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CFA® PROGRAM LEVEL I · CHEAT SHEET

Quantitative Methods

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

1 Returns of Financial Assets and Instruments

MODULE 1.1 · RATES OF RETURN

- Total (holding period) return is $(P_1 - P_0 + D)/P_0$, the price return plus the capital distribution return, with each component divided by the beginning price P_0.
- An ex post (actual) return uses prices and income already observed, while an ex ante (expected) return is an estimate for a future period.
- The geometric mean return $[(1 + R_1)(1 + R_2) \cdots (1 + R_n)]^{1/n} - 1$ is the measure for an annualized return or a compound annual growth rate; it cannot exceed the arithmetic mean, and the two are equal only when every period's return is identical.
- A holding period return is annualized with $(1 + HPR)^{365/\text{days}} - 1$, or $(1 + R_{\text{period}})^{c} - 1$ with c periods in a year; for a period shorter than a year this assumes the same return is earned in every remaining period.
- For a given positive stated annual rate, more frequent compounding gives a higher effective annual rate, $(1 + r_s/m)^m - 1$, and continuous compounding gives the highest, $e^r - 1$.
- The continuously compounded return is $r_{cc} = \ln(1 + HPR)$, which reduces to $\ln(P_1/P_0)$ only when no distributions are paid, and log returns are additive across periods.

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- The direction of an annualized return is known before calculating: a positive HPR over more than a year annualizes to a smaller figure and over less than a year to a larger one, while a negative HPR (between −100% and 0) becomes less negative over more than a year and more negative over less than a year.
- The geometric mean return cannot exceed the arithmetic mean return of the same returns, so an answer with a higher geometric mean can be ruled out.
- A log return is below the HPR for a gain and more negative than the HPR for a loss, which rules out answers on the wrong side of the HPR.

MODULE 1.2 · COMPONENTS AND MEASURES OF RETURN

- An interest rate can be read as a required rate of return, a discount rate or an opportunity cost of current consumption; a measure of risk is not one of these interpretations.
- Required return = real risk-free rate + expected inflation + risk premia, where the real risk-free rate plus expected inflation is the nominal risk-free rate, such as a short-term government bill yield.
- The real risk-free rate reflects only time preference and is linked to the nominal rate exactly by $(1 + r_{\text{nominal}}) = (1 + r_{\text{real}})(1 + \pi^e)$, or approximately by $r_{\text{real}} \approx r_{\text{nominal}} - \pi^e$.
- Gross return deducts trading commissions and other costs of generating the return but not management and administration fees; net return deducts both.
- With one tax rate on capital gains and another on distributions, the after-tax nominal return is price return $\times(1 - t_{cg})$ + distribution return $\times(1 - t_d)$.

- The leveraged return is $r_L = r_P + (V_D/V_E)(r_P - r_D)$, a gain or loss measured against the investor's own cash V_E.

EXAM SHORTCUTS

- The sign of $r_P - r_D$ shows whether borrowing raises or lowers a gain before any calculation: a gain is magnified only if r_P exceeds r_D, and a loss is always magnified.
- The real rate moves with the nominal risk-free rate and against expected inflation, so a falling bill yield with rising expected inflation means a lower real rate without computing it.

FORMULAS

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

2 Types of Financial Returns

MODULE 2.1 · FINANCIAL ASSETS, INSTRUMENTS, AND INDICATORS

- Total return is the capital appreciation (price) return plus the capital distribution return; distributions are realized when received, price gains only when the asset is sold, and unrealized gains still count in total return.

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- Equity returns come mainly from price return, with variable and discretionary dividends, while a traditional bond's return comes mainly from its fixed coupon and price return is usually the smaller part.
- Interest rates, market indexes and foreign exchange rates are financial indicators: they influence returns but produce no cash flows of their own.
- A T-bill's holding period return is $(\text{Face value} - \text{Price})/\text{Price}$, annualized as $(1 + HPR)^{365/t} - 1$; when market interest rates rise, fixed-income prices fall, and longer-dated bonds fall more.
- The domestic currency return is $(1 + r_{\text{local}})(1 + r_{FX}) - 1$, where r_{FX} is the change in the value of the foreign currency and is negative if it depreciates.
- Volatility lowers the geometric (compound) return, so the arithmetic mean overstates multiperiod performance, most of all for the more volatile asset.

EXAM SHORTCUTS

- A strengthening foreign currency puts the domestic return above the local return and a weakening one puts it below, so answers on the wrong side of the local return can be ruled out before compounding.

MODULE 2.2 · LONG-TERM RETURNS ON FINANCIAL ASSETS

- Under the risk-return tradeoff, expected long-term returns in a developed market rank short-term government bills < government bonds < corporate bonds < large-cap equities < small-cap equities, with bonds compared at similar maturities.
- The credit spread is the extra return corporate bonds offer over government bonds for their greater default risk, and longer-term fixed-income securities are expected to earn more than shorter-term ones because they face more inflation and interest rate risk.
- Systematic (macro) risk, such as inflation, interest rate and market risk, affects all investments to some degree and is not reduced by diversification; unsystematic (micro) risk, such as issuer and sector risk, is.
- The range, the highest return minus the lowest return, is the simplest measure of risk, and a wider range means more variability and more risk.
- A client who needs capital growth and tolerates risk tilts toward equities, a client who needs steady income with low risk tolerance tilts toward fixed-income securities, and a client who wants both holds a balanced mix.
- Each component of a portfolio's expected return is the weighted average of the asset-class components, $E(R_p) = \sum w_i E(R_i)$, and total return is the capital appreciation return plus the capital distribution return.

FORMULAS

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

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3 Benchmarking Returns

MODULE 3.1 · TIME-WEIGHTED AND MONEY-WEIGHTED RETURNS

- The money-weighted return is the IRR of the portfolio's cash flows, the rate that gives them an NPV of zero, with money going in and money coming out entered with opposite signs.
- The time-weighted return geometrically links the holding period returns of subperiods formed at each significant deposit or withdrawal, and is annualized with a root equal to the number of years, not the number of subperiods.
- The MWR depends on the timing and size of external cash flows: a deposit just before strong performance makes it higher than the TWR and a deposit just before poor performance makes it lower, while the TWR is unaffected.
- The MWR and the TWR are equal when there are no external cash flows during the period.
- The investment management industry prefers the TWR because managers usually do not control when clients add or withdraw money; the MWR suits a manager or investor who controls the cash flows.
- Firms claiming compliance with the voluntary GIPS must present time-weighted returns, except where the manager controls external cash flows and the portfolio is also closed-end, has a fixed life, calls committed capital or holds mainly illiquid investments.

EXAM SHORTCUTS

- With no deposits, withdrawals or paid-out income during the period, the MWR equals the TWR, so no IRR has to be computed.
- A deposit made just before the stronger subperiod puts the MWR above the TWR, and one made just before the weaker subperiod puts it below; withdrawals work the opposite way, so comparison questions need no IRR.
- If the subperiods are of equal length and each earns the same rate, the MWR and the TWR both equal that rate whatever the cash flows.

MODULE 3.2 · SECURITY MARKET INDEXES

- A price index uses constituent prices only and gives the price return; a total return index adds income, assumed reinvested, and its total return exceeds the price return when constituents pay distributions.
- A price-weighted index is the sum of prices divided by a divisor that is changed for splits, reverse splits, stock dividends and constituent changes, and its higher-priced stocks carry more weight.
- An equal-weighted index gives each constituent $1/N$ at each rebalancing, overweights small companies relative to their size and needs frequent, costly rebalancing as weights drift.
- A market-capitalization-weighted index weights each stock by its share of total market value, tracks aggregate investor wealth and rebalances automatically, but gives more weight to stocks whose prices have risen; a float-adjusted version uses market cap × float %.
- A fundamental-weighted index weights constituents by fundamentals such as earnings, dividends, cash flow, sales or book value and has a value tilt.
- Rebalancing resets weights to target after price moves and matters mainly for fundamental-weighted and equal-weighted indexes; reconstitution changes the constituents, with the divisor adjusted on that date.

EXAM SHORTCUTS

- For a period that starts at equal weights, an equal-weighted index return is the arithmetic mean of the constituent returns, so no share counts or divisor are needed.
- Only a price-weighted index changes its divisor for a stock split or stock dividend; equal-weighted, market-cap-weighted and fundamental-weighted indexes leave it unchanged.

FORMULAS

Money-weighted rate of return (MWR)

$$\sum_{t=0}^{T} \frac{CF_t}{(1+MWR)^t} = 0$$

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

4 The Time Value of Money in Finance

MODULE 4.1 · DISCOUNTED CASH FLOW VALUATION

- Every instrument here is valued as the present value of its expected cash flows, each discounted with $PV = FV/(1+r)^t$.
- A bond sells at a premium when its coupon rate is above its YTM, at par when they are equal and at a discount when the coupon rate is below the YTM.
- A perpetuity is worth PMT/r one period before its first payment, and preferred stock is valued the same way, D_p/r_p.
- In an amortizing loan each payment's interest is the rate times the opening balance, so the interest part falls and the principal part rises over the life of the loan.
- The Gordon growth model $V_0 = D_1/(r_e - g_c)$ uses next period's dividend and requires constant growth below the required return.
- In a multistage DDM the terminal value $P_n = D_{n+1}/(r_e - g_c)$ is discounted n periods, together with the dividend paid at n.

EXAM SHORTCUTS

- Compare the coupon rate with the YTM before calculating a bond price: a coupon above the YTM means a premium, equal means par, below means a discount, so prices on the wrong side of par can be ruled out at once.
- A zero-coupon bond, a coupon bond and a level loan are all one TVM entry; a zero is the same entry with PMT = 0.
- A level perpetuity or a preferred share needs no worksheet: value = payment ÷ rate.

MODULE 4.2 · IMPLIED RETURNS AND CASH FLOW ADDITIVITY

- The implied return on a zero-coupon bond is $(FV/PV)^{1/N} - 1$; a coupon bond's YTM is found with the calculator (CPT I/Y).
- A bond's price and its YTM move in opposite directions.
- Rearranging the Gordon model gives the required return $r_e = D_1/P_0 + g_c$ and the implied growth rate $g_c = r_e - D_1/P_0$.
- Under cash flow additivity the PV of a stream equals the sum of the PVs of its pieces, so an uneven stream can be replicated with annuities and zero-coupon bonds.

- No arbitrage sets the implied forward rate $1y1y = (1+S_2)^2/(1+S_1) - 1$ and the forward exchange rate $\text{Forward}/\text{Spot} = (1+r_{\text{price}})^T/(1+r_{\text{base}})^T$.
- In a one-period binomial model the hedge ratio is $h = (c_u - c_d)/(S_u - S_d)$, the hedged portfolio earns the risk-free rate, and $c_0 = hS_0$ minus the PV of the hedged portfolio.

EXAM SHORTCUTS

- With an upward-sloping spot curve the implied forward rate lies above both spot rates, so a forward rate between the two spot rates can be ruled out.
- Check the direction of a forward exchange rate first: when the price currency has the higher interest rate the forward is above spot, and when it has the lower rate the forward is below spot.
- When two cash flow streams differ only by $+X$ earlier and $-X$ later, the stream with the earlier cash flow has the higher PV at any positive discount rate, with no NPV calculation needed.

FORMULAS

The time value of money	$FV = PV(1+r)^t$ $PV = \dfrac{FV}{(1+r)^t}$
Fixed-coupon bonds	$P = \sum_{t=1}^{N} \dfrac{C}{(1+YTM)^t} + \dfrac{F}{(1+YTM)^N}$
Perpetual bonds	$PV_{\text{perpetuity}} = \dfrac{PMT}{r}$
Amortizing bonds and annuities	$PV_{\text{annuity}} = PMT \times \dfrac{1-(1+r)^{-N}}{r}$ $PMT = \dfrac{r \times PV}{1-(1+r)^{-N}}$
Equity instruments	$V_{\text{preferred}} = \dfrac{D_p}{r_p}$ $V_0 = \dfrac{D_1}{r_e - g_c}$ $D_1 = D_0(1+g_c)$
Zero-coupon bond	$r = \left(\dfrac{FV}{PV}\right)^{1/N} - 1$
Equity: implied required return	$r_e = \dfrac{D_1}{P_0} + g_c = \text{dividend yield} + \text{constant growth rate}$
Equity: implied growth rate	$g_c = r_e - \dfrac{D_1}{P_0} = \text{required return} - \text{dividend yield}$
Forward interest rates	$(1+S_2)^2 = (1+S_1)(1+1y1y) \quad \Rightarrow \quad 1y1y = \dfrac{(1+S_2)^2}{1+S_1} - 1$ $(1+S_3)^3 = (1+S_1)(1+1y1y)(1+2y1y)$

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Forward exchange rates	$\frac{\text{Forward}}{\text{Spot}} = \frac{(1+r_{\text{price}})^T}{(1+r_{\text{base}})^T}$ $\frac{\text{Forward}}{\text{Spot}} = \frac{1+r_{\text{price, period}}}{1+r_{\text{base, period}}}$
Option values: one-period binomial model	$h = \frac{c_u - c_d}{S_u - S_d}$

5 Statistical Characteristics of Asset Returns

MODULE 5.1 · MEASURES OF CENTRAL TENDENCY

- The arithmetic mean weights every observation equally and is sensitive to outliers, while the median, the middle value of sorted data (the average of the two middle values with an even count), is a robust estimator.
- The mode is the most frequent value; a dataset can have one mode, two (bimodal), several or none, and for continuous data the modal interval is reported.
- A trimmed mean drops a set percentage of the extreme observations, split equally between the two ends, and averages the rest; a winsorized mean replaces the extremes with percentile values and averages all n observations.
- When there are only a few outliers, a winsorized mean measures the center better than the arithmetic mean or a trimmed mean does.
- A quantile is a cut-off value with a given share of the observations at or below it, and the interquartile range $Q_3 - Q_1$ contains the central 50% of the data.
- Stationary data have a mean and variance that do not change over time; trending price levels are typically nonstationary, while their periodic percentage changes are much more likely to be stationary.

EXAM SHORTCUTS

- Changing only the largest or the smallest observation moves the mean but not the median, as long as that value keeps its rank.
- Quantile positions run in a fixed order (first decile, first quintile, first quartile, median), so an answer that puts a lower quantile above a higher one can be ruled out.
- A few huge positive values make the trimmed and winsorized means lower than the arithmetic mean, and a few huge negative values make them higher.

MODULE 5.2 · DISPERSION, SKEWNESS, AND KURTOSIS

- The range, maximum minus minimum, uses only the two extreme observations, while the mean absolute deviation $\sum|X_i - \bar{X}|/n$ averages the unsigned deviations from the mean.
- Sample variance divides the sum of squared deviations from the mean by $n - 1$ (Bessel's correction), which makes s^2 an unbiased estimator of σ^2; population variance divides by N.
- Taking the positive square root of the variance gives the standard deviation, which is in the same units as the data, while the variance is in squared units.
- Under the root of time law, with independent returns the variance over T periods is $T\sigma^2$ and the standard deviation is $\sigma\sqrt{T}$, although long-horizon variance is often lower in practice.
- A positively skewed distribution has a long right tail with mode < median < mean, a negatively skewed one has a long left tail with mean < median < mode, and a symmetrical one has all three equal.
- A normal distribution has kurtosis 3; excess kurtosis is kurtosis − 3, a leptokurtic distribution (above 3) has fatter tails, and more negative skew and greater excess kurtosis both mean greater risk.

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- In a skewed unimodal distribution the median lies between the mode and the mean, and the mean lies on the side of the long tail, so the direction of skew fixes the order of all three measures.

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MODULE 5.3 · COVARIANCE, CORRELATION, AND ALTERNATIVE MEASURES OF DISPERSION

- Sample covariance is $\sum(X_i - \bar{X})(Y_i - \bar{Y})/(n-1)$; its sign shows the direction of co-movement, but its size depends on the units and it has no upper or lower bound.
- Correlation $\rho_{XY} = \text{Cov}_{XY}/(s_X s_Y)$ has no units, lies between −1 and +1, and $\rho = 0$ means no linear relationship.
- Correlation is not causation, outliers can create or destroy a correlation, and spurious correlation arises by chance or because both variables are related to a third variable.
- A scatter plot can reveal a nonlinear relationship that a correlation coefficient would miss.
- Semivariance uses only the outcomes below the mean, and the target downside deviation uses only the outcomes below a target B but keeps the full sample size minus one in the denominator.
- The coefficient of variation $CV = s/\bar{X}$ measures risk per unit of mean return, is unit-free, and a lower CV is better.

EXAM SHORTCUTS

- With a zero risk-free rate the CV is the inverse of the Sharpe ratio, so one can be read straight from the other.
- A higher target never lowers the target downside deviation, which rules out an answer in which raising the target reduces it.

FORMULAS

Population vs. sample	$\text{Sample mean: } \bar{X} = \frac{\sum_{i=1}^{n} X_i}{n}$ $\text{Population mean: } \mu = \frac{\sum_{i=1}^{N} X_i}{N}$
Range and mean absolute deviation	$\text{range} = \text{maximum value} - \text{minimum value}$ $\text{MAD} = \frac{\sum_{i=1}^{n} \lvert X_i - \bar{X} \rvert}{n}$
Skewness	$\text{skewness} = \frac{1}{n}\sum_{i=1}^{n}\left(\frac{X_i - \bar{X}}{s}\right)^3$
Kurtosis	$\text{kurtosis} = \frac{1}{n}\sum_{i=1}^{n}\left(\frac{X_i - \bar{X}}{s}\right)^4$ $\text{excess kurtosis} = \text{kurtosis} - 3$
Covariance	$\text{Cov}_{XY} = \frac{\sum_{i=1}^{n}(X_i - \bar{X})(Y_i - \bar{Y})}{n-1} \quad \text{(sample)}$
Correlation	$\rho_{XY} = \frac{\text{Cov}_{XY}}{s_X s_Y}$ $\text{Cov}_{XY} = \rho_{XY}\, s_X\, s_Y$
Semivariance and target downside deviation	$\sigma^2_{\text{semi}} = \frac{\sum_{X_i < \bar{X}}(X_i - \bar{X})^2}{n}$ $s_{\text{target}} = \sqrt{\frac{\sum_{X_i < B}(X_i - B)^2}{n-1}}$
Coefficient of variation	$CV = \frac{s}{\bar{X}}$ $\left(\text{or } \frac{\sigma}{\mu}\right)$

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6 Statistical Distributions for Financial Asset Prices and Returns

MODULE 6.1 · PROBABILITY DISTRIBUTIONS AND EXPECTED VALUES

- A discrete random variable has a probability mass function with positive probabilities at individual outcomes; a continuous variable has a density, zero probability at any single point and probabilities assigned to intervals.
- A probability function is valid only if every $p(x)$ lies between 0 and 1 and the probabilities sum to 1.
- The CDF is $F(x) = P(X \leq x)$, and $P(a < X \leq b) = F(b) - F(a)$.
- Expected value is $E(X) = \sum P(x_i)x_i$; variance is $\sum P(x_i)[x_i - E(X)]^2$ in squared units, and the standard deviation is its square root.
- The sign of the covariance shows the direction of co-movement, but its size depends on the units; correlation $\rho = \text{Cov}(X, Y)/(\sigma_X \sigma_Y)$ is unit-free and lies between −1 and +1.

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- When the outcomes listed are mutually exclusive and exhaustive and one probability is missing, it equals 1 minus the sum of the others.
- Variance can be found as $\sigma^2 = E(X^2) - [E(X)]^2$, which avoids computing each deviation.
- For a continuous variable, including or excluding the endpoints does not change the probability of an interval.

MODULE 6.2 · DISCRETE AND CONTINUOUS PROBABILITY DISTRIBUTIONS

- A binomial variable counts successes in n independent trials with a constant p: $E(X) = np$ and $\sigma^2 = np(1 - p)$; a single trial is a Bernoulli distribution.
- A Poisson variable counts events in an interval at a constant rate λ, and its mean and variance both equal λ.
- For a continuous uniform variable on $[a, b]$, $P(x_1 \leq X \leq x_2) = (x_2 - x_1)/(b - a)$.
- The normal distribution is symmetric, fully described by its mean and variance, and unbounded in both directions.
- If $\ln Y$ is normal, Y is lognormal: bounded below by zero and positively skewed, which suits asset prices.
- The logistic distribution is symmetric like the normal but has fatter tails (excess kurtosis +1.2).

EXAM SHORTCUTS

- Identify the distribution from the wording: successes in a fixed number of trials is binomial, a count of events in an interval is Poisson, random draws for simulation are continuous uniform, and asset prices are lognormal.
- Normal bands: about 68% of outcomes lie within ±1σ and 95% within ±2σ, so about 2.5% lie beyond 2σ on each side and about 13.5% lie between 1σ and 2σ on each side.
- For a Poisson variable, the probability of at least one event is $1 - e^{-\lambda}$.

MODULE 6.3 · CONDITIONAL EXPECTATIONS AND BAYESIAN UPDATING

- A joint probability is $P(A \text{ and } B)$, marginal probabilities are the row and column totals, and a conditional probability uses only the outcomes consistent with the condition.
- The conditional expectation is $E(X \mid S) = \sum P(x_i \mid S)x_i$, and the conditional variance is measured around $E(X \mid S)$.
- In a probability tree a path probability is the product of its branch probabilities.
- Bayes' formula is $P(E \mid I) = P(I \mid E)P(E)/P(I)$, where $P(I)$ adds the joint probabilities of the information with every state.
- $P(I \mid E)$ and $P(E \mid I)$ are generally different, and the posterior still depends on the prior.

EXAM SHORTCUTS

- For Bayes' formula, write one row per state with prior × likelihood, add the rows to get $P(I)$, and divide the row for the state of interest by that total.
- Check a conditional expectation answer: the conditional expectations weighted by their branch probabilities must give back the unconditional expectation.

FORMULAS

Cumulative distribution function (CDF)	$F(x) = P(X \leq x)$ $P(a < X \leq b) = F(b) - F(a)$
Unconditional expected value (mean)	$E(X) = \sum_{i=1}^{n} P(x_i)\, x_i$
Unconditional variance and standard deviation	$\sigma^2(X) = \sum_{i=1}^{n} P(x_i)\, [x_i - E(X)]^2$ $\sigma(X) = \sqrt{\sigma^2(X)}$
Unconditional covariance	$\text{Cov}(X, Y) = \sum_{i=1}^{n} P(x_i, y_i)\, [x_i - E(X)]\, [y_i - E(Y)]$
Discrete distributions	$E(X) = np$ $\sigma^2(X) = np(1-p)$ $P(k \text{ events in interval } t) = \frac{(\lambda t)^k e^{-\lambda t}}{k!}$ $\text{mean} = \text{variance} = \lambda \text{ (for one unit of time, } t = 1)$
Continuous distributions	$P(x_1 \leq X \leq x_2) = \frac{x_2 - x_1}{b - a}$ $\text{mean} = \frac{a+b}{2}$ $\sigma^2 = \frac{(b-a)^2}{12}$
Conditional mean, variance and covariance	$E(X \mid S) = \sum_{i} P(x_i \mid S)\, x_i$ $\text{Var}(X \mid S) = \sum_{i} P(x_i \mid S)\, [x_i - E(X \mid S)]^2 = E(X^2 \mid S) - [E(X \mid S)]^2$
Updating probabilities with Bayes' formula	$P(E \mid I) = \frac{P(I \mid E)}{P(I)} \times P(E) = \frac{P(I \mid E)\, P(E)}{P(I \mid E)P(E) + P(I \mid E^c)P(E^c)}$

7 Estimation and Hypothesis Testing

MODULE 7.1 · THE CENTRAL LIMIT THEOREM, CONFIDENCE INTERVALS, AND SAMPLING

- By the central limit theorem, the mean of samples of size $n \geq 30$ from any population with a finite variance is approximately normal with mean μ and variance σ^2/n.
- The sample mean's standard error is $\sigma/\sqrt{n}$, or $s/\sqrt{n}$ when σ is unknown.
- A confidence interval is the point estimate ± reliability factor × standard error, with a t reliability factor and $n - 1$ df when σ is unknown.
- A desirable estimator is unbiased, efficient, consistent and robust.
- Parametric VaR is $z_\alpha \times \sigma \times$ portfolio value with the whole α in one tail; it is the minimum loss at the stated probability, not the worst possible loss.

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- Simple random, systematic, stratified and cluster sampling are probability methods; convenience and judgmental sampling are nonprobability methods.

EXAM SHORTCUTS

- Quadrupling the sample size halves the standard error.
- Reliability factors: two-tailed 90%, 95% and 99% use 1.65, 1.96 and 2.58; one-tailed 10%, 5% and 1% (VaR) use 1.28, 1.65 and 2.33.
- A higher confidence level widens an interval and a larger sample narrows it, which rules out answer choices that move the wrong way.

MODULE 7.2 · HYPOTHESIS TESTS OF THE POPULATION MEAN

- H_0 always contains the equality and is usually the claim the researcher hopes to reject; H_a is the claim the researcher seeks evidence for.
- The test statistic is (sample mean − μ_0) ÷ standard error, following a t-distribution with $n - 1$ df when s is used.
- H_0 is rejected when the statistic falls beyond the critical value; otherwise the decision is to fail to reject, and the null is never accepted.
- A Type I error rejects a true null with probability α; a Type II error fails to reject a false null with probability β; power is $1 - \beta$.
- With the sample size unchanged, a lower α makes a Type II error more likely and reduces power.

EXAM SHORTCUTS

- The hypothesis that contains the equality sign is H_0.
- A two-tailed 10% test and a one-tailed 5% test share the critical value 1.65.
- For a two-tailed test, H_0 is rejected when the sample mean falls outside $\mu_0 \pm$ critical value × standard error, so a confidence interval answers the test directly.

MODULE 7.3 · OTHER PARAMETRIC HYPOTHESIS TESTS

- Independent samples with equal variances use the pooled difference-in-means t-test with $n_1 + n_2 - 2$ df; the same subjects measured twice use the paired comparisons test with $n - 1$ df.
- A single variance is tested with $\chi^2 = (n-1)s^2/\sigma_0^2$ and $n - 1$ df; the chi-square distribution is right-skewed and bounded below by zero.
- Two variances are tested with $F = s_1^2/s_2^2$ and $n_1 - 1$, $n_2 - 1$ df.
- A correlation is tested with $t = r\sqrt{n-2}/\sqrt{1-r^2}$ and $n - 2$ df; its absolute value rises with $|r|$ and with n.
- The p-value is the smallest significance level at which H_0 can be rejected.
- p-hacking raises the frequency of Type I errors.

EXAM SHORTCUTS

- Choose the test from what is tested: a mean uses t when the population variance is unknown (z when it is known, or as a large-sample approximation), a test that a correlation is zero uses t when both variables are normally distributed, one variance uses chi-square, and two variances use F.
- With the larger variance in the numerator of the F-statistic, only the upper critical value is needed.
- When a p-value is given, reject H_0 if it is below α; no critical value is needed.

MODULE 7.4 · NONPARAMETRIC HYPOTHESIS TESTS

- A nonparametric test is used for ranks or categories, when the assumptions of a parametric test do not hold, or when the question is not about a parameter.
- The Spearman rank correlation is $r_s = 1 - 6\sum d_i^2/[n(n^2-1)]$, tested in large samples ($n > 30$) with the same t-statistic as a Pearson correlation.
- In a chi-square test of independence the expected count is row total × column total ÷ total, $\chi^2 = \sum(O-E)^2/E$ with $(r-1)(c-1)$ df, and only the right tail is used.
- A standardized residual is $(O-E)/\sqrt{E}$, and cells beyond ±2 are flagged by the rule of thumb.

EXAM SHORTCUTS

- Rank data point to the Spearman test; category counts point to a chi-square test on a contingency table.
- Contingency table df are $(r-1)(c-1)$, counting only category rows and columns and leaving out the totals.

FORMULAS

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

8 The Return and Risk of a Financial Portfolio

MODULE 8.1 · PORTFOLIO EXPECTED RETURN

- A portfolio's expected return is the weighted average $E(R_P) = \sum w_i E(R_i)$, with each weight equal to the asset's share of total portfolio value and the weights summing to 1.
- A portfolio's historical return for one period is $\sum w_{i,t-1} R_{i,t}$, using the weights at the start of the period.
- The cumulative (compound) return $\prod(1 + R_{P,t}) - 1$ and the geometric average include compounding, while the sum and the arithmetic average of the period returns ignore it.
- Without rebalancing, market moves shift the weights (portfolio drift), so each period's return must use the drifted weights from start-of-period market values.
- Style drift is a portfolio moving away from its stated strategy, either through portfolio drift or through changes in the holdings themselves, such as a small-cap stock growing into the mid-cap category.
- Exam convention: drift raises the weights of high-return securities in an equal-weighted portfolio and enlarges already large allocations in a portfolio that is not equally weighted, so it behaves like a momentum strategy with possibly higher concentration risk; current practice: in any unrebalanced portfolio the outperformers gain weight, and whether concentration or risk rises depends on which assets outperform.

EXAM SHORTCUTS

- For a portfolio that is not rebalanced, the cumulative return equals the initial-weight average of each asset's cumulative return, so the cumulative figure needs no period-by-period weights.

MODULE 8.2 · PORTFOLIO RISK MEASURES

- Two-asset portfolio variance is $\sigma_P^2 = w_1^2\sigma_1^2 + w_2^2\sigma_2^2 + 2w_1w_2\text{Cov}_{1,2}$, and the portfolio standard deviation is its square root.
- Covariance can be written $\text{Cov}_{1,2} = \rho_{1,2}\sigma_1\sigma_2$, which exam calculations use; an expected covariance, however, cannot be found by multiplying separate expected values of the three inputs.
- With positive weights, a correlation of +1 gives a portfolio standard deviation equal to the weighted average of the standard deviations (no diversification benefit), and any lower correlation gives less, with a larger benefit as ρ falls.
- With $\rho = -1$, $\sigma_P = |w_1\sigma_1 - w_2\sigma_2|$, which is zero only when $w_1\sigma_1 = w_2\sigma_2$.
- A negative covariance makes the cross term negative, so the portfolio is much less risky than the weighted average of the standard deviations suggests.

EXAM SHORTCUTS

- For two assets with positive weights, the portfolio standard deviation equals the weighted average of the two standard deviations only when $\rho = +1$ and is below it for any lower correlation, so with $\rho < +1$ an answer at or above the weighted average can be ruled out.

MODULE 8.3 · CORRELATION AND DIVERSIFICATION BENEFITS

- The diversification benefit grows as correlation falls: two-asset combinations lie on a straight line at $\rho = +1$, bow to the left when correlation is below +1, and include one zero-risk mix at $\rho = -1$.
- With N assets the variance-covariance matrix holds N variances and $(N^2 - N)/2$ unique covariances.
- Expected portfolio variance from scenarios is $\sum_m p_m[R_{P,m} - E(R_P)]^2$, with scenario probabilities that sum to 1.
- An equally weighted portfolio of N assets has variance $\bar{\sigma}^2/N + [(N-1)/N]\,\overline{\text{Cov}}$, which approaches the average covariance as N grows and is approximated for a large portfolio by $\bar{\rho}\,\bar{\sigma}^2$.
- Unsystematic risk is removed by diversification and is not rewarded with higher expected return; systematic risk is not removed and is rewarded.
- Roughly 20 to 30 well-chosen assets capture most of the diversification benefit, and beyond about 30 assets each new holding adds close to none.

EXAM SHORTCUTS

- The expected portfolio return from scenarios equals $\sum w_i E(R_i)$, the assets' expected returns weighted by portfolio weight, so it can be found without the scenario portfolio returns; the variance still needs them.

MODULE 8.4 · THE MINIMUM-VARIANCE PORTFOLIO AND THE EFFICIENT FRONTIER

- The minimum-variance frontier holds the lowest-risk portfolio for each level of expected return, and the global minimum-variance portfolio is its point of lowest risk.
- The efficient frontier is the upper part of the minimum-variance frontier from the global minimum-variance portfolio upward; points to the left of the frontier are unattainable and attainable points below the efficient frontier are inefficient.
- For two risky assets, $w_A = (\sigma_B^2 - \text{Cov}_{A,B})/(\sigma_A^2 + \sigma_B^2 - 2\text{Cov}_{A,B})$ and $w_B = 1 - w_A$ give the minimum-variance portfolio.
- The optimal risky (tangency) portfolio is where a line from the risk-free rate touches the efficient frontier, the efficient portfolio with the highest Sharpe ratio $(E(R_P) - R_f)/\sigma_P$.
- Combining the risk-free asset with portfolio P gives $E(R_C) = w_P E(R_P) + (1 - w_P)R_f$ and $\sigma_C = w_P\sigma_P$, with $w_P = (r_{\text{target}} - R_f)/(E(R_P) - R_f)$ for a target return and a weight above 100% meaning borrowing at the risk-free rate.
- Return-constrained optimization minimizes risk for a given return, risk-constrained optimization maximizes expected return for a given risk, and risk-adjusted return optimization seeks the highest Sharpe ratio.

