



2017

CFA® EXAM REVIEW

**COVERS
ALL TOPICS
IN LEVEL II**

LEVEL II CFA®

FORMULA SHEETS

WILEY

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Published by John Wiley & Sons, Inc., Hoboken, New Jersey.

Published simultaneously in Canada.

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QUANTATIVE METHODS

CORRELATION AND REGRESSION

$$\text{Sample covariance} = \text{Cov}(X, Y) = \sum_{i=1}^n (X_i - \bar{X})(Y_i - \bar{Y}) / (n - 1)$$

where:

n = sample size

X_i = i th observation of Variable X

\bar{X} = mean observation of Variable X

Y_i = i th observation of Variable Y

\bar{Y} = mean observation of Variable Y

$$\text{Sample correlation coefficient} = r = \frac{\text{Cov}(X, Y)}{s_X s_Y}$$

$$\text{Sample variance} = s_X^2 = \sum_{i=1}^n (X_i - \bar{X})^2 / (n - 1)$$

$$\text{Sample standard deviation} = s_X = \sqrt{s_X^2}$$

Test statistic

$$\text{Test-stat} = t = \frac{r\sqrt{n-2}}{\sqrt{1-r^2}}$$

Where:

n = Number of observations

r = Sample correlation

Linear Regression with One Independent Variable

$$\text{Regression model equation} = Y_i = b_0 + b_1 X_i + \varepsilon_i, \quad i = 1, \dots, n$$

- b_1 and b_0 are the regression coefficients.
- b_1 is the slope coefficient.
- b_0 is the intercept term.
- ε is the error term that represents the variation in the dependent variable that is not explained by the independent variable.

$$\text{Regression line equation} = \hat{Y}_i = \hat{b}_0 + \hat{b}_1 X_i, \quad i = 1, \dots, n$$

Regression Residuals

$$\sum_{i=1}^n [Y_i - (\hat{b}_0 + \hat{b}_1 X_i)]^2$$

where:

Y_i = Actual value of the dependent variable

$\hat{b}_0 + \hat{b}_1 X_i$ = Predicted value of dependent variable

The Standard Error of Estimate

$$\text{SEE} = \left(\frac{\sum_{i=1}^n (Y_i - \hat{b}_0 - \hat{b}_1 X_i)^2}{n-2} \right)^{1/2} = \left(\frac{\sum_{i=1}^n (\hat{\epsilon}_i)^2}{n-2} \right)^{1/2} = \left(\frac{\text{SSE}}{n-2} \right)^{1/2}$$

The Coefficient of Determination

Total variation = Unexplained variation + Explained variation

$$\begin{aligned} R^2 &= \frac{\text{Explained variation}}{\text{Total variation}} = \frac{\text{Total variation} - \text{Unexplained variation}}{\text{Total variation}} \\ &= 1 - \frac{\text{Unexplained variation}}{\text{Total variation}} \end{aligned}$$

Hypothesis Tests on Regression Coefficients

$$\text{CAPM: } R_{ABC} = R_F + \beta_{ABC}(R_M - R_F)$$

$$R_{ABC} - R_F = \alpha + \beta_{ABC}(R_M - R_F) + \epsilon$$

- The intercept term for the regression, b_0 , is α .
- The slope coefficient for the regression, b_1 , is β_{ABC} .

The regression sum of squares (RSS)

$$\text{RSS} = \sum_{i=1}^n (\hat{Y}_i - \bar{Y})^2 \rightarrow \text{Explained variation}$$

The sum of squared errors or residuals (SSE)

$$\text{SSE} = \sum_{i=1}^n (Y_i - \hat{Y}_i)^2 \rightarrow \text{Unexplained variation}$$

ANOVA Table

Source of Variation	Degrees of Freedom	Sum of Squares	Mean Sum of Squares
Regression (explained)	k	RSS	$MSR = \frac{RSS}{k} = \frac{RSS}{1} = RSS$
Error (unexplained)	$n - (k + 1)$	SSE	$MSE = \frac{SSE}{n - 2}$
Total	$n - 1$	SST	

k = the number of slope coefficients in the regression.

Prediction Intervals

$$s_f^2 = s^2 \left[1 + \frac{1}{n} + \frac{(X - \bar{X})^2}{(n-1)s_x^2} \right]$$

$$\hat{Y} \pm t_c s_f$$

MULTIPLE REGRESSION AND ISSUES IN REGRESSION ANALYSIS

Multiple regression equation

$$\text{Multiple regression equation} = Y_i = b_0 + b_1X_{1i} + b_2X_{2i} + \dots + b_kX_{ki} + \varepsilon_i, \quad i = 1, 2, \dots, n$$

Y_i = the i th observation of the dependent variable Y

X_{ji} = the i th observation of the independent variable X_j , $j = 1, 2, \dots, k$

b_0 = the intercept of the equation

b_1, \dots, b_k = the slope coefficients for each of the independent variables

ε_i = the error term for the i th observation

n = the number of observations

Residual Term

$$\hat{\varepsilon}_i = Y_i - \hat{Y}_i = Y_i - (\hat{b}_0 + \hat{b}_1X_{1i} + \hat{b}_2X_{2i} + \dots + \hat{b}_kX_{ki})$$

Confidence Intervals

$$\hat{b}_j \pm (t_c \times s_{\hat{b}_j})$$

estimated regression coefficient \pm (critical t -value)(coefficient standard error)

F-statistic

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

R^2 and Adjusted R^2

$$R^2 = \frac{\text{Total variation} - \text{Unexplained variation}}{\text{Total variation}} = \frac{\text{SST} - \text{SSE}}{\text{SST}} = \frac{\text{RSS}}{\text{SST}}$$

$$\text{Adjusted } R^2 = \bar{R}^2 = 1 - \left(\frac{n-1}{n-k-1} \right) (1 - R^2)$$

Testing for Heteroskedasticity- The Breusch-Pagan (BP) Test

$$\chi^2 = nR^2 \text{ with } k \text{ degrees of freedom.}$$

n = Number of observations.

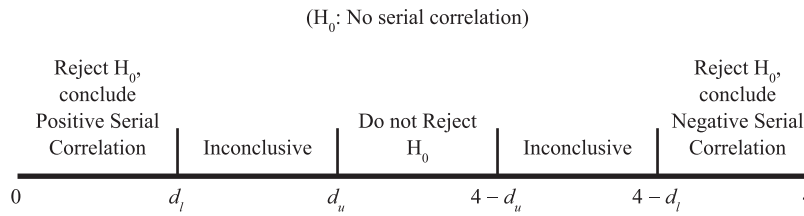
R^2 = Coefficient of determination of the **second regression** (the regression when the squared residuals of the original regression are regressed on the independent variables).

k = Number of independent variables.

Testing for Serial Correlation- The Durban-Watson (DW) Test

$DW \approx 2(1 - r)$; where r is the sample correlation between squared residuals from one period and those from the previous period.

Value of Durbin-Watson Statistic



Problems in Linear Regression and Solutions

Problem	Effect	Solution
Heteroskedasticity	Incorrect standard errors	Use robust standard errors (corrected for conditional heteroskedasticity)
Serial correlation	Incorrect standard errors (additional problems if a lagged value of the dependent variable is used as an independent variable)	Use robust standard errors (corrected for serial correlation)
Multicollinearity	High R^2 and low t -statistics	Remove one or more independent variables; often no solution based in theory

Model Specification Errors

$$Y_i = b_0 + b_1 \ln X_{1i} + b_2 X_{2i} + \varepsilon$$

Linear Trend Models

$$Y_t = b_0 + b_1 t + \varepsilon_t, \quad t = 1, 2, \dots, T$$

where:

y_t = the value of the time series at time t (value of the dependent variable)

b_0 = the y-intercept term

b_1 = the slope coefficient/trend coefficient

t = time, the independent or explanatory variable

ε_t = a random-error term

TIME-SERIES ANALYSIS

Linear Trend Models

$$y_t = b_0 + b_1t + \varepsilon_t, \quad t = 1, 2, \dots, T$$

where:

y_t = the value of the time series at time t (value of the dependent variable)

b_0 = the y-intercept term

b_1 = the slope coefficient/trend coefficient

t = time, the independent or explanatory variable

ε_t = a random-error term

Log-Linear Trend Models

A series that grows exponentially can be described using the following equation:

$$y_t = e^{b_0 + b_1t}$$

where:

y_t = the value of the time series at time t (value of the dependent variable)

b_0 = the y-intercept term

b_1 = the slope coefficient

t = time = 1, 2, 3, ..., T

We take the natural logarithm of both sides of the equation to arrive at the equation for the log-linear model:

$$\ln y_t = b_0 + b_1t + \varepsilon_t, \quad t = 1, 2, \dots, T$$

AUTOREGRESSIVE (AR) TIME-SERIES MODELS

$$x_t = b_0 + b_1x_{t-1} + \varepsilon_t$$

A p th order autoregressive model is represented as:

$$x_t = b_0 + b_1x_{t-1} + b_2x_{t-2} + \dots + b_px_{t-p} + \varepsilon_t$$

Detecting Serially Correlated Errors in an AR Model

$$t\text{-stat} = \frac{\text{Residual autocorrelation for lag}}{\text{Standard error of residual autocorrelation}}$$

where:

Standard error of residual autocorrelation = $1/\sqrt{T}$

T = Number of observations in the time series

Mean Reversion

$$x_t = \frac{b_0}{1 - b_1}$$

Multiperiod Forecasts and the Chain Rule of Forecasting

$$\hat{x}_{t+1} = \hat{b}_0 + \hat{b}_1 x_t$$

Random Walks

$$x_t = x_{t-1} + \varepsilon_t, E(\varepsilon_t) = 0, E(\varepsilon_t^2) = \sigma^2, E(\varepsilon_t \varepsilon_s) = 0 \text{ if } t \neq s$$

The first difference of the random walk equation is given as:

$$y_t = x_t - x_{t-1} = x_{t-1} + \varepsilon_t - x_{t-1} = \varepsilon_t, E(\varepsilon_t) = 0, E(\varepsilon_t^2) = \sigma^2, E(\varepsilon_t \varepsilon_s) = 0 \text{ for } t \neq s$$

Random Walk with a Drift

$$\begin{aligned} x_t &= b_0 + b_1 x_{t-1} + \varepsilon_t \\ b_1 &= 1, b_0 \neq 0, \text{ or} \\ x_t &= b_0 + x_{t-1} + \varepsilon_t, E(\varepsilon_t) = 0 \end{aligned}$$

The first-difference of the random walk with a drift equation is given as:

$$y_t = x_t - x_{t-1}, y_t = b_0 + \varepsilon_t, b_0 \neq 0$$

The Unit Root Test of Nonstationarity

$$\begin{aligned} x_t &= b_0 + b_1 x_{t-1} + \varepsilon_t \\ x_t - x_{t-1} &= b_0 + b_1 x_{t-1} - x_{t-1} + \varepsilon_t \\ x_t - x_{t-1} &= b_0 + (b_1 - 1)x_{t-1} + \varepsilon_t \\ x_t - x_{t-1} &= b_0 + g_1 x_{t-1} + \varepsilon_t \end{aligned}$$

Autoregressive Moving Average (ARMA) Models

$$x_t = b_0 + b_1 x_{t-1} + \dots + b_p x_{t-p} + \varepsilon_t + \theta_1 \varepsilon_{t-1} + \dots + \theta_q \varepsilon_{t-q}$$

$$E(\varepsilon_t) = 0, E(\varepsilon_t^2) = \sigma^2, E(\varepsilon_t \varepsilon_s) = 0 \text{ for } t \neq s$$

Autoregressive Conditional Heteroskedasticity Models (ARCH Models)

$$\hat{\varepsilon}_t^2 = a_0 + \hat{a}_1 \hat{\varepsilon}_{t-1}^2 + u_t$$

The error in period $t+1$ can then be predicted using the following formula:

$$\hat{\sigma}_{t+1}^2 = \hat{a}_0 + \hat{a}_1 \hat{\varepsilon}_t^2$$

EXCERPT FROM “PROBABILISTIC APPROACHES: SCENARIO ANALYSIS,
DECISION TREES, AND SIMULATION”

Table 2-1: Risk Types and Probabilistic Approaches

Discrete/ Continuous	Correlated/ Independent	Sequential/ Concurrent	Risk Approach
Discrete	Independent	Sequential	Decision tree %
Discrete	Correlated	Concurrent	Scenario analysis
Continuous	Either	Either	Simulations

ECONOMICS

CURRENCY EXCHANGE RATES: DETERMINATION AND FORECASTING

Currency Cross Rates

For example, given the USD/EUR and JPY/USD exchange rates, we can calculate the cross rate between the JPY and the EUR, JPY/EUR as follows:

$$\frac{\text{JPY}}{\text{EUR}} = \frac{\text{JPY}}{\text{USD}} \times \frac{\text{USD}}{\text{EUR}}$$

Cross Rate Calculations with Bid-Ask Spreads

$$\text{USD/EUR}_{\text{bid}} = 1.3802$$

- Represents the price of **EUR** (base currency).
- An investor can **sell** EUR for USD at this price (as it is the **bid** price quoted by the dealer).

$$\text{USD/EUR}_{\text{ask}} = 1.3806$$

- Represents the price of **EUR**
- An investor can **buy** EUR with USD at this price.

