPS

$$\frac{\text{Net income} - \text{Preferred dividends}}{\text{Weighted avg # of common shares}}$$

Comprehensive Income

$$\text{Net Income} + \text{Other comprehensive income}$$

Diluted EPS

$$\frac{\text{Net income} - \text{Preferred dividends} + \text{Convertible preferred dividends} + \text{Convertible bonds interest } (1-t)}{\text{Weighted avg # of Common shares} + \text{Shares from conversion of preferred} + \text{Shares from conversion of bonds} + \text{Shares from employee stock options}}$$

Calculating Inventory

$$\begin{aligned} & \text{Beginning inventory} \\ & + \text{Purchases (cash paid to suppliers)} \\ & - \text{Cogs (cost inventory sold)} \end{aligned}$$

Ending inventory

Free Cash Flows*

$$\text{FCFF} = \text{NI} + \text{NCC} + \text{Interest } (1-t) - \text{FC Inv} - \text{WC Inv}$$

$$\text{FCFF} = \text{CFO} + \text{Interest } (1-t) - \text{FC Inv}$$

$$\text{FCFE} = \text{CFO} - \text{FC Inv} + \text{Net borrowing}$$

$$\text{FCFE} = \text{FCFF} - \text{Interest } (1-t) + \text{Net borrowing}$$

Financial Statement Analysis

Coverage Ratios

$$\text{Debt coverage} = \frac{\text{CFO}}{\text{Total debt}}$$

$$\text{Debt payment ratio} = \frac{\text{CFO}}{\text{Cash paid for long-term debt repayment}}$$

$$\text{Interest coverage} = \frac{\text{CFO} + \text{Interest paid} + \text{Tax paid}}{\text{Interest paid}}$$

$$\text{Dividend payment ratio} = \frac{\text{CFO}}{\text{Dividends paid}}$$

$$\text{Reinvestment ratio} = \frac{\text{CFO}}{\text{Cash paid for long-term assets}}$$

$$\text{Investing & financing ratio} = \frac{\text{CFO}}{\text{Cash outflows from financing & investing activities}}$$

Performance Ratios

$$\text{Cash flow to revenue} = \frac{\text{CFO}}{\text{Net revenue}}$$

$$\text{Cash to income} = \frac{\text{CFO}}{\text{Operating income}}$$

$$\text{Cash return on assets} = \frac{\text{CFO}}{\text{Avg total assets}}$$

$$\text{Cash flow per share} = \frac{\text{CFO} - \text{Pref. dividends}}{\text{Weighted average common shares}}$$

$$\text{Cash return on equity} = \frac{\text{CFO}}{\text{Avg total equity}}$$

Activity Turnover Ratios

$$\text{Inventory turnover} = \frac{\text{COGS}}{\text{Avg inventory}}$$

$$\text{Total asset turnover} = \frac{\text{Revenue}}{\text{Avg total assets}}$$

$$\text{Payables turnover} = \frac{\text{Purchases}}{\text{Avg payables}}$$

$$\text{Fixed asset turnover} = \frac{\text{Revenue}}{\text{Avg net fixed assets}}$$

$$\text{Receivables turnover} = \frac{\text{Sales}}{\text{Avg receivables}}$$

$$\text{Working capital turnover} = \frac{\text{Revenue}}{\text{Avg working capital}}$$

Financial Statement Analysis

“Days of” Ratios*

$$\text{Days of inventory on hand} = \frac{365}{\text{Inventory turnover}}$$

$$\text{Days of payables outstanding} = \frac{365}{\text{Payables turnover}}$$

$$\text{Days of sales outstanding} = \frac{365}{\text{Receivables turnover}}$$

$$\text{NET cash conversion cycle} = \frac{\text{Days of inventory on hand (DOH)}}{} + \frac{\text{Days of sales outstanding (DSO)}}{} - \frac{\text{Days of payables outstanding (DPO)}}{}$$