EXAM SHORTCUTS

- Expected returns do not enter the two-asset minimum-variance weights, so any expected returns given in such a question can be set aside.

MODULE 8.5 · RISK AVERSION

- Optimal portfolio theory assumes rational, risk-averse investors who maximize utility, a single-period horizon, no taxes or transaction costs, and borrowing and lending at a constant risk-free rate.
- A risk-seeking investor has $A < 0$ and downward-sloping indifference curves, a risk-neutral investor has $A = 0$ and flat curves, and a risk-averse investor has $A > 0$ and upward-sloping curves.
- Utility is $U = E(r) - \frac{1}{2}A\sigma^2$ with the variance in decimals, so a higher coefficient of risk aversion A means a bigger penalty for risk.
- Risk tolerance, the inverse of risk aversion, can change with age, wealth and economic conditions.
- A risk-averse investor's indifference curves slope upward and are convex, curves higher and to the left give higher utility, and a more risk-averse investor has steeper curves.

MODULE 8.6 · CAPITAL ALLOCATION LINE AND CAPITAL MARKET LINE

- Under its assumptions (a riskless risk-free asset, a risky portfolio with return and risk above the risk-free rate, only these two assets, and unlimited borrowing and lending at the risk-free rate), the CAL is $E(R_C) = R_f + [(E(R_P) - R_f)/\sigma_P]\sigma_C$, with intercept R_f and slope equal to the risky portfolio's Sharpe ratio.
- Points on the CAL between the intercept and the risky portfolio involve lending at the risk-free rate, and points beyond the risky portfolio involve borrowing.
- An investor's optimal portfolio is where the CAL touches the highest attainable indifference curve; a more risk-averse investor chooses a lower-risk point on the same line.
- The CML is the CAL whose risky portfolio is the market portfolio, which holds all risky assets weighted by market value and is mean-variance efficient.
- Under the mutual fund theorem, every investor can obtain an efficient portfolio by combining the risk-free asset with the market portfolio.
- A CAL allows heterogeneous expectations, so each investor can have a different CAL, while the CML assumes homogeneous expectations and is the same for all investors.

EXAM SHORTCUTS

- Every portfolio on a CAL with a positive allocation to the risky portfolio has the Sharpe ratio of that risky portfolio, however much is lent or borrowed, so its Sharpe ratio can be read from the risky portfolio directly.

MODULE 8.7 · THE CAPITAL ASSET PRICING MODEL

- Because unsystematic risk can be diversified away at no cost, the market rewards investors only for bearing systematic risk.
- The CAPM is a single-factor model, $E(R_i) = R_f + \beta_i[E(R_M) - R_f]$, that assumes homogeneous expectations, utility-maximizing investors holding efficient portfolios, price takers and markets in equilibrium.
- Beta is $\mathrm{Cov}(R_i, R_M)/\sigma_M^2 = \rho_{i,M}\sigma_i/\sigma_M$, and the beta of the market portfolio is 1.
- Exam convention: a beta above 1 indicates an expected return above the market's and a beta below 1 one below it; current practice: this ordering holds only when the market risk premium is positive.
- The SML plots expected return against beta with intercept R_f and slope equal to the market risk premium and applies to any asset, while the CML plots against total risk and applies only to efficient portfolios.
- Portfolio theory is limited by non-normal returns, unstable correlations, imperfectly efficient markets, sensitivity to estimation error and a future that may differ from the past, and it ignores transaction costs and taxes.

FORMULAS

Expected return of a portfolio	$E(R_P) = \sum_{i=1}^{N} w_i\, E(R_i)$ $\sum_{i=1}^{N} w_i = 1$ $R_{P,t} = \sum_{i=1}^{N} w_{i,t-1}\, R_{i,t}$
Portfolio variance	$\sigma_P^2 = \sum_{i=1}^{N}\sum_{j=1}^{N} w_i w_j\, \mathrm{Cov}(R_i, R_j)$ $\sigma_P^2 = w_1^2\sigma_1^2 + w_2^2\sigma_2^2 + 2w_1w_2\, \mathrm{Cov}_{1,2}$ $\sigma_P = \sqrt{\sigma_P^2}$
Covariance and correlation	$\mathrm{Cov}_{1,2} = \rho_{1,2}\,\sigma_1\,\sigma_2 \quad\Longrightarrow\quad \sigma_P^2 = w_1^2\sigma_1^2 + w_2^2\sigma_2^2 + 2w_1w_2\rho_{1,2}\sigma_1\sigma_2$
More assets: the variance–covariance matrix	$\text{number of unique covariances} = \dfrac{N^2 - N}{2}$ $\sigma_P^2 = \sum_{i=1}^{N}\sum_{j=1}^{N} w_i w_j \rho_{i,j}\sigma_i\sigma_j$ $\rho_{i,i} = 1$
Large portfolios: variance approaches average covariance	$\sigma_P^2 = \dfrac{\bar{\sigma}^2}{N} + \dfrac{N-1}{N}\,\overline{\mathrm{Cov}}$ $\sigma_P^2 \approx \bar{\rho}\,\bar{\sigma}^2$
Minimum-variance portfolio of two risky assets	$w_A = \dfrac{\sigma_B^2 - \mathrm{Cov}_{A,B}}{\sigma_A^2 + \sigma_B^2 - 2\,\mathrm{Cov}_{A,B}}$ $w_B = 1 - w_A$
Adding a risk-free asset	$\text{Sharpe ratio} = \dfrac{E(R_P) - R_f}{\sigma_P}$ $E(R_C) = w_P E(R_P) + (1 - w_P)R_f$ $\sigma_C = w_P\,\sigma_P$ $w_P = \dfrac{r_{\text{target}} - R_f}{E(R_P) - R_f}$
Utility function	$U = E(r) - \frac{1}{2}A\sigma^2$
The capital allocation line (CAL)	$E(R_C) = R_f + \left[\dfrac{E(R_P) - R_f}{\sigma_P}\right]\sigma_C$
The capital market line (CML)	$E(R_P) = R_f + \left[\dfrac{E(R_M) - R_f}{\sigma_M}\right]\sigma_P$
Return-generating models and the CAPM	$E(R_i) = R_f + \beta_i\,[E(R_M) - R_f]$

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Beta	$\beta_i = \frac{\mathrm{Cov}(R_i, R_M)}{\sigma_M^2} = \frac{\rho_{i,M}\,\sigma_i\,\sigma_M}{\sigma_M^2} = \frac{\rho_{i,M}\,\sigma_i}{\sigma_M}$

9 Simulation of Financial Asset Prices and Returns

MODULE 9.1 · HISTORICAL SIMULATION

- Every simulation sets parameters, generates scenarios, evaluates them and compiles the results; historical simulation, bootstrapping and Monte Carlo simulation differ mainly in where the scenarios come from.
- Historical simulation applies actual past changes in prices, returns or risk factors to the current portfolio positions and assumes that past data represent the future.
- Historical simulation is nonparametric and captures skewness, excess kurtosis, fat tails and volatility clustering, but it can only produce outcomes from the lookback period and is weak when there are regime changes or unprecedented events.
- Missing historical data are filled with a proxy, a substitute instrument or a weighted combination of instruments with data available.
- VaR is the minimum loss over a specified period in the worst 5% (or 1%) of outcomes; the 95% historical VaR is the fifth percentile of the simulated P&L distribution, and daily VaR usually assumes a mean return of zero.
- Because a bond's duration shrinks as it approaches maturity, historical simulation for bonds applies past yield changes for the same remaining maturity to today's cash flows instead of using the bond's own past prices.

EXAM SHORTCUTS

- With N historical scenarios, the 95% VaR lies between the $(0.05N)$th-worst P&L and the next-worst one, so only those two outcomes need to be located (either one or a weighted average of the two is acceptable).

MODULE 9.2 · BOOTSTRAP RESAMPLING

- Bootstrapping is a nonparametric method that uses the sample at hand as a proxy for the population and builds new datasets by drawing from it at random with replacement, so each of n observations has a $1/n$ chance on every draw.
- In bootstrapping the same observation can be drawn several times within one scenario and can appear in many samples or in none.
- Historical simulation replays the past dataset as if it were the population, while bootstrapping builds new combinations of past observations, which reduces the risk of overfitting to one historical sequence.
- Bootstrapping can give the distribution of a European call's payoff at maturity under historical returns, which is not by itself the option's current no-arbitrage price, and can estimate the volatility of target date funds.
- Bootstrapping needs minimal assumptions and works with small samples, but it carries any bias in the original sample into every resample, cannot generate outcomes outside the observed range and is not suited to autocorrelated time series.

MODULE 9.3 · MONTE CARLO SIMULATION

- Monte Carlo simulation draws scenarios from probability distributions specified by the analyst and runs thousands of trials to build a simulated frequency distribution, with more trials giving more precise estimates.
- Monte Carlo simulation is used to estimate portfolio performance and to value securities without a closed-form pricing formula, such as Asian-style options, mortgage-backed securities and convertible bonds.
- Exam convention: a Monte Carlo value for a European call should match the Black-Scholes-Merton value, getting closer as more trials are run; current practice: this holds only when the simulated prices are lognormal with constant volatility and a risk-neutral expected return, with the average payoff discounted at the risk-free rate.
- The Cholesky decomposition maps independent standard normal draws into correlated normal variables using an assumed correlation; it does not estimate correlations or covariances.

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- Monte Carlo simulation is flexible, forward-looking and handles nonnormal distributions and correlations, but it is complex, model-dependent, computationally intensive and data-hungry, and it gives a statistical estimate without the cause-and-effect insight of analytic methods.
- Historical simulation assumes past data represent the future, bootstrapping assumes the sample represents the population, and Monte Carlo simulation assumes the process generating outcomes can be modeled statistically.

EXAM SHORTCUTS

- Identify the method from the source of the scenarios: actual past changes mean historical simulation, resampling with replacement from the observed sample means bootstrapping, and random draws from an assumed distribution mean Monte Carlo simulation.

FORMULAS

Multivariate simulation and the Cholesky decomposition

$$X_1 = \sigma_1 Z_1$$
$$X_2 = \sigma_2 \left(\rho Z_1 + \sqrt{1-\rho^2}\, Z_2\right)$$

10 Applications of Simple Linear Regression in Finance

MODULE 10.1 · LINEAR REGRESSION BASICS

- Simple linear regression explains the variation of a dependent variable Y, $\sum(Y_i - \bar{Y})^2$, with the variation of a single independent variable X.
- Ordinary least squares chooses the line that minimizes the sum of squared errors, $\text{SSE} = \sum(Y_i - \hat{Y}_i)^2$.
- The OLS estimates are $\hat{b}_1 = \text{Cov}(X, Y)/\sigma_X^2$ and $\hat{b}_0 = \bar{Y} - \hat{b}_1\bar{X}$, so the fitted line passes through the point of means.
- The slope is the expected change in Y for a one-unit rise in X, and the intercept is the predicted value of Y when X equals zero.
- The residual $Y_i - \hat{Y}_i$ is the gap between the actual and the fitted value; exam convention treats the residual, error term and disturbance term as the same thing, while current practice treats the residual as the sample estimate of the unobservable error term.
- Time series data follow one variable over time, cross-sectional data cover many subjects at one point in time, and panel data repeat cross-sectional observations over time.

EXAM SHORTCUTS

- The regression line passes through $(\bar{X}, \bar{Y})$, so once the slope is known the intercept is $\bar{Y} - \hat{b}_1\bar{X}$ with no further sums.

MODULE 10.2 · ANALYSIS OF VARIANCE (ANOVA) AND GOODNESS OF FIT

- Simple linear regression assumes a linear relationship, homoskedastic residuals, residuals uncorrelated with one another, and normally distributed residuals.
- Residual variance that widens or narrows with X or over time is heteroskedasticity, and residuals correlated with one another, such as a recurring seasonal pattern, show autocorrelation.
- ANOVA splits total variation into explained and unexplained parts, $\text{SST} = \text{SSR} + \text{SSE}$.
- In a simple regression $\text{MSE} = \text{SSE}/(n-2)$, $\text{SEE} = \sqrt{\text{MSE}}$, and $R^2 = \text{SSR}/\text{SST} = 1 - \text{SSE}/\text{SST}$, which equals r^2.
- $F = \text{MSR}/\text{MSE}$ with 1 and $n-2$ degrees of freedom is a one-tailed test, and with one independent variable it tests $H_0 : b_1 = 0$, the same hypothesis as the slope's t-test.
- Regressing Y on an indicator variable gives a slope equal to the difference in the mean of Y between periods with and without the condition, and an intercept equal to the mean when the indicator is 0.

EXAM SHORTCUTS

- With one independent variable, $F = t^2$ for the test of $H_0 : b_1 = 0$ against $H_a : b_1 \neq 0$, so at the same significance level the F-test and the two-tailed slope t-test reach the same decision and only one needs computing.
- When only R^2 and SSR are given, SST $=$ SSR$/R^2$ and SSE $=$ SST $-$ SSR, which lead straight to the MSE and the SEE.
- In a simple regression $r = \pm\sqrt{R^2}$, taking the sign of the slope.

MODULE 10.3 · PREDICTED VALUES AND FUNCTIONAL FORMS OF REGRESSION

- A predicted value is $\hat{Y} = \hat{b}_0 + \hat{b}_1 X_p$, using the intercept and the sign of each term.
- The prediction interval for Y is $\hat{Y} \pm t_c s_f$ with $n - 2$ degrees of freedom, where s_f is the standard error of the forecast.
- The forecast is more precise when the SEE is smaller, the sample is larger, X_p is closer to $\bar{X}$ and the independent variable has a greater variance.
- A log-lin model ($\ln Y$ on X) has a slope giving the relative change in Y for an absolute change in X, a lin-log model the absolute change in Y for a relative change in X, and a log-log model an elasticity.
- Exam convention: a higher R^2, a higher F-statistic and a lower SEE identify the better-fitting functional form; current practice: R^2 and SEE are directly comparable only when the dependent variable is the same.

EXAM SHORTCUTS

- The standard error of the forecast is always larger than the SEE, so a prediction interval narrower than $\hat{Y} \pm t_c \times$ SEE can be ruled out.

MODULE 10.4 · ESTIMATING CAPM VALUES WITH SIMPLE LINEAR REGRESSION

- The CAPM is estimated by regressing the asset's excess return $R_i - R_f$ on the market risk premium $R_M - R_f$; the slope is the asset's beta and the intercept is zero if the CAPM holds exactly.
- A security market index proxies the market return, short-term government debt yields proxy the risk-free rate, and at least 30 observations is the usual minimum.
- Beta is tested with $t = (\hat{b}_1 - \text{hypothesized value})/s_{\hat{b}_1}$, and its confidence interval is the slope $\pm$ critical value $\times$ the slope's standard error.
- The expected return is $E(R_i) = R_f + \hat{\beta}[E(R_M) - R_f]$, and a change in inputs gives $\Delta E(R_i) = \Delta R_f + \hat{\beta}\,\Delta[E(R_M) - R_f]$.
- The R^2 of the CAPM regression is the share of the asset's excess-return variation that is systematic, and $1 - R^2$ is the unsystematic share.
- Longer samples give more precise estimates but may include periods with a different beta, and more frequent data can be noisy for thinly traded assets.

EXAM SHORTCUTS

- A two-tailed 95% confidence interval for beta that excludes 1 means $H_0 : \beta = 1$ is rejected at the 5% level, and one that includes 1 means it is not, so either result gives the other.

FORMULAS

The model and the regression line

$$Y_i = b_0 + b_1 X_i + \varepsilon_i \quad \text{(population model)}$$

$$\hat{Y}_i = \hat{b}_0 + \hat{b}_1 X_i \quad \text{(estimated regression line, the line of best fit)}$$

Least squares criterion	$\text{SSE} = \sum_{i=1}^{n}(Y_i - \hat{Y}_i)^2$ $\hat{b}_1 = \dfrac{\text{Cov}(X,Y)}{\sigma_X^2}$ $\hat{b}_0 = \bar{Y} - \hat{b}_1\bar{X}$
Analysis of variance (ANOVA)	$\text{SST} = \text{SSR} + \text{SSE}$
Goodness-of-fit measures	$\text{SEE} = \sqrt{\text{MSE}} = \sqrt{\dfrac{\text{SSE}}{n-2}}$ $R^2 = \dfrac{\text{SSR}}{\text{SST}} = 1 - \dfrac{\text{SSE}}{\text{SST}}$
F-test	$F = \dfrac{\text{MSR}}{\text{MSE}}$ $df = 1\ (\text{numerator}),\ n-2\ (\text{denominator})$
t-test of a regression coefficient	$t = \dfrac{\hat{b}_1 - b_1}{s_{\hat{b}_1}}$ $df = n-2$
Predicted values	$\hat{Y} = \hat{b}_0 + \hat{b}_1 X_p$
Confidence (prediction) interval for a predicted value	$\hat{Y} \pm t_c\, s_f$ $df = n-2$ $s_f^2 = \text{SEE}^2\left[1 + \dfrac{1}{n} + \dfrac{(X_p - \bar{X})^2}{(n-1)s_X^2}\right]$
The CAPM as a one-factor regression	$E(R_i) = R_f + \beta_i\,[E(R_M) - R_f]$ $Z_{i,t} = b_0 + b_1 Z_{M,t} + \varepsilon_t$ $Z_{i,t} = R_{i,t} - R_{f,t}, \quad Z_{M,t} = R_{M,t} - R_{f,t}$

11 Introduction to Financial Data Science

- Financial data science applies quantitative and qualitative analysis to gain insight into a specific financial question, with main uses in evaluating investment opportunities, optimizing portfolios and mitigating risk.
- Big data can be structured (rows and columns), semi-structured (tagged, such as HTML code) or unstructured (social media posts, voice recordings, pictures, sensor output), and comes from traditional sources or from alternative sources: individuals, business processes and sensors.
- The characteristics of big data are volume, velocity (low latency means real time), variety of structures and, for financial data especially, veracity, meaning whether the data are reliable and credible.
- Data science processes data through capture, curation (ensuring data quality), storage, search and transfer, and a data lake keeps structured, semi-structured and unstructured data in their raw format.
- Data mining searches large datasets for patterns to predict outputs, while machine learning, a subcategory of AI, learns from input data without assumptions about their distribution and without human help.

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- Supervised learning uses labeled inputs and outputs, unsupervised learning finds structure in unlabeled inputs, and reinforcement learning learns by trial and error from rewards and penalties.
- Overfitting comes from a model that is too complex and treats noise as a true pattern; underfitting comes from one that is not complex enough and treats true parameters as noise.
- The training dataset is the largest, about 60%–80% of the data, with validation and test sets splitting the rest equally; observations are normally assigned at random, but time series data keep their chronological order through a time-based split or rolling-window validation.

EXAM SHORTCUTS

- Classify a data source by where it comes from, not by its structure: records from individuals, business processes and sensors are alternative data even when they are structured.
- Match the type of machine learning to what the algorithm is given: labeled inputs and outputs mean supervised learning, unlabeled inputs alone mean unsupervised learning, and rewards and penalties for its own actions mean reinforcement learning.

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Economics

Exam weight 6–9% · 8 readings · 23 formulas

12 The Firm and Market Structures

MODULE 12.1 · BREAKEVEN, SHUTDOWN, AND SCALE

- In the short run at least one input is fixed; in the long run every input is variable.
- A price taker breaks even at a price equal to minimum ATC and shuts down in the short run when price falls below minimum AVC.
- When price is between AVC and ATC the firm keeps operating in the short run, because its loss is smaller than its fixed cost, and exits in the long run unless price is expected to rise.
- In any market structure: $TR \geq TC$ means stay; $TVC \leq TR < TC$ means operate in the short run and exit in the long run if the shortfall is expected to persist; $TR < TVC$ means shut down.
- Marginal cost crosses AVC and ATC at their minimum points.
- The minimum efficient scale is the lowest point of LRATC; economies of scale make LRATC fall and diseconomies of scale make it rise.

EXAM SHORTCUTS

- Decide breakeven and shutdown with two comparisons in order: TR against TC, then TR against TVC.
- Short-run shutdown compares price with AVC; long-run exit compares price with ATC.

MODULE 12.2 · CHARACTERISTICS OF MARKET STRUCTURES

- Every firm maximizes profit where MR = MC; a price taker has $P = MR$, while a price searcher has $MR < P$.
- Monopolistic competition has many firms, differentiated products and low barriers, and earns zero economic profit in the long run with excess capacity.
- Oligopoly is defined by interdependence among a few large firms protected by high barriers to entry.
- Cournot firms decide simultaneously and the Stackelberg leader decides first; exam convention: they choose prices, the Cournot firm assuming its rival keeps last period's price and the Stackelberg leader charging a higher price and earning the larger share of total profit; current practice: they choose quantities and sell at one market price.
- In a Nash equilibrium no firm can gain by changing its choice alone, and the outcome need not maximize joint profit.
- The oligopoly price lies between the collusive (monopoly) price and the perfectly competitive price.

EXAM SHORTCUTS

- Classify a market from two facts first: the number of firms and the barriers to entry. Many firms with identical products is perfect competition; many with differentiated products and low barriers is monopolistic competition; a few interdependent firms behind high barriers is oligopoly; one firm with no close substitutes is monopoly.
- To find a Nash equilibrium, mark each player's best reply to every choice of the rival; a cell with both choices marked is an equilibrium.
- Under the kinked demand curve model, a cost change that keeps MC inside the gap in MR leaves price and output unchanged.

MODULE 12.3 · IDENTIFYING MARKET STRUCTURES

- A market structure is identified by the number of firms, the barriers to entry, the nature of substitutes and the nature of competition.
- The N-firm concentration ratio is the sum of the N largest market shares; the HHI is the sum of their squared shares.

- The HHI is more sensitive than the concentration ratio to mergers among the largest firms.
- Neither measure accounts for barriers to entry or potential competition, and neither measures the elasticity of firm demand directly.

EXAM SHORTCUTS

- With shares in whole percentages, square and add them to get the HHI on the 0 to 10,000 scale without converting to decimals.
- When two of the top N firms merge, the N-firm concentration ratio rises only by the share of the firm that enters the top N.

FORMULAS

The two concentration measures

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

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

13 Understanding Business Cycles

- The business cycle has four phases: trough (real GDP stops falling and growth turns positive), expansion (real GDP rising), peak (real GDP at its high for the cycle, then starting to fall) and contraction or recession (real GDP falling).
- The classical cycle plots the level of real GDP and the growth cycle its percentage gap from trend; the growth rate cycle turns earlier at peaks and troughs and, under the exam convention, is the preferred measure that shows GDP relative to a trend rate, while in current practice it tracks the growth rate itself, which can be compared with trend growth.
- A common rule of thumb dates a contraction from two consecutive quarters of falling real GDP and an expansion from two consecutive quarters of rising real GDP, while official dating bodies also weigh unemployment, industrial production and inflation.
- Credit cycles, swings in loan availability and interest rates, tend to amplify business cycles, can feed asset price bubbles and have on average lasted longer than business cycles.
- The inventory-sales ratio rises above normal late in an expansion as sales growth slows, leading firms to cut production, and falls below normal near the trough as sales pick up, leading firms to raise output.
- Firms first change how intensively they use existing workers and equipment, and only once the trend looks durable do they hire or lay off workers, invest in new capacity, or defer maintenance and delay replacing equipment.
- Durable goods spending is the most cyclical, services spending moderately cyclical and nondurable goods spending the least; imports rise with domestic GDP growth, while exports depend mainly on trading partners' growth.
- Leading indicators turn before peaks and troughs, coincident indicators turn at about the same time, and lagging indicators turn after a new phase is under way and confirm it.

EXAM SHORTCUTS

- The growth rate cycle reaches its high and low points before the level of real GDP does, because growth slows while the level is still rising and recovers while the level is still falling.
- Series that record decisions made before output changes, such as average weekly hours, new orders, building permits and share prices, are leading indicators.

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14 Fiscal Policy

MODULE 14.1 · FISCAL POLICY OBJECTIVES

- Fiscal policy is the government's use of taxes and government spending to steer economic activity, and monetary policy is the central bank's management of the quantity of money and credit.
- Both policies aim at price stability and economic growth, and only fiscal policy is a direct tool for redistributing income and wealth.
- Expansionary fiscal policy means higher spending or lower taxes, giving a larger deficit or smaller surplus; expansionary monetary policy is also called accommodative or easy, and contractionary monetary policy restrictive or tight.
- Automatic stabilizers such as unemployment compensation and the progressive income tax push the budget toward deficit in a recession and toward surplus in a boom without new legislation, while discretionary fiscal policy needs legislation and is slowed by policy lags.
- Exam convention: with tax rates held constant, the debt ratio rises when the real interest rate on government debt exceeds real GDP growth and falls when it is below; current practice: this holds when the primary budget is balanced, since a primary deficit or surplus can reverse the result.
- Concerns about deficits are higher future taxes, a loss of market confidence and crowding out of private investment; arguments against concern include debt held by citizens, debt that finances productive investment, needed tax reform, Ricardian equivalence and an economy below full capacity.

EXAM SHORTCUTS

- Classify a policy by who acts: taxes, government spending and transfers set by the government are fiscal policy, while money, credit and short-term rates managed by the central bank are monetary policy.

MODULE 14.2 · FISCAL POLICY TOOLS AND IMPLEMENTATION

- Fiscal spending tools are transfer payments (not counted in GDP), current spending and capital spending, and revenue tools are direct taxes on income or wealth and indirect taxes on goods and services; indirect taxes can be changed quickly, while direct taxes, transfers and capital spending take time.
- Government spending raises aggregate demand more than an equal tax cut, because households save part of a tax cut, and tax cuts aimed at low-income households, who have a higher MPC, work better.
- The fiscal multiplier is $1/[1 - MPC(1 - t)]$, which rises with the MPC and falls with the tax rate.
- Exam convention: equal increases in government spending and taxes leave the budget balanced and raise aggregate demand, so the balanced budget multiplier is positive; current practice: with an income tax the higher output also raises tax receipts, but the direction of the output effect is unchanged.
- Recognition, action and impact lags separate the need for discretionary fiscal policy from its effect, so a badly timed policy can destabilize the economy.
- The stance is judged from the change in the structural (cyclically adjusted) deficit, the deficit current policies would produce at full employment: a rise means expansionary policy, while a change in the actual deficit that leaves it unchanged reflects the cycle.

EXAM SHORTCUTS

- To leave aggregate demand unchanged when government spending rises by ΔG, taxes must rise by $\Delta G/MPC$, more than the spending increase.

FORMULAS

Fiscal policy tools: spending and revenue, advantages and disadvantages

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

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

15 Monetary Policy

MODULE 15.1 · CENTRAL BANK OBJECTIVES AND TOOLS

- A central bank supplies currency, acts as banker to the government and other banks, regulates and supervises the payments system, is lender of last resort, holds gold and foreign exchange reserves and conducts monetary policy; under the exam convention it is the sole supplier of money, while in current practice its monopoly covers banknotes and bank reserves (coins are often issued by the government or a mint) and commercial banks create most deposit money.
- Controlling inflation to promote price stability is a central bank's primary objective, and some central banks also aim for stable exchange rates, full employment, sustainable growth and moderate long-term interest rates.
- Most developed-country central banks aim for inflation in a range around 2% to 3%, not zero, because swings around a zero target would often mean deflation.
- Exam convention: open market operations, the policy rate and reserve requirements are the three working tools, used expansionarily by cutting the rate or requirements and buying securities; current practice: the Federal Reserve has set reserve requirements to zero and steers the federal funds rate mainly through the rate it pays on reserve balances.
- The federal funds rate is the market rate US banks charge each other for overnight loans of reserves, which the Federal Reserve targets, while the discount rate is what a bank pays to borrow from the Federal Reserve.
- A policy-rate change reaches the price level through other short-term rates, asset prices, expectations and exchange rates; a rate increase lowers aggregate demand and appreciates the currency, and if money neutrality holds, monetary policy has no long-run effect on real output.

EXAM SHORTCUTS

- Monetary tightening makes the domestic currency appreciate, so an answer in which tightening cuts spending through a weaker currency can be ruled out.

MODULE 15.2 · MONETARY POLICY EFFECTS AND LIMITATIONS

- An effective central bank has independence, credibility and transparency; operational independence means it sets the policy rate alone, and target independence means it also defines the inflation measure, the target and the horizon for reaching it.
- Inflation targeting, the most widely used regime, keeps expected inflation inside a band, most commonly 2% ± 1%, while an exchange rate target makes the central bank buy its currency with foreign reserves when it falls below target and sell it when it rises above, so the pegging country ends up with the anchor country's inflation rate.
- The neutral interest rate equals the real trend rate of economic growth plus the inflation target, and a policy rate above it is contractionary and below it expansionary; the exam convention describes the neutral rate as the money supply growth rate that neither speeds up nor slows growth, while current practice treats it as the policy rate that neither stimulates nor restrains the economy.
- Monetary policy can fail when long-term rates move against short-term rates because of expected inflation, in a liquidity trap where demand for money is very elastic, and when banks will not lend despite excess reserves, which led central banks to quantitative easing.
- Exam convention: the nominal policy rate cannot be cut below zero, leaving little room to stimulate; current practice: some central banks have set slightly negative rates; either way deflation is harder to reverse than inflation.
- With expansionary fiscal and contractionary monetary policy, interest rates rise and the public sector's share of GDP rises, while contractionary fiscal and expansionary monetary policy lower rates and let the private sector grow.

EXAM SHORTCUTS

- To judge the stance, add the real trend growth rate and the inflation target and compare the policy rate with that sum: above it means contractionary, below it expansionary.

FORMULAS

Effective central banks, targeting regimes and limits of policy	$\text{neutral interest rate} = \text{real trend rate of economic growth} + \text{inflation target}$

16 Introduction to Geopolitics

- Geopolitics studies interactions among nations, involving state actors (national governments) and nonstate actors (companies, nongovernment organizations and individuals), and a country's cooperation varies along a spectrum, driven by its national interests in security, economic needs and culture.
- Globalization is the long-run integration of economic activity and cultures across the world, and nationalism here means a country putting its own economic interests first, alone or in competition with others.
- The IMF promotes international monetary cooperation, balanced growth of trade and exchange stability and makes resources available, with adequate safeguards, to members with balance of payments difficulties; the World Bank fights poverty with loans, credits and grants to developing countries; the WTO, the sole international body for the rules of trade between nations, runs a dispute settlement process.
- Geopolitical risk changes the risk premium on a country's or region's assets and is described by its likelihood, its impact and its velocity, meaning how quickly investment values reflect it.
- A black swan is a low-likelihood exogenous event with substantial short-term effects; long-horizon investors usually need not react to one and should instead analyze medium- and low-velocity risks.
- National security tools are classified as active or threatened, while economic and financial tools are classified as cooperative or noncooperative, and sanctions count as a financial tool.
- Investors should focus on geopolitical risks with potentially high impact, judge whether their effects are discrete or broad, estimate them with scenario analysis and track their likelihood with signposts.

EXAM SHORTCUTS

- Place a country on the two axes and the archetype follows: noncooperative and nationalist is autarky, noncooperative and globalized is hegemony, cooperative and nationalist is bilateralism, and cooperative and globalized is multilateralism.
- Classify a geopolitical risk by what is known in advance: a known date with an unknown outcome is event risk, an unanticipated event is exogenous risk, and known factors with long-lasting effects are thematic risk.

17 International Trade

- A country has a comparative advantage in a good when its opportunity cost of producing it is lower than other countries', and specializing according to comparative advantage raises total output.
- Newer trade models add gains from economies of scale, more variety for consumers, stronger competition and a better allocation of resources.
- Consumers of imported goods and export industries gain from trade while import-competing producers and workers lose, but overall gains exceed losses, especially in the long run, and both trading partners share the net gains.
- Infant industry and national security arguments for trade restrictions have some support among economists, while protecting domestic jobs or industries has little or none.
- Tariffs, import quotas and VERs reduce imports, raise the domestic price, domestic quantity supplied and producer surplus, lower consumer surplus and reduce national welfare, with the possible exception of a tariff or quota imposed by a large importing country.
- A quota whose licenses the government sells for full value has the same outcome as an equivalent tariff, while free licenses to foreign exporters send the quota rents abroad, and a VER causes the same welfare loss as an equivalent quota with free licenses to foreign exporters.

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- An export subsidy raises the domestic price by the full subsidy in a small exporting country, while a large exporter's subsidy lowers the world price, benefiting foreign consumers and hurting foreign producers.
- A free trade area removes barriers among members, a customs union adds common restrictions on nonmembers, a common market adds free movement of labor and capital, an economic union adds common institutions and economic policy, and a monetary union adds a single currency.

EXAM SHORTCUTS

- Find comparative advantage from opportunity costs, not output: the country that gives up less of the other good has the advantage, even if the other country produces more of both goods.
- Each level of integration adds one feature to the level below, so classify an agreement by the highest feature it has: free trade among members, common restrictions on nonmembers, free movement of labor and capital, common institutions and economic policy, then a single currency.