Determining the EUR/USD_{bid} cross rate:

$$\text{EUR/USD}_{\text{bid}} = 1/(\text{USD/EUR}_{\text{ask}})$$

Determining the EUR/USD_{ask} cross rate:

$$\text{EUR/USD}_{\text{ask}} = 1/(\text{USD/EUR}_{\text{bid}})$$

Forward exchange rates (F) - One year Horizom

$$F_{\text{FC/DC}} = S_{\text{FC/DC}} \times \frac{(1 + i_{\text{FC}})}{(1 + i_{\text{DC}})}$$

$$F_{\text{PC/BC}} = S_{\text{PC/BC}} \times \frac{(1 + i_{\text{PC}})}{(1 + i_{\text{BC}})}$$

Forward exchange rates (F) - Any Investment Horizom

$$F_{\text{FC/DC}} = S_{\text{FC/DC}} \times \frac{1 + (i_{\text{FC}} \times \text{Actual}/360)}{1 + (i_{\text{DC}} \times \text{Actual}/360)}$$

$$F_{\text{PC/BC}} = S_{\text{PC/BC}} \times \frac{1 + (i_{\text{PC}} \times \text{Actual}/360)}{1 + (i_{\text{BC}} \times \text{Actual}/360)}$$

Currencies Trading at a Forward Premium/Discount

$$F_{\text{FC/DC}} - S_{\text{FC/DC}} = S_{\text{FC/DC}} \left(\frac{(i_{\text{FC}} - i_{\text{DC}}) \times \text{Actual}/360}{1 + (i_{\text{DC}} \times \text{Actual}/360)} \right)$$

$$F_{\text{PC/BC}} - S_{\text{PC/BC}} = S_{\text{PC/BC}} \left(\frac{(i_{\text{PC}} - i_{\text{BC}}) \times \text{Actual}/360}{1 + (i_{\text{BC}} \times \text{Actual}/360)} \right)$$

Covered Interest Rate Parity

$$F_{PC/BC} = S_{PC/BC} \times \frac{1 + (i_{PC} \times \text{Actual}/360)}{1 + (i_{BC} \times \text{Actual}/360)}$$

The forward premium (discount) on the base currency can be **expressed** as a percentage as:

$$\text{Forward premium (discount) as a \%} = \frac{F_{PC/BC} - S_{PC/BC}}{S_{PC/BC}}$$

The forward premium (discount) on the base currency can be **estimated** as:

$$\text{Forward premium (discount) as a \%} \approx F_{PC/BC} - S_{PC/BC} \approx i_{PC} - i_{BC}$$

Uncovered Interest Rate Parity

Expected future spot exchange rate:

$$S_{FC/DC}^e = S_{FC/DC} \times \frac{(1 + i_{FC})}{(1 + i_{DC})}$$

The expected percentage change in the spot exchange rate can be **calculated** as:

$$\text{Expected \% change in spot exchange rate} = \% \Delta S_{PC/BC}^e = \frac{S_{PC/BC}^e - S_{PC/BC}}{S_{PC/BC}}$$

The expected percentage change in the spot exchange rate can be **estimated** as:

$$\text{Expected \% change in spot exchange rate} \approx \% \Delta S_{PC/BC}^e \approx i_{PC} - i_{BC}$$

Purchasing Power Parity (PPP)

$$\text{Law of one price : } P_{FC}^X = P_{DC}^X \times S_{FC/DC}$$

$$\text{Law of one price : } P_{PC}^X = P_{BC}^X \times S_{PC/BC}$$

Absolute Purchasing Power Parity (Absolute PPP)

$$S_{FC/DC} = \text{GPL}_{FC} / \text{GPL}_{DC}$$

$$S_{PC/BC} = \text{GPL}_{PC} / \text{GPL}_{BC}$$

Relative Purchasing Power Parity (Relative PPP)

$$\text{Relative PPP: } E(S_{FC/DC}^T) = S_{FC/DC}^0 \left(\frac{1 + \pi_{FC}}{1 + \pi_{DC}} \right)^T$$

Ex Ante Version of PPP

$$\text{Ex ante PPP: } \% \Delta S_{FC/DC}^e \approx \pi_{FC}^e - \pi_{DC}^e$$

$$\text{Ex ante PPP: } \% \Delta S_{PC/BC}^e \approx \pi_{PC}^e - \pi_{BC}^e$$

Real Exchange Rates

The real exchange rate ($q_{FC/DC}$) equals the ratio of the domestic price level expressed in the foreign currency to the foreign price level.

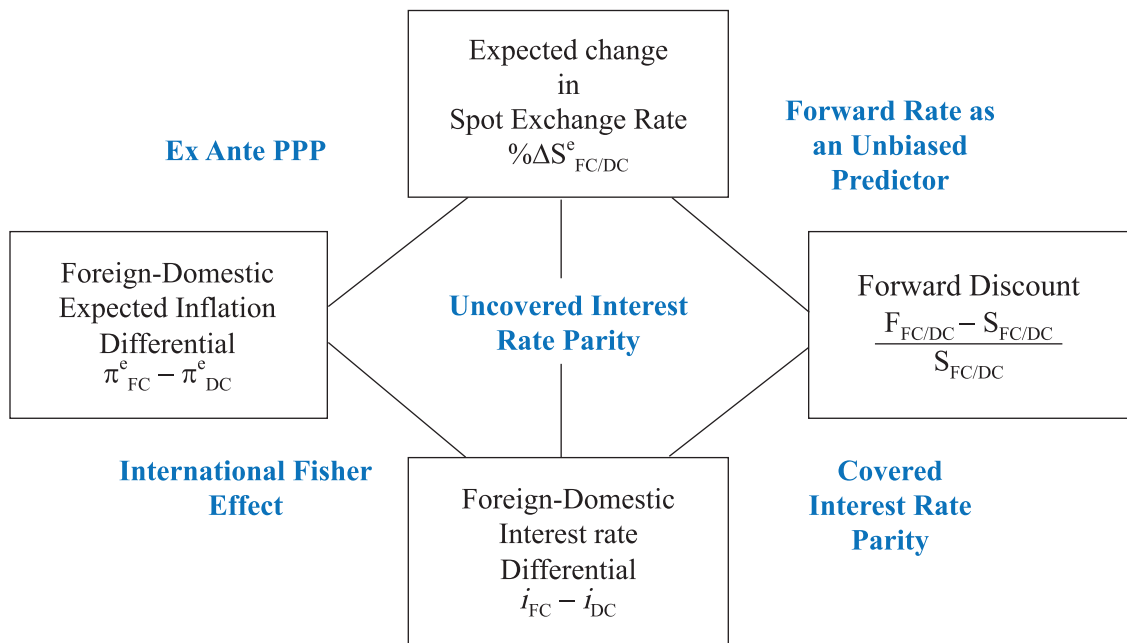
$$q_{FC/DC} = \frac{P_{DC} \text{ in terms of FC}}{P_{FC}} = \frac{P_{DC} \times S_{FC/DC}}{P_{FC}} = S_{FC/DC} \left(\frac{P_{DC}}{P_{FC}} \right)$$

The Fisher Effect

$$\text{Fischer Effect: } i = r + \pi^e$$

$$\text{International Fisher effect: } (i_{FC} - i_{DC}) = (\pi_{FC}^e - \pi_{DC}^e)$$

Figure 1: Spot Exchange Rates, Forward Exchange Rates, and Interest Rates



Balance of Payment

$$\text{Current account} + \text{Capital account} + \text{Financial account} = 0$$

Real Interest Rate Differentials, Capital Flows and the Exchange Rate

$$q_{L/H} - q_{L/H} = (i_H - i_L) - (\pi^e_H - \pi^e_L) - (\Phi_H - \Phi_L)$$

The Taylor rule

$$i = r_n + \pi + \alpha(\pi - \pi^*) + \beta(y - y^*)$$

where

i = the Taylor rule prescribed central bank policy rate

r_n = the neutral real policy rate

π = the current inflation rate

π^* = the central bank's target inflation rate

y = the log of the current level of output

y^* = the log of the economy's potential/sustainable level of output

$$q_{PC/BC} = \bar{q}_{PC/BC} + (r_n^{BC} - r_n^{PC}) + \alpha[(\pi_{BC} - \pi_{BC}^*) - (\pi_{PC} - \pi_{PC}^*)] \\ + \beta[(y_{BC} - y_{BC}^*) - (y_{PC} - y_{PC}^*)] - (\Phi_{BC} - \Phi_{PC})$$

ECONOMIC GROWTH AND THE INVESTMENT DECISION

Relationship between economic growth and stock prices

$$P = \text{GDP} \left(\frac{E}{\text{GDP}} \right) \left(\frac{P}{E} \right)$$

P = Aggregate price or value of earnings.

E = Aggregate earnings.

This equation can also be expressed in terms of growth rates:

$$\Delta P = \Delta(\text{GDP}) + \Delta(E/\text{GDP}) + \Delta(P/E)$$

Production Function

$$Y = AK^\alpha L^{1-\alpha}$$

Y = Level of aggregate output in the economy.

L = Quantity of labor.

K = Quantity of capital.

A = Total factor productivity. **Total factor productivity (TFP)** reflects the general level of productivity or technology in the economy. TFP is a scale factor i.e., an increase in TFP implies a proportionate increase in output for any combination of inputs.

α = Share of GDP paid out to capital.

$1 - \alpha$ = Share of GDP paid out to labor.

$$y = Y/L = A(K/L)^\alpha (L/L)^{1-\alpha} = Ak^\alpha$$

y = Y/L = Output per worker or **labor productivity**.

k = K/L = Capital per worker or **capital-labor ratio**.

Cobb-Douglas production function

$$\Delta Y/Y = \Delta A/A + \alpha \Delta K/K + (1 - \alpha) \Delta L/L$$

Potential GDP

$$\begin{aligned} \text{Growth rate in potential GDP} = & \text{Long-term growth rate of labor force} \\ & + \text{Long-term growth rate in labor productivity} \end{aligned}$$

Labor Supply

$$\text{Total number of hours available for work} = \text{Labor force} \times \text{Average hours worked per worker}$$

Neoclassical Model (Solow's Model)

$$\frac{Y}{K} = \left(\frac{1}{s}\right) \left[\left(\frac{\theta}{(1-\alpha)} \right) + \delta + n \right] \equiv \Psi$$

s = Fraction of income that is saved

θ = Growth rate of TEP

α = Elasticity of output with respect to capital

y = Y/L or income per worker

k = K/L or capital-labor ratio

δ = Constant rate of depreciation on physical stock

n = Labor supply growth rate.

Savings/Investment Equation:

$$sy = \left[\left(\frac{\theta}{(1-\alpha)} \right) + \delta + n \right] k$$

Growth rates of Output Per Capita and the Capital-Labor Ratio

$$\begin{aligned} \frac{\Delta y}{y} &= \frac{\theta}{(1-\alpha)} + \alpha s \frac{Y}{K} - \Psi \\ \frac{\Delta k}{k} &= \left(\frac{\theta}{(1-\alpha)} \right) + s \left(\frac{Y}{K} - \Psi \right) \end{aligned}$$

Production Function in the Endogenous Growth Model

$$y_e = f(k_e) = ck_e$$

FINANCIAL REPORTING AND ANALYSIS

INTERCORPORATE INVESTMENTS

Summary of Accounting Treatment for Investments

	In Financial Assets	In Associates	Business Combinations	In Joint Ventures
Influence	Not significant	Significant	Controlling	Shared Control
Typical percentage interest	Usually < 20%	Usually 20%–50%	Usually > 50%	Varies
Current Financial Reporting Treatment (prior to IFRS 9 taking effect)	Classified as <ul style="list-style-type: none"> • Held-to-maturity. • Available-for-sale. • Fair value through profit or loss (held for trading or designated as fair value). • Loans and receivables. 	Equity method	Consolidation	IFRS: Equity method or proportionate consolidation.
New Financial Reporting Treatment (post IFRS 9 taking effect)	Classified as <ul style="list-style-type: none"> • Fair value through profit or loss. • Fair value through other comprehensive income. • Amortized cost. 	Equity method	Consolidation	IFRS: Equity method

Types of Business Combination

Combination	Description
Merger	Company A + Company B = Company A
Acquisition	Company A + Company B = (Company A + Company B)
Consolidation	Company A + Company B = Company C

Adjusted Values Upon Reclassification of Sale of Receivables:

CFO	Lower
CFF	Higher
Total cash flow	Same
Current assets	Higher
Current liabilities	Higher
Current ratio	Lower
(Assuming it was greater than 1)	

Impact of Different Accounting Methods on Financial Ratios

	Equity Method	Acquisition Method
<i>Leverage</i>	Better (lower) as liabilities are lower and equity is the same	Worse (higher) as liabilities are higher and equity is the same
<i>Net Profit Margin</i>	Better (higher) as sales are lower and net income is the same	Worse (lower) as sales are higher and net income is the same
<i>ROE</i>	Better (higher) as equity is lower and net income is the same	Worse (lower) as equity is higher and net income is the same
<i>ROA</i>	Better (higher) as net income is the same and assets are lower	Worse (lower) as net income is the same and assets are higher

EMPLOYEE COMPENSATION: POST-EMPLOYMENT AND SHARE-BASED

Final year's salary = Current salary $\times [(1 + \text{Annual compensation increase})^{\text{years until retirement}}]$

Estimated annual payment = (Estimated final salary \times Benefit formula) \times Years of service

Annual unit credit = Value at retirement / Years of service

Types of Post-Employment Benefits

Type of Benefit	Amount of Post-Employment Benefit to Employee	Obligation of Sponsoring Company	Sponsoring Company's Pre-funding of Its Future Obligation
Defined contribution pension plan	Amount of future benefit is not defined. Actual future benefit will depend on investment performance of plan assets. Investment risk is borne by employee.	Amount of the company's obligation (contribution) is defined in each period. The contribution, if any, is typically made on a periodic basis with no additional future obligation.	Not applicable.
Defined benefit pension plan	Amount of future benefit is defined, based on the plan's formula (often a function of length of service and final year's compensation). Investment risk is borne by company.	Amount of the future obligation, based on the plan's formula, must be estimated in the current period.	Companies typically pre-fund the DB plans by contributing funds to a pension trust. Regulatory requirements to pre-fund vary by country.
Other post-employment benefits (e.g., retirees' health care)	Amount of future benefit depends on plan specifications and type of benefit.	Eventual benefits are specified. The amount of the future obligation must be estimated in the current period.	Companies typically do not pre-fund other post-employment benefit obligations.

A company's pension obligation will *increase* as a result of:

- Current service costs.
- Interest costs.
- Past service costs.
- Actuarial losses.

A company's pension obligation will *decrease* as a result of:

- Actuarial gains.
- Benefits paid.

Reconciliation of the Pension Obligation:

Pension obligation at the beginning of the period

- + Current service costs
- + Interest costs
- + Past service costs
- + Actuarial losses
- Actuarial gains
- Benefits paid

Pension obligation at the end of the period

The fair value of assets held in the pension trust (plan) will *increase* as a result of:

- A positive actual dollar return earned on plan assets; and
- Contributions made by the employer to the plan.

The fair value of plan assets will *decrease* as a result of:

- Benefits paid to employees.

Reconciliation of the Fair Value of Plan Assets:

Fair value of plan assets at the beginning of the period

- + Actual return on plan assets
- + Contributions made by the employer to the plan
- Benefits paid to employees

Fair value of plan assets at the end of the period

Balance Sheet Presentation of Defined Benefit Pension Plans

$$\text{Funded status} = \text{Pension obligation} - \text{Fair value of plan assets}$$

- If Pension obligation > Fair value of plan assets:
Plan is underfunded → Positive funded status → Net pension liability.
- If Pension obligation < Fair value of plan assets:
Plan is overfunded → Negative funded status → Net pension asset.

