Quants

Interest Rates, Present Value, and Future Value
Time Value of Money in Finance

1. Nominal risk-free rate = Real risk-free rate + Expected inflation rate.
2. Additive Model: Nominal Rate = Inflation Premium + Real Rate
3. Multiplicative Model: (1 + Nominal Rate) = (1 + Inflation Rate) (1 + Real Rate)
4. Required interest rate = Nominal risk-free rate+ default risk premium + liquidity premium +maturity risk premium.
5. Effective Annual Rate (EAR) = $(1+ \text{periodic rate})^m - 1$

   periodic rate = stated annual rate/m

   m = no. of compounding periods per year
6. For continuous compounding, EAR = $e^{rt} - 1$
7. Single Cash Flow: PV = $\frac{FV}{(1+r)^n}$ or FV = PV $(1 + r)^n$
8. FV = PV $(1 + {}^I/_y)^N$
9. $PV_{perpetuity} = \frac{PMT}{I/y}$

Discounted Cash Flow Applications

1. NPV = $PV_{(inflows)} - PV_{(outflows)}$
2. Holding Period Return(HPR) = $\frac{\text{Ending value} - \text{Beginning value}}{\text{Beginning value}}$ Or $\frac{P_1 - P_0 + D}{P_0}$
3. Money Weighted Rate of Return (MWROR) = IRR (depends on magnitude and timing)
4. Time Weighted Rate of Return (TWROR)

   = $[(1+ r_1)(1+ r_2) \ldots .(1+ r_n)]^{1/n} - 1$

   Where, $(1+ r_1)$ = HPR
5. Bank Discount Yield (BDY)=$\frac{F-P}{F} \times \frac{360}{n}$
6. Holding Period Yield (HPY) = $\frac{F-P}{P} \times 100$ Or $\frac{P_1 - P_0 + D_1}{P_0} = \frac{P_1 + D_1}{P_0} - 1$
7. Effective Annual Yield (EAY)= $(1 + HPY)^{\frac{365}{n}} - 1$
8. (Annualized HPY & annual compounding)

   ∴ HPY = $(EAY + 1)^{n/365} - 1$
9. Money Market Yield (MMY)= HPY X $\frac{360}{n}$[Annual HPY in multiplicative fashion]
10. Bond Equivalent Yield (BEY) =2 x semiannual discount rate (per annum compounded semiannually) = $\left[(1 + EAY)^{\frac{1}{2}} - 1\right] \times 2$

Organizing, Visualizing, and Describing Data
Statistical Measures of Asset Returns

1. Population mean (μ) = $\frac{\sum_{i=1}^{N} X_i}{N}$; where N is population size

   Sample mean ($\overline{X}$) = $\frac{\sum_{i=1}^{N} X_i}{n}$; when n is sample size

2. Sum of mean deviations = $\sum_{i=1}^{N}(x_i - \bar{x})$= 0

3. Geometric mean (GM) = $\sqrt[n]{(x_1 * x_2 \ldots\ldots x_n)}$

   Geometric mean return (R_g): 1 + R_g = $\sqrt[n]{(1+R_1)\ (1+R_2) \ldots .(1+R_n\ )}$

   AM $\geq$ GM [AM – GM increase as the dispersion of the observations increase.]

   AM = GM [When all observations are equal]

4. Harmonic mean (HM) = $\frac{N}{\sum_{i=1}^{N}\frac{1}{xi}}$ (average cost of shares purchase over time)

   AM > GM > HM (dollar cost averaging uses investing same amount every time period in a share; average price will be lowest as HM is < AM or GM)

5. Ly = (n+1) $\frac{y}{100}$[Quartiles, Deciles and Percentiles]

6. Range = Maximum Value – Minimum Value

7. Mean Absolute Deviation (MAD) = $\frac{\sum_{i=1}^{N}|\,xi-\bar{x}\,|}{N}$ = $\frac{\sum\,|\,x-\bar{x}\,|}{N}$

8. Population variance, σ^2 = $\frac{\sum_{i=1}^{N}(x-\mu)^2}{N}$

9. Population Standard Deviation (σ) = $\sqrt{\frac{\sum_{i=1}^{N}(x-\mu)^2}{N}}$

   $\sigma > \mathrm{MAD}$

10. S^2 = $\frac{\sum_{i=1}^{N}(x-\bar{x}\,)^2}{N-1}$

11. K = $\frac{\sum_{i=1}^{N} x-\mu}{\sigma}$

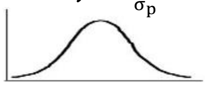
    Standardizing a variable converts the mean into 0 and Standard Deviation into 1