FORMULAS

Tariff welfare formulas (small country)

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

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

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

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

18 Capital Flows and the FX Market

MODULE 18.1 · THE FOREIGN EXCHANGE MARKET

- The FX market serves trade flows and the much larger capital flows; a position that reduces an existing currency risk is hedging, and one that creates or increases currency risk is speculating.
- The sell side is the large multinational dealer banks, and the buy side is corporations, real money and leveraged accounts, governments and central banks, and the retail market; the exam convention separates real money from leveraged accounts by derivatives use, while current practice separates them by leverage.
- A P/B quote states how many units of the price currency buy one unit of the base currency, so a higher quote means the base currency has appreciated, and the quote is direct for an investor whose home currency is the price currency.
- A spot rate is for immediate delivery (usually two business days), and a forward rate is agreed today for an exchange of fixed amounts on a specified future date.
- The real P/B rate equals the nominal P/B rate × $CPI_{\text{base}}/CPI_{\text{price}}$, so it rises with the nominal rate and the base-country price level and falls with the price-country price level.
- The base currency changes by new P/B ÷ old P/B − 1 and the price currency by old P/B ÷ new P/B − 1, and the two percentages differ in size.

EXAM SHORTCUTS

- In a price/base quote a higher number means the base currency (the denominator) has appreciated, so identify the base currency before judging which currency strengthened.
- The percentage change in the real P/B rate is approximately the nominal change plus base-country inflation minus price-country inflation, a quick estimate that needs no CPI ratio.

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MODULE 18.2 · MANAGING EXCHANGE RATES

- The IMF lists two regimes for countries without their own currency (formal dollarization and monetary union) and seven for countries with one, and moving toward floating generally gives more room for independent monetary policy.
- A currency board explicitly commits to swap domestic currency for a named foreign currency at a fixed rate, issuing currency only when fully backed, while a conventional fixed peg allows ±1% margins and a target zone wider bands such as ±2%.
- A crawling peg adjusts the peg rate itself, crawling bands widen the band over time as a step toward floating, managed floating reacts to indicators without a target rate, and an independent float uses intervention only to slow the rate of change.
- A currency appreciation raises imports and cuts exports, but these trade effects build up slowly; capital flows dominate exchange rate moves in the short and intermediate term, and trade flows matter more in the long term.
- Under $(X - M) \equiv (S - I) + (T - G)$, a trade deficit is matched by a capital account surplus, and shrinking it on a lasting basis requires domestic spending to fall relative to income.
- Capital restrictions aim to reduce the volatility of domestic asset prices, maintain fixed exchange rates, keep domestic interest rates low and protect strategic industries from foreign ownership.

EXAM SHORTCUTS

- Because $(X - M) \equiv (S - I) + (T - G)$, a trade deficit implies that private saving falls short of investment, the government runs a budget deficit, or both, and a larger capital account surplus cannot be the cure.

FORMULAS

Nominal and real exchange rates	$\text{real P/B rate} = \text{nominal P/B rate} \times \frac{CPI_{\text{base currency}}}{CPI_{\text{price currency}}}$
Percentage change in a currency's value	$\%\Delta \text{ base} = \frac{\text{new P/B}}{\text{old P/B}} - 1$ $\%\Delta \text{ price} = \frac{1/\text{new P/B}}{1/\text{old P/B}} - 1 = \frac{\text{old P/B}}{\text{new P/B}} - 1$
Exchange rates, trade and capital flows	$(X - M) \equiv (S - I) + (T - G)$

19 Exchange Rate Calculations

- A cross rate is found by arranging price/base quotes so the common currency cancels, $A/C = A/B \times B/C$, inverting a quote first when it has the wrong orientation.
- Under no-arbitrage, with domestic/foreign (price/base) quotes, $F/S = (1 + r_d)/(1 + r_f)$, with the price currency's rate in the numerator and the base currency's rate in the denominator.
- With price/base quotes the forward premium on the base currency is $(r_d - r_f)/(1 + r_f)$, roughly the rate differential; the exam convention prints the relation as $(r_f - r_d)/(1 + r_d)$, which holds only for quotes of foreign currency per unit of domestic currency.
- For a forward shorter than a year, each annualized money market rate is scaled to the period, usually $r \times \text{days}/360$, before applying parity.
- A forward quoted in points is $F = S + \text{points} \times \text{point size}$, where one point is the last decimal place of the spot quote, and a percentage quote gives $F = S(1 + \text{percentage})$.
- The forward premium (+) or discount (−) on the base currency is $F/S - 1$, and the price currency's premium or discount is found by inverting both quotes first.
- If the quoted forward differs from the no-arbitrage forward, borrowing one currency, converting at spot, investing and selling the proceeds forward earns a riskless profit, and arbitrage trading restores parity.

- The no-arbitrage forward rate is the rate that rules out arbitrage at a point in time, not the expected future spot rate, and interest rate differentials have historically forecast future spot rates poorly.

EXAM SHORTCUTS

- Before computing a cross rate, check its size: if one unit of the base currency buys more of the common currency than one unit of the price currency does, the cross rate must be above 1.
- The currency with the higher interest rate trades at a forward discount, so whether the forward is above or below spot is known before any calculation: with a P/B quote, forward exceeds spot when the price currency's rate is higher.
- The forward premium or discount on the base currency is roughly the interest rate differential for the period, $r_{\text{price}} - r_{\text{base}}$, which checks a computed forward rate.

FORMULAS

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

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Corporate Finance

Exam weight 6–9% · 7 readings · 18 formulas

20 Organizational Forms, Corporate Issuer Features, and Ownership

- Organizational forms differ in whether the law treats the business as distinct from its owners, whether owners also operate it, whether owner liability is limited, how profits are taxed and how easily it can raise capital.
- In a sole proprietorship and a general partnership the owners run the business, have unlimited liability and pay personal income tax on its profits.
- A limited partnership needs at least one general partner, who runs the business with unlimited liability, and at least one limited partner, whose liability is capped at the amount invested and who usually takes no part in management.
- A corporation exists as a legal person distinct from its owners and managers, all shareholders have limited liability, the shareholders elect a board that hires managers, and it has the widest access to debt and equity capital.
- Where both corporate earnings and dividends are taxed, the effective rate on distributed profit is $t_c + t_d(1 - t_c)$, and paying out less of the profit reduces the double-taxation burden.
- Most public companies are listed, so their shares trade on an exchange, and they must meet compliance and reporting requirements, while private companies disclose less, raise equity through private placements to accredited investors and offer investors no easy exit.
- Free float is the actively traded part of the shares outstanding, which excludes holdings of insiders, sponsors and strategic investors.
- A private company goes public through an IPO, a direct listing or acquisition by a SPAC, and a public company goes private when an acquirer, as in a management or leveraged buyout, buys all its shares and delists it.

EXAM SHORTCUTS

- To decide whether going public raises money for the company, ask whether new shares are issued: new shares in an IPO raise capital, while existing shares sold in an IPO pay the selling shareholders, and under the exam convention a direct listing raises no new capital (current practice also allows a primary direct listing that sells new shares).

FORMULAS

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

21 Investors and Other Stakeholders

- Lenders have a contractual claim to promised interest and principal and rank ahead of shareholders, whose claim is residual, so debt is less risky than equity and the cheaper form of capital.
- Lenders and shareholders can each lose their whole investment but no more, yet lenders can receive at most the promised payments while equity has theoretically unlimited upside, so shareholders may favor risk-increasing growth that lenders resist with covenants.
- Shareholder theory focuses governance on maximizing the market value of common equity and on the conflict between shareholders and managers, while stakeholder theory balances the interests of shareholders and all other affected groups.

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- Private lenders such as banks may see nonpublic information, which makes them a key funding source for small and medium-sized firms, while bondholders rely on public information and have little influence over operations.
- Independent directors better protect shareholders than inside directors; a two-tier board has a supervisory board overseeing a management board, and a staggered board makes a rapid overhaul by shareholders harder.
- Investors evaluate ESG factors because regulation increasingly targets climate and social issues, ESG problems can cause lost goodwill, fines and judgments, poor governance lets managers exploit shareholders, and many younger investors want ESG considered.
- Climate change brings physical risk from severe weather and transition risk from regulation or consumer choices, and assets made unviable by these changes are stranded assets.
- Adverse ESG outcomes fall most heavily on equity investors, debt investors are hurt mainly if losses cause default, and holders of longer-maturity debt may be more exposed than short-term lenders.

EXAM SHORTCUTS

- Compare the return on assets with the cost of debt before computing ROE: if the firm earns more on its assets than it pays on its debt, leverage raises ROE, and if it earns less, leverage lowers ROE.
- Classify a climate risk by its channel: damage done by the weather itself is physical risk, while a carbon tax, a new rule or a shift in demand toward low-carbon products is transition risk.

22 Corporate Governance: Conflicts, Mechanisms, Risks, and Benefits

- A principal-agent conflict arises when an agent's interests differ from the principal's, and its agency costs are direct, such as monitoring, or indirect, such as business lost.
- Shareholders are the principals and managers and directors their agents; typical conflicts are insufficient effort, the wrong risk appetite, empire building, entrenchment and self-dealing, and information asymmetry makes them harder to monitor.
- Controlling shareholders may act against minority shareholders, and a dual-class structure gives one class more votes than its economic claim, which CFA Institute opposes.
- Because creditors' upside is capped, shareholders may want more business risk, and new debt or larger dividends can shift value from creditors to shareholders, a risk greatest for long-term debtholders.
- Corporate governance is the set of internal controls and procedures defining the rights, roles and responsibilities of groups within a company to manage conflicts among stakeholders, and proxy voting is the main shareholder mechanism.
- Ordinary resolutions such as electing directors or appointing the auditor need a simple majority of votes cast, while bylaw changes, mergers, special board elections and liquidation go to extraordinary general meetings.
- The audit committee recommends the external auditor and oversees reporting and internal controls, and the compensation committee should consist of independent directors only, since managers should not set their own pay.
- Poor governance brings weak controls, related-party transactions, legal, reputational and default risk, while effective governance improves efficiency, lowers default risk and the cost of debt, and raises performance and company value.

EXAM SHORTCUTS

- Match the symptom to the conflict: too little risk-taking, copying competitors or projects that depend on the manager's own knowledge point to entrenchment, excessive risk-taking points to option-heavy pay, and unnecessary acquisitions point to pay tied to company size.

23 Working Capital and Liquidity

- The cash conversion cycle is $\text{CCC} = \text{DOH} + \text{DSO} - \text{DPO}$; the operating cycle is DOH + DSO, and the CCC is the part of it the company must finance itself.
- With a 365-day year, DOH, DSO and DPO equal 365 divided by inventory turnover, receivables turnover and payables turnover.
- A lower CCC is generally better; it rises with DOH or DSO and falls with DPO, and each lever has a cost: production bottlenecks, lost sales or forgone early-payment discounts.
- Forgoing a discount on terms a/b net c costs $(1 + a/(1-a))^{365/(c-b)} - 1$ per year.
- CCCs vary by industry, so compare a firm with its industry or its own history; net working capital removes cash and marketable securities and short-term and current debt, which ties it closely to the CCC.
- Primary liquidity sources are cash and marketable securities, bank borrowings and cash generated by the business, while secondary sources such as suspending dividends, delaying capital investment or selling assets are costlier and send a negative signal.
- A drag on liquidity delays inflows (higher DOH or DSO), a pull accelerates outflows (lower DPO), and the quick ratio excludes inventories while the cash ratio also excludes receivables.
- A conservative approach holds more short-term assets financed long term, an aggressive approach holds fewer financed with short-term debt, and a moderate approach funds permanent current assets long term and seasonal ones short term.

EXAM SHORTCUTS

- Compare the EAR of skipping the discount with the bank rate: if the EAR is higher, borrowing from the bank to take the discount is cheaper.
- Scaling every CCC component by the same factor scales the CCC by that factor, but a percentage change in one component is not the CCC's percentage change, so recompute the CCC in days.

FORMULAS

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

24 Capital Investments and Capital Allocation

MODULE 24.1 · CAPITAL INVESTMENTS AND PROJECT MEASURES

- Capital investments are going concern, regulatory/compliance, expansion and other projects, and the last two, which aim to grow the business, need the most analysis.

- The capital allocation process is idea generation (the most important step), analysis of proposals, the firm-wide capital budget, and monitoring with a post-audit that exposes systematic forecasting errors.
- NPV is the sum of a project's incremental after-tax cash flows discounted at its required rate of return, $\sum CF_t/(1+r)^t$, and an independent project is accepted when NPV > 0.
- The IRR is the discount rate at which NPV = 0, an independent project is accepted when the IRR exceeds the hurdle rate, and for a conventional independent project the NPV and IRR rules agree.
- NPV measures the expected increase in firm value and assumes reinvestment at the required return, while the IRR assumes reinvestment at the IRR and can give multiple values for unconventional cash flows.
- ROIC = NOPAT ÷ average invested capital = after-tax operating margin × capital turnover, with NOPAT = net income + interest × $(1-t)$; under the exam convention invested capital is long-term debt plus equity excluding working capital, while current practice usually counts all interest-bearing debt plus equity.

EXAM SHORTCUTS

- For a conventional independent project, NPV is positive exactly when the discount rate is below the IRR, so once the IRR is compared with the required return the sign of the NPV is known.

MODULE 24.2 · CAPITAL ALLOCATION PRINCIPLES AND REAL OPTIONS

- Capital allocation uses after-tax incremental cash flows rather than accounting income, including the tax savings from depreciation and amortization.
- Sunk costs are excluded, while opportunity costs, cannibalization and positive externalities are included in project cash flows.
- Financing costs are reflected in the required rate of return and are not also deducted from the project's cash flows.
- Cognitive errors include poor forecasting, ignoring the cost of internal funds (the cost of equity) and mixing real and nominal terms, while behavioral biases include pet projects, inertia in the capital budget, decisions based on EPS or ROE and failure to generate alternatives.
- Real options give the right but not the obligation to act and so never have negative value; they include timing, abandonment, expansion, flexibility (price-setting and production-flexibility) and fundamental options.
- A project with real options is worth its NPV without options plus the value of the options minus their cost.

EXAM SHORTCUTS

- Test each cost by asking whether the firm's total cash flows change if the project is accepted: amounts already spent are sunk and excluded, while forgone rent, cannibalized sales and extra sales of other products are included.
- If a project's NPV without options is already positive, it can be accepted without valuing its real options, because an option can only add value.

FORMULAS

Net present value (NPV)

$$NPV = CF_0 + \frac{CF_1}{(1+r)^1} + \frac{CF_2}{(1+r)^2} + \cdots + \frac{CF_n}{(1+r)^n} = \sum_{t=0}^{n} \frac{CF_t}{(1+r)^t}$$

Internal rate of return (IRR)

$$0 = \sum_{t=0}^{n} \frac{CF_t}{(1+IRR)^t}$$

Return on invested capital (ROIC)

$$ROIC = \frac{\text{NOPAT}}{\text{average book value of invested capital}} = \underbrace{\frac{\text{NOPAT}}{\text{Sales}}}_{\text{operating margin after tax}} \times \underbrace{\frac{\text{Sales}}{\text{average invested capital}}}_{\text{capital turnover}}$$

Real options

$$\text{Project value} = NPV_{\text{without options}} + \text{value of options} - \text{cost of options}$$

25 Capital Structure

MODULE 25.1 · WEIGHTED-AVERAGE COST OF CAPITAL

- With debt and common equity only, $WACC = w_d r_d(1-t) + w_e r_e$, where each weight is that source's share of total capital; preferred stock adds $w_p r_p$ with no tax adjustment.
- Debt costs less than equity because debtholders have a prior claim, and because interest is tax-deductible in most jurisdictions the cost of debt enters the WACC after tax, while the cost of equity does not.
- WACC weights can be target or market value weights, and market values are the right basis for today's opportunity cost of capital.
- The WACC is the discount rate for a project that mirrors the existing business and is financed in the firm's normal proportions.
- Capital structure reflects the capacity to service debt, shaped by internal factors (business characteristics, life cycle stage, existing leverage, tax rate) and external factors (market and business cycle conditions, regulation, industry norms).
- Stable or growing revenue and cash flow, low business risk, low operating leverage and liquid tangible assets owned outright support more debt, so start-ups are financed almost entirely with equity, growth firms use some debt and mature firms significant debt.

MODULE 25.2 · CAPITAL STRUCTURE THEORIES

- The MM propositions assume perfectly competitive markets with no taxes, transactions or bankruptcy costs, homogeneous expectations, borrowing and lending at the risk-free rate, no agency costs, and operating income unaffected by financing.
- Without taxes, MM Proposition I gives $V_L = V_U$, and Proposition II gives $r_e = r_0 + (D/E)(r_0 - r_d)$, so the cost of equity rises with leverage while the WACC is unchanged.
- With taxes, $V_L = V_U + tD$, firm value is maximized and the WACC minimized at 100% debt, and the cost of equity rises more slowly, $r_e = r_0 + (D/E)(r_0 - r_d)(1-t)$.
- Expected costs of financial distress combine the direct and indirect costs of distress with its probability, which rises with operating and financial leverage and weak management or governance, and they discourage heavy use of debt.
- Under the static trade-off theory $V_L = V_U + tD - PV(\text{costs of financial distress})$, so the optimal capital structure, where firm value is highest and the WACC lowest, lies below 100% debt; analysts without a stated target estimate it from the current market-value structure, its trend or industry averages.
- Pecking order theory ranks internal funds first, then debt, then new external equity, by how visible and negative a signal each sends, and under the free cash flow hypothesis more debt reduces the agency costs of equity.

EXAM SHORTCUTS

- Match the theory to its conclusion: MM without taxes makes capital structure irrelevant, MM with taxes points to 100% debt, the static trade-off theory gives an optimum below 100% debt, and pecking order theory has no target, with internal funds used first.

FORMULAS

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

Static trade-off theory	$V_L = V_U + tD - PV(\text{costs of financial distress})$

26 Business Models

- A business model covers who the customers are, what the product is, how the firm operates (key assets and suppliers), where it sells (channels) and how much it charges, while detailed revenue and expense forecasts belong in a financial plan.
- The channel strategy covers how the firm sells, whether directly or through intermediaries, and how it delivers; an omnichannel strategy combines digital and physical channels, and B2B or B2C describes the customers.
- Commodity producers are price takers, firms with few competitors or highly differentiated products have pricing power, and price discrimination takes the forms of tiered, dynamic, value-based and auction pricing.
- Pricing models include bundling, razors-and-blades and add-on pricing for multiple products, penetration, freemium and hidden-revenue models, and subscription, licensing and franchising as alternatives to outright purchase.
- The value proposition is how customers value the product given competing products and prices, and the value chain is how the firm executes it; the exam convention lists Porter's activities as inbound logistics, operations, outbound logistics, marketing, and sales and service, while Porter's own list groups the last two as marketing and sales, and service.
- Besides industry-specific conventional models, firms can be private label (contract) manufacturers, license their brand to others for a fee, or act as value-added resellers that add installation, service or customization to complex equipment.
- Network effects raise a network's value as its user base grows and favor initial penetration pricing, while crowdsourcing models benefit from content or improvements contributed by users.

EXAM SHORTCUTS

- Classify a price difference by what triggers it: the quantity bought means tiered pricing, the time of purchase means dynamic pricing, and the value customers perceive means value-based pricing.
- For a free product, a paid upgrade means freemium pricing and revenue from advertisers or user data means hidden revenue; for extras, options offered after the purchase decision mean add-on pricing, while a package priced from the start is bundling.

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Financial Statement Analysis

Exam weight 11–14% · 12 readings · 95 formulas

27 Introduction to Financial Statement Analysis

- The financial statement analysis framework has six steps in a fixed order: first the objective and context are stated and data are gathered, then the data are processed, analyzed and interpreted, and finally the conclusions or recommendations are reported and the analysis is updated.
- Adjusting the statements and computing ratios and common-size statements is processing the data; using those outputs to reach a conclusion is analyzing and interpreting the data.
- Financial reporting gives a wide range of users useful information on a company's performance and financial position, while financial statement analysis uses that information, with other relevant data, to make economic decisions about the company.
- Financial statement footnotes give the accounting methods, assumptions and estimates management chose, plus detail such as contingencies, legal actions and related-party transactions, and they are audited together with the primary statements.
- Form 10-K is the required annual SEC filing with audited statements, Form 10-Q is the quarterly filing whose interim statements need not be audited, Form 8-K reports material events, and Form DEF-14A is the proxy statement.
- An audit gives reasonable assurance, not a guarantee, against material errors in the statements, and the opinion is unqualified (clean), qualified (specific exceptions, or a scope limitation whose possible effect is material but confined to some items), adverse (not presented fairly) or a disclaimer (no opinion can be expressed).
- US GAAP, issued by the FASB, is rules-based and allows LIFO; IFRS, issued by the IASB, is principles-based, prohibits LIFO, allows inventory write-downs to be reversed and allows product development costs to be capitalized.
- Proxy statements are the source for board elections, compensation, management qualifications and stock option issuance, while press releases and earnings calls come from the issuer and are unlikely to have been audited.

28 Analyzing Income Statements

MODULE 28.1 · REVENUE RECOGNITION

- Under IFRS 15 and ASC 606, revenue is recognized when (or as) control of a promised good or service passes to the customer, at the amount the firm expects to be entitled to.
- The five steps are: identify the contract with the customer; identify its performance obligations; determine the transaction price; allocate that price to the obligations; and recognize revenue when (or as) each obligation is satisfied.
- Cash received before goods or services are delivered is recorded as a liability, unearned (deferred) revenue, and becomes revenue as the delivery takes place.
- Variable consideration such as a bonus enters the transaction price only to the extent that a significant later reversal is highly unlikely.
- With an input measure of progress, cumulative revenue equals cumulative cost to date divided by total expected cost, times the transaction price, and the period's revenue is that figure less revenue already recognized.
- A principal controls the good before transfer and reports gross revenue with the cost as an expense; an agent only arranges the sale and reports its net fee or commission.

EXAM SHORTCUTS

- In an over-time contract measured by inputs, amounts billed or collected can be ignored: cumulative revenue depends only on the cumulative cost to date, the total expected cost and the current transaction price.

MODULE 28.2 · EXPENSE RECOGNITION

- Under accrual accounting, an expense is recognized when the benefit is consumed, whether or not cash has been paid: by matching it with revenue, as a period cost, or by capitalizing it and expensing it gradually.
- With rising prices, FIFO gives the lowest COGS and the highest gross margin and net income, LIFO (US GAAP only) gives the highest COGS and the lowest margins, and weighted average cost falls in between.
- Straight-line depreciation equals cost minus salvage value, divided by the useful life.
- Indefinite-life intangibles such as acquired goodwill are not amortized but are tested for impairment at least annually; research costs are expensed, development costs may be capitalized under IFRS, and US GAAP generally expenses R&D except software developed for sale once technological feasibility is established.
- Compared with expensing, capitalizing an outlay gives higher net income, ROA, ROE and CFO but lower CFI in the year of the outlay, higher assets and equity, lower debt ratios, and lower net income, ROA and ROE in later years.
- Interest incurred while a firm builds an asset for its own use is capitalized under both IFRS and US GAAP, and adjusted interest coverage is (EBIT + depreciation of capitalized interest) / (interest expense + interest capitalized).

MODULE 28.3 · NONRECURRING ITEMS

- Unusual or infrequent items are shown pre-tax within income from continuing operations, and an analyst judges whether they really are one-off.
- Discontinued operations are reported net of tax below income from continuing operations, prior-period income statements presented are restated to show them separately, and analysts usually exclude them when forecasting earnings.
- Assets of a component held for sale are measured at the lower of carrying amount and fair value less costs to sell, so an expected loss on disposal is recognized at once and an expected gain only when the sale is completed.
- A change in accounting policy is applied retrospectively, restating the prior periods presented unless that is impractical, while a change in accounting estimate is applied prospectively with no restatement.
- A correction of a prior-period error is a prior-period adjustment: prior statements presented are restated, and the nature of the error and its effect on net income are disclosed.
- After a change in an asset's estimated life, new annual depreciation equals carrying value divided by remaining life, and earlier depreciation is not restated.

MODULE 28.4 · EARNINGS PER SHARE

- Basic EPS equals net income minus preferred dividends, divided by the weighted average number of common shares outstanding; common dividends are not subtracted.
- Stock dividends and stock splits are applied retroactively to all shares outstanding before the event, as if it had happened at the start of the year, and shares issued or repurchased after the event are not adjusted.
- Exam convention: a company with a simple capital structure reports basic EPS only. Current practice: that is the US GAAP rule, while IFRS requires every company within its scope to present both basic and diluted EPS.
- Under the if-converted method, diluted EPS adds back convertible preferred dividends and convertible debt interest × (1 – t) to the numerator and adds the conversion shares to the denominator.
- Under the treasury stock method, options and warrants add $(\bar{P} - X)/\bar{P} \times N$ shares, where $\bar{P}$ is the average market price, and they are dilutive only when $X < \bar{P}$.
- A security that would raise EPS or reduce a loss per share is antidilutive and is excluded, so diluted EPS can never exceed basic EPS.

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EXAM SHORTCUTS

- A convertible is dilutive when its per-share effect (preferred dividends, or interest × (1 – t), divided by the shares on conversion) is below basic EPS, so each convertible can be tested without computing diluted EPS with and without it.
- Options or warrants whose exercise price is not below the average market price are not dilutive, so they can be dropped before applying the treasury stock method.
- When a company reports a net loss available to common shareholders, every potential share is antidilutive and diluted EPS equals basic EPS, so no dilution test is needed.

MODULE 28.5 · RATIOS AND COMMON-SIZE INCOME STATEMENTS

- A vertical common-size income statement divides every line by revenue for the same period, which removes the effect of size for time-series and cross-sectional comparison.
- The effective tax rate is income tax expense divided by pretax income, not tax as a percentage of revenue.
- Gross, operating, pretax and net profit margin are gross profit, operating profit (EBIT), earnings before tax and net income, each divided by revenue.
- As a percentage of revenue, gross margin minus operating margin is operating expenses, operating margin minus pretax margin is net nonoperating expense, and pretax margin minus net margin is income tax expense.
- Gross margin improves when a firm raises prices or cuts unit production costs, product differentiation supports higher prices, and administrative costs do not affect gross margin.

EXAM SHORTCUTS

- The effective tax rate can be read straight from common-size figures: tax as a percentage of sales divided by pretax income as a percentage of sales, because revenue cancels.

FORMULAS

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

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Vertical common-size income statement	$\text{Common-size line item} = \frac{\text{Line item}}{\text{Revenue}}$ $\text{Effective tax rate} = \frac{\text{Income tax expense}}{\text{Pretax income}}$
Margin ratios	$\text{Gross profit margin} = \frac{\text{Revenue} - \text{COGS}}{\text{Revenue}}$ $\text{Operating profit margin} = \frac{\text{Operating profit (EBIT)}}{\text{Revenue}}$ $\text{Pretax margin} = \frac{\text{Earnings before tax}}{\text{Revenue}}$ $\text{Net profit margin} = \frac{\text{Net income}}{\text{Revenue}}$

29 Analyzing Balance Sheets

MODULE 29.1 · INTANGIBLE ASSETS AND MARKETABLE SECURITIES

- After acquisition, IFRS allows purchased intangibles to be carried under the cost model or, only if an active market exists, the revaluation model, while US GAAP requires the cost model.
- US GAAP expenses R&D costs when incurred (apart from certain legal costs); IFRS expenses research costs and capitalizes development costs once the project is technically feasible, the firm has the intention and resources to complete it and to use or sell the product, and a market exists.
- Finite-lived intangibles are amortized over the period they are expected to be used, while indefinite-lived intangibles, including goodwill, are not amortized but are tested for impairment at least annually.
- Goodwill equals the purchase price minus the fair value of the identifiable net assets acquired; it arises only in an acquisition, and a price below that fair value is a bargain purchase recognized immediately as a gain.
- US GAAP carries held-to-maturity debt at amortized cost, trading securities and derivatives at fair value through the income statement, and available-for-sale debt at fair value through other comprehensive income; the IFRS counterparts are amortized cost, FVTPL and FVOCI respectively.
- A deferred tax liability arises when income tax expense exceeds taxes payable because of a temporary difference, and permanent differences create no deferred taxes.

EXAM SHORTCUTS

- Under US GAAP, interest and dividend income and realized gains and losses go to the income statement for every classification of security, so only the balance sheet value and the location of unrealized gains and losses depend on the classification.

MODULE 29.2 · COMMON-SIZE BALANCE SHEETS

- A vertical common-size balance sheet divides every line item by total assets, while a common-size income statement uses revenue as the base.
- The current ratio is current assets divided by current liabilities; the quick ratio uses cash, marketable securities and receivables in the numerator, and the cash ratio uses only cash and marketable securities.
- In the debt-to-equity and debt ratios, debt usually means interest-bearing short- and long-term borrowings, excluding accounts payable and accruals, while the financial leverage ratio, total assets divided by total equity, captures all liabilities.
- Equity as a percentage of total assets is the reciprocal of the financial leverage ratio.
- Balance sheet ratios are limited because accounting standards and estimates differ across peers, ratios may not be comparable across industries, interpretation requires judgment, and the balance sheet is a snapshot at a single point in time.

EXAM SHORTCUTS

- If Firm A's current ratio is above Firm B's while A's quick ratio is below B's, A holds relatively more inventory, with no further data needed.
- From a common-size balance sheet alone, with e equal to equity as a fraction of total assets, the financial leverage ratio is $1/e$ and total liabilities to equity is $(1-e)/e$.

FORMULAS

Goodwill	$\text{Goodwill} = \text{purchase price} - \text{fair value of identifiable net assets acquired}$
Vertical common-size balance sheet	$\text{Common-size item} = \dfrac{\text{balance sheet item}}{\text{total assets}}$
Liquidity ratios (short-term obligations)	$\text{current ratio} = \dfrac{\text{current assets}}{\text{current liabilities}}$ $\text{quick ratio} = \dfrac{\text{cash} + \text{marketable securities} + \text{receivables}}{\text{current liabilities}}$ $\text{cash ratio} = \dfrac{\text{cash} + \text{marketable securities}}{\text{current liabilities}}$
Solvency ratios (long-term obligations)	$\text{long-term debt-to-equity} = \dfrac{\text{long-term debt}}{\text{total equity}}$ $\text{total debt-to-equity} = \dfrac{\text{total debt}}{\text{total equity}}$ $\text{debt ratio} = \dfrac{\text{total debt}}{\text{total assets}}$ $\text{financial leverage ratio} = \dfrac{\text{total assets}}{\text{total equity}}$

30 Analyzing Statements of Cash Flows I

MODULE 30.1 · CASH FLOW INTRODUCTION AND DIRECT METHOD CFO

- CFO relates mostly to working capital accounts, CFI to noncurrent assets, and CFF to noncurrent liabilities and equity.
- CFO + CFI + CFF equals the change in cash, and beginning cash plus that change equals ending cash.
- Earnings are of higher quality when CFO is close to, or above, net income; earnings that persistently exceed CFO are not backed by cash.
- An increase in an operating asset is a use of cash and an increase in an operating liability is a source of cash; decreases work the other way.
- Cash collected from customers equals net sales − ΔAR + Δunearned revenue, and cash paid to suppliers equals COGS + Δinventory − ΔAP.
- The direct method lists operating cash receipts and payments and ignores noncash items, for example depreciation or a gain on an asset sale, so net income never appears in a direct-method CFO section.

EXAM SHORTCUTS

- A balance sheet roll-forward such as beginning AR + sales − cash collected = ending AR links four items, so any three of them give the fourth.

MODULE 30.2 · INDIRECT METHOD CFO

- Under the indirect method, CFO equals net income plus noncash charges minus the investment in working capital.

- Depreciation, amortization, impairments and losses on asset disposals are added back to net income, while gains on disposals are subtracted, because the whole sale proceeds belong in CFI.
- Decreases in current operating assets and increases in current operating liabilities are added to net income; increases in operating assets and decreases in operating liabilities are subtracted.
- Only operating working capital enters CFO: short-term interest-bearing debt and dividends payable are financing items, and cash is ignored.
- The direct method shows the actual operating receipts and payments, while the indirect method shows why net income and CFO differ.

EXAM SHORTCUTS

- The direct and indirect methods give the same CFO total, so a CFO figure found with one method need not be recomputed with the other.
- Dividends paid, debt and stock issues or repayments, and purchases of PP&E or land can be skipped when computing indirect CFO; they matter only through a gain or loss they create.

MODULE 30.3 · INVESTING AND FINANCING CASH FLOWS AND IFRS/US GAAP DIFFERENCES

- Proceeds from an asset sale equal the carrying value of the asset sold plus the gain, or minus the loss, and only the proceeds are reported in CFI.
- CFF equals new borrowing minus principal repaid, plus stock issued minus stock repurchased, minus cash dividends paid, where dividends paid equal dividends declared (opening retained earnings plus net income less closing retained earnings) minus the change in dividends payable.
- Noncash investing and financing transactions, such as buying an asset with bonds or converting bonds into stock, are not in CFI or CFF but are disclosed in a footnote or supplementary schedule.
- Under US GAAP, interest received, dividends received, interest paid and taxes paid belong in CFO, and dividends paid belong in CFF.
- Exam convention: IFRS allows interest and dividends received in CFO or CFI and interest and dividends paid in CFO or CFF. Current practice: IFRS 18, effective for annual periods beginning on or after 1 January 2027, removes most of this choice for companies whose main business is not investing or financing.
- An inventory writedown is noncash and must be counted only once when cash paid to suppliers is computed: either subtract it from COGS and use the inventory change before the writedown, or keep it in COGS and use the balance sheet inventory change.