Calculating Periodic Pension Cost

$$\text{Periodic pension cost} = \text{Ending funded status} - \text{Beginning funded status} + \text{Employer contributions}$$

$$\begin{aligned} \text{Periodic pension cost} = & \text{Current service costs} + \text{Interest costs} + \text{Past service costs} \\ & + \text{Actuarial losses} - \text{Actuarial gains} - \text{Actual return on plan assets} \end{aligned}$$

Under the **corridor method**, if the net cumulative amount of unrecognized actuarial gains and losses at the beginning of the reporting period exceeds 10% of the greater of (1) the defined benefit obligation or (2) the fair value of plan assets, then the *excess* is amortized over the expected average remaining working lives of the employees participating in the plan and included as a component of periodic *pension expense* on the P&L.

Components of a Company's Defined Benefit Pension Periodic Costs

IFRS Component	IFRS Recognition	U.S. GAAP Component	U.S. GAAP Recognition
Service costs	Recognized in P&L.	Current service costs Past service costs.	Recognized in P&L. Recognized in OCI and subsequently amortized to P&L over the service life of employees.
Net interest income/expense	Recognized in P&L as the following amount: Net pension liability or asset \times interest rate ^(a) .	Interest expense on pension obligation Expected return on plan assets.	Recognized in P&L. Recognized in P&L as the following amount: Plan assets \times expected return.
Remeasurements: Net return on plan assets and actuarial gains and losses	Recognized in OCI and <u>not</u> subsequently amortized to P&L. <ul style="list-style-type: none"> • Net return on plan assets = Actual return – (Plan assets \times Interest rate). • Actuarial gains and losses = Changes in a company's pension obligation arising from changes in actuarial assumptions. 	Actuarial gains and losses including differences between the actual and expected returns on plan assets.	Recognized immediately in P&L or, more commonly, recognized in OCI and subsequently amortized to P&L using the corridor or faster recognition method. ^(b) <ul style="list-style-type: none"> • Difference between expected and actual return on assets = Actual return – (Plan assets \times Expected return). • Actuarial gains and losses = Changes in a company's pension obligation arising from changes in actuarial assumptions.

(a) The interest rate used is equal to the discount rate used to measure the pension liability (the yield on high-quality corporate bonds.)

(b) If the cumulative amount of unrecognized actuarial gains and losses exceeds 10 percent of the greater of the value of the plan assets or of the present value of the DB obligation (under U.S. GAAP, the projected benefit obligation), the difference must be amortized over the service lives of the employees.

Impact of Key Assumptions on Net Pension Liability and Periodic Pension Cost

Assumption	Impact of Assumption on Net Pension Liability (Asset)	Impact of Assumption on Periodic Pension Cost and Pension Expense
Higher discount rate	Lower obligation	Pension cost and pension expense will both typically be lower because of lower opening obligation and lower service costs.
Higher rate of compensation increase	Higher obligation	Higher service and interest costs will increase periodic pension cost and pension expense.
Higher expected return on plan assets	No effect, because fair value of plan assets are used on balance sheet	Not applicable for IFRS. No effect on periodic pension cost under U.S. GAAP. Lower periodic pension expense under U.S. GAAP.

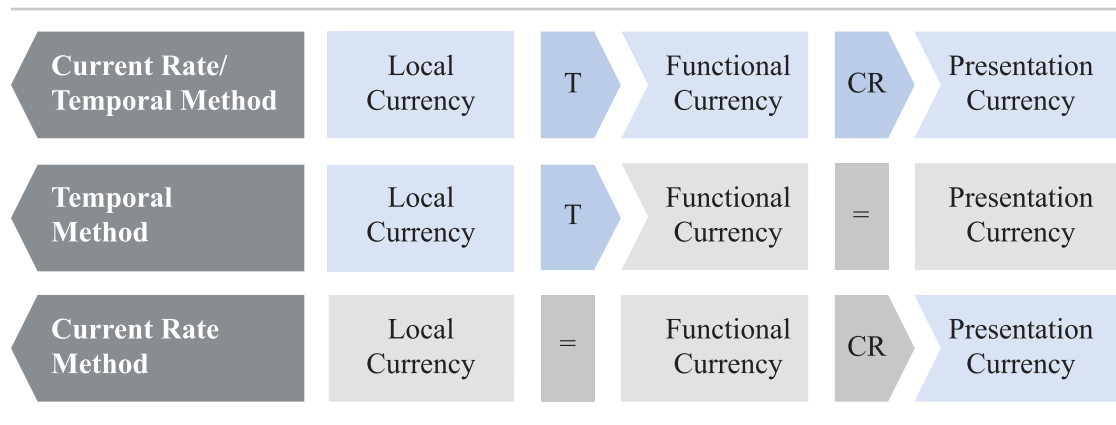
MULTINATIONAL OPERATIONS

- The **presentation currency (PC)** is the currency in which the parent company reports its financial statements. It is typically the currency of the country where the parent is located. For example, U.S. companies are required to present their financial results in USD, German companies in EUR, Japanese companies in JPY, and so on.
- The **functional currency (FC)** is the currency of the primary business environment in which an entity operates. It is usually the currency in which the entity primarily generates and expends cash.
- The **local currency (LC)** is the currency of the country where the subsidiary operates.

Table 1

Transaction	Type of Exposure	Foreign Currency	
		Strengthens	Weakens
Export sale	Asset (account receivable)	Gain	Loss
Import purchase	Liability (account payable)	Loss	Gain

Methods for Translating Foreign Currency Financial Statements of Subsidiaries



- The **current rate** is the exchange rate that exists on the balance sheet date.
- The **average rate** is the average exchange rate over the reporting period.
- The **historical rate** is the actual exchange rate that existed on the original transaction date.

Rules for Foreign Currency Translation

	Current Rate Method FC = LC	Temporal Method FC = PC
Income Statement Component	Exchange Rate Used	
Sales	Average rate	Average rate
Cost of goods sold	Average rate	Historical rate
Selling expenses	Average rate	Average rate
Depreciation expense	Average rate	Historical rate
Amortization expense	Average rate	Historical rate
Interest expense	Average rate	Average rate
Income tax	Average rate	Average rate
Net income before translation gain (loss)		Computed as Rev – Exp
Translation gain (loss)	N/A	Plug in Number
Net income	Computed as Rev – Exp	Computed as $\Delta RE +$
Less: Dividends	Historical rate	Dividends
Change in retained earnings	Computed as NI – Dividends Used as input for translated B/S	Historical rate From B/S
Balance Sheet Component	Exchange Rate Used	
Cash	Current rate	Current rate
Accounts receivable	Current rate	Current rate
Monetary assets	Current rate	Current rate
Inventory	Current rate	Historical rate
Nonmonetary assets measured at current value	Current rate	Current rate
Property, plant and equipment	Current rate	Historical rate
Less: Accumulated depreciation	Current rate	Historical rate
Nonmonetary assets measured at historical cost	Current rate	Historical rate
Accounts payable	Current rate	Current rate
Long-term notes payable	Current rate	Current rate
Monetary liabilities	Current rate	Current rate
Nonmonetary liabilities:		
Measured at current value	Current rate	Current rate
Measured at historical cost	Current rate	Historical rate
Capital stock	Historical rate	Historical rate
Retained earnings	From I/S	To balance Used as input for translated I/S
Cumulative translation adjustment	Plug in Number	N/A

Balance Sheet Exposure

Balance Sheet Exposure	Foreign Currency (FC)	
	Strengthens	Weakens
Net asset	Positive translation adjustment	Negative translation adjustment
Net liability	Negative translation adjustment	Positive translation adjustment

Effects of Exchange Rate Movements on Financial Statements

	Temporal Method, Net Monetary Liability Exposure	Temporal Method, Net Monetary Asset Exposure	Current Rate Method
Foreign currency strengthens relative to parent's presentation currency	↑Revenues ↑Assets ↑Liabilities ↓Net income ↓Shareholders' equity Translation loss	↑Revenues ↑Assets ↑Liabilities ↑Net income ↑Shareholders' equity Translation gain	↑Revenues ↑Assets ↑Liabilities ↑Net income ↑Shareholders' equity Positive translation adjustment
Foreign currency weakens relative to parent's presentation currency	↓Revenues ↓Assets ↓Liabilities ↑Net income ↑Shareholders' equity Translation gain	↓Revenues ↓Assets ↓Liabilities ↓Net income ↓Shareholders' equity Translation loss	↓Revenues ↓Assets ↓Liabilities ↓Net income ↓Shareholders' equity Negative translation adjustment

Relationship between Financial Reporting Quality and Earnings Quality

		Financial Reporting Quality	
		Low	High
Earnings (Results) Quality	High		HIGH financial reporting quality enables assessment. HIGH earnings quality increases company value.
	Low	LOW financial reporting quality impedes assessment of earnings quality and impedes valuation.	HIGH financial reporting quality enables assessment. LOW earnings quality decreases company value.

Accounting Warning Signs¹

Potential Issues	Possible Actions/Choices	Warning Signs
<ul style="list-style-type: none"> • Overstatement or non-sustainability of operating income and/or net income <ul style="list-style-type: none"> ○ Overstated or accelerated revenue recognition ○ Understated expenses ○ Misclassification of revenue, gains, expenses, or losses 	<ul style="list-style-type: none"> • Contingent sales with right of return, “channel stuffing” (the practice of inducing customers to order products they would otherwise not order or order at a later date through generous terms), “bill and hold” sales (encouraging customers to order goods and retain them on seller's premises) • Lessor use of finance (capital) leases • Fictitious (fraudulent) revenue • Capitalizing expenditures as assets • Lessee use of operating leases • Classifying non-operating income or gains as part of operations • Classifying ordinary expenses as non-recurring or non-operating • Reporting gains through net income and losses through other comprehensive income 	<ul style="list-style-type: none"> • Growth in revenue higher than that of industry or peers • Increases in discounts to and returns from customers • Higher growth rate in receivables than revenue • Large proportion of revenue in final quarter of year for a non-seasonal business • Cash flow from operations is much lower than operating income • Inconsistency over time in the items included in operating revenues and operating expenses • Increases in operating margin • Aggressive accounting assumptions, such as long, depreciable lives • Losses in non-operating income or other comprehensive income and gains in operating income or net income • Compensation largely tied to financial results
<ul style="list-style-type: none"> • Misstatement of balance sheet items (may affect income statement) <ul style="list-style-type: none"> ○ Over- or understatement of assets ○ Over- or understatement of liabilities ○ Misclassification of assets and/or liabilities 	<ul style="list-style-type: none"> • Choice of models and model inputs to measure fair value • Classification from current to non-current • Over- or understating reserves and allowances • Understating identifiable assets and overstating goodwill 	<ul style="list-style-type: none"> • Models and model inputs that bias fair value measures • Inconsistency in model inputs when measuring fair value of assets compared with that of liabilities • Typical current assets, such as accounts receivable and inventory, included in non-current assets • Allowances and reserves that fluctuate over time or are not comparable with peers • High goodwill value relative to total assets • Use of special purpose vehicles • Large changes in deferred tax assets and liabilities • Significant off-balance-sheet liabilities
<ul style="list-style-type: none"> • Overstatement of cash flow from operations 	<ul style="list-style-type: none"> • Managing activities to affect cash flow from operations • Misclassifying cash flows to positively affect cash flow from operations 	<ul style="list-style-type: none"> • Increase in accounts payable and decrease in accounts receivable and inventory • Capitalized expenditures in investing activities • Sales and leaseback • Increases in bank overdrafts

¹2015 CFA Program Curriculum Volume 2, page 305–305, Exhibit 4.

The Beinish Model

$$\begin{aligned} \text{M-score} = & -4.84 + 0.920(\text{DSR}) + 0.528(\text{GMI}) + 0.404(\text{AQI}) + 0.892(\text{SGI}) \\ & + 0.115(\text{DEPI}) - 0.172(\text{SGAI}) + 4.670(\text{Accruals}) - 0.327(\text{LEVI}) \end{aligned}$$

Altman Model

$$\begin{aligned} \text{Z-score} = & 1.2(\text{Net working capital/Total assets}) + 1.4(\text{Retained earnings/Total assets}) \\ & + 3.3(\text{EBIT/Total assets}) + 0.6(\text{Market value of equity/Book value of liabilities}) \\ & + 1.0(\text{Sales/Total assets}) \end{aligned}$$

INTEGRATION OF FINANCIAL STATEMENT ANALYSIS TECHNIQUES

A Financial Statement Analysis Framework:

Phase	Sources of Information	Examples of Output
1. Define the purpose and context of the analysis.	<ul style="list-style-type: none"> The nature of the analyst's function, such as evaluating an equity or debt investment or issuing a credit rating. Communication with client or supervisor on needs and concerns. Institutional guidelines related to developing specific work product. 	<ul style="list-style-type: none"> Statement of the purpose or objective of analysis. A list (written or unwritten) of specific questions to be answered by the analysis. Nature and content of report to be provided. Timetable and budgeted resources for completion.
2. Collect input data.	<ul style="list-style-type: none"> Financial statements, other financial data, questionnaires, and industry/economic data. Discussions with management, suppliers, customers, and competitors. Company site visits (e.g., to production facilities or retail stores). 	<ul style="list-style-type: none"> Organized financial statements. Financial data tables. Completed questionnaires, if applicable.
3. Process input data, as required, into analytically useful data.	<ul style="list-style-type: none"> Data from the previous phase. 	<ul style="list-style-type: none"> Adjusted financial statements. Common-size statements. Forecasts.
4. Analyze/interpret the data.	<ul style="list-style-type: none"> Input data and processed data. 	<ul style="list-style-type: none"> Analytical results.
5. Develop and communicate conclusions and recommendations (e.g., with an analysis report).	<ul style="list-style-type: none"> Analytical results and previous reports. Institutional guidelines for published reports. 	<ul style="list-style-type: none"> Analytical report answering questions posed in Phase 1. Recommendations regarding the purpose of the analysis, such as whether to make an investment or grant credit.
6. Follow-up.	<ul style="list-style-type: none"> Information gathered by periodically repeating above steps as necessary to determine whether changes to holdings or recommendations are necessary. 	<ul style="list-style-type: none"> Update reports and recommendations.