12. Chebyshev's inequality / Bienaymé Chebyshev's Theorem

    % of observations that lie within K standard deviation of mean is at least=$1-\frac{1}{K^2}$
    i.e., min Probability that variable will lie between$\mu \pm K\sigma = 1-\frac{1}{K^2}$
    (Applicable for all distribution) (K > 1)

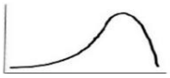
13. Coefficient of variation (CV) = $\frac{\sigma}{\mu}$x 100 OR ($\frac{S_x}{\bar{x}}$x 100)

14. Sharpe ratio (Reward to variability ratio/SR) = $\frac{\bar{R}_p - R_f}{\sigma_p}$

15. Symmetrical: Mean = Median = Mode 

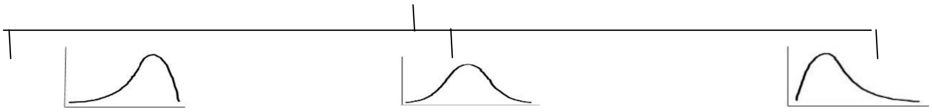
    Positive skewness: Mean > Median > Mode 

Negative skewness: Mean < Median < Mode



16. Skewness Extent to which a distribution is not symmetrical

Coefficient of Skewness (S_k) = $\frac{(x-\bar{x})^3}{n*SD^3} = \frac{\text{Third Moment}}{SD^3}$



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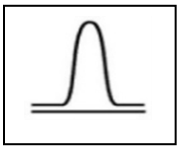
$|S_k|$ > 0.5 (considered significant levels of Skewness)

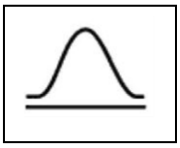
17. Kurtosis: Degree to which a distribution is more / less peaked

Coefficient of Kurtosis = $\frac{\Sigma(x-\bar{x})^4}{n*SD^4} = \frac{\text{Forth Moment}}{SD^4}$

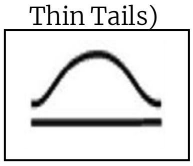
>3 Leptokurtic (More peaked Fat tails)



=3 Mesokurtic (Normal Distribution)



<3 Platykurtic (Less peaked Thin Tails)



Excess Kurtosis = Normal distribution with Kurtosis of 3

Excess Kurtosis >1 [considered significant]

Probability Concepts
Probability Trees and Conditional Expectations
Portfolio Mathematics

1. Probability = $\frac{\text{no of favourable outcomes}}{\text{total possible outcomes}}$

2. P(A) ⇒ Marginal / Unconditional Probability

   P (A ∩ B) ⇒ Joint Probability A and B

   P (A ∪ B) ⇒ Total Probability A or B

   P (B | A) ⇒ Conditional Probability of B given that A has occurred

3. P (A | B) = $\frac{P(A \cap B)}{P(B)}$

   Or P (A ∩ B) = P (A | B). P (B)

   (Multiplication rule of probability)

4. P (A ∪ B) = P (A) + P (B) – P (A ∩ B)

   (Addition rule)

5. For, mutually exclusive event, P (A ∩ B) = 0

   For, independent event, P (A ∩ B) = P (A) P (B)

   Also, P (A | B) = P (A) or P (B | A) = P (B)

6. P (R) = P (R | S_1) x P (S_1) + P(R | S_2) x P (S_2) + P(R | S_n) x P(S_n)

   Where $\{S_1, S_2 \ldots . S_n\}$ is mutually exclusive & exhaustive [total probability rule]

7. BAYES' THEOREM – Posterior Probability

   P (A |X) = $\frac{P(A \cap X)}{P(A \cap X) + P(B \cap X)} = \frac{P(A) * P(X|A)}{P(A).\ P(X|A) + P(B).(X|B)}$

   OR $\underbrace{P(I \mid O)}_{\text{Order}} = \frac{P(O|I)}{P(O)} * \underbrace{P(I)\,n_{P_r}}_{\text{Choose}} = \frac{n!}{(n-r)!}$ = Order$n_{C_r} = \frac{n!}{(n-r)!\,r!}$