EXAM SHORTCUTS

- The carrying value of PP&E disposed of can be found in one line as beginning net PP&E − depreciation + purchases − ending net PP&E, instead of working through gross cost and accumulated depreciation separately.

FORMULAS

Why a separate cash flow statement?	$\text{CFO} + \text{CFI} + \text{CFF} = \Delta\text{Cash}; \quad \text{Beginning cash} + \Delta\text{Cash} = \text{Ending cash}$
Timing differences show up on the balance sheet	$\text{Beginning AR} + \text{Sales} - \text{Cash collected} = \text{Ending AR}$

The direct method	$\text{Cash collected} = \text{Net sales} - \Delta\text{AR} + \Delta\text{Unearned revenue}$ $\text{Purchases} = \text{COGS} + \text{Ending inventory} - \text{Beginning inventory} = \text{COGS} + \Delta\text{Inventory}$ $\text{Cash paid to suppliers} = \text{Purchases} - \Delta\text{AP} = \text{COGS} + \Delta\text{Inventory} - \Delta\text{AP}$ $\text{Cash paid for wages} = \text{Wage expense} - \Delta\text{Wages payable}$ $\text{Cash paid for interest} = \text{Interest expense} - \Delta\text{Interest payable}$ $\text{Cash paid for insurance} = \text{Insurance expense} + \Delta\text{Prepaid insurance}$ $\text{Cash taxes paid} = \text{Tax expense} - \Delta\text{Taxes payable} - \Delta\text{Deferred tax liability} + \Delta\text{Deferred tax asset}$
Starting point: net income	$\text{CFO} = \text{NI} + \text{NCC} - \text{WC}_{\text{INV}}$
Investing activities (CFI)	$\text{Proceeds} = \text{Carrying value of asset sold} + \text{Gain (or} - \text{Loss)}$ $\text{Gross cost of disposals} = \text{Beginning gross PP\&E} + \text{Purchases} - \text{Ending gross PP\&E}$ $\text{Accumulated depreciation removed} = \text{Beginning AD} + \text{Depreciation expense} - \text{Ending AD}$ $\text{Carrying value disposed} = \text{Beginning net PP\&E} - \text{Depreciation} + \text{Purchases} - \text{Ending net PP\&E}$
Financing activities (CFF)	$\text{CFF} = (\text{New borrowing} - \text{Principal repaid}) + (\text{Stock issued} - \text{Stock repurchased}) - \text{Cash dividends paid}$ $\text{Dividends declared} = \text{Beginning retained earnings} + \text{Net income} - \text{Ending retained earnings}$ $\text{Dividends paid} = \text{Dividends declared} - \Delta\text{Dividends payable}$

31 Analyzing Statements of Cash Flows II

- The statement of cash flows helps an analyst assess a firm's liquidity, solvency and financial flexibility.
- Cash generated by collecting receivables faster, running down inventory or paying suppliers more slowly is classified as operating cash flow, but it is not a sustainable source of cash.
- For a mature firm whose working capital is not growing, CFO normally exceeds net income; net income that persistently runs well ahead of CFO may point to aggressive or improper accounting choices.
- Common-size cash flow statements come in two formats: every line divided by net revenue, or inflows divided by total inflows and outflows divided by total outflows.
- FCFF equals CFO + Int × (1 – t) – FCInv, or NI + NCC + Int × (1 – t) – FCInv – WCInv, where FCInv is cash paid for fixed assets less cash proceeds from fixed assets sold.
- FCFE equals CFO – FCInv + net borrowing, where net borrowing is debt issued minus debt repaid.
- When interest paid is classified in financing activities under IFRS, CFO already excludes it, so no after-tax interest is added back in FCFF and no interest is added back in the interest coverage ratio.
- Performance ratios, such as cash flow-to-revenue and cash-to-income, measure how well operations generate cash, while coverage ratios, such as debt coverage and the reinvestment ratio (CFO / cash paid for long-term assets), measure the ability to meet obligations and fund spending from CFO.

EXAM SHORTCUTS

- When FCFF is already known, FCFE follows directly as FCFF − Int × (1 − t) + net borrowing, without starting again from CFO.

FORMULAS

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

32 Analysis of Inventories

MODULE 32.1 · INVENTORY MEASUREMENT

- IFRS firms, and US GAAP firms not using LIFO or the retail method, measure inventory at the lower of cost or NRV; US GAAP LIFO and retail-method firms use the lower of cost or market.
- NRV is the estimated selling price minus selling costs and completion costs.
- Market is replacement cost, but not above NRV and not below NRV minus the normal profit margin.
- IFRS allows a write-up only up to the amount previously written down; US GAAP allows no reversal.
- When the loss is charged to COGS, a write-down raises COGS, lowers the current ratio, margins, ROA and ROE, raises inventory turnover and leaves the quick ratio unchanged.

EXAM SHORTCUTS

- Under lower of cost or market, market is the middle value of replacement cost, NRV and NRV minus the normal profit margin.
- An inventory write-down leaves the quick ratio unchanged, because the quick ratio excludes inventory, so an answer in which the quick ratio moves can be ruled out.

MODULE 32.2 · INFLATION IMPACT ON FIFO AND LIFO

- FIFO puts the oldest costs in COGS and the most recent in ending inventory, LIFO does the reverse, and IFRS prohibits LIFO.
- With rising prices and stable or increasing quantities, LIFO gives higher COGS, lower income and taxes and higher after-tax cash flow, while FIFO gives higher inventory, working capital and equity.
- FIFO inventory = LIFO inventory + LIFO reserve, and FIFO COGS = LIFO COGS − (ending − beginning LIFO reserve).
- FIFO inventory best approximates current cost on the balance sheet; LIFO COGS best approximates current cost on the income statement.
- A LIFO liquidation in inflation lowers COGS and raises margins and taxes, but the extra profit is not sustainable; a decrease in the LIFO reserve signals it.

EXAM SHORTCUTS

- With rising prices, start from LIFO's higher COGS: lower income, lower taxes and higher after-tax cash flow follow, and every comparison reverses when prices fall.
- With prices moving in one direction, weighted average cost figures always lie between FIFO and LIFO.

MODULE 32.3 · PRESENTATION AND DISCLOSURE

- Inventory disclosures include the cost flow method, carrying value by class, the cost expensed, write-downs, reversals (IFRS only) and inventory pledged as collateral.
- Rising raw materials and work in progress suggest management expects higher demand; finished goods growing faster than sales suggest weak demand or obsolete inventory.

- Inventory turnover = COGS ÷ average inventory, and days of inventory on hand equal 365 divided by that turnover.
- Low turnover points to slow-moving or obsolete inventory; high turnover with sales growth below the industry points to too little inventory.

FORMULAS

Inventory ratios

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

$$\text{Days of inventory on hand (DOH)} = \frac{365}{\text{inventory turnover}}$$

33 Analysis of Long-Term Assets

MODULE 33.1 · INTANGIBLE LONG-LIVED ASSETS

- Finite-lived intangibles are amortized over their useful life, while indefinite-lived intangibles, such as goodwill, are not amortized and are tested for impairment at least annually.
- Purchased intangibles are recorded at cost, and internally developed intangibles are generally expensed as incurred, so internally created brands, trademarks and goodwill are not on the balance sheet.
- In a business combination the price is allocated to the fair values of the target's identifiable assets and liabilities, including identifiable intangibles the target built and expensed, and the remainder is goodwill.
- Research costs are expensed under both IFRS and US GAAP; development costs may be capitalized under IFRS once the criteria are met and are generally expensed under US GAAP.
- Under US GAAP, software developed for sale is capitalized once technological feasibility is established, and software for internal use once it is probable the project will be completed and the software used as intended.
- Compared with expensing, capitalizing a cost gives higher net income, assets, equity and CFO and lower CFI in the year it is incurred, then lower net income and ROA in later years, with total cash flow identical apart from any tax differences.

MODULE 33.2 · IMPAIRMENT AND DERECOGNITION

- Under IFRS, a long-lived asset held for use is impaired when its carrying value exceeds its recoverable amount, the greater of fair value less costs to sell and value in use; the loss is the difference, and a later reversal is allowed up to the original loss.
- Under US GAAP, an asset held for use is impaired only if its carrying value exceeds its undiscounted future cash flows; the loss is carrying value minus fair value (or discounted cash flows if fair value is unknown), and no reversal is permitted.
- In the year of an impairment, net income, assets and equity fall and leverage ratios rise; in later years net income, ROA and ROE are higher; the impairment itself has no cash flow effect.
- Under the IFRS revaluation model, an increase goes to OCI as a revaluation surplus unless it reverses an impairment previously charged to the income statement, and a decrease is charged to profit or loss unless it reverses an existing revaluation surplus.
- An asset held for sale is no longer depreciated and is written down if its carrying value exceeds fair value less costs to sell; under both IFRS and US GAAP the loss can be reversed, but not above the original carrying value.
- On a sale, the gain or loss is proceeds minus carrying value; on an exchange, it is the fair value of the old asset (or of the new asset if that is more clearly evident) minus the carrying value of the old asset.

EXAM SHORTCUTS

- Under US GAAP, when undiscounted future cash flows are at or above carrying value there is no impairment, whatever the fair value, so step 2 is not needed.
- Because the US GAAP recoverability test uses undiscounted cash flows, a rise in interest rates alone does not trigger an impairment.

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MODULE 33.3 · LONG-TERM ASSET DISCLOSURES

- Assuming straight-line depreciation and zero salvage value, average age is about accumulated depreciation divided by annual depreciation expense, total useful life is about gross PP&E divided by it, and remaining useful life is about net PP&E divided by it.
- Fixed asset turnover is revenue divided by average fixed assets, and a higher ratio indicates more efficient use of long-term assets.
- Average age helps show whether a company runs older, less efficient assets and helps predict the timing of major capital spending and the related financing needs.
- Only US GAAP requires estimated amortization expense for each of the next five years, while only IFRS has revaluation disclosures and permits, and so discloses, impairment reversals for assets held for use.
- A longer useful life or a higher residual value lowers depreciation expense, which raises net income and the carrying value of the assets and lowers asset turnover.

EXAM SHORTCUTS

- Remaining useful life equals total useful life minus average age, so once two of the three estimates are known the third needs no further division.

FORMULAS

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

34 Topics in Long-Term Liabilities and Equity

MODULE 34.1 · LEASES

- Exam convention: a lease is a finance lease if any one of these holds: title passes to the lessee by the end of the term, the lessee has a purchase option it is expected to exercise, the term covers most of the asset's useful life, the lease payments have a present value at least equal to the asset's fair value, or the asset is so specialized that the lessor has no other use for it.
- Current practice under IFRS 16 and ASC 842 requires exercise of the purchase option to be reasonably certain, includes any lessee-guaranteed residual value in the lease payments, and asks whether their present value amounts to substantially all of the asset's fair value.
- At commencement a lessee records a right-of-use asset and a lease liability, each measured as the lease payments discounted at the rate implicit in the lease, except for short-term leases and, under IFRS, low-value leases.
- Under IFRS (other than for short-term and low-value leases) and for US GAAP finance leases, the lessee reports straight-line amortization of the ROU asset and interest expense separately, with the principal repaid in CFF; for a US GAAP operating lease it reports one straight-line lease expense and the whole payment in CFO.

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- In a finance lease the lessor derecognizes the asset, records a lease receivable equal to the net investment in the lease (present value of the lease payments plus present value of the expected residual value) and reports interest income; a sales-type lessor also recognizes the selling profit at inception.
- In an operating lease the lessor keeps the asset on its balance sheet, continues to depreciate it and reports the lease payments as income on a straight-line basis.

EXAM SHORTCUTS

- For a US GAAP operating lease, the lessee's single lease expense equals the lease payment and the ROU asset equals the lease liability throughout, so the expense needs no split into interest and amortization.

MODULE 34.2 · DEFERRED COMPENSATION AND DISCLOSURES

- In a defined contribution plan the employee bears the investment risk and pension expense equals the employer's contribution; in a defined benefit plan the employer bears the investment risk and reports the plan's funded status on the balance sheet.
- Funded status equals the fair value of plan assets minus the PVDBO (called the PBO under US GAAP); a positive amount is a net pension asset and a negative amount a net pension liability.
- Under IFRS, service cost (including past service cost) and net interest, the discount rate times the net pension asset or liability, go to the income statement, while remeasurements go to OCI and are never recycled.
- Given the same actuarial assumptions, IFRS and US GAAP give the same total periodic cost for a defined benefit plan and differ only in how it is split between the income statement and OCI.
- Equity-settled share-based pay is measured at fair value on the grant date and expensed over the vesting period under both IFRS and US GAAP, and later share price changes do not change the expense.
- IAS 19 disclosures for a defined benefit plan explain its characteristics and risks, identify the amounts it creates in the financial statements, and describe its effect on the amount, timing and uncertainty of future cash flows.

FORMULAS

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

35 Analysis of Income Taxes

MODULE 35.1 · DIFFERENCES BETWEEN ACCOUNTING PROFIT AND TAXABLE INCOME

- Taxes payable are computed from taxable income on the tax return, while income tax expense, the income statement charge, equals taxes payable + ΔDTL − ΔDTA.
- A DTL arises when revenues or gains reach the income statement before they are taxed, or when expenses or losses are deducted for tax before they are expensed; a DTA arises in the reverse cases and from tax loss carryforwards.
- An asset whose carrying value exceeds its tax base, or a liability whose carrying value is below its tax base, gives a DTL; the opposite cases give a DTA, equal to the absolute value of (carrying value − tax base) × tax rate.
- Permanent differences never reverse, create no DTA or DTL, and make the effective tax rate differ from the statutory rate.
- When the enacted tax rate changes, existing DTAs and DTLs are remeasured at the new rate, and the remeasurement flows through income tax expense.

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EXAM SHORTCUTS

- If a temporary difference first makes taxable income lower than pretax accounting profit, it creates a DTL; if it first makes taxable income higher, it creates a DTA.
- After an increase in the enacted tax rate, the direction of the change in income tax expense follows from the net position alone: it rises for a firm with a net DTL and falls for a firm with a net DTA.

MODULE 35.2 · DEFERRED TAX ASSETS AND LIABILITIES

- For a depreciable asset, the carrying value is cost less accumulated book depreciation and the tax base is cost less accumulated tax depreciation.
- Deferred tax assets and liabilities are not discounted to present value.
- Under US GAAP a DTA is kept in full and reduced by a valuation allowance when it is more likely than not that part of it will not be realized, while IFRS reduces the DTA directly; either reduction raises income tax expense.
- Because realizing a DTA is a subjective judgment, changes in the valuation allowance are a potential tool of earnings management, and a surprise reduction boosts earnings.
- A DTL expected to reverse is treated as a liability, while one not expected to reverse in the foreseeable future is treated as equity, and the analyst decides case by case.
- Reclassifying a DTL as equity lowers the debt-to-equity ratio, the financial leverage ratio and ROE, and leaves ROA unchanged.

EXAM SHORTCUTS

- Reclassifying a DTL as equity changes neither net income nor total assets, so an answer in which ROA changes can be ruled out.

MODULE 35.3 · TAX RATES AND DISCLOSURES

- The effective tax rate is income tax expense divided by pretax income, the cash tax rate is cash taxes paid divided by pretax income, and the statutory rate is set by law in the jurisdiction where the company is domiciled.
- The effective rate differs from the statutory rate because of different rates in foreign jurisdictions, permanent differences, new legislation or rate changes, and tax holidays; temporary differences typically do not cause the gap but make the cash tax rate differ from the effective rate.
- When forecasting from the rate reconciliation, an analyst includes continuous items such as foreign rate differences, tax-exempt income and nondeductible expenses, and sets aside sporadic items, for example tax holiday savings or a large asset sale.
- Accelerated tax depreciation with straight-line book depreciation creates a DTL, while impairments, restructuring charges and post-employment benefits create DTAs.
- Deferred tax assets and liabilities are classified as noncurrent under both IFRS and US GAAP.
- Income tax expense that keeps exceeding taxes payable means DTLs are growing faster than DTAs, and a decrease in the valuation allowance raises reported earnings.

EXAM SHORTCUTS

- When only temporary differences exist and the tax rate does not change, income tax expense is pretax accounting income × the tax rate, so no deferred tax schedule is needed to find it.

FORMULAS

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

36 Financial Reporting Quality

MODULE 36.1 · REPORTING QUALITY

- Financial reporting quality concerns the reports themselves: compliance with GAAP plus decision usefulness, which requires relevance (including materiality) and faithful representation (complete, neutral and free from error).

- Earnings quality concerns the results reported and is judged by their sustainability and by whether their level is adequate to keep the business going and give investors an adequate return.
- Low reporting quality means earnings, cash flows and balance sheet values cannot be reliably assessed, but high reporting quality can go together with low earnings quality.
- Conservative choices decrease current-period earnings and financial position and tend to raise later earnings, while aggressive choices increase current-period earnings, revenues, operating cash flows or financial position and tend to reduce later earnings; either bias departs from neutrality.
- Low-quality reporting typically involves motivation, such as earnings targets or debt covenants, opportunity, such as weak internal controls or inadequate board oversight, and rationalization.
- For a non-GAAP measure, the SEC requires the closest GAAP measure to be shown with equal prominence and reconciled to it, while IFRS requires the measure to be defined, its relevance explained and a reconciliation to the most comparable IFRS measure.

MODULE 36.2 · ACCOUNTING CHOICES AND ESTIMATES

- Revenue is recognized earlier under FOB shipping point than under FOB destination, and channel stuffing and fictitious bill-and-hold sales inflate current revenue.
- A lower allowance for uncollectible accounts, a smaller warranty reserve or a smaller valuation allowance on deferred tax assets raises net income, and such reserves can be used to smooth earnings.
- A longer useful life or a higher salvage value lowers depreciation and raises net income and carrying value, and delaying a goodwill impairment raises current earnings.
- Capitalizing a cost raises current earnings and lowers future earnings, and it moves the outflow from CFO to CFI, so reported CFO is higher by the full amount.
- Stretching payables raises current CFO and lowers next period's CFO, with no effect on reported earnings.
- When prices are rising, a LIFO liquidation (possible under US GAAP only) runs old, low costs through COGS and raises current earnings unsustainably.

EXAM SHORTCUTS

- An interest coverage covenant (EBIT / interest expense) is most easily met by overstating earnings; asset values do not enter the ratio, so manipulation of asset values can be ruled out as the route.

MODULE 36.3 · WARNING SIGNS

- A warning sign is not proof of manipulation; it calls for more analysis to find out whether there is a real business reason.
- Revenue warning signs include changes in revenue recognition methods, revenue growth out of line with peers, receivables turnover falling over several periods, falling total asset turnover and nonoperating or one-time sales included in revenue.
- A ratio of CFO to net income persistently below 1.0 suggests that accruals are inflating income, while a ratio above one is not by itself a warning sign.
- Aggressive estimates, aggressive revenue recognition and LIFO liquidation change net income but, apart from tax effects, leave the amount and classification of cash flows unchanged; capitalizing costs that peers expense raises both earnings and CFO.
- A jump in days payables well above historical levels suggests stretched payables, which make CFO higher but not sustainably so while leaving earnings unaffected.
- Large restructuring or impairment charges partly correct past understated expenses and overstated assets, so analysts consider spreading them over prior periods to see the true trend.

EXAM SHORTCUTS

- Channel stuffing shows up as rising days of sales outstanding (falling receivables turnover), so an answer pointing to payables can be ruled out.

FORMULAS

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

37 Financial Analysis Techniques

MODULE 37.1 · INTRODUCTION TO FINANCIAL RATIOS

- Financial analysis uses four tools: ratios, common-size statements, graphs and regression.
- Cross-sectional analysis compares a firm's ratios with those of other firms for the same period, while time-series analysis compares them with the firm's own past values.
- Ratios are informative only against peers or the firm's history, they are distorted by different accounting treatments, comparable industry ratios are hard to find for a conglomerate, and no conclusion should rest on a single ratio.
- A vertical common-size income statement divides each line by revenue and a vertical common-size balance sheet divides each line by total assets, while a horizontal common-size statement divides each item by its own base-year value.
- Regression analysis identifies relationships between variables and is mainly used for forecasting.

MODULE 37.2 · FINANCIAL RATIOS, PART 1

- Receivables turnover is revenue divided by average receivables, inventory turnover is COGS divided by average inventory, payables turnover is COGS (or purchases) divided by average trade payables, and each days ratio is 365 divided by the turnover.
- The cash conversion cycle equals DSO + DOH − days of payables, and the operating cycle equals DOH + DSO.
- The defensive interval equals cash, marketable securities and receivables divided by average daily cash expenditures, from which noncash charges in the expense lines are removed.
- Interest coverage is EBIT divided by interest payments, and fixed charge coverage is (EBIT + lease payments) divided by (interest payments + lease payments).
- Exam convention: total debt is interest-bearing short- and long-term debt with lease liabilities left out unless stated otherwise. Current practice: lease liabilities are on the balance sheet under IFRS 16 and ASC 842, and many analysts and rating agencies include them in debt.
- ROA is net income divided by average total assets, adjusted ROA adds interest expense × (1 − tax rate) to the numerator, and ROE is net income divided by average total equity.

EXAM SHORTCUTS

- For a ratio with a positive numerator and denominator, an equal decrease in both raises the ratio if it is above 1 and lowers it if it is below 1, and an equal increase does the opposite, so paying payables with cash raises a current ratio that is above 1.
- Collecting receivables into cash moves value inside the numerator of the current ratio, so the current ratio is unchanged while the cash ratio rises.

MODULE 37.3 · FINANCIAL RATIOS, PART 2

- A financial leverage ratio close to 1 means assets are financed mostly with equity, and if all liabilities are counted as debt, A/E = 1 + L/E.
- Fixed charge coverage is the more meaningful coverage measure for firms that lease many of their assets.
- Income from continuing operations is the right basis for the net profit margin, because discontinued operations will not recur.

- ROE uses total equity including preferred stock, while return on common equity removes preferred dividends from the numerator and preferred equity from the denominator.
- ROE rising while net margin and asset turnover fall, or ROA falling while ROE rises, points to higher financial leverage and more risk rather than better operations.
- Ratios should be close to the industry norm, so an activity ratio far better than the norm is a question to investigate rather than a sure strength.

EXAM SHORTCUTS

- When interest coverage is above 1, fixed charge coverage is lower than interest coverage, because adding lease payments to both numerator and denominator pulls the ratio toward 1.

MODULE 37.4 · DUPONT ANALYSIS

- ROE equals ROA times financial leverage, where financial leverage is average total assets divided by average total equity.
- In the three-part DuPont equation, ROE is the product of net profit margin, asset turnover (revenue / average total assets) and the equity multiplier (average total assets / average total equity).
- The five-part DuPont equation is ROE = tax burden (NI/EBT) × interest burden (EBT/EBIT) × EBIT margin × total asset turnover × financial leverage.
- Higher leverage raises the equity multiplier but lowers the interest burden ratio, so ROE rises with leverage only if the multiplier effect outweighs the fall in the interest burden ratio.
- For a profitable firm with positive equity, holding the other components constant, a higher asset turnover or a higher net profit margin raises ROE; with a net loss, higher asset turnover makes ROE more negative.

EXAM SHORTCUTS

- Tax burden × interest burden × EBIT margin equals the net profit margin, so a missing component can be solved from the identity and the five-part and three-part results must agree.

MODULE 37.5 · INDUSTRY-SPECIFIC FINANCIAL RATIOS

- Growth in same-store sales excludes new openings; a hotel's average daily rate is room revenue divided by rooms sold, and its occupancy rate is rooms sold divided by rooms available.
- Exam convention: net interest margin is interest income divided by interest-earning assets. Current practice: it is net interest income divided by average interest-earning assets.
- Value at risk is the loss a firm will exceed only a specified percentage of the time over a specified period, and it is not the worst possible loss.
- The coefficient of variation is the standard deviation of an item divided by its mean; the CV of sales measures sales risk, the CV of operating income measures business risk, and the CV of net income adds financial leverage, taxes and nonoperating items.
- Pro forma statements start from forecast revenue and tie other items to it with ratios such as the common-size COGS percentage and the operating profit margin.
- Sensitivity analysis changes one input at a time, scenario analysis sets a coherent set of values for several variables at once, and simulation draws values from probability distributions many times.

FORMULAS

Activity ratios	$$\text{receivables turnover} = \frac{\text{revenue}}{\text{average receivables}}$$
	$$\text{days of sales outstanding (DSO)} = \frac{365}{\text{receivables turnover}}$$
	$$\text{inventory turnover} = \frac{\text{cost of goods sold}}{\text{average inventory}}$$
	$$\text{days of inventory on hand (DOH)} = \frac{365}{\text{inventory turnover}}$$
	$$\text{payables turnover} = \frac{\text{cost of goods sold}}{\text{average trade payables}}$$
	$$\text{number of days of payables (DPO)} = \frac{365}{\text{payables turnover}}$$
	$$\text{purchases} = \text{ending inventory} - \text{beginning inventory} + \text{COGS}$$
	$$\text{total asset turnover} = \frac{\text{revenue}}{\text{average total assets}}$$
	$$\text{fixed asset turnover} = \frac{\text{revenue}}{\text{average net fixed assets}}$$
	$$\text{working capital turnover} = \frac{\text{revenue}}{\text{average working capital}}$$
Liquidity ratios	$$\text{current ratio} = \frac{\text{current assets}}{\text{current liabilities}}$$
	$$\text{quick ratio} = \frac{\text{cash} + \text{marketable securities} + \text{receivables}}{\text{current liabilities}}$$
	$$\text{cash ratio} = \frac{\text{cash} + \text{marketable securities}}{\text{current liabilities}}$$
	$$\text{defensive interval} = \frac{\text{cash} + \text{marketable securities} + \text{receivables}}{\text{average daily expenditures}}$$
	$$\text{average daily expenditures} = \frac{\text{COGS} + \text{SG\&A} + \text{R\&D} - \text{noncash charges (e.g., depreciation, amort}}{365}$$
	$$\text{cash conversion cycle} = \text{DSO} + \text{DOH} - \text{number of days of payables}$$

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Solvency ratios	$\text{debt-to-equity} = \dfrac{\text{total debt}}{\text{total shareholders' equity}}$ $\text{debt-to-capital} = \dfrac{\text{total debt}}{\text{total debt} + \text{total shareholders' equity}}$ $\text{debt-to-assets} = \dfrac{\text{total debt}}{\text{total assets}}$ $\text{financial leverage ratio} = \dfrac{\text{average total assets}}{\text{average total equity}}$ $\text{interest coverage} = \dfrac{\text{EBIT}}{\text{interest payments}}$ $\text{debt-to-EBITDA} = \dfrac{\text{total debt}}{\text{EBITDA}}$ $\text{fixed charge coverage} = \dfrac{\text{EBIT} + \text{lease payments}}{\text{interest payments} + \text{lease payments}}$
Profitability ratios	$\text{gross profit margin} = \dfrac{\text{gross profit}}{\text{revenue}}$ $\text{operating profit margin} = \dfrac{\text{operating income}}{\text{revenue}} \text{ or } \dfrac{\text{EBIT}}{\text{revenue}}$ $\text{pretax margin} = \dfrac{\text{EBT}}{\text{revenue}}$ $\text{net profit margin} = \dfrac{\text{net income}}{\text{revenue}}$ $\text{ROA} = \dfrac{\text{net income}}{\text{average total assets}}$ $\text{adjusted ROA} = \dfrac{\text{net income} + \text{interest expense}(1 - \text{tax rate})}{\text{average total assets}}$ $\text{operating ROA} = \dfrac{\text{operating income (or EBIT)}}{\text{average total assets}}$ $\text{ROE} = \dfrac{\text{net income}}{\text{average total equity}}$ $\text{return on common equity} = \dfrac{\text{net income} - \text{preferred dividends}}{\text{average common equity}}$
Two-part decomposition	$\text{ROE} = \dfrac{\text{net income}}{\text{average total equity}} = \underbrace{\dfrac{\text{net income}}{\text{average total assets}}}_{\text{ROA}} \times \underbrace{\dfrac{\text{average total assets}}{\text{average total equity}}}_{\text{financial leverage}}$
Original (three-part) DuPont equation	$\text{ROE} = \underbrace{\dfrac{\text{net income}}{\text{revenue}}}_{\text{net profit margin}} \times \underbrace{\dfrac{\text{revenue}}{\text{average total assets}}}_{\text{total asset turnover}} \times \underbrace{\dfrac{\text{average total assets}}{\text{average total equity}}}_{\text{financial leverage}}$

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

38 Introduction to Financial Statement Modeling

- A sales-based pro forma model starts from the revenue forecast, estimates COGS, SG&A, financing costs and taxes, then the balance sheet and capital expenditures, and derives the pro forma cash flow statement last from the projected income statement and balance sheet.
- Overconfidence bias shows up as confidence intervals that are too narrow and is countered by inviting critique of the forecasts, reviewing past forecast errors and using scenario analysis to produce a range.
- Conservatism bias, also called anchoring, is making only small adjustments to prior forecasts when new information arrives, while confirmation bias is seeking data that support one's view and discounting contrary evidence.
- Illusion of control bias includes seeking expert opinions to justify a view and overfitting a model with ever more variables, and representativeness bias includes base-rate neglect, which is countered by weighing the outside view with the inside view.
- Under Porter's five forces, pricing power and margins are higher when the threat of substitutes, the intensity of rivalry, the bargaining power of suppliers and of customers, and the threat of new entrants are low.
- With elastic demand the percentage fall in units sold exceeds the percentage rise in price, so a price increase reduces revenue, and the main influence on elasticity is the availability of substitutes.
- Passing through the money amount of an input-cost increase preserves gross and operating profit if volume holds, but it lowers the gross, operating and net margins because revenue is larger.
- For a cyclical company the forecast horizon should reach at least the middle of the business cycle, and a terminal value is very sensitive to the long-term growth rate because it is a growing perpetuity.

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39 Equity Instrument Features

- Equity is an ownership claim with a residual claim, an indefinite life and discretionary dividends; debt is a creditor claim with contractual payments and a maturity.
- Dividend payments are most associated with the mature phase of the company life cycle.
- Common shareholders have a residual claim, voting rights (which they can exercise by proxy) and variable dividends the company has no obligation to pay.
- Preferred shares pay a fixed percentage of par, rank ahead of common shares and usually carry no voting rights.
- Dividends in arrears on cumulative preferred shares must be paid before any common dividend; missed dividends on noncumulative shares are lost.
- Private equity is less liquid than public equity, with more concentrated ownership and control and more limited financial disclosure.
- Private equity investments fall into four types: venture capital, growth equity, special situations and buyout equity.

EXAM SHORTCUTS

- For a preferred share's embedded option, ask whose right it is: a holder's put or conversion right adds value, and an issuer's call right reduces it.

FORMULAS

Preference shares (preferred stock) $\text{Annual preferred dividend} = \text{dividend rate} \times \text{par value}$

40 Equity Jurisdictions, Classes, and the Voting Process

- Direct investing means buying a foreign company's securities in its home market, with obstacles such as account costs, unfamiliar procedures, different tax and reporting rules, foreign exchange risk and a possibly illiquid exchange; indirect vehicles such as depository receipts reduce some of these obstacles.
- A depository receipt represents a set number of a foreign company's shares held by a depository bank and trades in another market in that market's currency, yet its value still changes with the exchange rate, so the holder bears currency risk without exchanging currency.
- To rule out arbitrage, a DR should be priced at the foreign share price converted at the current exchange rate, times the number of shares per DR, although this relationship can break down.
- A GDR is issued neither in the United States nor in the issuer's home country; it is usually denominated in US dollars and, although not listed on US exchanges, can be sold to US institutional investors.
- In a sponsored DR the foreign company takes part in the issue and the voting rights pass to the investor; in an unsponsored DR a bank issues it alone and the depository bank keeps the votes.
- Dual listing puts the same shares on a home exchange and at least one foreign exchange, whereas a dual-class structure gives some classes of common stock more votes (and possibly different economic rights), which can let a group such as the founders keep effective control with less than a majority of the shares.
- Shareholder proposals are typically nonbinding, and a company need not put every one to a vote, although regulations may require management to give reasons for rejecting one.
- Only the shareholder of record on the record date, often 30 days or more before the meeting, may vote, so a holder who sells between the record date and the meeting can still vote and a buyer after the record date cannot vote those shares at that meeting.

EXAM SHORTCUTS

- When two holders of the same company's common shares get different votes, dividends or liquidation priority, the likely explanation is different share classes; cumulative, noncumulative, participating and nonparticipating are preferred-share features and can be eliminated.