DuPont Analysis

$$\text{ROE} = \text{Tax Burden} \times \text{Interest burden} \times \text{EBIT margin} \times \text{Total asset turnover} \times \text{Financial leverage}$$

$$\text{ROE} = \frac{\text{NI}}{\text{EBT}} \times \frac{\text{EBT}}{\text{EBIT}} \times \frac{\text{EBIT}}{\text{Revenue}} \times \frac{\text{Revenue}}{\text{Average Asset}} \times \frac{\text{Average Asset}}{\text{Average Equity}}$$

CORPORATE FINANCE

CAPITAL BUDGETING

Expansion Project

Initial investment outlay for a new investment = FCInv + NWCInv

$NWCInv = \Delta \text{Non-cash current assets} - \Delta \text{Non-debt current liabilities}$

Annual after-tax operating cash flows (CF)

$$CF = (S - C - D)(1 - t) + D \quad \text{or} \quad CF = (S - C)(1 - t) + tD$$

Terminal year after-tax non-operating cash flow (TNOCF):

$$TNOCF = Sal_T + NWCInv - t(Sal_T - BV_T)$$

Replacement Project

Investment outlays:

$$\text{Initial investment for a replacement project} = FCInv + NWCInv - Sal_0 + t(Sal_0 - BV_0)$$

Annual after-tax operating cash flow:

$$\Delta CF = (\Delta S - \Delta C)(1 - t) + t\Delta D$$

Terminal year after-tax non-operating cash flow:

$$TNOCF = Sal_T + NWCInv - t(Sal_T - B_T)$$

Mutually Exclusive Projects with Unequal Lives

1. Least Common Multiple of Lives Approach

In this approach, both projects are repeated until their “chains” extend over the same time horizon. Given equal time horizons, the NPVs of the two project chains are compared and the project with the higher chain NPV is chosen.

2. Equivalent Annual Annuity Approach (EAA)

This approach calculates the annuity payment (equal annual payment) over the project's life that is equivalent in present value (PV) to the project's NPV. The project with the higher EAA is chosen.

SML

$$R_i = R_F + \beta_i [E(R_M) - R_F]$$

R_i = Required return for project or asset i

R_F = Risk-free rate of return

β_i = Beta of project or asset i

$[E(R_M) - R_F]$ = Market risk premium

Economic Income

Economic income = After-tax operating cash flow + Increase in market value
 Economic income = After-tax operating cash flow + (Ending market value – Beginning market value)
 Economic income = After-tax operating cash flow – (Beginning market value – Ending market value)
 Economic income = After-tax cash flows – Economic depreciation

Economic Profit

Economic profit = [EBIT (1 – Tax rate)] – \$WACC
 Economic profit = NOPAT – \$WACC
 NOPAT = Net operating profit after tax
 \$WACC = Dollar cost of capital = Cost of capital (%) × Invested capital

Under this approach, a project's NPV is calculated as the sum of the present values of economic profit earned over its life discounted at the cost of capital.

$$NPV = MVA = \sum_{t=1}^{\infty} \frac{EP_t}{(1 + WACC)^t}$$

Residual Income

Residual income = Net income for the period – Equity charge for the period
 Equity charge for the period = Required return on equity × Beginning-of-period book value of equity

The RI approach calculates value from the perspective of equity holders only. Therefore, future residual income is discounted at the **required rate of return on equity** to calculate NPV.

$$NPV = \sum_{t=1}^{\infty} \frac{RI_t}{(1 + r_E)^t}$$

Claims Valuation

- First, we separate the cash flows available to debt and equity holders
- Then we discount them at their respective required rates of return.
 - Cash flows available to debt holders are discounted at the cost of debt.
 - Cash flows available to equity holders are discounted at the cost of equity.
- The present values of the two cash flow streams are added to calculate the total value of the company/asset.

CAPITAL STRUCTURE

The Capital Structure Decision

$$r_{WACC} = \left(\frac{D}{V}\right) r_D (1-t) + \left(\frac{E}{V}\right) r_E$$

r_D = Marginal cost of debt

r_E = Marginal cost of equity

t = Marginal tax rate

D = Market value of the company's outstanding debt

E = Market value of shareholders' equity

$V = D + E$ = Value of the company

MM Proposition II without Taxes: Higher Financial Leverage Raises the Cost of Equity

$$r_{WACC} = \left(\frac{D}{V}\right) r_D + \left(\frac{E}{V}\right) r_E = r_0$$

Company's cost of equity (r_E) under MM Proposition II without taxes is calculated as:

$$r_E = r_0 + (r_0 - r_D) \frac{D}{E}$$

Intercept
Independent variable
Dependent variable
Slope

The total value of the company is calculated as:

$$V = \frac{\text{Interest}}{r_D} + \frac{\text{EBIT} - \text{Interest}}{r_E}$$

The systematic risk (β) of the company's assets can be expressed as the weighted average of the systematic risk of the company's debt and equity.

$$\beta_A = \left(\frac{D}{V}\right) \beta_D + \left(\frac{E}{V}\right) \beta_E$$

This formula can also be expressed as:

$$\beta_E = \beta_A + (\beta_A - \beta_D) \left(\frac{D}{E}\right)$$

Relaxing the Assumption of no Taxes

$$V_L = V_U + tD$$

The WACC is then calculated as:

$$r_{WACC} = \left(\frac{D}{V}\right) r_D (1 - t) + \left(\frac{E}{V}\right) r_E$$

And the cost of equity is calculated as:

$$r_E = r_0 + (r_0 - r_D) (1 - t) \left(\frac{D}{E}\right)$$

Modigliani and Miller Propositions

	Without Taxes	With Taxes
Proposition I	$V_L = V_U$	$V_L = V_U + tD$
Proposition II	$r_E = r_0 + (r_0 - r_D) \frac{D}{E}$	$r_E = r_0 + (r_0 - r_D) (1 - t) \left(\frac{D}{E}\right)$

The Optimal Capital Structure: The Static Trade-Off Theory

$$V_L = V_U + tD - PV(\text{Costs of financial distress})$$

DIVIDENDS AND SHARE REPURCHASE

The expected decrease in share price when it goes ex-dividend can be calculated using the following equation:

$$P_W - P_X = \frac{1 - T_D}{1 - T_{CG}} \times D$$

P_W = Share price with the right to receive the dividend

P_X = Share price without the right to receive the dividend

D = Amount of dividend

T_D = Tax rate on dividends

T_{CG} = Tax rate on capital gains

Double Taxation System

$$ETR = CTR + [(1 - CTR) \times MTR_D]$$

ETR = Effective tax rate

CTR = Corporate tax rate

MTR_D = Investor's marginal tax rate on dividends

Split-Rate Tax System

$$ETR = CTR_D + [(1 - CTR_D) \times MTR_D]$$

CTR_D = Corporate tax rate on earnings distributed as dividends.

Stable Dividend Policy

The expected increase in dividends is calculated as:

$$\text{Expected dividend increase} = \text{Increase in earnings} \times \text{Target payout ratio} \times \text{Adjustment factor}$$

Adjustment factor = $1/N$

N = Number of years over which the adjustment is expected to occur

Analysis of Dividend Safety

$$\text{Dividend payout ratio} = (\text{dividends} / \text{net income})$$

$$\text{Dividend coverage ratio} = (\text{net income} / \text{dividends})$$

$$\text{FCFE coverage ratio} = \text{FCFE} / [\text{Dividends} + \text{Share repurchases}]$$

MERGERS AND ACQUISITION

Mergers and the Industry Life Cycle

<i>Industry Life Cycle Stage</i>	<i>Industry Description</i>	<i>Motives for Merger</i>	<i>Types of Merger</i>
Pioneering development	<ul style="list-style-type: none"> • Low but slowly increasing sales growth. • Substantial development costs. 	<ul style="list-style-type: none"> • Younger, smaller companies may sell themselves to larger firms in mature or declining industries to enter into a new growth industry. • Young companies may merge with firms that allow them to pool management and capital resources. 	<ul style="list-style-type: none"> • Conglomerate • Horizontal
Rapid accelerating growth	<ul style="list-style-type: none"> • High profit margins. • Low competition. 	<ul style="list-style-type: none"> • To meet substantial capital requirements for expansion. 	<ul style="list-style-type: none"> • Conglomerate • Horizontal
Mature growth	<ul style="list-style-type: none"> • Decrease in the entry of new competitors. • Growth potential remains. 	<ul style="list-style-type: none"> • To achieve economies of scale, savings, and operational efficiencies. 	<ul style="list-style-type: none"> • Horizontal • Vertical
Stabilization and market maturity	<ul style="list-style-type: none"> • Increasing capacity constraints • Increasing competition. 	<ul style="list-style-type: none"> • To achieve economies of scale in research, production, and marketing to match low costs and prices of competitors. • Large companies may buy smaller companies to improve management and provide a broader financial base. 	<ul style="list-style-type: none"> • Horizontal
Deceleration of growth and decline	<ul style="list-style-type: none"> • Overcapacity. • Eroding profit margins. 	<ul style="list-style-type: none"> • Horizontal mergers to ensure survival. • Vertical mergers to increase efficiency and profit margins. • Conglomerate mergers to exploit synergy. • Companies in the industry may acquire companies in young industries. 	<ul style="list-style-type: none"> • Horizontal • Vertical • Conglomerate

Source: Adapted from J. Fred Weston, Kwang S. Chung, and Susan E. Hoag, Mergers, Restructuring, and Corporate Control (New York: Prentice Hall, 1990, p.102) and Bruno Solnik and Dennis McLeavy, International Investments, 5th edition (Boston: Addison Wesley, 2004, p. 264–265).

Major Differences of Stock versus Asset Purchases

	Stock Purchase	Asset Purchase
Payment	Target shareholders receive compensation in exchange for their shares.	Payment is made to the selling company rather than directly to shareholders.
Approval	Shareholder approval required.	Shareholder approval might not be required.
Tax: Corporate	No corporate-level taxes.	Target company pays taxes on any capital gains.
Tax: Shareholder	Target company's shareholders are taxed on their capital gain.	No direct tax consequence for target company's shareholders.
Liabilities	Acquirer assumes the target's liabilities.	Acquirer generally avoids the assumption of liabilities.

Herfindahl-Hirschman Index (HHI)

$$\sum_i^n \left(\frac{\text{Sales or output of firm } i}{\text{Total sales or output of market}} \times 100 \right)^2$$

HHI Concentration Levels and Possible Government Response

Post-Merger HHI	Concentration	Change in HHI	Government Action
Less than 1,000	Not concentrated	Any amount	No action
Between 1,000 and 1,800	Moderately concentrated	100 or more	Possible challenge
More than 1,800	Highly concentrated	50 or more	Challenge

FCFF is estimated by:

	Net income
+	Net interest after tax
=	Unlevered income
+	Changes in deferred taxes
=	NOPLAT (net operating profit less adjusted taxes)
+	Net noncash charges
–	Change in net working capital
–	Capital expenditures (capex)
Free cash flow to the firm (FCFF)	

Net interest after tax = (Interest expense – Interest income) (1 – tax rate)

Working capital = Current assets (excl. cash and equivalents) – Current liabilities (excl. short-term debt)

Comparable Company Analysis

$$TP = \frac{(DP - SP)}{SP}$$

TP = Takeover premium

DP = Deal price per share

SP = Target's stock price per share

Bid Evaluation

Target shareholders' gain = Takeover premium = $P_T - V_T$

Acquirer's gain = Synergies – Premium
 $= S - (P_T - V_T)$

S = Synergies created by the merger transaction

The **post-merger value of the combined company** is composed of the pre-merger value of the acquirer, the pre-merger value of the target, and the synergies created by the merger. These sources of value are adjusted for the cash paid to target shareholders to determine the value of the combined post-merger company.

$$V_{A*} = V_A + V_T + S - C$$

V_{A*} = Value of combined company

C = Cash paid to target shareholders

EQUITY

EQUITY VALUATION: APPLICATIONS AND PROCESSES

Perceived mispricing:

$$\text{Perceived mispricing} = \text{True mispricing} + \text{Error in the estimate of intrinsic value.}$$

$$V_E - P = (V - P) + (V_E - V)$$

V_E = Estimate of intrinsic value

P = Market price

V = True (unobservable) intrinsic value

RETURN CONCEPTS

Holding Period Return

$$\text{Holding period return} = \frac{P_H - P_0 + D_H}{P_0}$$

P_H = Price at the end of the holding period

P_0 = Price at the beginning of the period

D_H = Dividend

Required Return

- The difference between an asset's expected return and its required return is known as **expected alpha**, **ex ante alpha** or **expected abnormal return**.
 - Expected alpha = Expected return – Required return
- The difference between the actual (realized) return on an asset and its required return is known as **realized alpha** or **ex post alpha**.
 - Realized alpha = Actual HPR – Required return for the period

When the investor's estimate of intrinsic value (V_0) is different from the current market price (P_0), the investor's expected return has two components:

1. The **required return** (r_T) earned on the asset's current market price; and
2. The **return from convergence of price to value** $[(V_0 - P_0)/P_0]$.

Internal Rate of Return

$$\text{Intrinsic Value} = \frac{\text{Next year's expected dividend}}{\text{Required return} - \text{Expected dividend growth rate}}$$

$$V_0 = \frac{D_1}{k_e - g}$$

If the asset is assumed to be efficiently-priced (i.e. the market price equals its intrinsic value), the IRR would equal the required return on equity. Therefore, the IRR can be estimated as:

$$\text{Required return (IRR)} = \frac{\text{Next year's dividend}}{\text{Market price}} + \text{Expected dividend growth rate}$$

$$k_e(\text{IRR}) = \frac{D_1}{P_0} + g$$

Equity Risk Premium

The required rate of return on a particular stock can be computed using either of the following two approaches. Both these approaches require the equity risk premium to be estimated first.

1. Required return on share i = Current expected risk-free return + β_i (Equity risk premium)
 - A beta greater (lower) than 1 indicates that the security has greater-than-average (lower-than-average) systematic risk.
2. Required return on share i = Current expected risk-free return + Equity risk premium \pm Other risk premia/discounts appropriate for i
 - This method of estimating the required return is known as the **build-up method**. It is discussed later in the reading and is primarily used for valuations of private businesses.