Common Probability Distribution
Appendices
Simulation Methods

1. Expected value E(x) = Weighted average of all possible outcomes $\sum PX$
2. $\sigma^2 = \sum P.(X-\bar{X})^2$
3. Cov $(R_A, R_B) = \sum P(S) \times [R_A - E(R_A)][R_B - E(R_B)]$
4. Correlation $(R_i, R_j) = \frac{Cov\,(R_i, R_j)}{\sigma_{R_i} * \sigma_{R_j}}$
5. Weight $(W_i) = \frac{\text{MV of investment in Asseet}}{\text{MV of the portfolio}}$
6. Expected value of portfolio composed of n asset : $E(R_P) = W_1E(R_1) + W_2E(R_2) + ... + W_nE(R_n)$
7. Var (R_p) for a two-asset portfolio = $W_A\sigma^2_{R_B} + W_B\sigma^2_{R_B} + 2W_AW_B \text{ cov } (R_AR_B)$

   Variance of n asset portfolio will have n(n-1)/2

   Unique cov (R_A, R_B) as cov (R_A, R_B) = cov (R_B, R_A)
8. Var (R_P) for a 3 asset portfolio = $W_A^2\sigma^2_{R_A} + W_B^2\sigma^2_{R_B} + W_C^2\sigma^2_{R_C} + 2\,[W_AW_B \text{ cov}(R_AR_B) + W_AW_C \text{ cov}(R_AR_C) + W_BW_C \text{ cov}(R_BR_C)\,]$

   Cov (R_AR_A) = Variance R_A or $\sigma^2_{R_A}$
9. Probability of function P(x) = P (X=x) (for discrete variables)

   $\Rightarrow 0 \le p(x) \le 1$

   $\Rightarrow \sum P(x) = 1$
10. Cumulative distribution function CDF F (x) = P (X ≤ x)
11. Bernoulli trials: $P(x) = n_{C_x}\, p^x(1-p)^{n-x}$
12. In Binominal Distribution,

    Df, P <0.5 + ve Skewness

    P = 0.5 Symmetrical

    P >0.5 -ve Skewness

    Expected value of a Binominal Random Variable ⇒ E(X) = np

    Variance of a Binominal Random Variable ⇒ Variance of X = np(1-p)

    Effective annual rate ⇒ $e^{R_{cc}}$

    ln $(\frac{S_1}{S_0})$ = ln (1+HPR) = R_{cc} (rate of continuous compounding)
13. $Z = \frac{\text{observation} - \text{population mean}}{\text{S.D.}} = \frac{\bar{x}-\mu}{\sigma}$

    90% confidence internal, $\bar{x}$ - 1.65s to $\bar{x}$ + 1.65s

    95% confidence internal, $\bar{x}$ - 1.96s to $\bar{x}$ + 1.96s

    99% confidence internal, $\bar{x}$ - 2.58s to $\bar{x}$ + 2.58s
14. Roy's Safety-First Ratio (SFR) = $\frac{E(R_P)-R_{min}}{\sigma_P}$ (higher the better)

    R_{min}= threshold level

    If threshold level = Risk free rate of return, i.e. $R_{min} = R_f$, SFR = Sharpe's Ratio

Sampling and Estimation
Estimation and Inference

1. Sample error of the mean = Sample mean – Population mean

   = $\bar{x} - \mu$

2. Standard error of sample mean ($\sigma_{\bar{x}}$)

   = $\frac{\sigma}{\sqrt{n}}$ (If σ is known)

   = $\frac{S}{\sqrt{n}}$ (If σ is not known)

3. Confidence Interval: $\bar{x} \pm Z\alpha/_{2} \frac{\sigma}{\sqrt{n}}$

   α- Level of significance (for 3 distribution)

4. Confidence Interval: $\bar{x} \pm t\alpha/_{2} \frac{S}{\sqrt{n}}$[σ not known]

   t is calculated as df(n-1) → $\boxed{\alpha/_{2}}$

Basics of Hypothesis Testing
Hypothesis Testing
Parametric and Non-Parametric Tests of Independence

1. Equality of mean (independent samples)

   t statistic of $\bar{x}_1 - \bar{x}_2$ = $\frac{(\bar{X}_1-\bar{X}_2)-(\mu_1-\mu_2)}{\sigma_{X_1-X_2}}$