Liquidity Ratios

$$\text{Current ratio} = \frac{\text{Current assets}}{\text{Current liabilities}}$$

$$\text{Quick ratio (acid test)} = \frac{\text{Cash} + \text{Mkt. securities} + \text{Receivables}}{\text{Current liabilities}}$$

$$\text{Cash ratio} = \frac{\text{Cash} + \text{Mkt. securities}}{\text{Current liabilities}}$$

$$\text{Defensive interval ratio} = \frac{\text{Cash} + \text{Mkt. securities} + \text{Receivables}}{\text{Average daily expenditures}}$$

Financial Statement Analysis

Solvency Ratios

$$\text{Debt to equity} = \frac{\text{Total debt}}{\text{Total equity}}$$

$$\text{Interest coverage} = \frac{\text{EBIT}}{\text{Interest payments}}$$

$$\text{Debt to capital} = \frac{\text{Total debt}}{\text{Total debt + equity}}$$

$$\text{Debt to EBITDA} = \frac{\text{Total debt}}{\text{EBITDA}}$$

$$\text{Debt to assets} = \frac{\text{Total debt}}{\text{Total assets}}$$

$$\text{Fixed charge coverage} = \frac{\text{EBIT} + \text{lease payments}}{\text{Interest payments} + \text{Lease payments}}$$

$$\text{Financial leverage} = \frac{\text{Avg total assets}}{\text{Avg total equity}}$$

Profitability Ratios

$$\text{Net profit margin} = \frac{\text{Net income}}{\text{Revenue}}$$

$$\text{Return on assets} = \frac{\text{Net income}}{\text{Avg total assets}}$$

$$\text{Gross profit margin} = \frac{\text{Gross profit}}{\text{Revenue}}$$

$$\text{Return on equity} = \frac{\text{Net income}}{\text{Avg total equity}}$$

$$\text{Operating profit margin} = \frac{\text{EBIT}}{\text{Revenue}}$$

$$\text{Return on total capital} = \frac{\text{EBIT}}{\text{Avg total capital}}$$

$$\text{Return on common equity} = \frac{\text{NI} - \text{Pref. dividends}}{\text{Avg common equity}}$$

Financial Statement Analysis

Straight-line Depreciation

$$\frac{\text{Original cost} - \text{salvage value}}{\text{Useful life}}$$

Double-declining Balance Depreciation

$$\frac{2}{\text{useful life}} \times \left(\text{Cost} - \text{Accumulated depreciation} \right)$$

Deferred Tax Liability*

$$\text{DTL} = (\text{CV} - \text{TB}) \times \text{Tax rate}$$

- If taxable income < pre-tax income, deferred tax liability
- If taxable income > pre-tax income, deferred tax asset

Effective Interest Method

$$\text{Interest expense} = \left[\begin{matrix} \text{CV of bond liability} \\ @ \text{ beg. of yr} \end{matrix} \right] \left[\begin{matrix} \text{Mkt rate} \\ \text{at issuance} \end{matrix} \right]$$

$$\text{Amount amortized} = \text{Int. expense} - \text{Int. payment (coupon)}$$

Retirement Plans

$$\text{Funded status} = \text{Fair value of fund's asset} - \text{PV of estimated pension liabilities}$$

Financial Statement Analysis



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Corporate Issuers

Weighted Average Cost of Capital

$$WACC = (Wd)(rd)(1-t) + (Wp)(rp) + (We)(re)$$

Cost of Preferred Stock

$$rp = \frac{\text{Dividend}}{\text{Current share price}}$$

CAPM

$$re = rf + B(rm - rf)$$

MRP

Levered Beta

$$B'e = Bu \left[1 + (1-t) \frac{D'}{E'} \right]$$

Unlevered Beta

$$Bu = Be \left[\frac{1}{1 + (1-t) \frac{D}{E}} \right]$$

Degree of Operating Leverage (DOL)

$$\frac{Q(P - V)}{Q(P - V) - F}$$

Degree of Financial Leverage (DFL)

$$\frac{Q(P - V) - F}{Q(P - V) - F - I}$$

Degree of Total Leverage

$$\frac{Q(P - V)}{Q(P - V) - F - I}$$

Break-even Quantity*

$$Q_{BE} = \frac{\text{Fixed operating costs (F)} + \text{Fixed interests (I)}}{(P - V) \leftarrow \text{Contribution margin}}$$