Gordon Growth Model (GGM) Estimates

$$\text{GCM equity risk premium estimate} = \frac{D_1}{P_0} + g - r_{\text{LTGD}}$$

Macroeconomic Model Estimates

$$\text{Equity risk premium} = \{[(1 + \text{EINFL})(1 + \text{EGREPS})(1 + \text{EGPE}) - 1] + \text{EINC}\} - \text{Expected RF}$$

$$\text{Expected inflation} = \frac{1 + \text{YTM of 20-year maturity T-bonds}}{1 + \text{YTM of 20-year maturity TIPS}} - 1$$

The Capital Asset Pricing Model (CAPM)

$$\text{Required return on } i = \text{Expected risk-free rate} + \beta_{i_i} (\text{Equity risk premium})$$

The Fama-French Model

$$r_i = R_F + \beta_i^{\text{mkt}} \text{RMRF} + \beta_i^{\text{size}} \text{SMB} + \beta_i^{\text{value}} \text{HML}$$

β_{mkt} = Market beta

β_{size} = Size beta

β_{value} = Value beta

The Pastor-Stambaugh model (PSM)

$$r_i = R_F + \beta_i^{\text{mkt}} \text{RMRF} + \beta_i^{\text{size}} \text{SMB} + \beta_i^{\text{value}} \text{HML} + \beta_i^{\text{liq}} \text{LIQ}$$

β^{lia} = Liquidity beta

BIRR model

$$r_i = \text{T-bill rate} + (\text{Sensitivity to confidence risk} \times \text{Confidence risk}) \\ + (\text{Sensitivity to time horizon risk} \times \text{Time horizon risk}) \\ + (\text{Sensitivity to inflation risk} \times \text{Inflation risk}) \\ + (\text{Sensitivity to business cycle risk} \times \text{Business cycle risk}) \\ + (\text{Sensitivity to market timing risk} \times \text{Market timing risk})$$

Build-up method

$$r_i = \text{Risk-free rate} + \text{Equity risk premium} + \text{Size premium} + \text{Specific-company premium}$$

For companies with publicly-traded **debt**, the **bond-yield plus risk premium** approach can be used to calculate the cost of equity:

$$\text{BYPRP cost of equity} = \text{YTM on the company's long-term debt} + \text{Risk premium}$$

Adjusting Beta for Beta Drift

$$\text{Adjusted beta} = (2/3) (\text{Unadjusted beta}) + (1/3) (1.0)$$

Estimating the Asset Beta for the Comparable Publicly Traded Firm:

β_{ASSET} reflects only business risk of the comparable company. Therefore it is used as a proxy for business risk of the project being studied.

$$\beta_{\text{ASSET}} = \beta_{\text{EQUITY}} \left[\frac{1}{1 + \left((1 - t) \frac{D}{E} \right)} \right]$$

β_{EQUITY} reflects business and financial risk of comparable company.

where:

D/E = debt-to-equity ratio of the comparable company.

t = marginal tax rate of the comparable company.

To adjust the asset beta of the comparable for the capital structure (financial risk) of the project or company being evaluated, we use the following formula:

β_{PROJECT} reflects business and financial risk of the project.

$$\beta_{\text{PROJECT}} = \beta_{\text{ASSET}} \left[1 + (1 - t) \frac{D}{E} \right]$$

β_{ASSET} reflects business risk of project.

where:

D/E = debt-to-equity ratio of the subject company.

t = marginal tax rate of the subject company.

Country Spread Model

$$\text{ERP estimate} = \text{ERP for a developed market} + \text{Country premium}$$

Weighted Average Cost of Capital (WACC)

$$\text{WACC} = \frac{\text{MVD}}{\text{MVD} + \text{MVCE}} r_d (1 - \text{Tax rate}) + \frac{\text{MVCE}}{\text{MVD} + \text{MVCE}} r$$

MVD = Market value of the company's debt

r_d = Required rate of return on debt

MVCE = Market value of the company's common equity

r = Required rate of return on equity

DISCOUNTED DIVIDEND VALUATION

One-Period DDM

$$V_0 = \frac{D_1}{(1+r)^1} + \frac{P_1}{(1+r)^1} = \frac{D_1 + P_1}{(1+r)^1}$$

V_0 = The value of the stock today ($t = 0$)

P_1 = Expected price of the stock after one year ($t = 1$)

D_1 = Expected dividend for Year 1, assuming it will be paid at the end of Year 1 ($t = 1$)

r = Required return on the stock

Multiple-Period DDM

$$V_0 = \frac{D_1}{(1+r)^1} + \dots + \frac{D_n}{(1+r)^n} + \frac{P_n}{(1+r)^n}$$

$$V_0 = \sum_{t=1}^n \frac{D_t}{(1+r)^t} + \frac{P_n}{(1+r)^n}$$

Expression for calculating Value of a share of stock

$$V_0 = \sum_{t=1}^{\infty} \frac{D_t}{(1+r)^t}$$

Gordon Growth Model

$$V_0 = \frac{D_0(1+g)}{(r-g)}, \text{ or } V_0 = \frac{D_1}{(r-g)}$$

Present value of Growth Opportunities

$$V_0 = \frac{E_1}{r} + \text{PVGO}$$

P/E ratio

$$\text{Justified leading P/E ratio} = \frac{P_0}{E_1} = \frac{D_1/E_1}{r-g} = \frac{(1-b)}{r-g}$$

$$\text{Justified trailing P/E} = \frac{P_0}{E_0} = \frac{D_1/E_0}{r-g} = \frac{D_0(1+g)/E_0}{r-g} = \frac{(1-b)(1+g)}{r-g}$$

Value of Fixed-Rate Perpetual Preferred Stock

$$V_0 = \frac{D}{r}$$

Two-Stage Dividend Discount Model

$$V_0 = \sum_{t=1}^n \frac{D_0(1+g_s)^t}{(1+r)^t} + \frac{D_0(1+g_s)^n(1+g_L)}{(1+r)^n(r-g_L)}$$

g_s = Short term supernormal growth rate

g_L = Long-term sustainable growth rate

r = required return

n = Length of the supernormal growth period

The H-Model

$$V_0 = \frac{D_0(1+g_L)}{r-g_L} + \frac{D_0H(g_s-g_L)}{r-g_L}$$

g_s = Short term high growth rate

g_L = Long-term sustainable growth rate

r = required return

H = Half-life = 0.5 times the length of the high growth period

The H-model equation can be rearranged to calculate the required rate of return as follows:

$$r = \left(\frac{D_0}{P_0} \right) [(1+g_L) + H(g_s-g_L)] + g_L$$

The [Gordon growth](#) formula can be rearranged to calculate the required rate of return given the other variables.

$$r = \frac{D_1}{P_0} + g$$

Sustainable growth rate (SGR)

$$g = b \times \text{ROE}$$

b = Earnings retention rate, calculated as $1 - \text{Dividend payout ratio}$

ROE can be calculated as:

$$\text{ROE} = \frac{\text{Net income}}{\text{Sales}} \times \frac{\text{Sales}}{\text{Total assets}} \times \frac{\text{Total assets}}{\text{Shareholders' equity}}$$

PRAT model

$$g = \text{Profit margin} \times \text{Retention rate} \times \text{Asset turnover} \times \text{Financial leverage}$$

$$g = \frac{\text{Net income} - \text{Dividends}}{\text{Net income}} \times \frac{\text{Net income}}{\text{Sales}} \times \frac{\text{Sales}}{\text{Total assets}} \times \frac{\text{Total assets}}{\text{Shareholders' equity}}$$

FREE CASH FLOW VALUATION

FCFF/FCFE

$$\text{Firm Value} = \sum_{t=1}^{\infty} \frac{\text{FCFF}_t}{(1 + \text{WACC})^t}$$

$$\text{WACC} = \frac{\text{MV(Debt)}}{\text{MV(Debt)} + \text{MV(Equity)}} r_d (1 - \text{Tax Rate}) + \frac{\text{MV(Equity)}}{\text{MV(Debt)} + \text{MV(Equity)}} r$$

$$\text{Equity Value} = \text{Firm Value} - \text{Market value of debt}$$

$$\text{Equity Value} = \sum_{t=1}^{\infty} \frac{\text{FCFE}_t}{(1 + r)^t}$$

Computing FCFF from Net Income

$$\text{FCFF} = \text{NI} + \text{NCC} + \text{Int}(1 - \text{Tax Rate}) - \text{FCInv} - \text{WCInv}$$

Investment in fixed capital (FCInv)

$$\text{FCInv} = \text{Capital expenditures} - \text{Proceeds from sale of long-term assets}$$

Investment in working capital (WCInv)

$$\text{WCInv} = \text{Change in working capital over the year}$$

$$\text{Working capital} = \text{Current assets (exc. cash)} - \text{Current liabilities (exc. short-term debt)}$$

Table: Noncash Items and FCFF

Noncash Item	Adjustment to NI to Arrive at FCFF
Depreciation	Added back
Amortization and impairment of intangibles	Added back
Restructuring charges (expense)	Added back
Restructuring charges (income resulting from reversal)	Subtracted
Losses	Added back
Gains	Subtracted
Amortization of long-term bond discounts	Added back
Amortization of long-term bond premiums	Subtracted
Deferred taxes	Added back but requires special attention

Computing FCFF from CFO**Table: IFRS versus U.S. GAAP Treatment of Interest and Dividends**

	IFRS	U.S. GAAP
Interest received	CFO or CFI	CFO
Interest paid	CFO or CFF	CFO
Dividend received	CFO or CFI	CFO
Dividends paid	CFO or CFF	CFF

$$\text{FCFF} = \text{CFO} + \text{Int}(1 - \text{Tax rate}) - \text{FCInv}$$

Computing FCFF from EBIT

$$\text{FCFF} = \text{EBIT}(1 - \text{Tax rate}) + \text{Dep} - \text{FCInv} - \text{WCInv}$$

Computing FCFF from EBITDA

$$\text{FCFF} = \text{EBITDA}(1 - \text{Tax rate}) + \text{Dep}(\text{Tax rate}) - \text{FCInv} - \text{WCInv}$$

Computing FCFE from FCFF

$$\text{FCFE} = \text{FCFF} - \text{Int}(1 - \text{Tax rate}) + \text{Net borrowing}$$

Computing FCFE from Net Income

$$\text{FCFE} = \text{NI} + \text{NCC} - \text{FCInv} - \text{WCInv} + \text{Net Borrowing}$$

Computing FCFE from CFO

$$\text{FCFE} = \text{CFO} - \text{FCInv} - \text{Net borrowing}$$

Computing FCFE from EBIT

$$\text{FCFE} = \text{EBIT}(1 - \text{Tax rate}) - \text{Int}(1 - \text{Tax rate}) + \text{Dep} - \text{FCInv} - \text{WCInv} + \text{Net borrowing}$$

Computing FCFE from EBITDA

$$\text{FCFE} = \text{EBITDA}(1 - \text{Tax rate}) - \text{Int}(1 - \text{Tax rate}) + \text{Dep}(\text{Tax rate}) - \text{FCInv} - \text{WCInv} + \text{Net borrowing}$$

Uses of FCFF

Increases in cash balances

Plus: Net payments to providers of debt capital

- + Interest expense (1 – tax rate)
- + Repayment of principal
- New borrowings

Plus: Net payments to providers of equity capital

- + Cash dividends
- + Share repurchases
- New equity issues

= Uses of FCFF

Uses of FCFE

Increases in cash balances

Plus: Net payments to providers of equity capital

- + Cash dividends
- + Share repurchases
- New equity issues

= Uses of FCFE

Constant Growth FCFF Valuation Model

$$\text{Value of the firm} = \frac{\text{FCFF}_1}{\text{WACC} - g} = \frac{\text{FCFF}_0(1 + g)}{\text{WACC} - g}$$

WACC = Weighted average cost of capital

g = Long-term constant growth rate in FCFF

Constant Growth FCFE Valuation Model

$$\text{Value of equity} = \frac{\text{FCFE}_1}{r - g} = \frac{\text{FCFE}_0(1 + g)}{r - g}$$

r = Required rate of return on equity

g = Long-term constant growth rate in FCFE

An International Application of the Single-Stage Model

$$\text{Value of equity} = \frac{\text{FCFE}_0(1 + g_{\text{real}})}{r_{\text{real}} - g_{\text{real}}}$$

General expression for the two-stage FCFF model:

$$\text{Firm value} = \sum_{t=1}^n \frac{\text{FCFF}_t}{(1 + \text{WACC})^t} + \frac{\text{FCFF}_{n+1}}{(\text{WACC} - g)} \frac{1}{(1 + \text{WACC})^n}$$

$$\text{Firm value} = \text{PV of FCFF in Stage 1} + \text{Terminal value} \times \text{Discount Factor}$$

General expression for the two-stage FCFE model:

$$\text{Equity value} = \sum_{t=1}^n \frac{\text{FCFE}_t}{(1 + r)^t} + \frac{\text{FCFE}_{n+1}}{(r - g)} \frac{1}{(1 + r)^n}$$

$$\text{Equity value} = \text{PV of FCFE in Stage 1} + \text{Terminal value} \times \text{Discount Factor}$$

Determining Terminal Value

$$\begin{aligned} \text{Terminal value in year } n &= \text{Justified Trailing P/E} \times \text{Forecasted Earnings in Year } n \\ \text{Terminal value in year } n &= \text{Justified Leading P/E} \times \text{Forecasted Earnings in Year } n + 1 \end{aligned}$$

Non-operating Assets and Firm Value

$$\text{Value of the firm} = \text{Value of operating assets} + \text{Value of non-operating assets}$$

MARKET-BASED VALUATION: PRICE AND ENTERPRISE VALUE MULTIPLES

Price to Earnings Ratio

$$\text{Trailing P/E ratio} = \frac{\text{Current Stock Price}}{\text{Last year's EPS}}$$

$$\text{Forward P/E ratio} = \frac{\text{Current Stock Price}}{\text{Expected EPS}}$$

Price to Book Ratio

$$\text{P/B ratio} = \frac{\text{Market price per share}}{\text{Book value per share}}$$

$$\text{P/B ratio} = \frac{\text{Market value of common shareholders' equity}}{\text{Book value of common shareholders' equity}}$$

Book value of equity = Common shareholders' equity
 = Shareholders' equity – Total value of equity claims that are senior to common stock

$$\text{Book value of equity} = \text{Total assets} - \text{Total liabilities} - \text{Preferred stock}$$

Price to Sales Ratio

$$\text{P/S ratio} = \frac{\text{Market price per share}}{\text{Sales per share}}$$

Relationship between the P/E ratio and the P/S ratio

$$\text{P/E} \times \text{Net profit margin} = (\text{P} / \text{E}) \times (\text{E} / \text{S}) = \text{P/S}$$

Price to Cash Ratio

$$\text{P/C Fratio} = \frac{\text{Market price per share}}{\text{Free cash flow per share}}$$

Dividend Yield

Justified trailing dividend yield

$$\text{Trailing dividend yield} = \text{Last year's dividend} / \text{Current price per share}$$

Justified leading dividend yield

$$\text{Leading dividend yield} = \text{Next year's dividend} / \text{Current price per share}$$

Justified P/E Multiple Based on Fundamentals

$$V_0 = \frac{D_1}{(r - g)}$$

Justified leading P/E multiple

$$\text{Justified leading P/E} = \frac{P_0}{E_1} = \frac{D_1/E_1}{r - g} = \frac{(1 - b)}{r - g}$$

(1 - b) is the payout ratio.