   Where, $\sigma_{x_1-x_2}$ = $\sqrt{\frac{S_{P^2}}{n_1} + \frac{S_{P^2}}{n_2}}$

   $S^2_{p^2}$ = $\frac{(n_1-1)S_1^2+(n_2-1)S_2^2}{n_1+n_2-2}$

2. Equality of mean: Dependent Samples

   t = $\frac{\bar{d}-\mu}{S_{\bar{d}}}$

   Where, $\bar{d}$ = Mean of differences between the samples; $S_{\bar{d}} = \frac{\text{Standard deviation of the differences}}{\sqrt{n}}$

3. Testing of variance (Chi square statistic):

   X^2 Statistic = $\frac{(n-1)S^2}{\sigma^2}$

   Where, S^2 = Sample variance

   σ^2 = Hypothesized value for sample variance.

4. Testing of equality of variance (F distribution)

   F statistic = $\frac{S_1^2}{S_2^2}$

Economics

Topics in Demand and Supply Analysis

1. Own Price Elasticity = $\frac{\%\Delta Q}{\%\Delta P}$
2. Cross price Elasticity of Demand: $\frac{\%\Delta Q_x}{\%\Delta P_y}$
3. Income Elasticity of Demand: $\frac{\%\Delta Q_D}{\%\Delta Y}$ Y: Income
4. Own Price Elasticity > 1: demand is elastic
5. Own Price Elasticity < 1: demand is inelastic
6. Cross price Elasticity < 0: related good is complement
7. Cross price Elasticity > 0: related good is a substitute
8. Income Elasticity < 0: good is an inferior good
9. Income Elasticity > 0: good is an normal good
10. Accounting Profit : TR – Accounting Cost
11. Economic Profit : TR – (AC + Implicit cost)
12. TCV = Wages x labour
13. AVC = $\frac{TVC}{Q} = \frac{WxL}{Q} = \frac{W}{(Q/L)} = \frac{W}{AP_L}$
14. AVC $\propto \frac{1}{AP_L}$

The Firm & Market Structures

1. Perfect Competition $\rightarrow$ Firm faces infinitely elastic demand

   MR = AR = P = D

   (Price is determined by the market supply and demand.)
2. MR = $P(1 - \frac{1}{E_p})$
3. HHI = $\sum(\text{market share})^2$
4. N_{firm} = $\sum$ (market share)

Aggregate Output, Price & Economic Growth

1. GDP Deflator = $\frac{\text{Nominal GDP}}{\text{Real GDP}}$ x 100
2. Per capita Real GDP = $\frac{\text{Real GDP}}{\text{Population}}$
3. **GDP:**

   Under Expenditure Approach

   C+I+G+(X-M)

   Under Income Approach

   NI + Depη (CCA) + Statistical Discrepancy or C+S+T
4. **National Income**

   Compensation of Employees (Wages/COE) + Interest Income + Rent + Corporate & Govt. Enterprise Profit before Taxes+ Unincorporated Business Net Income + Indirect Business Taxes – Subsidies
5. **Personal Income**

   National Income + Transfer payment to household

   - Taxes (Indirect Business & Corporate)

   - Undistributed corporate profits
6. Potential GDP = aggregate working hours x labor paid

   Growth in potential GDP = growth in labor force + growth in labor productivity

$$\underset{\text{(Savings)}}{S} = \underset{\text{(Investment)}}{I} + \underset{\text{(Fiscal balance)}}{(G-T)} + \underset{\text{(Trade balance)}}{(X-M)}$$

7. Personal Disposable Income = Personal Income – Personal Taxes.
8. Sustainability of Economic Growth:

   Potential GDP = aggregate hours worked x labor productivity

   Growth in Potential GDP = growth in labor force + growth in labor productivity.
9. Production Function:

   Total Y = A x f (L, K)
10. Production per worker basis:

$$Y/L = A \times f\left(\frac{k}{L}\right)$$

Introduction to Business Cycle
Understanding Business Cycle

1. Unemployed Rate = % of people in labor force who are unemployed
   *people who are voluntarily unemployed, not include
2. Participation Ratio = % of working age population who are employed or actively seeking employment.
3. CPI (best indication) = $\frac{\text{cost of basket current prices}}{\text{cost of basket at base prices}}$
4. Consumers Price Index = $\frac{\sum p_1 q_0}{\sum P_O q_0} \times 100$
5. Laspeyre's Index = $\frac{\Sigma p_1 q_0}{\Sigma p_0 q_0}$
6. Paasche's Index = $\frac{\Sigma p_1 p_1}{\Sigma p_0 q_1}$
7. Fishers Index = $\sqrt{\frac{\Sigma p_1 q_0}{\Sigma p_0 q_0} \times \frac{\Sigma p_1 p_1}{\Sigma p_0 q_1}} \times 100$
8. Broad Money = Narrow Money + Liquid Assets
9. Money Multiplies = $\frac{C+I}{C+Y}$ * When people hold some cash

Monetary & Fiscal Policy
Fiscal Policy
Monetary Policy

1. High powered money = Fed Currency + Reserve + Govt. money (coin)
2. M = money supply = mH
3. Money created = $\frac{\text{new deposit}}{\text{reserve requirement}}$
4. Money multiplier = $\frac{1}{\text{reserve ratio}}$ = m
5. money supply(M) x velocity(V) = price(P) x real output(Y) [MV = PY]
6. The Fisher effect:

   $R_{Nom} = R_{Real} + E[I]$

   For risky securities:

   $R_{Nom} = R_{Real} + E[I] + RP$
7. Nominal = real + inflation

   (1+nominal) = (1+ real) (1+ inflation) + risk premium
8. Neutral int. rate = real tread rate of growth + infl. Target
9. Policy rate = neutral + $\frac{1}{2}$ (actual target) growth + $\frac{1}{2}$ (actual - target) inflation
10. Fiscal multiplier = $\frac{1}{1-MPC(1-t)}$

International Trade and Capital Flows
International Trade

1. Terms of trade = $\frac{\text{price of exports}}{\text{price of imports}}$

2. The relation between the trade deficit, saving and domestic investment:

   X – M = private savings + government savings – investment.

Currency Exchange Rates
Capital Flows and the FX Market
Exchange Rate Calculations

1. Real exchange rate (d/f) = nominal exchange rate x $\left[\frac{CPI_{foreign}}{CPI_{domestic}}\right]$
2. $R_{P/B} = S_{P/B}\,(P_B/P_A)$
3. New Exchange Rate = old exchange rate $\left(\frac{1+\text{Inf A}}{1+\text{Inf B}}\right)$
4. Cross Rate = $\frac{MXN}{AUD} = \frac{MXN}{USD} \times \frac{USD}{AUD}$
5. Interest Rate Parity (IRP) = $S_{A/B}$ x $\left(\frac{1+iA}{1+iB}\right)^T$
6. Marshall - Lerner condition:

   $W_X\varepsilon_X + W_M(\varepsilon_M - 1) > 0$

7. The Absorption Approach:

   BT (Balance of Trade) = Y (Income) –E (Expense)

FRA

Introduction to Financial Statement Analysis

1. Balance Sheet – Financial position – at a point in time

   Assets = liabilities + owners' equity.

Income Statement
Analyzing Income Statements

1. Revenues – Expenses = Net Income
2. Net Income = Revenues - Ordinary Expenses + Other Income – Other Expenses + Gains – Losses
3. Profit = Cash receive during period x $\frac{\text{Total Expected Profit}}{\text{Sales}}$
4. Straight line Depreciation:

   $\frac{\text{Cost}-\text{residual value}}{\text{Useful Life}}$
5. Double Declining Depreciation:

   $\frac{2}{\text{Useful life}}$ (Cost – accumulated Depreciation)[* salvage value not to be considered here]
6. Basic EPS = $\frac{\text{EAFESH}}{\text{wtd. Average of no.of shares}}$
7. Diluted EPS = $\frac{[PAT-pref.div]+conveitble\ prefeved\ div+convertible\ in(1-t)}{Wtd.average\ no.of\ shares + shares\ from\ conversion\ of\ convertible\ preference\ share\ debt + Shares\ from\ conversion\ of\ convertible\ preference\ shares\ from\ of\ options\ |\ wairants}$
8. Comprehensive Income = Net Income (PAT) + Other Comprehensive Income [OCI]
9. Gross profit margin = $\frac{\text{GP}}{\text{Revence/sales}}$
10. Net profit margin = $\frac{\text{NP}}{\text{sales}}$

Balance Sheets
Analyzing Balance Sheets

1. Balance Sheet – Financial position – at a point in time

Assets = liabilities + owners' equity.