Operating Break-even Quantity

$$Q_{OBE} = \frac{\text{Fixed operating costs (F)}}{(P - V)}$$

P = price per unit

V = variable cost per unit

Equity Investments

Leverage Ratio

$$\frac{\text{Value of asset}}{\text{Investor's equity position}} \quad \text{or} \quad \frac{1}{\text{initial margin requirement}}$$

Margin Call Price

$$P_0 \frac{(1 - \text{initial margin})}{(1 - \text{maintenance margin})}$$

Market Cap

$$(\# \text{ of shares})(\text{price per share})$$

Price-to-book Ratio

Free Cash Flow to Equity *

$$\frac{\text{Market cap}}{\text{Book value}}$$

$$\text{NI} + \text{depr} - \Delta \text{inWC} - \text{FCInv} + \text{net borrowing}$$

or

$$\text{CFO} - \text{FCInv} + \text{net borrowing}$$

Price at t=0

$$P_0 = \frac{D_1}{r - g} \rightarrow D_1 = (D_0)(1+g)$$

$$g = (\text{ROE})(\text{RR})$$

$$\text{RR} = (1 - \text{div. payout ratio})$$

Enterprise Value

$$\text{mkt value of common and preferred equity} + \text{mkt value of debt} - \text{cash and short term investments}$$

Fixed Income

Full Price of a Bond

$$PV \times \left(1 + \frac{YTM}{n}\right)^{\frac{t}{T}}$$

Flat Price of a Bond

$$\begin{aligned} &\text{Full price - Accrued interest} \\ &\downarrow \\ &\text{Full price} - (\text{coupon})(\frac{t}{T}) \end{aligned}$$

Effective Yield

$$EFF = (1 + r)^n - 1$$

Periodic Rate

$$r = \frac{YTM}{n}$$

Money Market Instruments*

$$\text{Money market yield} = \frac{FV - PV}{PV} \times \left[\frac{360}{n} \right]$$

$$\text{Bond equivalent yield} = \frac{FV - PV}{PV} \times \left[\frac{365}{n} \right]$$

$$\text{Discount yield} = \frac{FV - PV}{FV} \times \left[\frac{360}{n} \right]$$

Yield or Bond with an embedded option

Z-spread

$$\text{Yield on government bonds} + OAS + \text{Option value}$$

$$OAS = z\text{-spread} - \text{option value}$$

Fixed Income

Single Monthly Mortality (SMM) rate

Prepayment for the month

$$\text{Mortgage balance at the beginning of month} - \text{Scheduled principal repayments that month}$$

Loan-to-value (LTV) Ratio *

$$\text{LTV} = \frac{\text{Loan amount}}{\text{Market value of collateral}}$$

Debt-Service coverage (DSCR) ratio

$$\text{DSCR} = \frac{\text{Net operating income}}{\text{Debt service}}$$

Modified Duration

$$\frac{\text{Macaulay Duration}}{(1 + \frac{\text{YTM}}{n})}$$

% Change in Bond Price

$$\left[- \text{Annual modified duration} \right] \times \left[\Delta \text{YTM} \right]$$

Approximate Modified Duration

$$\frac{V_- - V_+}{2 \times V_0 \times \Delta \text{YTM}}$$

Effective Duration

$$\frac{V_- - V_+}{2 \times V_0 \times \Delta \text{Curve}}$$

Money Duration

$$\text{Annual Modified Duration} \times \text{Full price of a bond}$$

Price Value of a Basis Point

$$\text{PVBP} = \frac{V_- - V_+}{2}$$

Fixed Income

Approximate Convexity

$$\frac{V_- + V_+ - 2V_0}{(\Delta YTM)^2 V_0}$$

Effective Convexity

$$\frac{V_- + V_+ - 2V_0}{(\Delta \text{curve})^2 V_0}$$

Change in Bond's Full Price*

$$\left[- \text{Annual modified duration} \right] \times \left[\Delta YTM \right] + \frac{1}{2} \left[\text{Annual convexity} \right] \left[\Delta YTM \right]^2$$