Justified trailing P/E multiple

$$\text{Justified trailing P/E} = \frac{P_0}{E_0} = \frac{D_1/E_0}{r - g} = \frac{D_0(1 + g)/E_0}{r - g} = \frac{(1 - b)(1 + g)}{r - g}$$

Justified P/B Multiple Based on Fundamentals

$$\frac{P_0}{B_0} = \frac{\text{ROE} - g}{r - g}$$

ROE = Return on equity

r = required return on equity

g = Sustainable growth rate

Justified P/S Multiple Based on Fundamentals

$$\frac{P_0}{S_0} = \frac{(E_0/S_0)(1 - b)(1 + g)}{r - g}$$

 E_0/S_0 = Net profit margin

1 - b = Payout ratio

Justified P/CF Multiple Based on Fundamentals

$$V_0 = \frac{\text{FCFE}_0(1 + g)}{(r - g)}$$

Justified Dividend Yield

$$\frac{D_0}{P_0} = \frac{r - g}{1 + g}$$

P/E-to-growth (PEG) ratio

$$\text{PEG} = \frac{\text{P/E}}{\text{Growth (\%)}}$$

Terminal price based on fundamentals

$$\begin{aligned}\text{TV}_n &= \text{Justified leading P/E} \times \text{Forecasted earnings}_{n+1} \\ \text{TV}_n &= \text{Justified trailing P/E} \times \text{Forecasted earnings}_n\end{aligned}$$

Terminal price based on comparables

$$\begin{aligned}\text{TV}_n &= \text{Benchmark leading P/E} \times \text{Forecasted earnings}_{n+1} \\ \text{TV}_n &= \text{Benchmark trailing P/E} \times \text{Forecasted earnings}_n\end{aligned}$$

EV/EBITDA Multiple

$$\begin{aligned}\text{Enterprise value} &= \text{Market value of common equity} + \text{Market value of preferred stock} \\ &\quad + \text{Market value of debt} - \text{Value of cash and short-term investments} \\ \text{EBITDA} &= \text{Net income} + \text{Interest} + \text{Taxes} + \text{Depreciation and amortization}\end{aligned}$$

Alternative Denominators in Enterprise Value Multiples

Free Cash Flow to the Firm =	Net Income	plus Interest Expense	minus Tax Savings on Interest	plus Depreciation	plus Amortization	less Investment in Working Capital	less Investment in Fixed Capital
EBITDA =	Net Income	plus Interest Expense	plus Taxes	plus Depreciation	plus Amortization		
EBITA =	Net Income	plus Interest Expense	plus Taxes		plus Amortization		
EBIT =	Net Income	plus Interest Expense	plus Taxes				

Justified forward P/E after accounting for Inflation

$$\frac{P_0}{E_1} = \frac{1}{\rho + (1 - \lambda)I}$$

λ = The percentage of inflation in costs that the company can pass through to revenue.

ρ = Real rate of return

I = Rate of inflation

Unexpected earnings (UE)

$$UE_t = EPS_t - E(EPS_t)$$

Standardized unexpected earnings (SUE)

$$SUE_t = \frac{EPS_t - E(EPS_t)}{\sigma[EPS_t - E(EPS_t)]}$$

EPS_t = Actual EPS for time t

$E(EPS_t)$ = Expected EPS for time t

$\sigma[EPS_t - E(EPS_t)]$ = Standard deviation of $[EPS_t - E(EPS_t)]$

RESIDUAL INCOME VALUATION

The Residual Income

$$\text{Residual income} = \text{Net income} - \text{Equity charge}$$

$$\text{Equity charge} = \text{Cost of equity capital} \times \text{Equity capital}$$

$$\text{Residual income} = \text{After-tax operating profit} - \text{Capital charge}$$

$$\text{Capital charge} = \text{Equity charge} + \text{Debt charge}$$

$$\text{Debt charge} = \text{Cost of debt} \times (1 - \text{Tax rate}) \times \text{Debt capital}$$

Economic Value Added

$$\text{EVA} = \text{NOPAT} - (\text{C}\% \times \text{TC})$$

NOPAT = Net operating profit after tax = EBIT (1 – Tax rate)

C% = Cost of capital (WACC)

TC = Total capital

Market Value Added

$$\text{MVA} = \text{Market value of the company} - \text{Accounting book value of total capital}$$

$$\text{Market value of company} = \text{Market value of debt} + \text{Market value of equity.}$$

The Residual Income Model

$$\text{RI}_t = E_t - (r \times B_{t-1})$$

RI_t = Residual income at time t

E_t = Earnings at time t

r = Required rate of return on equity

B_{t-1} = Book value at time t-1

Intrinsic value of a stock:

$$V_0 = B_0 + \sum_{i=1}^{\infty} \frac{\text{RI}_t}{(1+r)^t} = B_0 + \sum_{i=1}^{\infty} \frac{E_t - rB_{t-1}}{(1+r)^t}$$

V_0 = Intrinsic value of the stock today

B_0 = Current book value per share of equity

B_t = Expected book value per share of equity at any time t

r = Required rate of return on equity

E_t = Expected EPS for period t

RI_t = Expected residual income per share

Residual Income Model (Alternative Approach)

$$RI_t = EPS_t - (R \times B_{t-1})$$

$$RI_t = (ROE - r)B_{t-1}$$

$$V_0 = B_0 + \sum_{t=1}^{\infty} \frac{(ROE_t - r)B_{t-1}}{(1+r)^t}$$

$$V_0 = B_0 + \frac{ROE - r}{r - g} B_0$$

Tobin's q

$$\text{Tobin's } q = \frac{\text{Market value of debt and equity}}{\text{Replacement cost of total assets}}$$

Multi-Stage Residual Income Valuation

$$V_0 = B_0 + \sum_{t=1}^T \frac{(E_t - rB_{t-1})}{(1+r)^t} + \frac{P_T - B_T}{(1+r)^T}$$

When residual income fades over time as ROE declines towards the required return on equity, the intrinsic value of a stock is calculated using the following formula:

$$V_0 = B_0 + \sum_{t=1}^{T-1} \frac{(E_t - rB_{t-1})}{(1+r)^t} + \frac{E_T - rB_{T-1}}{(1+r-\omega)(1+r)^{T-1}}$$

$$\omega = \text{Persistence factor.}$$

Implied Growth Rate

$$g = r - \left[\frac{(ROE - r) \times B_0}{V_0 - B_0} \right]$$

PRIVATE COMPANY VALUATION

The Capitalized Cash Flow Method

$$V_f = \frac{FCFF_1}{WACC - g_f}$$

V_f = Value of the firm

$FCFF_1$ = Free cash flow to the firm for next twelve months

WACC = Weighted average cost of capital

g_f = Sustainable growth rate of free cash flow to the firm

$$V = \frac{FCFE_1}{r - g}$$

V = Value of the equity

$FCFE_1$ = Free cash flow to the equity for next twelve months

r = Required return on equity

g = Sustainable growth rate of free cash flow to the equity

Methods Used to Estimate the Required Rate of Return for a Private Company

Capital Asset Pricing Model

$$\text{Required return on equity} = \text{Risk-free rate} + (\text{Beta} \times \text{Market risk premium})$$

Expanded CAPM

$$\begin{aligned} \text{Required return on equity} = & \text{Risk-free rate} + (\text{Beta} \times \text{Market risk premium}) \\ & + \text{Small stock premium} + \text{Company-specific risk premium} \end{aligned}$$

Build-Up Approach

$$\begin{aligned} \text{Required return on equity} = & \text{Risk-free rate} + \text{Equity risk premium} + \text{Small stock} \\ & \text{premium} + \text{Company-specific risk premium} + \text{Industry risk} \\ & \text{premium} \end{aligned}$$

Discount for Lack of Control (DLOC)

$$DLOC = 1 - \left[\frac{1}{1 + \text{Control Premium}} \right]$$

COMMODITIES AND COMMODITY DERIVATIVES: AN INTRODUCTION

Backwardation and Contango

$$F_0 = S_0 e^{rT}$$

$$F_0 = S_0 e^{(r+U)T}$$

$$F_0 = S_0 e^{(r+U-Y)T}$$

Return Components of Commodity Futures Investments

Rebalancing (diversification) return:

$$\text{Total return} = \text{Spot return} + \text{Roll return} + \text{Collateral return} + \text{Rebalancing return}$$

Spot return:

$$RS = \frac{S_t - S_{t-1}}{S_{t-1}}$$

Roll return:

$$R_r = \frac{F_{t,T} - F_{t-1,t}}{F_{t-1,t}} = \frac{F_{t,T} - S_t}{S_t}$$

Total return:

$$\begin{aligned} \text{Total return} &= \text{Collateral return} + \text{Futures return} \\ &= \text{Collateral return} + \text{Spot return} + \text{Roll Return} \end{aligned}$$

Excess return:

$$\text{Excess return} = \text{Spot return} + \text{Roll return} = \text{Futures return}$$

FIXED INCOME

THE TERM STRUCTURE AND INTEREST RATE DYNAMICS

Forward pricing model:

$$P(T^* + T) = P(T^*)F(T^*, T)$$

Relationship between Spot and Forward Rates:

$$(1 + {}_x s_0)^x = (1 + {}_1 s_0)(1 + {}_1 f_1)(1 + {}_1 f_2)(1 + {}_1 f_3) \dots (1 + {}_1 f_{x-1})$$
$${}_x s_0 = [(1 + {}_1 s_0)(1 + {}_1 f_1)(1 + {}_1 f_2)(1 + {}_1 f_3) \dots (1 + {}_1 f_{x-1})]^{1/x} - 1$$

VALUATION AND ANALYSIS: BONDS WITH EMBEDDED OPTIONS

Value of callable bond = Value of straight bond – Value of embedded call option

Value of embedded call option = Value of straight bond – Value of callable bond

Value of putable bond = Value of straight bond + Value of embedded put option

Value of embedded put option = Value of putable bond – Value of straight bond

Effective Duration:

$$\text{Effective Duration} = \frac{(PV_-) - (PV_+)}{2 \times (\Delta \text{ Curve}) \times PV_0}$$

ΔCurve = the magnitude of the parallel shift in the benchmark yield curve (in decimal).

PV_- = Full price of the bond when the benchmark yield curve is shifted down by ΔCurve .

PV_+ = Full price of the bond when the benchmark yield curve is shifted up by ΔCurve .

PV_0 = Current full price of the bond (i.e., with no shift).

Properties of Effective Durations of Cash and Common Types of Bonds

Type of Bond	Effective Duration
Cash	0
Zero-coupon bond	\approx Maturity
Fixed-rate bond	$<$ Maturity
Callable bond	\leq Duration of straight bond
Putable bond	\leq Duration of straight bond
Floater (Libor flat)	\approx Time (in years) to next reset

Effective Convexity

$$\text{Effective Convexity} = \frac{(PV_-) + (PV_+) - 2(PV_0)}{(\Delta \text{ Curve})^2 \times PV_0}$$

Floating-Rate Securities

Value of capped floater = Value of uncapped floater – Value of embedded cap.

Value of embedded cap = Value of uncapped floater – Value of capped floater

Value of floored floater = Value of non-floored floater + Value of embedded floor.

Value of embedded floor = Value of floored floater – Value of non-floored floater

Convertible Bonds

$$\text{Conversion value} = \text{Market price of common stock} \times \text{Conversion ratio}$$

$$\text{Market conversion price} = \frac{\text{Market price of convertible security}}{\text{Conversion ratio}}$$

$$\text{Market conversion premium per share} = \text{Market conversion price} - \text{Current market price}$$

$$\text{Market conversion premium ratio} = \frac{\text{Market conversion premium per share}}{\text{Market price of common stock}}$$

$$\text{Premium over straight value} = \frac{\text{Market price of convertible bond}}{\text{Straight value}} - 1$$

Valuation of a convertible bond that is not callable or putable:

$$\text{Convertible security value} = \text{Straight Value} + \text{Value of the call option on the stock}$$

Valuation of a convertible bond that is callable but not putable:

$$\begin{aligned} \text{Convertible callable bond value} &= \text{Straight value} + \text{Value of the call option on the stock} \\ &\quad - \text{Value of the call option on the bond} \end{aligned}$$

Valuation of a convertible bond that is callable and putable:

$$\begin{aligned} \text{Convertible callable and putable bond value} &= \text{Straight value} \\ &\quad + \text{Value of the call option on the stock} \\ &\quad - \text{Value of the call option on the bond} \\ &\quad + \text{Value of the put option on the bond} \end{aligned}$$

CREDIT ANALYSIS MODELS

Structural Models

$$\text{Value of risky debt} = \text{Value of risk-free debt} - \text{Value of put option on company assets}$$

Credit risk measures:

$$\text{Probability of default} = \text{Prob}(AT < K) = 1 - \text{Prob}(AT \geq K) = 1 - N(e_2)$$

$$e_1 = \frac{\ln \frac{A_t}{K} + \mu(T-t) + \frac{1}{2}\sigma^2(T-t)}{\sigma\sqrt{(T-t)}}$$

$$e_2 = e_1 - \sigma\sqrt{(T-t)}$$

$$\text{Expected loss} = KN(-e_2) - A_t e^{\mu(T-t)} - N(-e_1)$$

$$\text{Present value of expected loss} = KP(t, T) - D(t, T) = Ke^{-r(T-t)}N(-d_2) - A_t N(-d_1)$$

Reduced Form Models

Credit risk measures:

- $$\text{Probability of default} = 1 - E \left[\frac{1}{\left([1 + \lambda(X_0)\Delta] [1 + \lambda(X_\Delta)] \cdots [1 + \lambda(X_{T-\Delta})\Delta] \right)} \right]$$
- $$\text{Expected loss} = \sum_{i=0}^{T-\Delta} E \left[\frac{\iota(X_i)K}{[1 + \lambda(X_0)\Delta] [1 + \lambda(X_\Delta)] \cdots [1 + \lambda(X_i)\Delta]} \lambda(X_i)\Delta \right]$$
- $$\text{Present value of expected loss} = KP(t, T) - D(t, T)$$

Credit risk measures assuming constant default probability and loss given default:

- Expected percentage loss per year = $\lambda\gamma$
- Probability of default = $1 - e^{-\lambda(T-t)}$
- Expected loss = $K[1 - e^{-\lambda\gamma(T-t)}]$
- Present value of expected loss = $KP(t, T) - D(t, T) = KP(t, T)[1 - e^{-\lambda\gamma(T-t)}]$

$$\text{Credit spread} = \text{Credit spread} = y_D(t, T) - y_P(t, T) = \lambda\gamma$$

DERIVATIVES INSTRUMENTS—VALUATION AND STRATEGIES

PRICING AND VALUATION OF FORWARD COMMITMENTS

Valuing a Forward Contract at Expiration ($t = T$)

Value of long position:

$$V_T(T) = S_T - F_0(T)$$

Value of short position:

$$V_T(T) = F_0(T) - S_T$$

Valuing a Forward Contract at Initiation ($t = 0$)

$$V_0(T) = S_0 - [F_0(T) / (1 + r)^T]$$

Valuing a Forward Contract during Its Life ($T = t$)

$$V_t(T) = S_t - [F_0(T) / (1 + r)^{T-t}]$$

$$V_t(T) = \text{PV of differences in forward prices} = \text{PV}_{t,T}[F_t(T) - F_0(T)]$$

where $\text{PV}_{t,T}()$ means the present value at time t of an amount paid in $T - t$ years (or at time T).