41 Equity Issuance and Trading

MODULE 41.1 · EQUITY MARKETS AND EXCHANGES

- In the primary market newly issued shares are sold and the issuer receives the cash, and it is most active when share prices are rising overall; in the secondary market investors trade shares already issued, and it is active whether prices rise or fall.
- Underwriters may gain more over time by placing underpriced shares with institutional clients than from the higher fees of a higher offer price, a conflict with the issuer's owners that helps explain why IPOs are often underpriced and jump on the first trading day.
- Exam convention: a direct listing admits a private company's existing shares to trading without an underwriter and raises no new capital; current practice: that describes the traditional direct listing, and some exchanges, the NYSE among them, also permit a primary direct listing of new shares.
- A SPAC raises cash in its own IPO, holds it in a trust account and must buy a shareholder-approved private company within a set period or return the cash, while a back-door listing has a private company acquire an already listed company to use its listing.
- A primary follow-on offering sells new shares and dilutes each existing share's claim on net income and assets; a secondary follow-on sells existing privately held shares, creates no new shares and brings the company no proceeds.
- The bid-ask spread is the lowest ask minus the highest bid (as a percentage, divided by the lowest ask), and an investor buys at the ask and sells at the bid; OTC dealers post firm quotes, yet OTC markets are less transparent than exchanges.

EXAM SHORTCUTS

- Of the two follow-on offerings, only the primary one creates new shares, so a secondary follow-on can be ruled out whenever a question asks which offering is dilutive or brings the company cash.

MODULE 41.2 · EQUITY INDEXES AND LIQUIDITY MEASURES

- Market float is shares outstanding less restricted or otherwise untradeable shares, so shares of controlling shareholders and restricted shares are excluded while holdings of institutions such as mutual funds, pension funds and ETFs stay in.
- Average daily volume is total shares traded over a period divided by the number of days, and the turnover ratio is average daily volume divided by market float.
- The days needed to exit a position equal the position divided by the volume allowed per day (the permitted share of ADV times ADV), with a fractional result rounded up.
- Market depth is the relative size of orders at or near the best bid and offer, market breadth is the number of orders at prices close to them, and market resiliency is the ability to hold a stable market-clearing price, a more resilient market reaching its new clearing price sooner after a shock.
- Broad-based equity indexes hold the largest listed companies, weighted by float-adjusted market capitalization, and a composite market index usually covers over 90% of the total value of the market.
- A fund confined to one industry is benchmarked against a sector index, a fund built on a cross-industry trend against an investment theme index, and a fund selecting on value or quality against a factor-based index; multi-market indexes combine national indexes for a region, a development stage or the world.

EXAM SHORTCUTS

- When an equal-weighted index outperforms a cap-weighted index with the same constituents, the smaller constituents have done better on average than the larger ones, so no weight calculation is needed to answer which group drove the gap.

FORMULAS

Quotes and the spread	$\text{bid-ask spread} = \text{lowest ask} - \text{highest bid}$ $\text{bid-ask spread}(\%) = \dfrac{\text{lowest ask} - \text{highest bid}}{\text{lowest ask}}$ $\text{mid-market price} = \dfrac{\text{lowest ask} + \text{highest bid}}{2}$
VWAP	$\text{VWAP} = \dfrac{\sum_i (\text{price}_i \times \text{volume}_i)}{\sum_i \text{volume}_i}$
Float, trading volume and other liquidity measures	$\text{market float} = \text{shares outstanding} -$ $\text{restricted shares or shares not available for trading}$ $\text{average daily volume} = \dfrac{\sum_{i=1}^{n} (\text{shares traded on day } i)}{n}$ $\text{turnover ratio} = \dfrac{\text{average daily volume}}{\text{market float}}$

42 Sources of Equity Returns

MODULE 42.1 · DIVIDENDS, STOCK SPLITS, AND SHARE REPURCHASES

- A share repurchase has the same effect on total shareholder wealth as a cash dividend of the same amount, but each holder decides whether to sell, and among cash distributions only a repurchase reduces the number of shares outstanding.
- A special cash dividend is a one-time payment on top of any regular dividend, which lets cyclical firms share profits in good years without committing to them in bad years, while a liquidating dividend is viewed more as a return of capital.
- Stock dividends and forward splits raise the share count and lower the price per share in proportion, and reverse splits do the opposite, so the company's total value, a shareholder's wealth and proportional ownership are unchanged.
- In time order a dividend is declared, the stock goes ex-dividend, the record date passes and the dividend is paid; other things equal, the share price falls by the dividend amount when the stock goes ex-dividend, the first day a buyer no longer receives it.
- Exam convention: the ex-dividend date precedes the record date by one or two business days, with the gap set by the settlement cycle; current practice: US equity trades have settled T+1 since May 2024, so a US company's two dates are now normally the same day.
- On the ex-dividend date the percentage price change equals the negative dividend effect plus the market effect plus the company-specific effect, so for a stock as risky as the market the company-specific part is the actual change plus the dividend percentage minus the index move.

EXAM SHORTCUTS

- A 3-for-2 split and a 50% stock dividend are economically identical (50% more shares, each worth one-third less), so other things equal neither lowers the share price more than the other.
- The ex-dividend date comes one business day less than the settlement period before the record date, so T+2 settlement gives a one-day gap and T+1 settlement puts the two dates on the same day.

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MODULE 42.2 · RETURN CALCULATIONS FOR EQUITIES

- Price return is $(P_1 - P_0)/P_0$, using only the split-adjusted price change, and total return is $(P_1 - P_0 + D)/P_0$, adding the cash dividends received.
- Stock splits, stock dividends and reverse splits do not change the rate of return once the beginning price, ending price and dividend per share are on the same share basis.
- A dividend reinvested in the same stock buys D/P_{PD} extra shares per share held at the price on the payment date, and the return is $r_E = [P_1(1 + D/P_{PD}) - P_0]/P_0$, with the cash dividend not added again.
- A dividend invested elsewhere, such as in a bank deposit, enters the holding period return as the dividend plus what it earns until the end of the period.
- A share's value is $P_0 = [E(P_1) + E(D_1)]/(1 + r_E)$, where r_E is the required rate of return; this is the basis of discounted cash flow models, in which a share is worth the present value of expected future cash flows.
- A holding period may be shorter or longer than a year, so a return question has to be read for whether an annualized figure is wanted.

EXAM SHORTCUTS

- Splits, stock dividends and reverse splits leave the rate of return unchanged, so working with the value of the whole position avoids restating every per-share figure on a new share basis.

FORMULAS

Price return and total return on equity	$\text{price return} = \dfrac{P_1 - P_0}{P_0}$ $\text{total return} = \dfrac{P_1 - P_0 + D}{P_0}$
Reinvested dividends	$r_E = \dfrac{P_1\left(1 + \dfrac{D}{P_{PD}}\right) - P_0}{P_0}$
Equity value as a present value	$P_0 = \dfrac{E(P_1) + E(D_1)}{1 + r_E}$

43 Introduction to Equity Valuation

- Intrinsic value cannot be observed and is estimated with valuation models; a perceived value above the market price means the stock looks undervalued, below it overvalued, and equal to it fairly valued.
- Naïve or story-based valuation rests on a story unconnected to the company's finances, relative valuation compares multiples with a peer group, and absolute valuation uses only the company's own characteristics, such as the present value of expected cash flows.
- Exam convention: book value of equity = share capital + additional paid-in capital + retained earnings − treasury stock; current practice also adds AOCI and other reserves, so the two agree only when those items are zero, and noncontrolling interest is excluded in both.
- Book value is most useful for companies with substantial tangible assets and least useful for early-stage or asset-light companies and those whose value lies in intangibles, and a negative book value alone does not mean the shares cannot provide value to investors.
- Market capitalization (share price × shares outstanding) reflects the company's fair value as a going concern, so a P/B above 1 signals excess value and a P/B below 1 a value shortfall to investigate.
- Enterprise value is the market value of the common and preferred stock and of the debt, less cash and short-term investments, and it is usually divided by EBITDA, EBIT or revenue to compare companies with different capital structures.

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- In present value models, dividends, FCFE and residual income are discounted at the required return on equity, while FCFF, the cash available to both debt and equity holders, is discounted at the WACC to give firm value.
- An asset-based model values equity at the fair value of assets minus liabilities and preferred stock and can give a floor value, whereas multiplier models compare equity multiples or EV multiples with peers.

EXAM SHORTCUTS

- Pick the model from the facts given: stable, predictable dividends point to a dividend discount model, a non-payer with a stable capital structure to FCFE, negative FCFE or an unstable capital structure to FCFF, and liquidation or mostly liquid tangible assets to an asset-based model.

FORMULAS

Book value, market capitalization and enterprise value	$\text{book value} = \text{share capital} + \text{additional paid-in capital} + \text{retained earnings} + \text{accumulated other comprehensive income (and other reserves)} - \text{treasury stock}$ $\text{book value per share (BVPS)} = \frac{\text{book value of equity}}{\text{shares outstanding}}$
Limits of book value	$\text{P/B} = \frac{\text{market price per share}}{\text{BVPS}} = \frac{\text{market capitalization}}{\text{book value of equity}}$ $\text{EV} = \text{market value of common and preferred stock} + \text{market value of debt} - \text{cash and short-term investments}$

44 Discounted Cash Flow (DCF) and Growth Models

MODULE 44.1 · CASH FLOW METRICS

- A present value model values equity as the present value of a cash flow measure forecast over a horizon plus the present value of a terminal value, using a discount rate that matches the measure.
- A DDM takes the minority shareholder's view and suits mature firms with high, consistent payouts, while FCFE, the capacity to pay dividends, takes a controlling shareholder's view; the discount rate for both is the required return on equity.
- $FCFE = \text{net income} + \text{depreciation} - WCInv - CapEx + \text{net borrowing}$, and with a target debt-to-assets ratio DR it becomes $\text{net income} - (1 - DR)(\text{net investment})$.
- FCFF is a pre-leverage cash flow, $FCFF = FCFE + \text{interest}(1 - t) - \text{net borrowing}$, discounted at the WACC and used when heavy capital spending makes FCFE negative or the capital structure is volatile.
- Residual income per share is $EPS_t - r \times BVPS_{t-1}$, discounted at the required return on equity, and the model requires clean surplus accounting.
- The valuation process chooses the cash flow measure, forecasts it, chooses a matching discount rate, estimates the terminal value and finally sums the present values.

EXAM SHORTCUTS

- For a firm with no debt, FCFF equals FCFE, so there is no interest or net borrowing adjustment to make.

MODULE 44.2 · VALUATION MODELS

- The constant growth model $V_0 = D_1/(r - g) = D_0(1 + g)/(r - g)$ requires g below r and below the long-run growth rate of the economy, and it fits mature firms with stable leverage and a high payout ratio best.
- The constant growth model gives value one period before the cash flow in its numerator, and the same form values FCFE at the cost of equity and FCFF at the WACC.
- In a two-stage model each high-growth dividend is discounted at r, and the terminal value $V_n = D_{n+1}/(r - g_L)$ is discounted n periods.

- If the constant growth model fits the company, the growth rate implied by the market price is $g = r - D_1/P_0$.
- Sustainable growth is $g = b \times ROE$, where b is the retention ratio, assuming constant ROE, constant payout and no new equity; the required return and beta are not inputs.
- The WACC weights the after-tax cost of debt and the cost of equity by market values, the present value of FCFF at the WACC is firm value, and equity value is firm value minus the market value of debt.

EXAM SHORTCUTS

- Under constant growth, $V_t = V_0(1+g)^t$, so a value at a future date follows from today's value without forecasting the later dividend.

MODULE 44.3 · MODEL LIMITATIONS AND PREFERRED STOCK VALUATION

- The cash flow measure and its size, the length of the forecast horizon and the discount rate are all estimates in a present value model, and small changes in r, especially in $r - g$, move the value a lot.
- DDMs ignore stock buybacks, past dividend growth is a poor guide for a firm whose competitive environment is deteriorating, and a rapidly growing firm needs a multistage model with a finite high-growth period.
- Preferred stock ranks ahead of common equity for dividends and in liquidation, so its required return is lower than that of common equity, and its dividend is the stated rate times par.
- A perpetual preferred is worth D_p/r_p, the constant growth model with g = 0, while a finite-maturity preferred is valued like a bond as the present value of its dividends and its face value.
- An embedded option's value is subtracted when the issuer holds the right and added when the investor holds it, so a callable preferred is worth less and pays a higher dividend, while putable and convertible preferreds are worth more than identical option-free preferreds.

EXAM SHORTCUTS

- For a perpetual preferred, a required yield above the dividend rate means a value below par, so a price above par can be ruled out without calculation.

FORMULAS

Cash flow measures for present value models and the valuation process	$V_0 = \sum_{t=1}^{n} \frac{E(CF_t)}{(1+r)^t} + \frac{E(TV_n)}{(1+r)^n}$
Free cash flow to equity	$FCFE = \text{net income} + \text{depreciation} - WCInv - CapEx + \text{net borrowing}$ $FCFE = CFO - FCInv + \text{net borrowing}$ $\text{net investment} = CapEx - \text{depreciation} + WCInv$ $FCFE = \text{net income} - \text{net investment} + \text{net borrowing}$ $\text{net borrowing} = DR \times \text{net investment}$ $FCFE = \text{net income} - \text{net investment} + DR \times \text{net investment} = \text{net income} - (1 - DR)(\text{net investment})$
Free cash flow to the firm	$FCFF = CFO - CapEx + \text{interest}(1-t)$ $FCFF = FCFE + \text{interest}(1-t) - \text{net borrowing}$
EBITDA	$FCFF = EBITDA(1-t) + (\text{depreciation} \times t) - FCInv - WCInv$
Residual income	$RI_t = EPS_t - r \times BVPS_{t-1}$

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Constant growth (Gordon growth) model	$V_0 = \frac{D_1}{r-g} = \frac{D_0(1+g)}{r-g}$ $g = r - \frac{D_1}{P_0}$
Multistage (two-stage) models	$V_0 = \sum_{t=1}^{n} \frac{D_t}{(1+r)^t} + \frac{V_n}{(1+r)^n}$ $V_n = \frac{D_{n+1}}{r-g_L}$
Estimating the constant growth rate	$g = (1 - \text{dividend payout ratio}) \times ROE = b \times ROE$ $SGR_{FCFE} = \left(1 - \frac{FCFE}{\text{net income}}\right)\left(\frac{\text{net income}}{\text{beginning book value}}\right)$ $SGR_{FCFF} = \left(1 - \frac{FCFF}{NOPAT}\right)\left(\frac{NOPAT}{\text{beginning book value of total capital}}\right)$
Weighted average cost of capital	$WACC = \frac{MV_d}{MV_d + MV_e} r_d(1-t) + \frac{MV_e}{MV_d + MV_e} r_e$
Non-callable, non-convertible preferred	$V_0 = \sum_{t=1}^{N} \frac{D_p}{(1+r_p)^t} + \frac{FV}{(1+r_p)^N}$ $V_0 = \frac{D_p}{r_p}$

45 Relative Value Equity Valuation Approaches

MODULE 45.1 · PRICE MULTIPLES AND EQUITY VALUATION

- Price multiples put the share price over a per-share measure, EV multiples put EV over a firm-level measure belonging to all capital providers, a trailing multiple uses the most recent past period and a leading multiple uses next period's forecast.
- The method of comparables takes its benchmark from the mean or median multiple of a peer group and rests on the law of one price, and when a few extreme values skew the peers' multiples the median, or the mean after removing outliers, is the better benchmark.
- A stock whose price multiple is above the benchmark looks overvalued, and one whose multiple is below the benchmark looks undervalued.
- The justified leading P/E from the constant growth model is $\text{payout ratio}/(r-g)$, the trailing version multiplies it by $(1+g)$, and it rises with g, falls as r rises and, with r and g constant, rises with the payout ratio.
- The justified P/B is $(ROE - g)/(r-g)$, so with r above g it is above 1.0 if ROE exceeds r, equal to 1.0 if ROE equals r and below 1.0 if ROE is below r.
- The PEG ratio, $(P/E)/g$ with g in whole percentage points, adjusts for growth only and a PEG above the peers' benchmark looks overvalued, while the regression approach adjusts for several fundamentals at once and its fitted equation, intercept included, gives the justified multiple.

EXAM SHORTCUTS

- With r above g, the justified P/B is above 1.0 exactly when ROE is above r, so the side of 1.0 can be read from ROE and r before any calculation.

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MODULE 45.2 · PRICE AND ENTERPRISE VALUE MULTIPLES

- A share's value is $P_0 = E_1/r + PVGO$, so the PVGO share of the price is $1 - (E_1/P_0)/r$, and a negative PVGO suggests management is investing in negative-NPV projects.
- Core earnings strip out nonrecurring items, and for cyclical firms normalized EPS is either the average EPS over the most recent cycle, which ignores growth in firm size, or the average ROE over the cycle times current BVPS, which captures it better.
- P/S is used when earnings are negative or not comparable, suits mature and cyclical firms with similar revenue recognition and little or no leverage, and its justified value is the justified trailing P/E times the profit margin.
- EBIT, EBITDA and FCFF belong to all capital providers and are paired with EV; the justified EV/EBITDA is $FCFF_1/(WACC - g)$ divided by EBITDA, rising with g and falling with WACC.
- P/B works best for firms with mainly tangible assets and similar accounting, leverage and asset mix, banks are often valued on price-to-tangible book, and value-to-book or EV-to-book helps when leverage differs or book equity is negative.
- The justified dividend yield is $(r - g)/(1 + g)$ or payout times earnings yield, and for yields the rule is reversed: an actual yield above the justified yield signals an undervalued stock.

EXAM SHORTCUTS

- Match the multiple to the situation: negative or non-comparable earnings point to P/S, a capital-intensive industry with different leverage across peers to EV/EBITDA, negative book equity to value-to-book or EV-to-book, and a peer group with non-payers rules out dividend-based multiples.

MODULE 45.3 · PEER GROUPS AND MULTIPLES-BASED VALUATION

- An industry-based peer group holds firms with the same principal business activity, and suitable peers are hard to find for unique firms, industries with members at widely different life cycle stages, firms in different tax or regulatory jurisdictions and conglomerates.
- A statistical factor-based peer group, usually formed with a multifactor model, holds firms with the same or close exposures to risk-return factors regardless of industry, but its relationships are estimated from past data and may not persist.
- Comparables can mislead when the whole peer group is overvalued or undervalued, and multiples built on current unadjusted figures can be distorted by accounting choices, nonrecurring items or cyclicality.
- Comparing a stock with its own past multiples or with peer averages over a whole business cycle reduces the risk of benchmarking against a currently mispriced peer group, though differences in growth and required return still have to be controlled for.
- A terminal value can be estimated as $TV_n = \text{justified leading P/E}_n \times E_{n+1}$, with the justified leading P/E equal to $\text{payout}/(r - g)$.

EXAM SHORTCUTS

- When next-period earnings are $E_n(1 + g)$, the justified trailing P/E applied to E_n gives the same terminal value as the justified leading P/E applied to E_{n+1}, so either pairing can be used.

FORMULAS

Method of forecasted fundamentals

$$\frac{P_0}{E_1} = \frac{D_1/E_1}{r - g} = \frac{\text{payout ratio}}{r - g}$$

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

Reconciling the two methods

$$PEG = \frac{P/E}{g} \quad (g \text{ in whole percentage points})$$

$$\widehat{P/B}_i = b_0 + b_1\, ROE_i + b_2\, g_i$$

Value = assets in place + growth opportunities	$P_0 = \frac{E_1}{r} + PVGO$ $\frac{PVGO}{P_0} = 1 - \frac{E_1/P_0}{r}$
Price-to-sales (P/S)	$\frac{P_0}{S_0} = \frac{P_0}{E_0} \times \frac{E_0}{S_0} = \frac{\text{payout} \times (1+g)}{r-g} \times \text{profit margin}$
Enterprise value multiples	$EV = \text{market value of common and preferred stock} + \text{market value of debt} - \text{cash and short-term investments}$ $EV = \frac{FCFF_1}{WACC - g}$ $FCFF = EBITDA(1-t) + \text{Dep} \times t - \text{CapEx} - \text{WCInv}$
Balance-sheet multiples	$\frac{EV}{BV \text{ of capital}} = \frac{ROC \times (1 - \text{reinvestment rate})}{WACC - g}$
Cash-flow multiples and yields	$\frac{D_0}{P_0} = \frac{D_0}{E_0} \times \frac{E_0}{P_0} \quad (\text{payout} \times \text{earnings yield})$ $\frac{D_0}{P_0} = \frac{r-g}{1+g}$
Using projected future values	$TV_n = \text{justified leading P/E}_n \times E_{n+1}$ $\text{justified leading P/E}_n = \frac{\text{payout}}{r-g}$

46 Financial Statement Forecasting in Equity Valuation

MODULE 46.1 · FINANCIAL STATEMENT FORECAST MODELS

- A disaggregated valuation model forecasts full financial statements through revenue, expense, asset and financing modeling; it improves the estimate of future cash flows but does not change how the discount rate is estimated and still needs a terminal value.
- Revenue can be forecast with the historical approach (the company's own past growth, for mature firms with stable business models), the bottom-up approach (company drivers such as units × prices, same-store sales plus new stores, or capacity × utilization × price) or the top-down approach (nominal GDP growth, or industry growth and market share).
- A revenue premium stated as a percentage of GDP growth gives growth of $g_{GDP}(1+x)$, while a premium stated in percentage points is added to GDP growth.
- Exam convention: forecast revenue growth is market growth plus the proportional change in market share, $g_{market} + (\text{new share}/\text{old share} - 1)$; current practice: computing next year's sales in levels gives the exact growth.
- Expenses can be linked to revenue by a regression $\Delta\text{Expense} = b_0 + b_1 \times \Delta\text{Revenue}$ for established companies with enough data, itemized when new information must be reflected, or set by a direct margin, with $\text{COGS} = \text{forecast revenue} \times (1 - \text{gross margin})$.
- A constant growth asset model keeps total asset turnover constant, and financing needs equal the change in operating assets minus the change in non-debt liabilities minus the change in retained earnings, a positive result being new financing needed and a negative one a surplus.

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EXAM SHORTCUTS

- The exam-convention market-share growth differs from the exact growth computed in levels only by the product of the two changes, so the two answers are close unless both changes are large.

MODULE 46.2 · MODELS BASED ON COMPANY CHARACTERISTICS

- A start-up is valued with a P/S multiple of anticipated sales discounted by the VC investor's ROI multiple, a growth-stage firm mainly through a terminal value from a P/E on forecast net income, a mature firm with a constant growth model, and a declining firm with adjusted historical data, higher discount rates and a probability-weighted value.
- $\text{ROI multiple} = (1+r)^n$, post-money value is expected revenue × P/S divided by the ROI multiple, pre-money value is post-money value minus the VC investment, and the VC's fractional ownership is the investment divided by post-money value.
- A growth-stage terminal value is $TV_n = NI_n \times P/E$, discounted at r for n years or divided by the target ROI multiple when the required return is stated as a multiple.
- When the going-concern assumption is in doubt, value is the probability-weighted average of the going-concern value and the distress sale value, where the equity's distress value is what shareholders recover after creditor claims and liquidation costs.
- From a forecast model, $FCFF = NOPAT - \text{net investment}$ gives firm value $FCFF_1/(WACC - g)$, and equity value is firm value minus the market value of debt.
- The sustainable growth rate of FCFF is the reinvestment rate $1 - FCFF/NOPAT$ times the return on capital, NOPAT divided by the beginning book value of total capital (debt plus equity).

EXAM SHORTCUTS

- Read margins from the growth assumptions: revenue forecast to grow faster than expenses means rising margins, and most operating expenses growing faster than revenue means a falling operating profit margin, though the effect on gross and net margins needs more information.

FORMULAS

Revenue modeling	$g_{revenue} = g_{market} + \left(\frac{\text{new share}}{\text{old share}} - 1\right)$
Expense (profit) modeling	$\Delta\text{Expense} = b_0 + b_1 \times \Delta\text{Revenue}$ $\text{COGS} = \text{forecast revenue} \times (1 - \text{gross margin})$
Financing modeling	$\text{financing needs} = \Delta\text{operating assets} - \Delta\text{non-debt liabilities} - \Delta\text{retained earnings}$
Start-up stage: venture capital arithmetic	$\text{ROI multiple} = (1+r)^n \implies r = (\text{ROI multiple})^{1/n} - 1$ $\text{post-money value} = \frac{\text{expected revenue} \times (P/S)}{\text{ROI multiple}}$ $\text{pre-money value} = \text{post-money value} - \text{VC investment}$ $f = \frac{\text{VC investment}}{\text{post-money value}}$
Growth stage	$TV_n = NI_n \times P/E$ $V_0 = \frac{TV_n}{(1+r)^n}$ or $V_0 = \frac{TV_n}{\text{ROI multiple}}$
Decline stage	$\text{value} = P(\text{going concern}) \times \text{going-concern value} + P(\text{distress}) \times \text{distress sale value}$

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Enterprise value and EV multiples	$\text{EV} = \text{market value of common and preferred stock} + \text{market value of debt} - \text{cash and short-term investments}$
Valuing equity from forecast model outputs	$SGR_{FCFF} = \left(1 - \frac{FCFF}{NOPAT}\right)\left(\frac{NOPAT}{\text{beginning book value of total capital}}\right)$

47 Industry and Competitive Analysis

MODULE 47.1 · INDUSTRY ANALYSIS FRAMEWORK

- Industry and competitive analysis has five steps: define the industry, survey it, analyze its structure with Porter's five forces, examine external influences with PESTLE, and analyze the competitive strategies of its companies.
- Commercial classification systems such as GICS, ICB and TRBC group companies by the products and services they offer into hierarchical tiers; they are consistent, but groups can be too broad or too narrow, and a company in several industries is often placed by the product that earns the most revenue.
- Defensive industries have relatively stable demand through expansions and contractions, cyclical industries have earnings that depend heavily on the stage of the cycle and usually high operating leverage, and growth industries grow revenue strongly through all phases of the cycle.
- Industry size is one year's total sales of the product or service; the top-down approach uses government or third-party data and suits industries with many private or small firms, while the bottom-up approach adds up company revenues and works best when large listed companies dominate.
- ROIC is NOPAT divided by average invested capital (long-term liabilities plus equity), a return to all capital providers, and ROIC above WACC means value is being created.
- The HHI is the sum of squared market shares in percent, with a maximum of 10,000 and a reading above 1,800 often taken as high concentration; unless the industry is segmented or highly differentiated, higher concentration means less competition and more pricing power.

MODULE 47.2 · PORTER'S FIVE FORCES AND PESTLE ANALYSIS

- Porter's five forces are the threat of new entrants, the threat of substitutes, the bargaining power of suppliers, the bargaining power of customers and rivalry among existing competitors; when they are strong, industry returns on capital are unlikely to exceed the cost of capital.
- An economic moat is a durable competitive advantage, from sources such as cost advantages, efficient scale, proprietary intangible assets, network effects and high switching costs, and the longer it lasts the longer profits stay above the cost of capital.
- The threat of entry is stronger when barriers are low, and rivalry is stronger with slow growth, high fixed costs, difficulty exiting, many similar-sized firms and little differentiation.
- Suppliers have power when they are few, when inputs are scarce or customized, or when they hold proprietary technology, customers have power when they are large and concentrated and products are commodity-like, and firms may respond with backward or forward vertical integration.
- PESTLE covers political, economic, social, technological, legal and environmental influences on an industry, and monetary policy and regulation are indirect political channels.
- In the innovation matrix, breakthrough innovation solves a distinct problem in an indistinct domain, sustaining innovation a distinct problem in a distinct domain, disruptive innovation an indistinct problem in a distinct domain, and basic research has no specific commercial objective.

FORMULAS

Profitability	$\text{operating profit margin} = \frac{\text{operating income}}{\text{total revenue}}$ $\text{ROIC} = \frac{\text{NOPAT}_t}{\text{average invested capital}}$

Market share and concentration

$$\text{market share} = \frac{\text{company sales}}{\text{industry size}}$$

$$HHI = \sum_{i=1}^{N} (\text{market share}_i)^2$$

48 Company Analysis: Past, Present, and Future

MODULE 48.1 · CORPORATE STRATEGY AND INDUSTRY POSITION

- A business model explains how a company defines and creates value (its customers, products and services, key resources and protection from rivals), while the competitive strategy is only the part about how it wins against rivals.
- An intentional competitive strategy is proactive, with clear measurable goals and monitored performance, and is more likely to create long-term value than an unintentional one, which is reactive and may simply keep the status quo or copy industry norms.
- Looking forward, a strategy is judged by whether it can respond to the threats found with Porter's five forces, whether it is neutral to or helped by the PESTLE influences, and whether the company can execute it.
- A start-up focuses on product and business-model development, partnerships and raising capital, a growth company on sales growth, a mature company on efficiency and defending market share, and a declining company on cost management, restructuring, reinvention or exit.
- The serviceable market is the part of the total addressable market the company can reach, $\text{TAM} \times \text{technical fit} \times \text{geographic reach}$, and the obtainable market is the share of it the company can realistically win given its scale and strategy.
- Porter's generic strategies are cost leadership (lowest costs and prices with enough volume), differentiation (distinctive products earning a price premium behind an economic moat) and focus (a niche, possibly mixing both), and a firm with no clear advantage is stuck in the middle.

EXAM SHORTCUTS

- Read the strategy from the customer and industry clues: price-conscious customers with little product differentiation and limited innovation point to cost leadership, customers who value uniqueness point to differentiation, and a narrow customer group, region or product points to focus.

MODULE 48.2 · REVENUE, PROFITABILITY, AND CAPITAL

- Net income is the most comprehensive earnings measure but is volatile and less useful for start-ups and highly cyclical industries; EBIT removes financing and tax effects but is distorted by depreciation policies; EBITDA allows comparison across differing investment policies, leverage and taxes but is not a GAAP/IFRS measure and ignores the cost of replacing assets.
- Pricing power, the ability to change the terms of an offer in the company's favor without hurting sales, is high when demand is inelastic and grows with differentiation, switching costs, brand loyalty, barriers to entry and a lack of substitutes.
- Operating profit is $Q(P - VC) - FC$, and the larger the share of fixed costs, the more operating profit changes in percentage terms relative to a change in volume, in both directions.
- Exam convention: $\text{FCFE} = \text{NI} + \text{D\&A} - \Delta\text{working capital} - \Delta\text{LT assets} + \Delta\text{debt}$; current practice: the D&A add-back is correct only when the long-term asset change is gross investment, and working capital excludes cash and short-term debt.
- The cash conversion cycle is $\text{DOH} + \text{DSO} - \text{DPO}$; a longer CCC means a greater need to finance working capital, and a negative CCC means operations fund the company.
- Value is created when ROIC, NOPAT over average invested capital, exceeds the WACC, and the degree of financial leverage, $\%\Delta \text{ net income} / \%\Delta \text{ operating income}$, rises when borrowing adds interest expense.

EXAM SHORTCUTS

- With price, variable cost per unit and fixed costs unchanged, a change in units sold moves operating profit by the change in units times $P - VC$, so the whole profit figure need not be recomputed.

FORMULAS

Market potential for start-up and growth companies	$\text{Serviceable market} = \text{TAM} \times \text{technical fit (\%)} \times \text{geographic reach (\%)}$
Operating profitability	$\text{EBITDA} = \text{revenue} - \text{COGS} - \text{operating expenses (excluding D\&A)}$ $\text{EBIT} = \text{EBITDA} - \text{depreciation and amortization}$ $\text{Net income} = \text{EBIT} - \text{interest expense} - \text{taxes}$
Operating leverage	$\text{Operating profit} = Q \times (P - VC) - FC$
Free cash flow to equity	$\text{FCFE} = \text{NI} + \text{D\&A} - \text{capital expenditures} - \Delta\text{working capital} + \text{net borrowing}$
Working capital management	$\text{CCC} = \text{DOH} + \text{DSO} - \text{DPO}$
Capital investments	$\text{Net capital expenditure} = \text{total capital expenditure} - \text{D\&A}$ $\text{ROIC} = \frac{\text{NOPAT}}{\text{average invested capital}}$ $\text{invested capital} \approx \text{total long-term liabilities} + \text{total equity}$
Capital structure	$\text{DFL} = \frac{\%\Delta \text{ net income}}{\%\Delta \text{ operating income}}$

49 Equity Analyst Research Reports

- An initiating-coverage report is thorough because readers may know little about the company, while subsequent reports are shorter updates often triggered by expected events such as earnings releases, and the front page is written last.
- The financial analysis and valuation section shows only the measures that support the price target, which is set by intrinsic value from several valuation techniques and can be absolute or relative, a point or a range, usually over one to two years.
- As a rough guideline, a stock expected to rise by at least about 10%–15% (in absolute terms or relative to a benchmark) is a buy, one expected to fall by at least that much is a sell, and one in between is a hold.
- A subsequent report gives the recommendation with the rationale for any change, variance analysis of expected versus actual results, and changes to the valuation and risks, and every report should distinguish facts from opinions and disclose potential conflicts of interest.
- Sell-side research is produced by investment banks and brokers for clients in a standardized format under conflict-of-interest constraints, whereas buy-side research is produced by investing firms for internal use, is customized and is mostly unregulated because it is not published.
- Sell-side coverage tilts toward stocks that generate trading volume and its recommendations are mostly buy or hold and in line with the consensus, while the buy side has more scope to cover smaller stocks and includes activist short selling.
- Analysts using the same model can reach different values through their assumptions on revenue and costs, capital investment, the terminal value and financing, and a valuation driven mainly by financing deserves skepticism.