Duration
Convexity

Duration Gap

$$\frac{\text{Macaulay Investment Duration}}{\text{Duration Horizon}}$$

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Derivatives

Spot Price

$$S_0 = \frac{F_0(T)}{(1 + r_f)^T}$$

Contract Value at time = t

$$V_t = S_t - PV_t [F_0(T)]$$

Spot price at initiation with cost of carry

$$S_0 = \frac{F_0(T)}{(1 + r_f)^T} + \boxed{PV(\text{Benefits}) - PV(\text{Costs})}$$

“Cost of carry”

Contract Value at time = t with Costs and Benefits

$$S_t - \left(PV_t [F_0(T)] + PV_t (\text{Benefits}) - PV_t (\text{Costs}) \right)$$

Put-Call parity*

$$\boxed{S} + \boxed{P} = \boxed{C} + \boxed{\frac{X}{(1 + r)^T}}$$

Underlying asset Put Call Risk-free bond

Forward Put-Call parity

$$\boxed{\frac{\text{Fwd price}}{(1 + r)^T}} + \boxed{P} = \boxed{C} + \boxed{\frac{X}{(1 + r)^T}}$$

Forward contract Put Call Risk-free bond

Portfolio Management

Diversification Ratio

Risk of equally weighted portfolio of “n” securities

Risk of a single random security

Holding Period Return (HPR)

Portfolio Variance

$$\frac{\text{Final price}}{\text{Initial price}} - 1$$

$$w_A^2 \sigma_A^2 + w_B^2 \sigma_B^2 + 2w_A w_B \text{ covariance}_{AB}$$

Covariance of x and y

$$\text{covariance (xy)} = (\sigma_y)(\sigma_x)(\text{correlation of x \& y})$$

For any point on the Capital Allocation Line (CAL) *

$$E(r)p = (w_{R_f})(R_f) + (w_{R_p})[E(R_p)]$$

$$\sigma_p = (w_{R_p})(\sigma_{R_p})$$

For any point on the Capital Market Line (CML)

$$E(r)p = (w_{R_f})(R_f) + (w_m)[E(R_m)]$$

$$\sigma_p = (w_m)(\sigma_m)$$

Beta of Stock “i”

$$\text{Beta}_i = \frac{\text{covariance}_{i,mkt}}{\sigma_{mkt}^2} \quad \text{or} \quad \frac{[\rho_{i,mkt}][\sigma_i]}{\sigma_{mkt}}$$

Market Model

$$R_i = B(R_m) + \alpha_i + e_i$$

CAPM

$$E(r) = R_f + B [E(R_m) - R_f]$$

Portfolio Management

Sharpe Ratio

$$\frac{(R_p - R_f)}{\sigma_p}$$

For any point on the Capital Market Line (CML)

$$E(R_p) = \left(\frac{[E(R_m) - R_f]}{\sigma_m} \right) \sigma_p + R_f$$

Treynor Ratio

$$\frac{(R_p - R_f)}{B}$$

Security Market Line (SML)

$$E(r) = [E(R_m) - R_f] B + R_f$$

M² ratio

$$\frac{(R_p - R_f)}{\sigma_p} \sigma_m - (R_m - R_f)$$

Jensen's Alpha

$$R_p - [R_f + B (R_m - R_f)]$$



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Ethical and Professional Standards

1: Professionalism

1A. Knowledge of the law

1B. Independence & Objectivity

1C. Misrepresentation

1D. Misconduct

5: Investment analysis, recommendations, and actions

5A. Diligence & reasonable basis

5B. Communication with clients and prospective clients

5C. Record retention

2: Integrity of capital markets

2A. Material nonpublic information

2B. Market manipulation

6: Conflicts of interest *

6A. Disclosure of conflicts

6B. Priority of transactions

6C. Referral fees

3: Duties to clients

3A. Loyalty, prudence and care

3B. Fair dealing

3C. Suitability

3D. Performance presentation

3E. Preservation of confidentiality

7: Responsibilities as a CFA® institute member / candidate

7A. Conduct as participants in CFA® programs

7B. Reference to CFA® institute, the CFA® designation, and the CFA® program

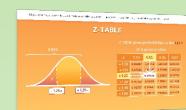
4. Duties to employers

4A. Loyalty

4B. Additional compensation arrangements

4C. Responsibilities of supervisors

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