Table 1-1: Value of a Forward Contract

Time	Long Position Value	Short Position Value
At initiation	Zero, as the contract is priced to prevent arbitrage	Zero, as the contract is priced to prevent arbitrage
During life of the contract	$S_t - \left[\frac{F_0(T)}{(1 + r)^{T-t}} \right]$	$\left[\frac{F_0(T)}{(1 + r)^{T-t}} \right] - S_t$
At expiration	$S_T - F_0(T)$	$F_0(T) - S_T$

Carry Arbitrage Model When the Underlying Has Cash Flows

$$F_0(T) = (S_0 - \gamma_0 + \theta_0) (1 + r)^T$$

or

$$F_0(T) = S_0(1 + r)^T - (\gamma_0 - \theta_0) (1 + r)^T$$

Valuing a Forward Contract When the Underlying Has Carry Benefits/Costs

$$V_t(T) = \text{PV of differences in forward prices} = \text{PV}_{t,T}[F_t(T) - F_0(T)]$$

With continuous compounding, the forward price is calculated as:

$$F_0(T) = S_0 e^{(r_c + \theta_c - \gamma_c)T}$$

Pricing a Forward Rate Agreement

$$FRA(0, h, m) = \left[\frac{1 + L_0(h + m) \left(\frac{h + m}{360} \right)}{1 + L_0(h) \left(\frac{h}{360} \right)} - 1 \right]$$

where:

$FRA(0, h, m)$ = The annualized rate on an FRA initiated at Day 0, expiring on Day h, and based on m-day Libor

h = Number of days until FRA expiration

m = Number of days in underlying hypothetical loan

h + m = Number of days from FRA initiation until end of term of underlying hypothetical loan

L_0 = (Unannualized) Libor rate today

A generic formula used to compute the settlement payment of an FRA to the long position is:

$$\begin{aligned} \text{FRA payoff} &= NP \times [(\text{Market Libor} - \text{FRA rate}) \times \text{No. of days in the loan term} / 360] \\ &= 1 + [\text{Market Libor} \times (\text{No. of days in the loan term} / 360)] \end{aligned}$$

Fixed-Income Forward and Futures Contracts

$$\begin{aligned} \text{Accrued interest} &= \text{Accrual period} \times \text{Periodic coupon amount} \\ AI &= (\text{NAD} / \text{NTD}) \times (C / n) \end{aligned}$$

where:

NAD = Number of accrued days since the last coupon payment.

NTD = Number of total days during the coupon payment period.

C = Stated annual coupon amount.

n = Number of coupon payments per year.

Markets Where Accrued Interest Is Included in the Bond Price Quote

$$\begin{aligned} F_0(T) &= \text{Future value of underlying adjusted for carry cash flows} \\ F_0(T) &= (S_0 - \gamma_0 + \theta_0) (1 + r)^T \end{aligned}$$

Markets Where Accrued Interest Is Not Included in the Bond Price Quote

$$F_0(T) = QF_0(T) \times CF(T) \text{ and } QF_0(T) = 1/CF(T) \times F_0(T)$$

$$F_0(T) = (S_0 - PVCI_{0,T}) \times (1 + r)^T = [B_0(T + Y) + AI_0 - PVCI_{0,T}] \times (1 + r)^T$$

The futures price of the bond is calculated as:

$$F_0(T) = [B_0(T + Y) + AI_0 - PVCI_{0,T}] \times (1 + r)^T - AI_T$$

The quoted futures price of the bond is calculated as:

$$QF_0(T) = 1/CF(T) \times [B_0(T + Y) + AI_0 - PVCI_{0,T}] \times (1 + r)^T - AI_T$$

Currency Forward Contracts

$$\text{Interest rate parity: } F_{0,PC/BC} = \frac{S_{0,PC/BC} \times (1 + r_{PC})^T}{(1 + r_{BC})^T}$$

r_{PC} = Price-currency risk-free rate

r_{BC} = Base-currency risk-free rate

T = Length of the contract in years

Valuing a Currency Forward Contract

$$V_t(T) = (F_{t,PC/BC} - F_{0,PC/BC}) / (1 + r_{PC})^{T-t}$$

Plain-Vanilla Interest Rate Swaps

$$\begin{aligned} \text{Net fixed rate payment}_t &= [\text{Swap fixed rate} - (\text{Libor}_{t-1} + \text{Spread})] \\ &\quad * (\text{No. of days}/360) * \text{Notional principal} \end{aligned}$$

Pricing a Swap: Determining the Swap Fixed Rate

$$\begin{aligned} 100 &= \frac{C}{1 + \left(\text{Libor-90} * \frac{90}{360} \right)} + \frac{C}{1 + \left(\text{Libor-180} * \frac{180}{360} \right)} + \frac{C}{1 + \left(\text{Libor-270} * \frac{270}{360} \right)} \\ &\quad + \frac{C}{1 + \left(\text{Libor-360} * \frac{360}{360} \right)} + \frac{100}{1 + \left(\text{Libor-360} * \frac{360}{360} \right)} \end{aligned}$$

$$\text{Swap fixed rate} = \left[\frac{1 - B_0(N)}{B_0(1) + B_0(2) + B_0(3) + \dots + B_0(N)} \right] \times 100$$

Valuing Equity Swaps

pay-fixed, receive-return-on-equity

$$[(1 + \text{Return on equity}) * \text{Notional amount}] - \text{PV of the remaining fixed-rate payments}$$

pay-floating, receive-return-on-equity

$$[(1 + \text{Return on equity}) * \text{Notional amount}] - \text{PV (Next coupon payment + Par value)}$$

pay-return-on-one-equity-instrument, receive-return-on-another-equityinstrument

$$[(1 + \text{Return on Index 2}) * \text{Notional amount}] - [(1 + \text{Return on Index 1}) * \text{Notional amount}]$$

VALUATION OF CONTINGENT CLAIMS

The One-Period Binomial Model

$$H = hS - c$$

Hedge Ratio for Call Options

Value of a call option

$$c = \frac{\pi c^+ + (1 - \pi) c^-}{(1 + r)}$$

where:

$$\pi = \frac{(1 + r - d)}{(u - d)}$$

Put options

$$p = \frac{\pi p^+ + (1 - \pi) p^-}{(1 + r)}$$

where:

$$\pi = \frac{(1 + r - d)}{(u - d)}$$

Single-period call valuation equation under the no-arbitrage approach.

$$\rightarrow c = hS + PV(-hS^- + c^-)$$

Single-period put valuation equation under the no-arbitrage approach.

$$p = hS + PV(-hS^+ + p^+) \quad \dots \text{(Equation 4)}$$

Hedge ratio for puts:

$$h = \frac{p^+ - p^-}{S^+ - S^-} \leq 0$$

The Expectations Approach to Option Valuation

$$c = PV[\pi c^+ + (1 - \pi)c^-]$$

$$p = PV[\pi p^+ + (1 - \pi)p^-]$$

$$E(c_1) = \pi c^+ + (1 - \pi)c^-$$

$$E(p_1) = \pi p^+ + (1 - \pi)p^-$$

$$c = PV_r[E(c_1)]$$

$$p = PV_r[E(p_1)]$$

The Two-Period Binomial Model

$$\pi = \frac{1 + r - d}{u - d}$$

$$c^+ = \frac{\pi c^{++} + (1 - \pi)c^{+-}}{1 + r}$$

$$c^- = \frac{\pi c^{+-} + (1 - \pi)c^{--}}{1 + r}$$

Value of the option today:

$$c = \frac{\pi c^+ + (1 - \pi)c^-}{1 + r}$$

The Expectations Approach in a Two-Period Setting

$$c = PV \left[\pi^2 c^{++} + 2\pi(1 - \pi)c^{+-} + (1 - \pi)^2 c^{--} \right]$$

$$p = PV \left[\pi^2 p^{++} + 2\pi(1 - \pi)p^{+-} + (1 - \pi)^2 p^{--} \right]$$

$$\begin{aligned} E(c_2) &= \pi^2 c^{++} + 2\pi(1 - \pi)c^{+-} + (1 - \pi)^2 c^{--} \\ E(p_2) &= \pi^2 p^{++} + 2\pi(1 - \pi)p^{+-} + (1 - \pi)^2 p^{--} \end{aligned}$$

$$\begin{aligned} c &= PV [E \pi (c_2)] \\ p &= PV [E \pi (p_2)] \end{aligned}$$

The Black-Scholes-Merton (BSM) Option Valuation Model

$$\begin{aligned} c &= SN(d_1) - e^{-rT} XN(d_2) \\ p &= e^{-rT} XN(-d_2) - SN(-d_1) \end{aligned}$$

where:

$$d_1 = \frac{\ln(S/X) + (r + \sigma^2 / 2)T}{\sigma\sqrt{T}}$$

$$d_2 = d_1 - \sigma\sqrt{T}$$

σ , = The annualized standard deviation of the continuously compounded return on the stock.

r = The continuously compounded risk-free rate of return.

$N(d_1)$ = Cumulative normal probability of d_1 . For example, if d_1 is 0.8252, then $N(d_1)$ will be 0.7954 (look up the normal distribution table).

Table 4-1: BSM and Binomial Option Valuation Model Comparison

Option Valuation Model Terms	Call Option		Put Option	
	Underlying	Financing	Underlying	Financing
Binomial model	hS	$PV(-hS^- + c^-)$	hS	$PV(-hS^- + p^-)$
BSM model	$N(d_1)S$	$-N(d_2)e^{-rT}X$	$-N(-d_1)S$	$N(-d_2)e^{-rT}X$

The carry-benefit-adjusted BSM model is as follows:

$$\begin{aligned} c &= Se^{-\gamma T}N(d_1) - e^{-rT}XN(d_2) \\ p &= e^{-rT}XN(-d_2) - Se^{-\gamma T}N(-d_1) \end{aligned}$$

where:

$$\begin{aligned} d_1 &= \frac{\ln(S/X) + (r - \gamma + \sigma^2 / 2)T}{\sigma\sqrt{T}} \\ d_2 &= d_1 - \sigma\sqrt{T} \end{aligned}$$

Carry-benefit-adjusted put-call parity:

$$p + Se^{-\gamma T} = c + e^{-rT}X$$

The Black Model

Under the Black model, European-style options on futures are valued as:

$$\begin{aligned} c &= e^{-rT} [F_0(T)N(d_1) - XN(d_2)] \\ p &= e^{-rT} [XN(-d_2) - F_0(T)N(-d_1)] \end{aligned}$$

where:

$$\begin{aligned} d_1 &= \frac{\ln[F_0(T)/X] + (\sigma^2 / 2)T}{\sigma\sqrt{T}} \\ d_2 &= d_1 - \sigma\sqrt{T} \end{aligned}$$

Futures option put-call parity can be expressed as:

$$c = e^{-rT} [F_0(T) - X] + p$$

Interest Rate Options

Under the standard market model, the prices of interest rate call and put options can be expressed as:

$$c = (AP)e^{-r(t_{j-1} + t_m)} \left[FRA(0, t_{j-1}, t_m)N(d_1) - R_X(d_2) \right]$$

$$p = (AP)e^{-r(t_{j-1} + t_m)} \left[R_X N(-d_2) - FRA(0, t_{j-1}, t_m)N(-d_1) \right]$$

where:

AP = Accrual period in years

$$d_1 = \frac{\ln \left[FRA(0, t_{j-1}, t_m) / R_X \right] + (\sigma^2 / 2) t_{j-1}}{\sigma \sqrt{t_{j-1}}}$$

$$d_2 = d_1 - \sigma \sqrt{t_{j-1}}$$

Swaptions

$$\text{Payer swaption} = (AP)PVA [R_{\text{FIX}}N(d_1) - R_X N(d_2)]$$

$$\text{Receiver swaption} = (AP)PVA [R_X N(-d_2) - R_{\text{FIX}}N(-d_1)]$$

where:

PVA = PV of annuity matching the forward swap payment based on a notional amount of 1.

AP = Accrual period.

$$d_1 = \frac{\ln(R_{\text{FIX}} / R_X) + (\sigma^2 / 2)T}{\sigma \sqrt{T}}$$

$$d_2 = d_1 - \sigma \sqrt{T}$$

R_{FIX} = Market swap fixed rate (annualized) at the time of swaption expiration ($t = T$).

R_X = The swaption exercise rate starting at Time T, again quoted on an annual basis. As before, we will assume a notional amount of 1.

σ = Volatility of the forward swap rate. Specifically, it represents the annualized standard deviation of continuously compounded percentage changes in the forward swap rate.

Option Greeks and Implied Volatility

$$\text{Call option delta} = e^{-\delta T} N(d_1)$$

$$\text{Put option delta} = -e^{-\delta T} N(-d_1)$$

Estimating Option Value Using Delta

$$\text{For calls: } \hat{c} - c \cong \text{Delta}_c (\hat{S} - S)$$

$$\text{For puts: } \hat{p} - p \cong \text{Delta}_p (\hat{S} - S)$$

where \hat{c} , \hat{p} , and \hat{S} denote some new value for the call, put, and stock, respectively.

$$\text{Gamma}_c = \text{Gamma}_p = \frac{e^{-\delta T}}{S\sigma\sqrt{T}} n(d_1).$$

Estimating Option Value Using Delta and Gamma

$$\begin{aligned} \text{For calls: } \hat{c} - c &\approx \text{Delta}_c (\hat{S} - S) + \frac{\text{Gamma}_c}{2} (\hat{S} - S)^2 \\ \text{For puts: } \hat{p} - p &\approx \text{Delta}_p (\hat{S} - S) + \frac{\text{Gamma}_p}{2} (\hat{S} - S)^2 \end{aligned}$$

where \hat{c} , \hat{p} , and \hat{S} denote new values for the call, put, and stock, respectively.