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- Exam convention: when investment grows at the same rate as net income, free cash flow shows no overall change; current practice: equal dollar increases leave free cash flow unchanged, while equal percentage growth makes their difference grow at that rate.

EXAM SHORTCUTS

- "Sell-side" and "buy-side" say who produces a report and nothing about its recommendation, so an answer that links sell-side research to sell ratings can be eliminated.

FORMULAS

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

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

MODULE 50.1 · ESTIMATING THE COST OF EQUITY WITH THE MARKET MODEL AND CAPM

- The CAPM, $E(R_i) = R_f + \beta_i[E(R_m) - R_f]$, prices only systematic risk, and its security market line has the risk-free rate as intercept and the market risk premium as slope.
- Beta equals $\rho_{i,m}\sigma_i/\sigma_m$ and is estimated by regressing the stock's returns on a market proxy over a lookback period, where a longer sample lowers the standard error but may describe a business or capital structure that no longer applies.
- Exam convention: the square root of R^2 is described as the stock–index correlation; current practice: it gives the correlation's magnitude, and the sign follows the sign of beta.
- Adjusted beta is $\omega \times \text{raw beta} + (1-\omega) \times 1.0$, with ω commonly 2/3, because market model betas tend to revert toward 1.0.
- In the pure-play approach the peers' levered beta is unlevered with the peers' D/E and tax rate and relevered with the subject company's D/E and tax rate, the $(1-t)$ term appearing in both steps.
- The forward-looking market risk premium is $D_1/P_0 + g - R_f$, a long-term government rate is the more appropriate risk-free rate, and for emerging markets the country risk premium, the sovereign yield spread times $\sigma_{\text{equity index}}/\sigma_{\text{sovereign debt}}$, is added to the MRP inside the beta term.

EXAM SHORTCUTS

- Adjusted beta is a weighted average of the raw beta and 1.0, so it lies between them: a raw beta above 1 is adjusted down and one below 1 is adjusted up, and any answer outside that range can be ruled out.
- When the subject and its peers share one tax rate, a subject with lower leverage than the peers has a lower levered beta than theirs, and one with higher leverage a higher beta.

MODULE 50.2 · ARBITRAGE PRICING THEORY

- A single market factor does not adequately explain why returns differ across stocks, which motivates multifactor models such as arbitrage pricing theory, $E(R_i) = R_f + \beta_{1i}f_1 + \cdots + \beta_{ki}f_k$.
- APT is a statistical factor model that specifies neither the number nor the identity of its factors, whereas the CAPM has one factor, the market portfolio.
- The four-factor model adds size (SMB), value (HML) and momentum (UMD) factors to the market factor, and each of these three is measured by a zero-cost portfolio holding equal amounts long and short.
- A positive SMB beta means the stock behaves like a small-cap stock and a positive HML beta like a value stock, while negative betas point to large-cap and growth behavior, and a negative factor beta must keep its sign in the expected return.
- Betas on the long-short factors average about zero across stocks, so individual betas are often negative, while the market beta averages 1.0.

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- Multifactor models are used to estimate the cost of equity (two stocks with the same market beta can have different required returns), to describe a stock's or portfolio's style, and to form statistical factor-based peer groups, although betas estimated from past data may not persist.

FORMULAS

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

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CFA® PROGRAM LEVEL I · CHEAT SHEET

Fixed Income

Exam weight 11–14% · 19 readings · 62 formulas

51 Fixed-Income Instrument Features

- The coupon rate is the annual percentage of par paid as interest, so each periodic coupon equals the coupon rate times par value divided by the number of payments per year.
- A bond with an original maturity of one year or less is a money market security, one with an original maturity of more than one year is a capital market security, and a bond with no stated maturity is a perpetual bond.
- A zero-coupon (pure discount) bond pays no interest before maturity and is sold at a discount to par, so the investor's whole return is the gap between the price paid and the par value received.
- For a fixed-coupon bond, price and yield move in opposite directions; a premium bond yields less than its coupon rate and a discount bond yields more.
- Senior debt ranks ahead of junior (subordinated) debt in bankruptcy or liquidation, so junior debt carries more credit risk and must offer a higher yield.
- A bond's spread is its extra yield over a government bond of the same maturity, with the government yield curve used as the benchmark.
- The bond indenture (trust deed) is the legal contract between issuer and bondholders; it sets out the sources of repayment, any collateral, credit enhancements and the covenants.
- Affirmative covenants state what the issuer must do, including cross-default and pari passu clauses; negative covenants restrict what the issuer may do, including the negative pledge clause and limits subject to an incurrence test.

EXAM SHORTCUTS

- A bond priced above par has a yield below its coupon rate, and a bond priced below par has a yield above it, so comparing the price with par answers a yield-versus-coupon question without any calculation.

52 Fixed-Income Cash Flows and Types

- A bullet bond pays only interest before maturity and repays all principal at maturity; a fully amortizing bond's level payments retire the debt by the last payment; a partially amortizing bond's level payments leave a balloon payment at maturity.
- A sinking fund provision obliges the issuer to retire part of the issue on a set schedule, which lowers bondholders' credit risk but adds reinvestment risk.
- A floating-rate note pays the market reference rate plus a fixed margin, so its per-period coupon is (MRR + margin) divided by the number of payments per year.
- A capital-indexed bond such as TIPS keeps a fixed coupon rate, effectively a real rate, and adjusts its principal for inflation, so each coupon is that rate applied to the adjusted principal; an interest-indexed bond adjusts the coupon rate and leaves the principal unprotected.
- An embedded option benefits whoever holds the right to exercise it: callable bond = straight bond − call, with a higher yield, and putable bond = straight bond + put, with a lower yield.
- For a convertible bond, the conversion ratio is par divided by the conversion price, and the conversion value is the conversion ratio times the current share price.
- A foreign bond is issued by a foreign issuer and traded in another country's domestic market, while a Eurobond is issued beyond the jurisdiction of any single country and may be denominated in any currency.

- On an original issue discount bond such as a zero-coupon bond, the rise in value toward par is interest, and many jurisdictions tax part of the discount each year as interest income even though no cash is received.

EXAM SHORTCUTS

- A partially amortizing payment uses the same calculator entries as the fully amortizing payment, with the balloon entered as FV instead of zero.
- Only a zero-coupon bond held to maturity has no reinvestment risk, so any coupon bond can be eliminated from that answer even if it is held to maturity.
- A callable bond is worth less and a putable bond more than an otherwise identical straight bond, so the three can be ranked by price, and in reverse by yield, without valuing any of them.

53 Fixed-Income Issuance and Trading

- Bond markets are segmented mainly by type of issuer (sector), credit quality and original maturity.
- Investment grade means a rating from AAA down to BBB– at S&P, or from Aaa down to Baa3 at Moody's; a rating of BB+ or below (Ba1 or below at Moody's) is high yield.
- Exam convention: money market securities have an original maturity of one year or less, intermediate-term ones between 1 and 10 years, and long-term ones more than 10 years; current practice applies the money market label to instruments issued with maturities of up to about one year, such as Treasury bills, commercial paper and repos.
- Fallen angels are bonds of issuers downgraded from investment grade to high yield because their credit quality deteriorated, while distressed debt is the debt of issuers that are in bankruptcy or expected to file for it.
- A well-established investment-grade company can fund short-term (including seasonal) working capital with commercial paper, medium-term investments and permanent working capital with intermediate-term debt, and fixed-asset investment with long-term debt.
- Compared with equity indexes, bond indexes have many more constituents and higher turnover, tracker funds use sampling, and broad bond indexes usually carry large weights in sovereign bonds.
- In an underwritten offering the intermediaries guarantee the issue price; in a best-efforts offering they earn a commission with no price guarantee; a shelf registration registers the aggregate amount once and lets the bonds be issued over time.
- Most secondary bond trading takes place in over-the-counter dealer markets, and the dealer's spread between ask and bid widens as liquidity falls: a fraction of 1 bp for on-the-run sovereign debt of developed markets, and 10–20 bp or more for seasoned, smaller or less liquid corporate issues.

54 Fixed-Income Markets for Corporate Issuers

- Lines of credit become more reliable from uncommitted to committed to revolving; committed and revolving lines carry a commitment fee and revolving lines usually add restrictive covenants, while an uncommitted line usually costs only interest on the amount drawn.
- Factoring transfers receivables, with the credit-granting and collection functions, to a factor at a discount to face value, whereas assigning receivables as collateral keeps them with the borrower as security for a loan.
- Commercial paper is short-term unsecured debt issued by large, highly rated firms, usually maturing in under three months, and issuers manage its rollover risk with backup lines of credit.
- In a repo the security seller borrows cash and the security buyer lends it against the security; $\text{purchase price} = \text{market value of collateral}/\text{initial margin}$ and $\text{repurchase price} = \text{purchase price} \times (1 + \text{repo rate} \times \text{days}/360)$.
- $\text{Variation margin} = \text{initial margin} \times \text{adjusted purchase price} - \text{market value of collateral}$; a negative figure means the loan is overcollateralized and the borrower may ask for collateral back.

- The repo rate is higher when alternative money market rates are higher, when the term is longer and longer rates exceed short rates, and when the repo is undercollateralized or collateral is not delivered; it is lower for higher-quality collateral and for collateral in high demand or low supply.
- With a normal yield curve, both investment-grade and high-yield issuers pay higher yields at longer maturities, and the increase is bigger for high-yield issuers because their credit spreads are larger.
- Compared with investment-grade issues, high-yield issues carry more covenants, are often secured, usually mature in 10 years or less, more often allow early repayment through callable bonds or prepayable leveraged loans, and have more equity-like returns.

EXAM SHORTCUTS

- The haircut depends only on the initial margin, $1 - 1/\text{initial margin}$, so it can be found without the collateral value, the repo rate or the term.

FORMULAS

Repurchase agreements

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

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

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

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

55 Fixed-Income Markets for Government Issuers

- Sovereign bonds are backed by the power to tax, so they usually carry the highest credit rating in their home market, and the sovereign is usually the largest issuer there.
- External debt of an emerging market government in a reserve currency spares foreign investors the direct currency risk but leaves indirect currency risk, because the government must earn enough of that currency to repay.
- Ricardian equivalence would make a government indifferent to the maturity of its debt only if taxpayers save more when they expect higher taxes, have rational expectations, borrow and lend without transaction costs and pass tax savings on to future generations; these conditions do not hold, so governments keep a fairly stable mix of short- and long-term debt.
- Short-term sovereign debt is seen as safe and highly liquid, which likely holds its yields down, but relying on it too heavily creates rollover risk; longer-term sovereign debt supplies the benchmark yields used to price other borrowers' credit risk.
- General obligation bonds are backed by local taxing power, revenue bonds are repaid from the fees of the one project they fund, agency (quasi-government) bonds are issued by entities a national government creates, and supranational bonds are issued by institutions set up by several sovereign governments.
- In a government bond auction, noncompetitive bids are filled first, then competitive bids from the highest price (lowest yield) down until the offering is used up; the cut-off yield is the highest accepted yield, which matches the lowest accepted price.
- In a single-price auction every successful bidder pays the price at the cut-off yield, while in a multiple-price auction each successful competitive bidder pays its own bid.
- On-the-run government bonds, the most recently issued of each maturity, trade most actively and supply the default-risk-free benchmark yields, and demand from holders with noneconomic objectives pushes sovereign yields below non-sovereign yields.

56 Fixed-Income Bond Valuation: Prices and Yields

- A bond's price is the present value of its coupons and principal discounted at the YTM; a semiannual bond uses the coupon $C/2$, the periodic rate $YTM/2$ and $2N$ periods.
- A quoted YTM is a stated annual rate, the periodic yield times the number of periods per year, and it is an effective annual rate only for an annual-pay bond.
- An investor earns the YTM only if the bond is held to maturity, the issuer makes every promised payment and each coupon is reinvested at that same YTM.
- Between coupon dates, the full price is the value on the last coupon date compounded at the periodic YTM, $PV^{full} = PV_0 \times (1+r)^{t/T}$; accrued interest is $t/T \times PMT$, and subtracting accrued interest from the full price gives the flat (quoted) price.
- Accrued interest is usually counted on an actual/actual basis for government bonds and on a 30/360 basis for corporate bonds.
- A bond whose coupon rate is above its YTM trades at a premium, one whose coupon equals its YTM trades at par, and one whose coupon is below its YTM trades at a discount.
- For option-free bonds, other things equal, a lower coupon and a longer maturity make the price more sensitive to a yield change, and convexity makes the price rise from a yield fall larger than the price drop from an equal yield rise.
- Matrix pricing estimates the YTM of a bond that is not traded or trades infrequently from the yields of traded bonds with very similar credit quality, coupon and maturity, interpolating linearly between the maturities that bracket the target.

EXAM SHORTCUTS

- Comparing the coupon rate with the YTM shows whether the price is above, at or below par before any calculation, so answer choices on the wrong side of par can be ruled out at once.
- If a discount bond's price is unchanged after time has passed, its YTM must have risen, and if a premium bond's price is unchanged, its YTM must have fallen; no repricing is needed to answer the direction question.

FORMULAS

Price = present value of the promised cash flows

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

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

Accrued interest, flat price and full price

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

Matrix pricing

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

57 Yield and Yield Spread Measures for Fixed-Rate Bonds

- For a bond that pays more than once a year, the quoted YTM is the periodic yield times the number of periods per year; for a semiannual-pay bond this is the semiannual bond basis.
- $EAY = (1 + \text{stated annual yield}/n)^n - 1$; holding the EAY constant, a higher periodicity means a lower stated yield, and holding the stated yield constant, a higher periodicity means a higher EAY.
- Current yield is the annual cash coupon divided by the flat price and ignores capital gains, losses and reinvestment income; simple yield adds the straight-line amortization of a discount, or subtracts that of a premium, before dividing by the flat price.
- For an option-free bond priced at a discount, coupon rate < current yield < YTM; at a premium the order reverses, and at par all three are equal.

- A yield to call uses the periods to the call date and the call price in place of maturity and par, and the yield to worst is the lowest of the YTM and all the yields to call.
- A G-spread is the bond's yield minus a government benchmark yield of the same maturity, interpolated if needed, while an I-spread is measured against the swap rate of the same currency and tenor.
- The Z-spread is the constant spread that, added to every benchmark spot rate, discounts the bond's cash flows to its market price, and it equals the G-spread when the spot curve is flat.
- $\text{OAS} = \text{Z-spread} - \text{option value}$; for a callable bond the OAS is below the Z-spread, and for an option-free bond the two are equal.

EXAM SHORTCUTS

- For an option-free bond, the price relative to par fixes the order of coupon rate, current yield and YTM, so a ranking question needs no yield calculation.
- A yield to call reuses the YTM inputs; only N, set to the periods to the call date, and FV, set to the call price, change.
- When the spot curve is flat, the Z-spread equals the G-spread, so no trial-and-error search is needed.

FORMULAS

Periodicity and the effective annual yield	$EAY = \left(1 + \frac{\text{stated annual yield}}{n}\right)^{n} - 1$ $\text{stated yield}_{m} = m\left[(1 + EAY)^{1/m} - 1\right]$
Current yield and simple yield	$\text{current yield} = \frac{\text{annual cash coupon}}{\text{flat price}}$ $\text{simple yield} = \frac{\text{annual coupon} \pm \text{straight-line amortization}}{\text{flat price}}$
Option-adjusted price and option-adjusted yield	$\text{callable bond value} = \text{straight bond value} - \text{call option value}$
Z-spread	$\text{price} = \sum_{t=1}^{N} \frac{CF_t}{(1 + S_t + Z)^t}$
Option-adjusted spread (OAS)	$\text{OAS} = \text{Z-spread} - \text{option value (bp)}$ $\text{option value} = \text{Z-spread} - \text{OAS}$

58 Yield and Yield Spread Measures for Floating-Rate Instruments

- An FRN's coupon rate is reset each period to the market reference rate set at the start of the period plus the quoted margin, and the coupon is paid at the end of the period, in arrears.
- The quoted margin is fixed in the indenture and reflects the issuer's credit risk at issuance, while the discount (required) margin is the spread investors currently require, the margin that would make the FRN worth par on a reset date.
- On a reset date an FRN trades at par when QM = DM, below par when DM > QM because credit quality has worsened, and above par when DM < QM because credit quality has improved.
- While the issuer's credit quality is unchanged, the QM stays equal to the DM; neither the passage of time nor a change in the MRR opens a gap between them.
- The simplified FRN valuation projects each coupon at today's MRR plus the QM and discounts at today's MRR plus the DM, both divided by the periods per year, and it ignores expected changes in the MRR.

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- US Treasury bills and commercial paper are quoted as discount yields on a 360-day year, computed on face value, while the convention for bank CDs, repos and market reference rates is an annualized add-on rate.
- A money market instrument's BEY annualizes the add-on return over a 365-day year, $HPY \times 365/\text{days}$, and for a discount instrument priced below face value it is higher than the quoted discount yield.
- To compare a money market yield with a semiannual-pay bond's YTM, compound the HPY to an effective annual yield, $(1+HPY)^{365/\text{days}}-1$, and restate it as $2[(1+EAY)^{1/2}-1]$.

EXAM SHORTCUTS

- An FRN priced below par on a reset date must have DM > QM, and one priced above par must have DM < QM, so answer choices on the wrong side of the quoted margin can be eliminated without solving for I/Y.
- An add-on yield quoted on a 360-day basis converts to a 365-day basis, the BEY, by multiplying by 365/360; the holding period yield is not needed.

FORMULAS

Simplified valuation on a reset date

$$V=\sum_{t=1}^{N}\frac{(\text{MRR}+\text{QM})\times FV/m}{\left(1+\frac{\text{MRR}+\text{DM}}{m}\right)^{t}}+\frac{FV}{\left(1+\frac{\text{MRR}+\text{DM}}{m}\right)^{N}}$$

Key formulas: money market yields

$$\text{Add-on yield (365-day)}=HPY\times\frac{365}{\text{days}}$$

$$\text{Discount yield}=\frac{FV-P}{FV}\times\frac{360}{\text{days}}$$

$$P=FV\times\left(1-\text{discount yield}\times\frac{\text{days}}{\text{year}}\right)$$

$$FV=PV\times\left(1+\text{add-on yield}\times\frac{\text{days}}{\text{year}}\right)$$

Comparing with a semiannual-pay bond

$$EAY=(1+HPY)^{365/\text{days}}-1$$

$$\text{semiannual bond basis}=2\left[(1+EAY)^{1/2}-1\right]$$

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

- A spot rate is the market discount rate for a single payment at a future date, which is why it equals the YTM of a zero-coupon bond of that maturity.
- The no-arbitrage price of a bond discounts each cash flow at the spot rate for its own date, and the bond's YTM is the internal rate of return at that price, not a simple or geometric average of the spot rates.
- A par rate is the coupon rate at which a bond of a given maturity would be priced at par, given the spot curve.
- ${}_{A\text{y}B\text{y}}=\left[(1+S_{A+B})^{A+B}/(1+S_A)^{A}\right]^{1/B}-1$, where the $1/B$ root annualizes a multi-year forward rate.
- A spot rate is the geometric mean of the one-period rates up to its maturity: $S_N=\left[(1+S_1)(1+{}_{1y1y})\cdots(1+{}_{(N-1)y1y})\right]^{1/N}-1$.
- Discounting each cash flow by the compounded chain of one-period forward rates up to its date gives the same no-arbitrage price as discounting at spot rates.
- Beyond the first year, forward > spot > par when the curve is normal (upward-sloping), forward < spot < par when it is inverted, and all three are equal when it is flat.
- The par curve and the forward curve are derived from the spot curve, while the yield curve for coupon bonds is observed from the YTMs of actively traded bonds, with gaps filled by linear interpolation.

EXAM SHORTCUTS

- A forward rate is roughly the difference of the total rates, for example $2y1y \approx 3S_3 - 2S_2$; the exact figure needs compounding, but the approximation screens out wrong answer choices quickly.
- To find a par rate from answer choices, plug in the middle choice: a price below 100 means the par rate is higher, and a price above 100 means it is lower.

FORMULAS

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

60 Interest Rate Risk and Return

- A fixed-rate bond's return comes from the promised coupons and principal, the income from reinvesting coupons, and any capital gain or loss on a sale before maturity.
- With every payment made on time and coupons reinvested at the YTM, the realized return equals the YTM at purchase whether the bond is kept until it matures or sold earlier at an unchanged YTM.
- Higher yields lower the sale price but raise reinvestment income; over a short horizon market price risk dominates, and over a long horizon reinvestment risk dominates.
- A capital gain or loss is the sale price minus the carrying value on the constant-yield price trajectory, so movement along that trajectory counts as interest income rather than as a gain or loss.
- When the investment horizon equals the bond's Macaulay duration, a one-time change in YTM right after purchase leaves the horizon yield approximately equal to the YTM at purchase.
- Duration gap = Macaulay duration − investment horizon; a positive gap leaves the investor exposed to rising rates through price risk, and a negative gap leaves the investor exposed to falling rates through reinvestment risk.
- Macaulay duration is the weighted average time until a bond's cash flows are received, with each weight equal to the cash flow's present value at the YTM divided by the full price; a coupon bond's Macaulay duration is shorter than its maturity.
- Other things equal, reinvestment risk is greater for bonds with higher coupons and longer maturities, and a zero-coupon bond held to maturity has none.

EXAM SHORTCUTS

- For a bond held to maturity after a one-time change in YTM right after purchase, the realized return lies between the original YTM and the new reinvestment rate, so any answer outside that range can be ruled out.
- A zero-coupon bond's Macaulay duration equals its maturity, so it needs no weighting calculation.

FORMULAS

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Horizon yield	$$\text{Horizon yield} = \left(\frac{\text{sale price (or principal)} + \text{coupons} + \text{reinvestment income}}{\text{purchase price}}\right)^{1/H} - 1$$
Holding period return, Macaulay duration and the investment horizon	$$\text{Duration gap} = \text{Macaulay duration} - \text{investment horizon}$$
Calculating and interpreting Macaulay duration	$$\text{MacDur} = \sum_{t=1}^{N} t \times w_t$$ $$w_t = \frac{CF_t/(1+r)^t}{\text{full price}}$$ $$\sum_t w_t = 1$$

61 Yield-Based Bond Duration Measures and Properties

- $\text{ModDur} = \text{MacDur}/(1+r)$, where r is the periodic yield ($YTM/2$ for a semiannual-pay bond with durations in years), so with a positive yield modified duration is smaller than Macaulay duration.
- $\%\Delta P \approx -\text{ModDur} \times \Delta\text{YTM}$; this straight-line estimate works well for small yield changes, and for large changes it understates the price rise when yields fall and overstates the price fall when yields rise.
- $\text{ApproxModDur} = (V_- - V_+)/(2 \times V_0 \times \Delta\text{YTM})$, with ΔYTM entered as the annual yield change in decimal form.
- Money duration is modified duration times the full price of the position, $\Delta V \approx -\text{Money duration} \times \Delta\text{YTM}$, and the PVBP, the change in full price for a 1 bp yield change, is approximately money duration × 0.0001.
- Other things equal, a higher coupon rate or a higher YTM lowers duration, and a longer maturity usually raises it; for discount bonds at long maturities, duration can fall as maturity rises toward the perpetuity duration $(1 + \text{YTM})/\text{YTM}$.
- A zero-coupon bond's Macaulay duration equals its maturity, so for the same maturity and yield it has more interest rate risk than any coupon bond.
- A callable bond has a lower duration than an otherwise identical option-free bond, and a putable bond has less price volatility at high yields, where the put acts as a floor on its price.

EXAM SHORTCUTS

- A floating-rate note's Macaulay duration is roughly the time to its next reset date, whatever its final maturity, so no cash flow weighting is needed.
- When bonds on one price-yield chart have the same price at the current yield, the bond whose curve is steepest at that yield has the highest modified duration.

FORMULAS

Modified duration	$$\text{ModDur} = \frac{\text{MacDur}}{1+r} \quad (\text{annual-pay: } r = \text{YTM})$$ $$\text{ModDur} = \frac{\text{MacDur}}{1 + \text{YTM}/2} \quad (\text{semiannual-pay, YTM on a semiannual bond basis, du}$$ $$\%\Delta P \approx -\text{ModDur} \times \Delta\text{YTM}$$
Approximate modified duration	$$\text{ApproxModDur} = \frac{V_- - V_+}{2 \times V_0 \times \Delta\text{YTM}}$$

Money duration and PVBP	$\text{Money duration} = \text{ModDur} \times \text{full price of the position}$ $\text{Money duration per 100 of par} = \text{ModDur} \times \text{full price per 100}$ $\Delta V \approx -\text{Money duration} \times \Delta\text{YTM}$ $\text{PVBP} = \frac{V_- - V_+}{2}$ $\text{PVBP} \approx \text{Money duration} \times 0.0001$

62 Yield-Based Bond Convexity and Portfolio Properties

- Convexity measures the curvature of the price-yield relationship; for an option-free bond, duration alone understates the price gain when yields fall and overstates the price loss when yields rise.
- $\%\Delta PV^{Full} \approx -\text{AnnModDur} \times \Delta YTM + \frac{1}{2} \times \text{AnnConvexity} \times (\Delta YTM)^2$.
- Approximate convexity is $(V_- + V_+ - 2V_0)/[(\Delta YTM)^2 V_0]$.
- A longer maturity, a lower coupon and a lower yield raise convexity; with the same duration, more dispersed cash flows give more convexity.
- Callable bonds and mortgage-backed securities can have negative convexity at low yields; option-free bonds always have positive convexity.
- Money convexity is annual convexity × the full value of the position.
- Portfolio duration and convexity come either from the aggregate portfolio cash flows, the theoretically correct approach, or in practice as averages weighted by full market value, which give the portfolio's percentage change only for a parallel shift of the yield curve.

EXAM SHORTCUTS

- For an option-free bond the convexity adjustment is positive whether yields rise or fall.
- The convexity term grows with the square of the yield change, so doubling the change roughly quadruples it.

FORMULAS

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

63 Curve-Based and Empirical Fixed-Income Risk Measures

- Yield-based duration and convexity assume fixed, known cash flows, so callable bonds, putable bonds and mortgage-backed securities are measured with effective duration and effective convexity against shifts in a benchmark yield curve.
- $\text{EffDur} = (V_- - V_+)/(2V_0\,\Delta\text{Curve})$ and $\text{EffCon} = (V_- + V_+ - 2V_0)/[(\Delta\text{Curve})^2\,V_0]$, with V_- and V_+ produced by a pricing model.
- Effective duration measures sensitivity to the benchmark curve only and holds the credit and liquidity spread constant, while modified duration does not separate benchmark changes from spread changes.

- A callable bond has negative convexity and a lower effective duration than the option-free bond at low yields, where the call price caps its price; a putable bond always has positive convexity and has a lower effective duration at high yields, where the put price floors its price.
- $\%\Delta PV^{Full} \approx -\text{EffDur} \times \Delta\text{Curve} + \frac{1}{2} \times \text{EffCon} \times (\Delta\text{Curve})^2$, and the convexity effect takes the sign of the convexity whatever the direction of the rate change.
- A key rate duration is the sensitivity of value to the benchmark yield at one maturity with all other yields held constant; key rate durations sum to effective duration and measure shaping risk from nonparallel shifts.
- Analytical durations assume that credit spreads do not change when benchmark yields move, while empirical duration is estimated from historical prices; in a flight to quality a corporate bond portfolio's empirical duration is lower than its analytical duration, and for government bonds the two should be similar.

EXAM SHORTCUTS

- For a portfolio of zero-coupon bonds with annual compounding, each key rate duration is the zero's portfolio weight times its maturity divided by one plus its yield, as in the 2-year and 7-year example, so no repricing is needed.

FORMULAS

Why effective duration and effective convexity for bonds with embedded options	$\text{effective duration (EffDur)} = \dfrac{V_- - V_+}{2V_0\,\Delta\text{Curve}}$ $\text{effective convexity (EffCon)} = \dfrac{V_- + V_+ - 2V_0}{(\Delta\text{Curve})^2\,V_0}$
Percentage price change for a change in the benchmark yield	$\%\Delta PV^{Full} \approx -\text{EffDur} \times \Delta\text{Curve} + \frac{1}{2} \times \text{EffCon} \times (\Delta\text{Curve})^2$
Key rate duration and shaping risk	$\%\Delta V \approx -\sum_k \text{KeyRateDur}_k \times \Delta r_k$

64 Credit Risk

- Bottom-up credit analysis looks at the borrower's capacity, capital, collateral, covenants and character, and top-down analysis looks at conditions, country and currency.
- $\text{Expected loss} = \text{PD} \times \text{LGD}$, where in money terms $\text{LGD} = \text{expected exposure} \times (1 - \text{recovery rate})$ and the loss severity is $1 - \text{recovery rate}$.
- Exam convention: loss given default is often given as a rate (LGD%) and multiplied directly by the probability of default to give expected loss as a percentage; current practice states LGD as a money amount or as a percentage of exposure at default, the percentage form being the loss severity.
- The expected loss rate, $\text{PD} \times (1 - \text{recovery rate})$, estimates the fair credit spread; an actual spread above it means investors are more than fairly compensated, and one below it means they are under-compensated.
- Ratings from AAA/Aaa down to BBB−/Baa3 are investment grade and ratings of BB+/Ba1 and below are non-investment grade (high-yield).
- Credit ratings lag market prices, struggle with risks such as litigation, natural disasters and debt-financed buybacks, and can be wrong, so ratings are no substitute for an investor's own due diligence.
- Spreads narrow when growth and profits are strong and widen in a recession; in a contraction credit curves rise and flatten, and in an expansion they fall and steepen.
- $\%\Delta P_{\text{full}} \approx -\text{ModDur} \times \Delta\text{Spread} + \frac{1}{2}\,\text{Convexity} \times (\Delta\text{Spread})^2$, and the liquidity spread inside a yield spread equals the yield at the bid price less the yield at the offer price.

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- Bid and offer yields come from the same TVM entries with only PV changed, so the second yield needs one new entry and one compute.
- For an option-free bond, with the benchmark yield and all other factors unchanged, back out a spread change from a price change by starting from $-\%\Delta P/\text{ModDur}$; for a price fall the true widening is slightly larger than this, and for a price gain the true narrowing is slightly smaller.

FORMULAS

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

65 Credit Analysis for Government Issuers

- A national government services its debt mainly through its power to tax, so sovereign credit analysis asks whether the country has the conditions for stable growth with low inflation.
- The five qualitative factors of sovereign credit are institutions and policy (including the government's willingness to pay, given sovereign immunity), fiscal flexibility, monetary effectiveness, economic flexibility and external status.
- The three quantitative factors are fiscal strength (a low debt burden and good debt affordability), economic growth and stability, and external stability (high FX reserves relative to GDP and to external debt, and low external debt relative to GDP).
- A higher debt/GDP or interest/revenue ratio means weaker fiscal strength, and debt burden and debt affordability can point in different directions for the same country.
- A country with a reserve currency can more easily issue debt to foreign investors in its own currency and can maintain larger budget deficits and debt.
- Agencies and government sector banks carry implied government support and ratings close to the sovereign's, while supranational ratings depend on the implicit support of the sponsoring governments and institutions.
- General obligation bonds are unsecured and backed by the issuing government's taxing power, while revenue bonds are serviced only from one project's revenues and often carry more credit risk.
- Regional governments cannot print money and usually must balance their operating budgets, and revenue bonds are analyzed like corporate bonds, with a higher debt-service coverage ratio (project revenue net of operating costs, divided by the interest and principal due) meaning a safer bond.

66 Credit Analysis for Corporate Issuers

- The qualitative factors in corporate credit analysis are the business model, industry competition, business risk and corporate governance, the last judged through covenants and accounting policies.
- All else equal, credit quality is higher with strong operating profits and recurring revenues, low leverage, high coverage of debt service by income and high liquidity for short-term obligations.
- EBITDA is operating income plus depreciation and amortization, FFO starts from net income from continuing operations and adds back noncash items, and RCF is the chosen operating cash flow measure minus dividends.
- Higher EBIT margin, EBIT/interest expense and RCF/net debt indicate higher credit quality, while for debt/EBITDA a lower value indicates higher credit quality; net debt is debt minus cash and marketable securities.