DERIVATIVES STRATEGIES

Equity Swaps and Equity Futures

$$\text{Number of currency futures contracts} = \frac{\text{Foreign currency required}}{\text{Futures contract size denominated in foreign currency}}$$

$$\text{Number of currency futures contracts} = \frac{\text{Size of equity portfolio to be hedged}}{(\text{Futures multiplier} \times \text{Stock index value})}$$

$$\text{Gain/loss on futures contract} = \text{Change in equity index} \times \text{Multiplier} \times \text{Number of contracts}$$

Position Equivalencies

$$\text{Put-call parity: } p_t + S_0 = c_t + \text{PV}(X)$$

Synthetic long asset = Long call and short put

Synthetic short asset = Long put and short call

Synthetic put = Short stock and long call

Synthetic call = Long stock and long put

Synthetic risk-free rate (synthetic cash) = Long stock and short futures

Synthetic stock = Risk-free rate and long futures

Covered Calls, Protective Puts, and Collars

$$\text{Covered call} = \text{Long underlying stock plus sell (short) a call on the stock.}$$

$$\text{Total premium income} = \text{Premium per option sold} \times \text{Number of options per contract} \times \text{Number of contracts}$$

$$\text{Maximum gain} = (X - S_0) + c_0$$

$$\text{Maximum loss} = S_0 - c_0$$

$$\text{Breakeven price} = S_0 - c_0$$

$$\text{Expiration value} = S_T - \text{Max}[(S_T - X), 0]$$

$$\text{Profit or loss at expiration} = S_T - \text{Max}[(S_T - X), 0] + c_0 - S_0$$

Protective Puts

Protective put = Long underlying stock plus buy (long) a put on the stock

Maximum gain = Theoretically unlimited

Maximum loss = $(S_0 - X) + p_0$

Breakeven point = $S_0 + p_0$

$S_T - \text{Max}[(X - S_T), 0]$

$S_T - \text{Max}[(X - S_T), 0] + p_0 - S_0$

Collars

Collar = Long underlying stock plus buy (long) a put and sell (short) a call

Maximum gain = $X_H - S_0 - p_0 + c_0$

Maximum loss = $(S_0 - X_L) + p_0 - c_0$

Breakeven point = $S_0 + p_0 - c_0$

$S_T - \text{Max}[(S_T - X_H), 0]$

$S_T + \text{Max}[(X_L - S_T), 0]$

$S_T - \text{Max}[(S_T - X_H), 0] - p_0 + c_0 - S_0$

$S_T + \text{Max}[(X_L - S_T), 0] - p_0 + c_0 - S_0$

Bull Spreads

Bull spread = Long a call (or put) at a lower exercise price (X_L) and the sale of a call (or put) with a higher exercise price (X_H)

Maximum gain = $X_H - X_L - \text{Net premium}$

Maximum loss = $c_L - c_H$

Breakeven point = Occurs in the region where the lower call is in-the-money.

Bear Spreads

Bear spread = Long a put at a higher exercise price (X_H) and the sale of a put with a lower exercise price (X_L)

Maximum gain = $X_H - X_L - \text{Net premium}$

Maximum loss = $c_L - c_H$

Breakeven point = Occurs in the region where the lower call is in-the-money.

Long straddle

Long straddle = Long a put and long a call with the same strike price and expiration

Net premium paid / Current underlying share price

$\sigma_{\text{annual}} = \sigma_{\text{daily}} \times \text{Square root} (\# \text{trading days in the year} / \text{Days until option expires})$

ALTERNATIVE INVESTMENTS

PRIVATE REAL ESTATE INVESTMENTS

Net Operating Income

Rental income at full occupancy
 + Other income (such as parking)
 = Potential gross income (PGI)
 – Vacancy and collection loss
 = Effective gross income (EGI)
 – Operating expenses (OE)
 = **Net operating income (NOI)**

The Direct Capitalization Method

$$\text{Cap rate} = \text{Discount rate} - \text{Growth rate}$$

The cap rate can be defined as the **current yield** on an investment:

$$\text{Capitalization rate} = \frac{\text{NOI}_1}{\text{Value}}$$

Rearranging the above equation, we can estimate the value of a property by dividing its first-year NOI by the cap rate.

$$\text{Value} = \frac{\text{NOI}_1}{\text{Cap rate}}$$

An estimate of the appropriate cap rate for a property can be obtained from the selling price of similar or comparable properties.

$$\text{Cap rate} = \frac{\text{NOI}}{\text{Sale price of comparable property}}$$

The cap rate derived by dividing rent by recent sales prices of comparables is known as the **all risks yield (ARY)**. The value of a property is then calculated as:

$$\text{Market value} = \frac{\text{Rent}_1}{\text{ARY}}$$

Other Forms of the Income Approach

$$\text{Gross income multiplier} = \frac{\text{Selling price}}{\text{Gross income}}$$

$$\text{Value of subject property} = \text{Gross income multiplier} \times \text{Gross income of subject property}$$

The Discounted Cash Flow Method (DCF)

$$\text{Value} = \frac{\text{NOI}_1}{(r - g)}$$

The Terminal Capitalization Rate

$$\text{Terminal value} = \frac{\text{NOI for the first year of ownership for the next investor}}{\text{Terminal cap rate}}$$

Appraisal-Based Indices

$$\text{Return} = \frac{\text{NOI} - \text{Capital expenditures} + (\text{Ending market value} - \text{Beginning market value})}{\text{Beginning market value}}$$

Loan to Value ratio

$$\text{LTV ratio} = \frac{\text{Loan amount}}{\text{Appraised value}}$$

Debt Service Coverage ratio

$$\text{DSCR} = \frac{\text{NOI}}{\text{Debt service}}$$

Equity dividend rate/Cash-on-cash return

$$\text{Equity dividend rate} = \frac{\text{First year cash flow}}{\text{Equity investment}}$$

PUBLICLY TRADED REAL ESTATE SECURITIES

VALUATION: NET ASSET VALUE APPROACH

Capitalization rate

$$\text{Capitalization rate} = \frac{\text{NOI of a comparable property}}{\text{Total value of comparable property}}$$

Net Asset Value per Share

$$\text{NAVPS} = \frac{\text{Net Asset Value}}{\text{Shares outstanding}}$$

VALUATION: RELATIVE VALUATION (PRICE MULTIPLE) APPROACH

Funds from operations (FFO)

Accounting net earnings
Add: Depreciation charges on real estate
Add: Deferred tax charges
Add (Less): Losses (gains) from sales of property and debt restructuring
Funds from operations

Adjusted funds from operations (AFFO)

Funds from operations
Less: Non-cash rent
Less: Maintenance-type capital expenditures and leasing costs
Adjusted funds from operations

AFFO is preferred over FFO as it takes into account the capital expenditures necessary to maintain the economic income of a property portfolio.

PRIVATE EQUITY VALUATION

Quantitative Measures of Return

- **PIC (paid in capital)**: Ratio of paid in capital to date to committed capital.
- **DPI (distributed to paid-in) or cash-on-cash return**: Value of cumulative distributions paid to LPs as a proportion of cumulative invested capital.
 - $(DPI = \text{Cumulative distributions} / PIC)$
- **RVPI (residual value to paid-in)**: Value of LPs' shareholdings held with the fund as a proportion of cumulative invested capital.
 - $RVPI = NAV \text{ after distributions} / PIC$
- **TVPI (total value to paid-in)**: Value of portfolio companies' distributed (realized) and undistributed (unrealized) value as a proportion of cumulative invested capital.
 - $TVPI = DPI + RVPI$

NAV before distributions = Prior year's NAV after distributions + Capital called down – Management Fees + Operating results

NAV after distributions = NAV before distributions – Carried interest – Distributions

Total Exit Value

Exit value = Initial cost + Earnings growth + Multiple expansion + Debt reduction

Post-money valuation (POST)

$POST = PRE + I$

Proportionate ownership of the VC investor

$= I / POST$

Post-money value

Post-money value = $\frac{\text{Exit value}}{(1 + \text{Required rate of return})^{\text{Number of years to exists}}}$

Required wealth

Required wealth = Investment $\times (1 + IRR)^{\text{Number of years to exit}}$

Ownership proportion

$$\text{Ownership proportion} = \text{Required wealth} / \text{Exit value}$$

Shares to be issued

$$\text{Shares to be issued} = \frac{\text{Proportion of venture capitalist investment} \times \text{Shares held by company founders}}{\text{Proportion of investment of company founders}}$$

Price per share

$$\text{Price per share} = \frac{\text{Amount of venture capital investment}}{\text{Number of shares issued to venture capital investment}}$$

Adjusted discount rate

$$\text{Adjusted discount rate} = \frac{1+r}{1-q} - 1$$

r = Discount rate unadjusted for probability of failure.

q = Probability of failure.

PORTFOLIO MANAGEMENT

THE PORTFOLIO MANAGEMENT PROCESS AND THE INVESTMENT POLICY STATEMENT

Risk Tolerance

Willingness to Take Risk	Ability to Take Risk	
	<i>Below Average</i>	<i>Above Average</i>
<i>Below Average</i>	Below-average risk tolerance	Resolution needed
<i>Above Average</i>	Resolution needed	Above-average risk tolerance

Return Requirements and Risk Tolerances of Various Investors

Type of Investor	Return Requirement	Risk Tolerance
Individual	Depends on stage of life, circumstances, and obligations	Varies
Pension Plans (Defined Benefit)	The return that will adequately fund liabilities on an inflation-adjusted basis	Depends on plan and sponsor characteristics, plan features, funding status, and workforce characteristics
Pension Plans (Defined Contribution)	Depends on stage of life of individual participants	Varies with the risk tolerance of individual participants
Foundations and Endowments	The return that will cover annual spending, investment expenses, and expected inflation	Determined by amount of assets relative to needs, but generally above- average or average
Life Insurance Companies	Determined by rates used to determine policyholder reserves	Below average due to factors such as regulatory constraints
Non-Life-Insurance Companies	Determined by the need to price policies competitively and by financial needs	Below average due to factors such as regulatory constraints
Banks	Determined by cost of funds	Varies

AN INTRODUCTION TO MULTIFACTOR MODELS

Arbitrage Pricing Theory and the Factor Model

$$E(R_p) = R_F + \lambda_1 \beta_{p,1} + \dots + \lambda_K \beta_{p,K}$$

$E(R_p)$ = Expected return on the portfolio p

R_F = Risk-free rate

λ_j = Risk premium for factor j

$\beta_{p,j}$ = Sensitivity of the portfolio to factor j

K = Number of factors

Active Return

$$\text{Active return} = R_p - R_B$$

$$\text{Active return} = \text{Return from factor tilts} + \text{Return from asset selection}$$

Active Risk

$$TE = s(R_p - R_B)$$

$$\text{Active risk squared} = s^2(R_p - R_B)$$

$$\text{Active risk squared} = \text{Active factor risk} + \text{Active specific risk}$$

$$\text{Active specific risk} = \sum_{i=1}^n w_i^a \sigma_{\varepsilon_i}^2$$

Where:

w_i^a = The i^{th} asset's active weight in the portfolio (i.e., the difference between the asset's weight in the portfolio and its weight in the benchmark)

$\sigma_{\varepsilon_i}^2$ = The residual risk of the i^{th} asset (i.e., the variance of the i^{th} asset's returns that is not explained by the factors)

$$\text{Active factor risk} = \text{Active risk squared} - \text{Active specific risk}$$

The Information Ratio

$$IR = \frac{\bar{R}_p - \bar{R}_B}{s(R_p - R_B)}$$

MEASURING AND MANAGING MARKET RISK

Estimating VaR—Parametric Method

$$z = \frac{R - \mu}{\sigma}$$

$$E(R_p) = \sum_{i=1}^n w_i R_i$$

$$\sigma_p = \sqrt{w_i^2 \sigma_i^2 + w_j^2 \sigma_j^2 + 2w_i \sigma_i w_j \sigma_j \rho_{i,j}}$$

Equity Exposure—CAPM

$$E(r_a) = r_f + \beta [E(r_M) - r_f]$$

Fixed Income Exposure

First- and second-order yield effects on bond price:

$$\frac{\Delta B}{B} = -D \frac{\Delta y}{1+y} + \frac{1}{2} C \frac{(\Delta y)^2}{(1+y)^2}$$

Delta

$$\text{Delta} = \frac{\Delta c}{\Delta S}$$

Gamma

$$\Gamma = \text{gamma} = \frac{\Delta \text{delta}}{\Delta S}$$

New call price:

$$c + \Delta c \approx c + \Delta_c \Delta S + \frac{1}{2} \Gamma_c (\Delta S)^2$$

Vega

$$\text{Vega} \approx \frac{\Delta c}{\Delta \sigma_s}$$

New call price:

$$c + \Delta c \approx c + \Delta_c \Delta S + \frac{1}{2} \Gamma_c (\Delta S)^2 + \text{vega} \Delta \sigma_s$$

ECONOMICS AND INVESTMENT MARKETS

Taylor Rule

$$R_A = \sum_{i=1}^N \Delta w_i R_{Ai}$$

where R_{Ai} = Active security return = $R_i - R_B$.

ANALYSIS OF ACTIVE PORTFOLIO MANAGEMENT

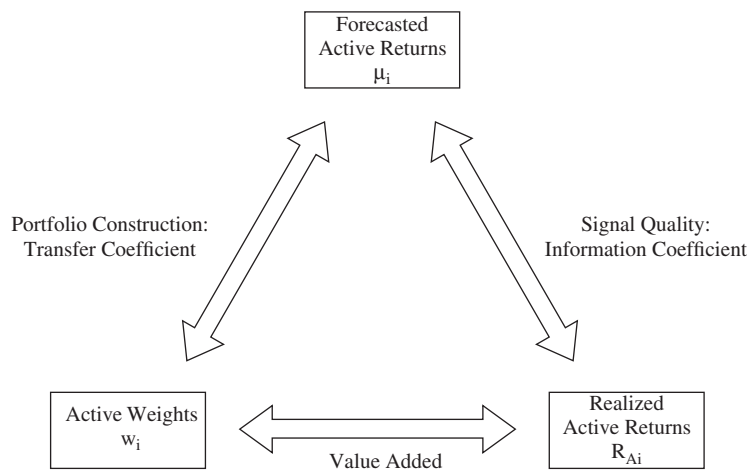
Sharpe Ratio

$$SR_P = \frac{R_P - R_f}{STD(R_P)}$$

Optimal Level of Risk

$$\sigma^*(R_A) = \frac{IR}{SR_B} \sigma(R_B)$$

Figure 2-1: The Correlation Triangle



Mean-Variance-Optimal Active Security Weights

$$\Delta w_i^* = \frac{\mu_i}{\sigma_i^2} \frac{\sigma_A}{IC\sqrt{BR}}$$

where:

Δw_i^* = Active security weight

μ_i = Active return forecast

σ_A = Active portfolio risk

σ_i = Forecasted volatility of the active return on security i

IC = Information coefficient

BR = Breadth

The Basic Fundamental Law

$$E(R_A)^* = IC\sqrt{BR} \sigma_A$$

The Full Fundamental Law

$$E(R_A) = TC \cdot IC \sqrt{BR} \sigma_A$$