- The priority of claims runs first lien, senior secured (second lien), junior secured, senior unsecured, senior subordinated, subordinated, junior subordinated; debt in the same category ranks pari passu, and any secured claim not covered by collateral ranks with senior unsecured claims.
- Recovery rates fall and credit risk rises with each step down in seniority, although in practice strict priority is often not applied because a negotiated settlement shortens a costly bankruptcy.
- The issuer credit rating (corporate family rating) is typically based on senior unsecured debt, and issue ratings are notched above or below it according to seniority and covenants, with notching more common for lower-rated issuers.
- Under structural subordination, a subsidiary's own bonds have the first claim on its cash flows, so the parent's bonds are effectively subordinated to them for those cash flows even though they are not formally junior.

67 Fixed-Income Securitization

- In a securitization, an originator sells a pool of loans or receivables, the collateral, to a special purpose entity, which issues asset-backed securities paid from the borrowers' loan repayments.
- Securitization lets originators increase business activity, earn fees, hold lower capital reserves and turn illiquid loan portfolios into cash.
- Investors gain risk and return tailored to their needs, access to loan pools without the expertise to originate and service loans, and securities that are easier to sell than the underlying loans.
- For economies and financial markets, securitization decreases liquidity risk, improves market efficiency and gives originators lower financing costs and lower leverage.
- ABS investors bear uncertainty in the timing and size of cash flows, for example from unexpected prepayments, and the credit risk of the collateral passes through to them.
- The seller (depositor) originates and sells the loans, the SPE (issuer or trust) buys them and issues the ABS, the servicer collects from borrowers, and the trustee safeguards the collateral and cash flows for ABS holders.
- The SPE owns the collateral outright as a legally separate entity, which makes it bankruptcy remote: the seller's creditors cannot reach the pool, and ABS holders have no claim on the seller's other assets.
- Collections from the pool pay the servicing fee and other administrative fees first, so ABS investors receive less than the total payments collected.

68 Asset-Backed Security (ABS) Instrument and Market Features

- Covered bonds are senior debt of financial institutions backed by a segregated cover pool, usually mortgages, that stays on the issuer's balance sheet because no SPE is created.
- Covered bond investors have dual recourse to the cover pool and to the issuer's unencumbered assets, the cover pool is dynamic, and covered bonds generally yield less than comparable ABS.
- When an issuer misses a payment, a hard-bullet covered bond defaults at once and payments are accelerated, a soft-bullet one lets the maturity slip by up to a year, and a conditional pass-through one becomes a pass-through security at maturity if payments are still owed.
- Internal credit enhancements are overcollateralization, excess spread and subordination, under which junior tranches absorb losses first, up to their principal, to protect the senior tranches.
- Credit tranching redistributes default risk, while time tranching redistributes prepayment risk.
- Credit card ABS are backed by nonamortizing receivables; during the lockout (revolving) period investors receive only interest and fees, and principal repaid by cardholders buys new receivables.
- Solar ABS are backed by loans to homeowners to install solar energy systems, and many deals have a pre-funding period in which the trust adds new solar loans to the pool.
- A CDO differs from ordinary ABS by having a collateral manager who actively buys and sells securities in the pool, and the CLO, backed by leveraged loans, is now its most common form.

EXAM SHORTCUTS

- Under subordination, the senior tranche loses nothing until collateral losses exceed the total of the tranches ranked below it, so smaller losses need only be allocated among the junior tranches.

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

- Contraction risk is the risk that prepayments run faster than expected, typically when rates fall, which shortens the average life and forces reinvestment at lower rates; extension risk is the risk that they run slower, typically when rates rise, which lengthens it.
- Time tranching reallocates prepayment risk among bond classes without removing it, and the tranches that mature first give more protection against extension risk.
- A lower loan-to-value ratio and a lower debt-to-income ratio mean lower default risk, and a borrower with an underwater nonrecourse loan has a stronger incentive to default strategically.
- A GSE is legally separate from the government, so agency RMBS it guarantees carry only the GSE's own guarantee, while non-agency RMBS rely on credit enhancement.
- A pass-through's net coupon is below the pool's weighted average coupon because servicing and guarantee or insurance fees are deducted, and the WAC and WAM weight each mortgage by its share of the outstanding balance.
- A PAC tranche makes its scheduled payments as long as prepayments stay within a range, which reduces both contraction and extension risk, while the support tranche absorbs the variation and bears high prepayment risk.
- A principal-only security benefits from falling rates and faster prepayments, while an interest-only security is hurt by them.
- Commercial mortgages are nonrecourse, so CMBS analysis focuses on the property: a higher $\text{DSCR} = \text{NOI}/\text{debt service}$ and a lower LTV indicate better credit quality, call protection is common, and balloon risk is a form of extension risk.

FORMULAS

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

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Derivatives

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70 Derivative Instrument and Derivative Market Features

- A derivative is a contract whose value is derived from an underlying, and every derivative specifies four features: its underlying, contract price, settlement date and contract size.
- The forward price is normally set so that the contract is worth zero to both parties at initiation; at settlement the long receives $S_T - F$ and the short receives $F - S_T$, so one side's gain is the other's loss.
- A deliverable contract exchanges the underlying for the contract price, a cash-settled contract exchanges only the net gain or loss, and ignoring trading costs the two are economically the same.
- Hedging uses a derivative to offset an existing risk, while speculating takes on an exposure the party did not have, so the same trade can be a hedge for one party and speculation for another.
- Compared with a cash market trade, a derivative gives highly leveraged exposure for little cash, can cost much less to trade and may move the underlying's price less.
- For exchange-traded derivatives, the central clearinghouse becomes the buyer to every seller and the seller to every buyer (novation), guaranteeing performance and collecting deposits from both sides, which keeps counterparty credit risk very low.
- Exam convention: exchange-traded derivatives are standardized, liquid, transparent and margined through the clearinghouse, while OTC derivatives are customized, less transparent, largely unregulated, carry more counterparty risk and are not subject to collateral deposit requirements; current practice: an OTC trade outside a CCP still has collateral set by the contract and the counterparties, and for many covered counterparties uncleared-swap margin rules require initial and variation margin.
- Since 2008, a central clearing mandate has required many swaps to be cleared through a central counterparty, which lowers counterparty risk but concentrates it in the CCP.

EXAM SHORTCUTS

- A hedger takes now the derivative position that matches the trade it must make later in the cash market: a party that will have to sell the underlying sells forward, and a party that will have to buy it buys forward.

FORMULAS

Long and short exposure

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

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

71 Forward Commitment and Contingent Claim Features and Instruments

MODULE 71.1 · FORWARDS AND FUTURES

- A forward is a private, customized agreement that obligates both parties, with nothing paid at initiation; the long profits if the underlying's price at settlement is above the forward price, and the short profits if it is below.
- A futures contract is a standardized, exchange-traded forward whose gains and losses are settled daily and whose performance the clearinghouse guarantees, which keeps counterparty credit risk minimal.
- Futures margin is collateral posted by both buyer and seller, not a loan; initial margin must be deposited before a trade, and maintenance margin is the minimum balance the account must keep.
- When a futures account falls below the maintenance margin, the margin call requires a deposit that restores it to the initial margin, or the position is closed out.

- The settlement price used for the daily mark-to-market is the average price of trades during a closing period, and price limits cap how far it may move from the previous day's settlement price.

MODULE 71.2 · SWAPS AND OPTIONS

- In a plain fixed-for-floating interest rate swap, the fixed and floating amounts on the same notional principal are netted and only the party that owes more pays; each floating rate is set at the start of its period and paid at the end.
- An interest rate swap works like a set of forwards on the floating rate, one for each settlement date with the fixed rate as the forward price, and the swap rate is chosen to give the swap zero value when it starts.
- In a credit default swap, the protection buyer makes fixed periodic payments and the protection seller pays only if a credit event occurs, covering the drop in the reference security's value.
- $c_T = \max(0,\ S_T - X)$ and $p_T = \max(0,\ X - S_T)$; the buyer's profit is the value at expiration minus the premium paid, and the writer's profit is the reverse.
- A long call and a short put have long exposure to the underlying, while a long put and a short call have short exposure.
- A forward commitment (forwards, futures, most swaps) obligates both parties and has a linear payoff, while a contingent claim (options, credit default swaps) pays off only if a particular event occurs and has a one-sided payoff; an option buyer pays a premium for the right.

EXAM SHORTCUTS

- Both sides of a call break even at $X + c_0$ and both sides of a put at $X - p_0$, so the writer's breakeven needs no separate calculation.

FORMULAS

Value at expiration and profit for long and short option positions

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

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

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

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

72 Derivative Benefits, Risks, and Issuer and Investor Uses

- Derivatives let users change, transfer and manage risk without buying or selling cash market securities, and they create exposures, such as a floor under a sale price, that cash markets do not offer.
- Option prices reveal the market's implied volatility, and futures and forward prices indicate the expected prices of their underlyings, including expected future interest rates.
- Easier short selling, lower transaction costs, greater leverage and greater liquidity make it cheaper to exploit mispricing, which improves market efficiency.
- With margin equal to a fraction m of contract value, a price change of $\Delta P\%$ changes the margin deposit by about $\Delta P\%/m$, so leverage is $1/m$.
- Basis risk arises when the derivative's underlying or settlement date does not match the hedged position, and liquidity risk arises when the hedge's cash flows do not match those of the hedged position.
- An option buyer bears counterparty credit risk while the writer, who already holds the premium, does not, and both sides of a forward can be exposed.
- A cash flow hedge reduces the variability of future cash flows, a fair value hedge offsets changes in the balance-sheet value of an asset or liability, and a net investment hedge reduces the volatility of the reported value of a foreign subsidiary's equity.
- A firm with floating-rate debt that pays fixed in a swap has a cash flow hedge, while a firm with fixed-rate debt carried at fair value that receives fixed and pays floating has a fair value hedge.

FORMULAS

Risks

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

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

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

- Arbitrage locks in a risk-free gain with no net investment, so assets with identical payoffs in every state must sell for the same price (the law of one price).
- A derivative must cost the same as the portfolio of the underlying and risk-free borrowing or lending that replicates its payoff, so it is priced with the risk-free rate and no assumption about investors' risk preferences.
- For an underlying that has neither carrying costs nor benefits, the no-arbitrage forward price is the future value of the spot price, $F_0(T) = S_0(1 + R_f)^T$.
- If $F_0(T) > S_0(1 + R_f)^T$, sell the forward, borrow S_0 and buy the underlying; if $F_0(T) < S_0(1 + R_f)^T$, buy the forward, short the underlying and invest the proceeds.
- The forward price is the cost of buying the underlying and carrying it to settlement, $F_0(T) = [S_0 + PV_0(\text{cost}) - PV_0(\text{benefit})](1 + R_f)^T$, and it is not a forecast of the expected future spot price.
- With continuously compounded annual rates for the risk-free rate r, costs c and benefits b, $F_0(T) = S_0\, e^{(r+c-b)T}$.
- For an exchange rate quoted as price currency per unit of base currency, $F = S_0[(1 + R_{\text{price}})/(1 + R_{\text{base}})]^T$, and the higher-rate currency trades at a forward discount.
- Other things equal, a higher risk-free rate or higher storage and insurance costs raise the forward price, and higher dividends, coupons or convenience yield lower it.

EXAM SHORTCUTS

- A cash benefit paid at settlement lowers the forward price by exactly its amount, so a $2 dividend paid at settlement needs no discounting or compounding.
- The currency with the higher interest rate trades at a forward discount, so the direction of the forward rate relative to spot can be read from the two interest rates before any calculation.

FORMULAS

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

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

Spot versus expected future price, and the cost of carry

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

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

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

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

Currency forwards

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

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

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

- The forward price is written into the contract at initiation and does not change, while the forward's value is normally zero at initiation and then moves with the spot price.
- For an underlying with no costs or benefits of holding, a long forward is worth $V_t = S_t - F_0(T)(1 + R_f)^{-(T-t)}$ during its life and $S_T - F_0(T)$ at expiration, and the short's value is the negative of the long's.

- With costs and benefits of holding, $V_t(T) = [S_t + PV_t(\text{cost}) - PV_t(\text{benefit})] - F_0(T)(1+R_f)^{-(T-t)}$.
- In AyBy notation, the first number is when the loan starts and the second is how long it lasts, so 2y3y is a 3-year loan from year 2 to year 5.
- $F_{A,B} = [(1+Z_{A+B})^{A+B}/(1+Z_A)^A]^{1/B} - 1$, the rate that makes rolling over at the forward rate earn the same as investing at the longer spot rate.
- The long in an FRA pays the fixed FRA rate and receives MRR, so it gains when MRR rises; a future borrower hedges by going long and a future lender by going short.
- The FRA payment to the long is $\text{Notional} \times (\text{MRR} - \text{FRA rate}) \times \frac{\text{days}}{360}$ discounted at $1 + \text{MRR} \times \frac{\text{days}}{360}$, because it is paid at the start of the loan period.
- A multi-period interest rate swap is a series of FRAs, so each FRA amounts to a swap with only one period.

FORMULAS

Value and price of a forward: at initiation, during its life, at expiration	$V_t(T) = [S_t + PV_t(\text{cost}) - PV_t(\text{benefit})] - F_0(T)(1+R_f)^{-(T-t)}$
Implied (no-arbitrage) forward rates	$(1+Z_{A+B})^{A+B} = (1+Z_A)^A (1+F_{A,B})^B \quad \text{so} \quad F_{A,B} = \left[\frac{(1+Z_{A+B})^{A+B}}{(1+Z_A)^A}\right]^{1/B} - 1$ $1 + Z_{\text{long}}\frac{d_{\text{long}}}{360} = \left(1 + Z_{\text{short}}\frac{d_{\text{short}}}{360}\right)\left(1 + F\frac{d_{\text{long}} - d_{\text{short}}}{360}\right)$
Forward rate agreements (FRAs)	$\text{Payment to long} = \frac{\text{Notional} \times (\text{MRR} - \text{FRA rate}) \times \frac{\text{days}}{360}}{1 + \text{MRR} \times \frac{\text{days}}{360}}$

75 Pricing and Valuation of Futures Contracts

- A forward's price stays fixed and its whole gain or loss is paid at settlement, while a futures contract is marked to market daily, so its price resets to each settlement price and its value returns to zero after each daily settlement.
- Ignoring interest, the daily futures cash flows add up to the same total as the payoff of a forward entered at the same price; what differs is the timing.
- An interest rate futures price is quoted as $100 - (100 \times \text{MRR})$, so a long futures position gains when rates fall.
- $\text{BPV} = \text{notional principal} \times \text{period (in years)} \times 0.0001$ gives the change in an interest rate futures contract's value for a 1 bp change in the rate.
- A positive correlation between rates and futures prices makes futures more attractive to a long, so the futures price is above the forward price; a negative correlation makes the forward more attractive and the futures price lower; with zero correlation or constant rates the two are equal.
- Forward–futures price differences reflect the value of the mark-to-market cash flows and do not create arbitrage opportunities, and in practice they are usually too small to observe.
- Because an FRA's settlement is discounted at the realized MRR, its payoff is nonlinear in the rate while a futures payoff is linear; this convexity bias grows with the length of the period and can make prices differ noticeably for longer-term rates.

FORMULAS

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

76 Pricing and Valuation of Interest Rates and Other Swaps

- An interest rate swap is equivalent to a series of FRAs in which the fixed-rate payer is long at the swap fixed rate, and its first net payment is already known at initiation.

- Market FRAs each carry their own no-arbitrage rate and start at zero value, while the FRAs embedded in a swap all use the swap fixed rate, so their individual values are generally not zero but sum to zero.
- A fixed-rate payer's position replicates borrowing at a fixed rate and investing the money at the floating rate, and a floating-rate payer's position replicates borrowing at a floating rate and putting the money into a fixed-rate bond.
- A swap's price is its fixed par swap rate, which is set at initiation and does not change, while its value is zero at initiation and then changes as expected future MRRs change.
- $F = \left[1 - 1/(1+S_N)^N\right] \Big/ \sum_{n=1}^{N} 1/(1+S_n)^n$, the fixed rate per period that makes the fixed leg and the expected floating leg equal in present value.
- Value to the fixed-rate payer = PV(expected floating payments) − PV(remaining fixed payments), so a rise in expected MRRs after initiation gives the fixed-rate payer a gain and the floating-rate payer an equal loss.

EXAM SHORTCUTS

- The par swap rate needs only the spot-rate discount factors, $F = (1 - \text{last discount factor}) / \text{sum of the discount factors}$, so the implied floating rates do not have to be computed first.

FORMULAS

$$\sum_{n=1}^{N} \frac{\text{MRR}_n}{(1+S_n)^n} = \sum_{n=1}^{N} \frac{F}{(1+S_n)^n}$$

Solving for the par swap rate

$$F = \frac{1 - \dfrac{1}{(1+S_N)^N}}{\displaystyle\sum_{n=1}^{N} \frac{1}{(1+S_n)^n}}$$

Value during the life

$$\text{Value to fixed-rate payer} = PV(\text{expected floating payments}) - PV(\text{remaining fixed payments})$$

77 Pricing and Valuation of Options

- A call is in the money when $S > X$ and a put when $S < X$; either is at the money when $S = X$.
- Exercise value is $\max(0,\ S - X)$ for a call and $\max(0,\ X - S)$ for a put, and time value is the premium minus the exercise value, so the whole premium of an option with zero exercise value is time value.
- Time value generally shrinks as expiration approaches and is zero at expiration; it is typically positive but can be negative for a deep in-the-money European put.
- European option bounds: $\max[0,\ S_t - X(1+R_f)^{-(T-t)}] \le c_t \le S_t$ and $\max[0,\ X(1+R_f)^{-(T-t)} - S_t] \le p_t \le X(1+R_f)^{-(T-t)}$.
- Other things equal, a higher underlying price or a lower exercise price raises a call's value and lowers a put's, a higher risk-free rate raises calls and lowers puts, and higher volatility raises both.
- A longer time to expiration raises a call's value and usually a put's, but a deep in-the-money European put can be worth less with a longer life, more likely when it is deeper in the money, the risk-free rate is higher and the time to expiration is longer.
- Benefits of holding the underlying, such as dividends, lower call values and raise put values, while storage costs do the opposite.
- At expiration only the underlying price and the exercise price matter, because time value is zero; interest rates and volatility affect only time value.

FORMULAS

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

78 Option Replication Using Put-Call Parity

- A fiduciary call (long call plus a bond paying X) and a protective put (share plus long put) both pay $\max(S_T, X)$, so $c + X(1+R_f)^{-T} = S + p$.
- Put–call parity in this form holds for European options with the same exercise price and expiration on an underlying with no income and no holding costs during the option's life.
- Rearranging parity gives synthetic positions: a synthetic call is long the stock, long the put and short the bond (borrowing $PV(X)$), and a synthetic put is long the call, short the stock and long the bond (lending $PV(X)$).
- When one side of parity is cheap relative to the other, buying the cheap side and selling the expensive side earns the price difference today as an arbitrage profit.
- Put–call forward parity replaces the spot price with the present value of the forward price, $F_0(T)(1+R_f)^{-T} + p_0 = c_0 + X(1+R_f)^{-T}$, so $p_0 - c_0 = [X - F_0(T)](1+R_f)^{-T}$.
- For a firm financed by equity and zero-coupon debt with face value D, shareholders hold a call on the firm's assets with exercise price D, or equivalently the assets plus a long put.
- Debtholders hold a risk-free claim to D plus a short put written to the shareholders; that put is the firm's credit risk, and $V_0 = c_0 + PV(D) - p_0$.

FORMULAS

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

79 Valuing a Derivative Using a One-Period Binomial Model

- A one-period binomial model values an option from the current underlying price, the exercise price, the up-move and down-move factors and the risk-free rate; it needs neither real-world probabilities nor a risk-adjusted discount rate.
- For a call, the hedge portfolio is long h shares and short one call, with $h = (c_1^u - c_1^d)/(S_1^u - S_1^d)$; its certain end value is discounted at the risk-free rate and $c_0 = hS_0 - V_0$.
- For a put, the hedge portfolio is long h shares and long one put, with $h = (p_1^d - p_1^u)/(S_1^u - S_1^d)$ and $p_0 = V_0 - hS_0$.
- $\pi_U = (1 + R_f - R^d)/(R^u - R^d)$ and $\pi_D = 1 - \pi_U$, and an option's value is its payoffs weighted by π_U and π_D and discounted one period at the risk-free rate.
- Risk-neutral probabilities are pseudo-probabilities derived from the no-arbitrage hedge, under which the underlying's expected return equals the risk-free rate; they are not the actual probabilities of the moves.
- The hedge approach and risk-neutral valuation both discount at the risk-free rate and give the same option value.

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- For European options with the same exercise price and expiration on an underlying with no income or holding costs, once the call is valued the put follows from put–call parity, $p_0 = c_0 - S_0 + X/(1+R_f)$, with no second hedge calculation.

FORMULAS

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

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Alternative Investments

Exam weight 6–9% · 7 readings · 11 formulas

80 Alternative Investment Features, Methods, and Structures

- Alternative investments are everything outside long-only holdings of cash and publicly traded stocks and bonds, and they fall into three broad categories: private capital, real assets and hedge funds.
- Investors add alternatives for diversification, because their returns have relatively low correlations with stocks and bonds, and for higher potential returns from an illiquidity premium and less efficient markets, although correlations that are low on average can rise sharply under economic stress.
- Compared with traditional investments, alternatives have more specialized managers, less liquid assets, longer horizons, larger commitments, less regulation and transparency, higher fees and scarce, less reliable return data.
- Fund investing gives the broadest diversification with the lowest amounts and leaves due diligence to the manager, co-investing lowers fees overall by putting part of the money directly into deals alongside the manager, and direct investing gives full control with no outside-manager fees but the least diversification and the highest size and expertise requirements.
- In a limited partnership the GP makes all investment decisions and bears the partnership's liabilities, while LPs own shares in proportion to their contributions, typically have no say in management and no liability beyond their investment.
- The management fee, typically 1%–2% a year regardless of performance, is charged on AUM for hedge funds and on committed capital for private equity funds.
- The performance fee is paid only once a hurdle rate is met, on the whole gain under a soft hurdle and only on the gain above the hurdle under a hard hurdle, and a high-water mark bars fees on gains that merely recover earlier losses.
- A deal-by-deal (American) waterfall and a catch-up clause favor the GP, a whole-of-fund (European) waterfall, a high-water mark and a clawback favor the LPs, and a clawback is most valuable with a deal-by-deal waterfall.

FORMULAS

Calculating the performance fee

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

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

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

81 Alternative Investment Performance and Returns

- Over a fund's life returns are negative in the capital commitment phase, still negative but improving in the deployment phase and positive in the distribution phase, the J-curve, which makes the IRR the most appropriate measure, while MOIC ignores timing.
- The leveraged return is $r + (V_B/V_0)(r - r_B)$, so borrowing adds return when the portfolio earns more than the borrowing rate and deepens losses when it earns less, and margin calls can force sales at bad prices.
- Level 3 values rest on unobservable inputs and change little, which smooths reported returns so risk and correlation with traditional investments look lower than they are; exam convention: stale values can also make returns look higher; current practice: staleness by itself only smooths, and the direction of any effect on the average return is not fixed.

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- Lockup periods, notice periods, redemption fees and gates restrict redemptions, and under either-or fees the investor pays the greater of the management fee and the incentive fee each year.
- Survivorship bias, especially large for hedge funds, overstates index returns and understates risk, backfill bias may magnify it, and comparing funds of the same vintage year deals with differences in life-cycle stage.
- An after-fee return requires the stated asset base for the management fee, whether the performance fee is net of or independent of the management fee, the type of hurdle and any high-water mark, none of which should be assumed.
- An investor in a fund of funds pays the underlying funds' fees, already reflected in their net values, plus the fund of funds' own fees on top.
- Under a deal-by-deal (American) waterfall the GP earns a fee on each profitable exit even if other deals lose money, a whole-of-fund (European) waterfall bases the fee on the net gain across all deals, and a clawback lets LPs recover the excess.

EXAM SHORTCUTS

- Delaying distributions without changing their amounts leaves MOIC unchanged but lowers the IRR, so when only timing changes, MOIC can be ruled out as the measure that reflects it.

FORMULAS

Life cycle and the J-curve	$\text{MOIC} = \dfrac{\text{total capital returned} + \text{value of remaining assets}}{\text{total capital paid in}}$
Leverage	$\text{leveraged return} = \dfrac{r(V_0 + V_B) - r_B V_B}{V_0}$ $\text{leveraged return} = r + \dfrac{V_B}{V_0}(r - r_B)$
After-fee return mechanics	$\text{total fees} = mV_1 + \max\left[0,\ p(V_1 - V_0)\right]$ $r_{\text{after fees}} = \dfrac{V_1 - V_0 - \text{total fees}}{V_0}$

82 Investments in Private Capital: Equity and Debt

- An LBO fund buys a public company largely with debt and takes it private; an MBO keeps the existing management and an MBI brings in a new team.
- Venture capital runs from pre-seed (angel) and seed capital, the first round with VC funds, through early-stage and later-stage financing to mezzanine-stage financing before an IPO.
- Exit routes are a trade sale, an IPO, a direct listing, a SPAC, a secondary sale and a write-off; a recapitalization extracts cash but is not a true exit.
- A PIPE is a private sale of a listed company's shares, and the company stays listed.
- Among private debt types, direct lending carries the lowest risk, unitranche debt moderate risk, and mezzanine, venture and distressed debt high risk.
- Private equity indexes overstate returns through survivorship and backfill bias, and infrequent valuation understates volatility and correlation.
- A fund's vintage year is the year of its first investment, and investors should diversify across vintage years.

EXAM SHORTCUTS

- Place a VC round by whether sales have begun: formative stages come before production and sales, later-stage capital comes after, and mezzanine-stage financing prepares for an IPO.

83 Real Estate and Infrastructure

MODULE 83.1 · REAL ESTATE

- Real estate investments are classified as public or private and as debt or equity; an equity investor owns the property and controls borrowing, management and exit decisions, while a debt investor's claim is secured by the property and ranks ahead of equity in default.
- Direct real estate gives control, diversification and tax benefits, but brings illiquidity, price opacity, management complexity, a need for specialized market knowledge, high initial capital and concentration risk.
- Exam convention: exchange-traded REITs face no redemption or liquidation risk, because investors exit by selling shares; current practice: a REIT keeps its tax exemption only if it distributes most of its taxable income, and non-traded REITs exist whose redemption programs may be limited or suspended.
- Equity real estate strategies run from least to most risky as core (high-quality property, stable income, open-end), core-plus, value-add and opportunistic (closed-end, finite life).
- The more a holding relies on steady lease income the more it behaves like a bond, and the more it relies on development or rising prices the more it behaves like equity, with first mortgages and investment-grade CMBS the least risky.
- Publicly traded REITs offer diversification and liquidity but are more correlated with equities than direct real estate, with the correlation rising in steep downturns, although adding real estate still improves a stock-and-bond portfolio's risk-return profile.

MODULE 83.2 · INFRASTRUCTURE

- Economic infrastructure covers transportation, utilities and energy (including waste disposal and treatment) and information and communication technology (including telecom towers), while social infrastructure covers prisons, schools and health care facilities.
- Infrastructure revenue comes from availability payments made regardless of use, usage-based payments such as tolls, or take-or-pay arrangements with a minimum price for an agreed volume, and the projects carrying the most risk are usually those whose revenue depends on demand that is still uncertain.
- A greenfield investment is an asset still to be constructed, typically under build-operate-transfer; a brownfield investment expands or privatizes an existing asset, for example through a sale-leaseback; and a secondary-stage investment is a fully operational brownfield asset needing no further development.
- Secondary-stage and brownfield assets have stable cash flows, a relatively high current yield, little growth potential and lower risk and return, with secondary-stage assets the least risky, while greenfield assets have uncertain cash flows, more growth potential and higher risk and expected return.
- Direct infrastructure investment is illiquid because the assets are huge and long-lived, and MLPs, ETFs, mutual funds and private equity funds offer indirect exposure with more liquidity.
- Infrastructure risks include regulatory risk, financial leverage, cash flows below expectations, construction risk and operational risk, and the assets suit long-term institutions such as pension plans, life insurers and sovereign wealth funds.

84 Natural Resources

- Raw land, farmland and timberland are illiquid and valued mainly by location; raw land produces little or no current cash flow, farmland has the steadiest income, and timberland lets the owner choose when to harvest, whereas farm crops must be harvested within a short window.
- Derivatives are the most common route to commodity exposure, and exchange-traded futures carry no counterparty risk because the clearinghouse guarantees performance.
- Exam convention: commodity ETPs, both ETFs and ETNs, suit investors limited to buying equity shares; current practice: an ETN is an unsecured debt note carrying issuer credit risk, so an equity-only mandate would normally have to allow debt before holding one.

- The futures price is approximately spot × $(1 + r_f)$ + storage costs − convenience yield, the convenience yield being the nonmonetary benefit of holding the physical good, which lowers the futures price.
- A positive net cost of carry puts futures above spot (contango) and lowers long-only returns, while a negative net cost of carry puts futures below spot (backwardation) and raises them.
- Commodity supply is inelastic in the short run, so prices can swing sharply over the economic cycle or after supply shocks such as natural disasters.
- In recent decades commodities have had higher returns and higher volatility than global stocks or bonds, while timberland and farmland have had higher average returns with volatility below global stocks and similar to global bonds.
- Commodities have historically offered diversification through low correlation with global equities and bonds and an inflation hedge because their prices tend to move with inflation, but holding them produces no current income.

EXAM SHORTCUTS

- When storage costs equal the convenience yield they cancel, so with a positive risk-free rate the futures price exceeds the spot price by the financing cost alone and the market is in contango.

FORMULAS

Commodity valuation: cost of carry

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

85 Hedge Funds

- A hedge fund is a privately offered pool open to investors above a wealth or sophistication threshold, lightly regulated and free to use long and short positions, leverage and derivatives, and it is usually evaluated on an absolute or risk-adjusted basis instead of against a conventional benchmark.
- Compared with private equity, hedge funds hold more liquid assets, have a shorter horizon and allow periodic redemptions, and they charge the management fee on assets under management where private equity charges it on committed capital.
- The four strategy families are equity hedge (including market neutral), event-driven (including merger arbitrage, long the target and short the acquirer), relative value (including convertible arbitrage) and opportunistic (macro and managed futures).
- During a lockup period the investor cannot redeem (hard lockup) or can redeem only with a significant penalty (soft lockup), a notice period is the time the fund has to pay out a redemption, a gate partially limits redemptions, and a high-water mark restricts the incentive fee to value above the fund's previous peak.
- A separately managed account is tailored to one investor and often has lower fees but needs more oversight and aligns interests less closely, while a fund of funds offers diversification and access for smaller investors at the cost of a second layer of fees.
- Hedge fund returns come from market beta, strategy beta and alpha; funds often short away market beta because it is cheap to buy through index funds, and they use leverage to magnify strategy beta and alpha.
- The coefficient of variation, $\sigma / \bar{R}$, measures risk per unit of return, and a lower CV means better risk-adjusted performance, whereas a low standard deviation or a high return alone ignores the other side.
- Because index data are reported voluntarily, survivorship and backfill bias both overstate hedge fund index returns, and selection bias distorts category comparisons.

FORMULAS

Where returns come from, index biases and diversification

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

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

86 Introduction to Digital Assets

MODULE 86.1 · DISTRIBUTED LEDGER TECHNOLOGY

- Digital assets are created, stored and transferred electronically and secured with distributed ledger technology; a cryptocurrency runs on its own blockchain, while a crypto token is built on an existing one.
- The three parts of a DLT network are the digital ledger, the consensus mechanism and the network of participants, and validating and then updating the ledger makes its records immutable while keeping them visible to all participants.
- Under proof of work, miners solve a cryptographic problem and an attack would need most of the network's computing power; under proof of stake, validators pledge collateral, and the exam convention says validators guard the network by controlling most of its computational power, while in current practice an attacker would need most of the stake.
- A permissionless network is open to every user with all transactions visible and no need for parties to trust one another, while a permissioned network restricts some users' activities and is more cost effective.
- Stablecoins hold their value by being linked to another asset through reserves or, for algorithmic stablecoins, supply adjustments; exam convention: they cannot be converted into fiat currency and have no legal or regulatory backing; current practice: some issuers redeem them for fiat and some jurisdictions regulate issuers.
- Tokenization records ownership of physical assets on DLT, an NFT represents a distinct item, ICO buyers usually receive crypto tokens with no voting rights in an unregulated offering, utility tokens pay for network services, and governance tokens give voting rights over the network.

MODULE 86.2 · DIGITAL ASSET CHARACTERISTICS

- Unlike traditional financial assets, most digital assets have no backing and generate no cash flows, so they have no fundamental value; they are recorded on decentralized ledgers, are not legal tender in many jurisdictions and lack well-developed regulatory standards.
- Centralized crypto exchanges are the most popular type but more vulnerable to attack, while decentralized exchanges keep running if one computer is hit and are difficult to regulate.
- Direct investment carries the risks of fraud, permanent loss of coins whose passkey is lost, and, in thinly held coins, price manipulation by whales.
- Indirect exposure comes from coin trusts, which hold the coins and trade over the counter, cash-settled and leveraged futures, exchange-traded products (exam convention: typically not holding the coins; current practice: some spot ETPs launched since 2024 do), crypto stocks and crypto hedge funds.
- Asset-backed tokens are digital claims collateralized by nondigital assets, which allow fractional ownership, create an immutable ownership record that improves transparency and lowers transaction costs, and are generally classified by regulators as securities.
- Cryptocurrency returns come mainly from price appreciation, with limited supply a major driver, and have been high but highly volatile; their historically low correlations with traditional assets may offer diversification, although correlations can rise in periods of extreme stress.

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CFA® PROGRAM LEVEL I · CHEAT SHEET

Portfolio Construction

Exam weight 8–12% · 6 readings · 26 formulas

87 Portfolio Risk and Return: Part I

MODULE 87.1 · HISTORICAL RISK AND RETURN

- Over long periods the asset classes with the highest average returns have also had the highest standard deviations, small-cap stocks being highest on both and T-bills lowest, although the pattern holds broadly and not for every pair.
- Over long periods equities have earned higher average returns than fixed-income securities with a higher standard deviation, which fits risk-averse investors holding riskier asset classes only for a higher expected return.
- The approximate real return is the nominal return minus inflation, and over 1926–2017 real returns were more stable than nominal returns because inflation itself varied a lot.
- Return distributions are not normal: negative skewness means a tendency toward large downside surprises, and excess kurtosis (kurtosis above 3) means extreme outcomes occur more often than a normal distribution predicts.
- Illiquidity can depress a security's price and so raise its expected return, which matters most in emerging markets and for thinly traded securities such as low-quality corporate bonds.

MODULE 87.2 · RISK AVERSION

- Given two investments with the same expected return, a risk-averse investor picks the less risky one, a risk-neutral investor is indifferent and a risk-seeking investor picks the riskier one.
- Utility is $U = E(r) - \frac{1}{2}A\sigma^2$ with returns in decimals, where A is positive for a risk-averse investor, zero for a risk-neutral one and negative for a risk seeker, and a risky portfolio is worth less to a more risk-averse investor.
- An indifference curve joins risk-return combinations with the same expected utility; for a risk-averse investor it slopes upward, a more risk-averse investor has steeper curves, and curves higher and to the left give more utility.
- Combining a risky portfolio with the risk-free asset gives $E(R_p) = wE(R_{risky}) + (1-w)R_f$ and $\sigma_p = w\sigma_{risky}$, a straight capital allocation line, with $w > 1$ meaning borrowing at the risk-free rate.
- Under two-fund separation every investor's optimal portfolio combines the same optimal risky portfolio with the risk-free asset, and investors differ only in how much they put in each.
- The optimal portfolio is where the investor's highest attainable indifference curve is tangent to the CAL, or to the efficient frontier when only risky assets are available, so a more risk-averse investor sits nearer the risk-free end.

EXAM SHORTCUTS

- A risk-free asset has $\sigma = 0$, so its utility equals its return for every investor whatever the value of A, and no utility calculation is needed to rank it.

MODULE 87.3 · PORTFOLIO STANDARD DEVIATION

- Historical returns are a sample, so the sample variance divides the squared deviations by $T - 1$, and the standard deviation is its square root.
- Covariance measures how two returns move together: positive when they tend to be above or below their means in the same periods, negative when one tends to be above its mean while the other is below, and zero when there is no linear relationship.
- Covariance is in squared return units and depends on the assets' volatilities, whereas the correlation $\rho_{1,2} = \mathrm{Cov}_{1,2}/(\sigma_1\sigma_2)$ has no units and lies between −1 and +1.
- Two-asset portfolio variance is $w_1^2\sigma_1^2 + w_2^2\sigma_2^2 + 2w_1w_2\rho_{1,2}\sigma_1\sigma_2$, so its inputs are the weights, the standard deviations and the covariance or correlation, with expected returns and beta not needed for σ_p.

MODULE 87.4 · THE EFFICIENT FRONTIER

- For any correlation below +1, portfolio standard deviation is less than the weighted average of the assets' standard deviations, and the lower the correlation, the larger this diversification benefit.
- With long positions only, a zero-variance portfolio of two risky assets exists only when $\rho = -1$, with $w_1 = \sigma_2/(\sigma_1 + \sigma_2)$.
- Correlation does not affect a portfolio's expected return, only its risk, so a lower correlation moves each mix of weights to the left at the same expected return.
- Adding an asset with the same standard deviation as the portfolio and a correlation with it below +1 reduces portfolio risk, and among otherwise equal candidates the one with the lowest correlation reduces it most.
- The efficient frontier is the upper part of the minimum-variance frontier starting at the global minimum-variance portfolio; portfolios below it are inefficient, portfolios above it are not attainable, and it is concave.
- The Markowitz inputs are each security's expected return and variance and the covariances between all pairs, investors' risk aversion is not an input, and when investors can lend and borrow at a risk-free rate below the frontier's expected returns, the CAL touches the frontier only at the optimal risky portfolio.

EXAM SHORTCUTS

- With $\rho = +1$, portfolio standard deviation is the weighted average of the assets' standard deviations, so the full variance formula is not needed.
- A portfolio with a lower expected return and a higher standard deviation than another attainable portfolio is dominated, so it can be ruled out as efficient without plotting the frontier.

FORMULAS

Utility function	$U = E(r) - \frac{1}{2}A\sigma^2$
Adding the risk-free asset: the capital allocation line	$E(R_p) = w\,E(R_{risky}) + (1-w)R_f$ $\sigma_p = w\,\sigma_{risky}$
One asset	$\sigma^2 = \frac{\sum_{t=1}^{T}(R_t - \mu)^2}{T}$ (population) $s^2 = \frac{\sum_{t=1}^{T}(R_t - \bar{R})^2}{T-1}$ (sample)
Two assets: covariance	$\text{Cov}_{1,2} = \frac{\sum_{t=1}^{T}(R_{1,t} - \bar{R}_1)(R_{2,t} - \bar{R}_2)}{T-1}$
Correlation	$\rho_{1,2} = \frac{\text{Cov}_{1,2}}{\sigma_1\sigma_2}$ $\text{Cov}_{1,2} = \rho_{1,2}\,\sigma_1\,\sigma_2$
Portfolio standard deviation	$E(R_p) = w_1E(R_1) + w_2E(R_2)$ $\sigma_p^2 = w_1^2\sigma_1^2 + w_2^2\sigma_2^2 + 2w_1w_2\text{Cov}_{1,2} = w_1^2\sigma_1^2 + w_2^2\sigma_2^2 + 2w_1w_2\rho_{1,2}\sigma_1\sigma_2$ $\sigma_p = \sqrt{\sigma_p^2}$
Investing in assets that are less than perfectly correlated	$\sigma_p^2 = (w_1\sigma_1 + w_2\sigma_2)^2 \quad \Rightarrow \quad \sigma_p = w_1\sigma_1 + w_2\sigma_2$ $w_1 = \frac{\sigma_2}{\sigma_1 + \sigma_2}$

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88 Portfolio Risk and Return: Part II

MODULE 88.1 · SYSTEMATIC RISK AND BETA

- Combining a risky portfolio P with the risk-free asset gives $E(R_C) = wE(R_P) + (1 - w)R_f$ and $\sigma_C = w\sigma_P$, so every combination lies on a straight line from R_f through P.
- The optimal CAL is the steepest line from R_f, tangent to the efficient frontier at the optimal risky portfolio, which has the highest excess return per unit of standard deviation of all risky portfolios.
- Under homogeneous expectations every investor's tangency portfolio is the market portfolio of all risky assets in market-value weights, and the CML, $E(R_P) = R_f + [(E(R_M) - R_f)/\sigma_M]\sigma_P$, measures risk by standard deviation, with investors differing only in how much they lend or borrow at R_f.
- Exam convention: total risk = systematic risk + unsystematic risk, with total risk measured by standard deviation; current practice: the sum is exact for variances only; in either case only systematic risk is priced, because capital market theory assumes unsystematic risk can be diversified away at no cost.
- The market model $R_i = \alpha_i + \beta_i R_m + e_i$ regresses an asset's return on the market's rate of return and gives the abnormal return $R_i - (\alpha_i + \beta_i R_m)$, while multifactor models such as Fama and French (market, size, book-to-market) and Carhart (adding momentum) use several factors.
- Beta is $Cov(R_i, R_m)/\sigma_m^2 = \rho_{i,m}\sigma_i/\sigma_m$, measures systematic risk only, and equals 1 for the market.

EXAM SHORTCUTS

- The risk-free asset has a beta of 0 and the market portfolio a beta of 1, so the beta of any portfolio on the CML equals its weight in M, with no covariance calculation needed.

MODULE 88.2 · THE CAPM AND THE SML

- The CAPM, $E(R_i) = R_f + \beta_i[E(R_m) - R_f]$, is the equation of the security market line, whose intercept is R_f and whose slope is the market risk premium.
- The CAPM assumes risk-averse, utility-maximizing investors, frictionless markets, a single common period, homogeneous expectations, infinitely divisible assets and competitive markets in which investors are price takers.
- The CML measures risk by standard deviation and in equilibrium holds only efficient portfolios, while the SML measures risk by beta and holds all properly priced securities and portfolios, so a single stock plots below the CML but on the SML.
- A security whose forecast return exceeds its CAPM required return plots above the SML and is undervalued, one whose forecast is below plots below the SML and is overvalued, and the difference is its expected alpha.
- With a positive market risk premium a negative beta gives a required return below R_f, and when $E(R_m)$ is below R_f a negative beta gives a required return above R_f.
- The Sharpe ratio and M² use total risk and suit a single manager's or concentrated portfolio, M² ranking portfolios as the Sharpe ratio does, while the Treynor measure and Jensen's alpha use beta and suit a well-diversified fund.

EXAM SHORTCUTS

- M² is above R_M exactly when the portfolio's Sharpe ratio is above the CML slope, so the sign of the M² alpha can be read from the Sharpe ratio comparison.
- Any asset with a beta of 1 has the market's required return under the CAPM whatever its total risk, so no calculation is needed for it.

FORMULAS

Adding a risk-free asset to a risky portfolio	$E(R_C) = w\,E(R_P) + (1 - w)\,R_f$ $\sigma_C = w\,\sigma_P$
The capital allocation line (CAL) and the capital market line (CML)	$E(R_P) = R_f + \left[\frac{E(R_M) - R_f}{\sigma_M}\right]\sigma_P$

Systematic and unsystematic risk	$\text{total risk} = \text{systematic risk} + \text{unsystematic risk}$
Return generating models and the market model	$E(R_i) - R_f = \beta_{i,1}E(F_1) + \beta_{i,2}E(F_2) + \cdots + \beta_{i,k}E(F_k)$ $R_i = \alpha_i + \beta_i R_m + e_i$
Calculating and interpreting beta	$\beta_i = \frac{Cov(R_i, R_m)}{\sigma_m^2} = \frac{\rho_{i,m}\,\sigma_i\,\sigma_m}{\sigma_m^2} = \rho_{i,m}\frac{\sigma_i}{\sigma_m}$
The CAPM, its assumptions, and the security market line (SML)	$E(R_i) = R_f + \beta_i\,[E(R_m) - R_f]$ $\beta_i = \frac{Cov(R_i, R_m)}{\sigma_m^2}$
Applying the CAPM and the SML: finding mispriced securities	$\text{forecast return} = \frac{P_1 - P_0 + D_1}{P_0}$ $\text{required return} = R_f + \beta[E(R_m) - R_f]$

89 Portfolio Management: An Overview

MODULE 89.1 · PORTFOLIO MANAGEMENT PROCESS

- The portfolio approach judges each investment by its effect on the risk and return of the whole portfolio.
- Combining assets whose returns are not perfectly positively correlated reduces risk without necessarily giving up expected return.
- The diversification ratio is the standard deviation of an equally weighted portfolio ÷ the average standard deviation of its securities; the lower the ratio, the greater the benefit.
- Planning produces the IPS and its benchmark; execution covers asset allocation, security analysis and portfolio construction; feedback covers monitoring, rebalancing and performance measurement.
- In a DC plan the employee makes the investment decisions and bears the investment risk; in a DB plan the employer promises the benefit and bears the risk.

EXAM SHORTCUTS

- Sort a portfolio activity by its output: anything written into the IPS, including the benchmark, is planning; allocating, selecting and building is execution; monitoring, rebalancing and measuring performance is feedback.

MODULE 89.2 · ASSET MANAGEMENT AND POOLED INVESTMENTS

- Asset managers are buy-side firms; a multi-boutique firm owns several specialist managers through one holding company.
- Active management tries to beat a benchmark; passive management, including smart beta, tracks one, and its share of AUM has been growing.
- NAV per share = (fund assets − fund liabilities) ÷ shares outstanding.
- Open-end funds issue and redeem shares at NAV; closed-end funds keep a fixed share count, and their market prices can differ significantly from NAV; ETFs trade in the market at prices kept close to NAV.
- Hedge funds are far less regulated than mutual funds, are often limited to qualified investors and typically charge 2% of assets plus 20% of excess performance.

FORMULAS

Measuring the benefit: the diversification ratio	$\text{Diversification ratio} = \frac{\sigma \text{ of an equally weighted portfolio of the } n \text{ securities}}{\text{average } \sigma \text{ of the } n \text{ individual securities}}$

Mutual funds and other pooled investments	$NAV = \frac{\text{fund assets} - \text{fund liabilities}}{\text{shares outstanding}}$

90 Basics of Portfolio Planning and Construction

- The investment policy statement is the written plan that starts the portfolio management process: it forces the client to articulate circumstances, objectives and constraints, reconciles return expectations with risk tolerance, and sets a benchmark for judging results.
- At a minimum an IPS describes the client's circumstances and constraints, sets out a strategy built on them and names a benchmark for evaluating performance; permitted assets and leverage limits belong in the investment guidelines.
- Risk and return objectives can be absolute or relative, a risk objective being relative only when it refers to a benchmark, and the two objectives must be set together so that they are compatible.
- Willingness to take risk reflects the investor's psychology and ability to take risk reflects financial circumstances such as horizon, wealth relative to needs and income stability; when the two conflict the lower assessment governs, although with high ability and low willingness the adviser may educate the client.
- The constraints are liquidity, time horizon, taxes, legal and regulatory factors and unique circumstances, a rule imposed by law being a legal constraint and a rule the investor chooses a unique circumstance.
- Asset classes for strategic allocation should have highly correlated returns within each class, low correlations between classes, and together approximate the universe of permissible investments.
- The strategic asset allocation is the efficient asset-class portfolio that best fits the IPS, tactical asset allocation is a temporary deviation from it to exploit perceived short-term mispricing, and risk budgeting allocates a total risk limit among strategic, tactical and security selection risk.
- ESG approaches include negative and positive screening, thematic and impact investing, engagement and ESG integration, and a negatively screened portfolio should be judged against an index that excludes the same kinds of companies.

91 The Behavioral Biases of Individuals

MODULE 91.1 · COGNITIVE ERRORS VS. EMOTIONAL BIASES

- Cognitive errors come from faulty reasoning and can often be mitigated through awareness, education, training or better information, while emotional biases arise from feelings or impulses and are hard to overcome, so the portfolio may have to accommodate them.
- Belief perseverance biases, rooted in cognitive dissonance, are conservatism, confirmation, representativeness, illusion of control and hindsight bias.
- Information-processing biases are anchoring and adjustment, mental accounting, framing and availability.
- Conservatism is failing to update a reasonable view, or updating it too slowly, confirmation bias is seeking and interpreting evidence to fit an existing view, and anchoring is adjusting too little from a specific starting number.
- Representativeness takes two forms, base-rate neglect (ignoring how common a trait is in the population) and sample-size neglect (generalizing from a small sample).
- Availability bias judges probability by how easily examples come to mind, and framing bias produces different choices from the same facts depending on how they are presented.

EXAM SHORTCUTS

- To classify a bias, ask whether better information or a simple change in thinking would make the investor drop it: if so, treat it as cognitive; if the view rests on emotion the investor will not or cannot change, treat it as emotional.

MODULE 91.2 · EMOTIONAL BIASES

- The six emotional biases are loss aversion, overconfidence, self-control, status quo, endowment and regret aversion.
- A loss-averse investor feels losses more than equal gains and judges outcomes against a reference point, so may sell winners too early, hold losers and take on more risk to avoid realizing a loss, unlike a risk-averse investor, who picks the less risky of two choices with the same expected return.
- Overconfidence, which includes illusion of knowledge, self-attribution, prediction overconfidence and certainty overconfidence, leads investors to underestimate risk, overtrade and diversify too little, and it is classified as emotional although it has cognitive elements.
- Self-control bias puts short-term satisfaction ahead of long-term goals, status quo bias makes doing nothing the default, endowment bias values an asset more because it is owned, and regret aversion makes errors of commission weigh more than errors of omission.
- A market anomaly does not fit the prevailing risk-return model, and it is a market inefficiency only if it offers positive risk-adjusted returns; many apparent anomalies disappear once small samples, time-period bias or a misspecified risk model are accounted for.
- Biases such as overconfidence, confirmation, anchoring and fear of regret may contribute to bubbles, the halo effect may explain overvaluation of growth stocks, and home bias leads investors to overweight domestic or local companies.

92 Introduction to Risk Management

- Risk management identifies the risk tolerance, identifies and measures the risks faced, and modifies and monitors them, with the aim of holding the optimal bundle of risks rather than minimizing or eliminating risk.
- Risk governance is senior management's determination of risk tolerance, of the elements of the optimal risk exposure strategy and of the framework for overseeing risk management, set at the enterprise level.
- Risk tolerance depends on expertise in the lines of business, skill at responding to negative outside events, the regulatory environment and financial strength, and a low risk tolerance does not require cutting every identified risk.
- Risk budgeting allocates the total acceptable risk to assets or investments, using a single metric such as variance, beta, duration or VaR, a split by investment category, or aggregated risk factors.
- Financial risks are credit, liquidity and market risk, while operational, solvency, regulatory, political and tax, legal, model, tail and accounting risks are non-financial, and because risks interact, especially in periods of market stress, they must be assessed together as well as one at a time.
- VaR is the minimum loss over a stated period that will occur with a stated probability, so it is not the worst possible loss, and CVaR is the expected loss given that the loss exceeds the VaR threshold.
- A stress test examines a specific, usually extreme, change in one key variable, while scenario analysis changes several inputs at once.
- Risk can be avoided, prevented, accepted through self-insurance, transferred to another party such as an insurer, or shifted by changing the distribution of outcomes with derivatives, the choice being a cost–benefit comparison.

CFA® PROGRAM LEVEL I · CHEAT SHEET

Ethical and Professional Standards

Exam weight 10–15% · 10 readings

93 Ethics and Trust in the Investment Profession

- Ethics is the body of shared beliefs about which behavior is good and which is bad, and ethical conduct can also be described as behavior that improves outcomes for stakeholders, balancing self-interest against the impact on others.
- A code of ethics states a group's values, principles and general expectations, while standards of conduct set the minimum acceptable behavior in particular situations and are an optional part of a code.
- Professions establish trust through demanding requirements for expertise, knowledge and skill, standards of ethical behavior, monitoring of professional conduct, continuing education, a focus on clients' needs, and mentoring others in the profession.
- Investment advice and management are intangible products whose quality clients find hard to judge, and unethical conduct raises perceived investment risk and the cost of capital while reducing capital invested, the efficiency of capital allocation and economic growth.
- The suitability standard requires recommended securities to match the client's return requirements and risk tolerance, while the stronger fiduciary standard requires acting in the client's best interests.
- The challenges to ethical behavior are overconfidence in one's own ethics, situational influences and rules-focused compliance cultures; a lack of ethical principles is a personal trait, not a situational influence.
- Law and ethics overlap but neither is a subset of the other: some legal acts are unethical, and some illegal acts, such as whistle-blowing or civil disobedience, are considered ethical by many.
- The ethical decision-making framework has four steps: identify the facts, stakeholders, duties, principles and conflicts; consider influences, guidance and alternatives; decide and act; and reflect on the outcome.

94 Code of Ethics and Standards of Professional Conduct

- The Professional Conduct Program enforces the Code and Standards on the principles of fairness and confidentiality: the Disciplinary Review Committee is responsible for enforcement and the Professional Conduct staff carry out inquiries.
- An inquiry can start from self-disclosure on the annual Professional Conduct Statement, a written complaint, evidence from public sources, a report by an exam proctor, or CFA Institute's own monitoring of social media and review of exam materials.
- The Professional Conduct staff may conclude with no disciplinary sanction, a cautionary letter or a disciplinary sanction, and a member or candidate who rejects a proposed sanction is referred to a disciplinary review panel for a hearing.
- Exam convention: the sanctions listed are condemnation by the member's peers (public censure) and suspension of a candidate's continued participation in the CFA Program. Current practice: the preamble to the Code and Standards also names revocation of membership, of candidacy and of the right to use the CFA designation.
- Component 1 of the Code names four qualities, integrity, competence, diligence and respect, while complying with GIPS, advocating new laws, educating the general public, honoring contractual provisions and maximizing return per unit of risk are not components of the Code.
- Standards I to VII cover, in order: professionalism; integrity of capital markets; duties to clients; duties to employers; investment analysis, recommendations, and actions; conflicts of interest; and responsibilities as a CFA Institute member or candidate.

- Under Standard I(A), a member follows the Code and Standards where local law is less demanding and follows local law where it is stricter.
- The Code and Standards bind members of CFA Institute, including charterholders, and candidates for the CFA designation, so a member who does not yet hold the charter can still be sanctioned.

EXAM SHORTCUTS

- Specific duties such as keeping records or distinguishing fact from opinion come from the Standards, so an answer that places them in the Code of Ethics can be ruled out.

95 Guidance for Standard I: Professionalism

- Under Standard I(A), a member compares the applicable laws with the Code and Standards and follows whichever is strictest on each point, so where applicable law is weaker or silent the Code and Standards govern.
- A member who learns that coworkers or clients are breaking applicable rules goes to a supervisor or the compliance department to have the conduct remedied and, if it is not remedied, must dissociate, which in an extreme case may mean resigning.
- The Code and Standards do not require a member to report wrongdoers to governmental or regulatory authorities, although local law may require it.
- Under Standard I(B), modest gifts and ordinary business entertainment are acceptable, the test being whether an item could reasonably be expected to compromise independence and objectivity, and a gift from a client may be accepted but must be disclosed to the employer.
- Issuer-paid research is permitted if the compensation is a flat fee not tied to the report's conclusions, recommendations or market impact and the issuer payment is disclosed.
- Under Standard I(C), misrepresentation covers plagiarism, selective data presented in order to mislead, the omission of relevant information and any knowing attempt to mislead investors, but factual data from recognized financial and statistical reporting services may be used without citation.
- Standard I(D) covers only professional conduct: dishonesty, fraud or deceit violates it, while civil disobedience is generally not a violation and personal bankruptcy is not one unless fraudulent or deceitful professional conduct was involved.
- Under Standard I(E), the member, not the employer, is responsible for developing the competence a new role requires, and continuing education is recommended but not required.

96 Guidance for Standard II: Integrity of Capital Markets

- Standard II(A) applies only when information is both material, meaning disclosure would move the price or a reasonable investor would want to know it, and nonpublic, meaning it has not been disseminated to the marketplace in general.
- Selective disclosure, such as telling a group of analysts on a conference call or a roadshow audience, leaves the information nonpublic for everyone who heard it.
- Acting or causing others to act on material nonpublic information includes trading for oneself, clients, the employer or family members, executing an order from someone known to be trading on it, recommending or tipping, and trading related funds, swaps or options, while possession alone is not a violation.
- Under the mosaic theory, an analyst may act on a conclusion drawn from public information and nonmaterial nonpublic information even if the conclusion would be material had the company disclosed it, but never on an item that is itself material and nonpublic.
- Standard II(B) is violated by spreading false or misleading information to affect prices or volume, or by trades intended to mislead market participants.
- Strategies that exploit market inefficiencies, transactions made for tax purposes and block trades used to limit price impact are not manipulation when they carry no intent to mislead.

- A member who holds material nonpublic information should make reasonable efforts to achieve public dissemination of it by the company.
- The firm's core control is a firewall, with a clearance area, review of employee trades, watch, restricted and rumor lists, and monitoring and restriction of proprietary trading.

EXAM SHORTCUTS

- Under Standard II(B), whether the member profited does not matter; the deciding element is the intent to mislead, so a trade that merely moves the price is not a violation without it.

97 Guidance for Standard III: Duties to Clients

- Standard III(A) requires loyalty to clients, reasonable care and prudent judgment, with clients' interests placed before the employer's and the member's own, but it does not create a fiduciary duty where none already exists.
- For a pension plan, the duty of loyalty runs to the plan participants and beneficiaries, not to the sponsoring company, its management or its shareholders.
- Client brokerage (soft dollars) is an asset of the client and must be used for the client's benefit, such as research that assists in managing client accounts, while a client's instruction to direct its trades to a named broker may be followed with disclosure that best execution may not be achieved.
- Proxies must be voted in an informed and responsible way in clients' interests, although a cost-benefit analysis may show that voting a particular proxy is not worthwhile.
- Fair dealing is not equal treatment: disclosed service tiers open to anyone willing to pay are allowed, but a partly filled order is allocated pro rata to each account's order size, across all accounts for which the trade is suitable, at the same average price.
- In an advisory relationship, Standard III(C) requires a reasonable inquiry into the client's experience, objectives and constraints before acting, regular reassessment, and a judgment of suitability in the context of the total portfolio; a manager running a portfolio to a mandate acts only within its stated objectives and constraints.
- Standard III(D) requires reasonable efforts to make performance information fair, accurate and complete, and a brief presentation is allowed if detailed information is available on request and the presentation says it gives only limited information.
- Under Standard III(E), confidential information about current, former and prospective clients may be disclosed only if it concerns illegal activities by the client, if the law requires disclosure, or if the client or prospective client permits it, and giving it to the Professional Conduct Program in an investigation is permitted.

EXAM SHORTCUTS

- Client consent or disclosure does not make an unfair allocation or dissemination practice acceptable, so an answer that relies on consent to justify one can be ruled out.

98 Guidance for Standard IV: Duties to Employers

- Under Standard IV(A), an employer–employee relationship exists whenever a person works in the service of another, with no written contract or monetary compensation required.
- Independent practice that competes with the employer for compensation or other benefit is allowed only after the member notifies the employer of the types of services, expected duration and compensation and obtains the employer's consent before the practice begins.
- Until a resignation is effective, a member may prepare to compete, for example by interviewing, leasing office space or registering a new firm, but may not solicit the employer's current or prospective clients, induce colleagues to leave, or copy client lists, models or other files.
- After leaving, and absent a valid non-compete agreement, a member may contact former clients using memory or public sources, while records created or kept for the employer remain its property in any medium.

- Whistleblowing against the employer's interest to protect clients or market integrity is not a breach of loyalty when it is not for personal gain and complies with applicable law.
- Under Standard IV(B), a benefit that competes with the employer's interest, or that might reasonably be expected to create a conflict of interest with it, may be accepted only with written consent, e-mail included, from all parties involved.
- Under Standard IV(C), a supervisor must make reasonable efforts to prevent, detect and act on violations by anyone under his or her supervision or authority, and delegating supervisory duties does not transfer the supervisory responsibility.
- A member asked to supervise where compliance procedures are absent or inadequate must decline in writing to accept supervisory responsibility until the firm adopts adequate procedures.

EXAM SHORTCUTS

- Ask when a client bonus is earned: one that depends on future performance is an additional compensation arrangement needing written consent in advance under Standard IV(B), while one that rewards performance already achieved is a gift to be disclosed under Standard I(B).

99 Guidance for Standard V: Investment Analysis, Recommendations, and Actions

- Standard V(A) requires diligence, independence and thoroughness, and every analysis, recommendation or action must rest on a reasonable and adequate basis backed by appropriate research and investigation.
- How much research is enough depends on the member's investment philosophy, role in the decision-making process and the employer's resources and support.
- A member may rely on third-party or the firm's own research after a reasonable and diligent review of its assumptions, rigor, timeliness, objectivity and independence, but a rumor, an overheard tip or a single popular-press article is not a reasonable basis.
- Standard V(B) requires members to disclose the nature and costs of their services, the general principles and basic format of their investment process with prompt disclosure of material changes, and significant limitations and risks.
- A projection must be presented as an opinion, so writing that a future event will happen violates Standard V(B), while a short recommendation is allowed if clients are told that the full analysis is available.
- Under Standard V(C), records in any medium belong to the firm, and a member who changes employers must re-create supporting records from public sources or the covered company rather than rely on memory.
- Where no regulation or firm policy sets a retention period, records should be kept for at least seven years.
- Suitability under Standard III(C) applies when advising a particular client, while a research analyst publishing a general recommendation is judged under Standard V(A).

EXAM SHORTCUTS

- Standard V(A) judges the work done before a recommendation, so the investment's later loss or gain does not by itself decide whether the Standard was violated.

100 Guidance for Standard VI: Conflicts of Interest

- Standard VI(A) requires members to avoid conflicts where reasonably possible and otherwise to make full and fair disclosure in prominent, plain-language form, so a line of fine print buried in a legal appendix does not meet it.
- The conflict that most often requires disclosure is the member's own stock ownership in a company he or she recommends or that clients hold, including beneficial ownership through a trust, and disclosing the holding meets the Standard without declining the assignment or selling the stock.
- Market making, investment banking relationships, board seats held by the member or senior firm officers, paid consulting work for the issuer, and compensation arrangements that could create incentives at odds with clients' objectives must be disclosed.

- Under Standard VI(B), transactions for clients and employers have priority over those in which the member is the beneficial owner, client transactions also come before the firm's proprietary trading, and front-running violates the Standard.
- Fee-paying client accounts of family members are treated exactly like other client accounts, neither favored nor disadvantaged.
- A member may trade personally in a security that is not suitable for any client without first offering it to clients, the overriding test being that personal trades do not disadvantage any client.
- Standard VI(C) requires disclosure of any compensation, consideration or benefit, cash or non-cash, received from or paid to others for recommending products or services, with its nature and estimated value, before the client or prospect enters into an agreement for services.
- Recommended procedures for Standard VI(B) include limits on employee participation in equity IPOs, restrictions on private placements, blackout periods before client trades, and reporting procedures such as pre-clearance and duplicate trade confirmations.

EXAM SHORTCUTS

- To tell look-alike benefits apart, start from the trigger: a client's gift for results already achieved falls under I(B), a benefit tied to future performance or competing outside pay under IV(B), a holding, relationship or pay scheme that could impair independence and objectivity under VI(A), and pay for recommending products or services under VI(C).

101 Guidance for Standard VII: Responsibilities as a CFA Institute Member or CFA Candidate

- Conduct that breaches Standard VII(A) includes cheating, or offering to help someone cheat, on a CFA Institute exam, breaking CFA Program rules and policies, disclosing confidential exam information, improperly using the CFA designation and misrepresenting information on the Professional Conduct Statement.
- Confidential exam information includes specific questions and the broad topic areas or formulas that were or were not tested, the obligation continues after the testing window closes, and discussing the curriculum itself is allowed.
- Standard VII(A) does not restrict expressing opinions, so criticizing CFA Institute, the CFA Program, pass rates or CFA Institute's advocacy positions is allowed.
- To remain an active member and keep the right to use the CFA designation, a charterholder must pay annual membership dues and file the annual Professional Conduct Statement.
- No partial CFA designation exists, so a title such as "CFA Level II" is not allowed, but a candidate may state facts such as the levels passed, the years they were passed and that each was passed on the first attempt.
- Claiming superior ability, or promising higher returns, lower risk or better service, because of the designation or exam results violates Standard VII(B).
- Stating that one is a charterholder, describing accurately what the designation requires, and stating that holding the charter reflects a commitment to high ethical standards are allowed.
- Members should check that their firms know how to refer correctly to a member's CFA designation or candidacy.

102 Application of the Code and Standards: Level I

- Application questions test which Standard a fact pattern touches and whether the conduct crosses the line, and the explanation must name the fact that decides the outcome.
- Under Standard I(A), a member who cannot stop a violation through supervisors or compliance must dissociate, and a partial fix that leaves some clients affected is not enough.
- Members cannot contract out of their duties to clients, so a client agreement may not excuse the firm from acting in clients' best interests or restrict clients' legal claims.
- Soft dollars may pay only for research and services that benefit clients, never for office furniture or personal expenses.

- A fee-based premium service is allowed if all clients know it exists and it never delivers recommendation changes ahead of other clients, and disclosing the service does not make early delivery acceptable.
- Under Standard IV(B), a benefit that competes with or could create a conflict with the employer's interest needs written consent from all parties involved, and when the outside party has already made its offer in writing, the employer's written consent is what remains.
- Putting a family member's account ahead of clients violates Standard VI(B) even when the information acted on is public.
- Candidates may share general impressions of exam difficulty but not specific questions or which topics were or were not tested, and soliciting such information also violates Standard VII(A).

EXAM SHORTCUTS

- If the information in a stem came from a general newswire, it is public, so Standard II(A) is not the issue and the answer usually lies in priority of transactions or fair dealing.

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