Liquidity:

1. Current Ratio = $\frac{\text{Current Assets}}{\text{Current Liabilities}}$
2. Quick Ratio = $\frac{\text{CA}-\text{Inventing}}{\text{Current Liabilities}}$
3. Cash Ratio = $\frac{\text{cash}+\text{marketable securities}}{\text{Current Liabilities}}$

Solvency:

4. Debt-to-Equity = $\frac{\text{Total Debt}}{\text{Total shareholders' equity}}$
5. Debt-to-Capital = $\frac{\text{total debt}}{\text{total debt}+\text{total equity}+\text{preference}}$
6. Debt-to-Assets = $\frac{\text{total Debt}}{\text{Total Assets}}$
7. Financial leverage = $\frac{\text{average Assets}}{\text{Average Equity}}$ = A/E

Cash Flow Statements
Analyzing Statements of Cash Flows I
Analyzing Statements of Cash Flows II

1. FCFF = NI + Interest [1-tax] + Depreciation – Working Capital Investment - FC Investment
2. FCFE = CFO – FC Inv + Net Borrowing

Performance Ratio:

1. Cash flow to Revenue = $\frac{\text{CFO}}{\text{net revenue}}$
   Cash return on Asset = $\frac{\text{CFO}}{\text{average total assets}}$
2. Cash return on Equity = $\frac{\text{CFO}}{\text{average total equity}}$
3. Cash to Income = $\frac{\text{CFO}}{\text{operating income}}$
4. Cash flow per share = $\frac{\text{CFO}-\text{preferred div.}}{\text{wtd average of common share}}$

Coverage Ratio:

1. Debt coverage = $\frac{\text{CFO}}{\text{total debt}}$
2. Interest coverage = $\frac{\text{CFO}+\text{int paid}+\text{taxes paid}}{\text{int paid}}$
3. Reinvestment Ratio = $\frac{\text{CFO}}{\text{cash paid for long}-\text{term assets}}$
4. Debt payment ratio = $\frac{\text{CFO}}{\text{cash long term debt repay}}$
5. Dividend payment = $\frac{\text{CFO}}{\text{dividends paid}}$
6. Investing & Financing = $\frac{\text{CFO}}{\text{Cash outflows from CFI}+\text{CFF}}$

Financial Analysis Techniques

1. Vertical common-size income statement ratios = $\frac{\text{Income statement accounts}}{\text{Sales}}$
2. Vertical common-size balance-sheet ratios = $\frac{\text{Balance sheet accounts}}{\text{Total assets}}$

Activity:

3. Receivable turnover = $\frac{\text{Annual sales/Credit sales}}{\text{Average receivables}}$
4. Days of sales outstanding = $\frac{365}{\text{Receivables Turnover}}$
5. Inventory Turnover = $\frac{\text{COGS}}{\text{average inventory}}$
6. Days = $\frac{365}{\text{inventory turnover}}$
7. Payables turnover = $\frac{\text{purchases}}{\text{average payables}}$
8. Days = $\frac{365}{\text{payables turnover}}$
9. Total Asset Turnover = $\frac{\text{Revenue}}{\text{average total assets}}$
10. Fixed Asset Turnover = $\frac{\text{Revenue}}{\text{average net fixed assets}}$
11. Working Capital Turnover = $\frac{\text{Revenue}}{\text{average working capital}}$

Profitability:

12. Net profit margin = $\frac{\text{Net income}}{\text{revenue/sales}}$

    Net Income = Earnings after takes but before div.

    Total Cap = long -term + short term debt + common & preferred equity = Total Assets E+L = A

13. Gross profit Margin = $\frac{\text{GP}}{\text{Revenue}}$
14. Operating profit Margin = $\frac{\text{Operating income}}{\text{Revenue}}$
15. Pretax Margin = $\frac{\text{EBT}}{\text{sales}}$
16. ROA = $\frac{\text{Net income}}{\text{average total asets}}$ or $\frac{\text{Net income+intex}\,(1-t)}{\text{average total assets}}$
17. Operating return on total assets = $\frac{\text{EBIT}}{\text{average total assets}}$
18. ROTC = $\frac{\text{EBIT}}{\text{Average total capital}}$ (E+D+P)
19. ROE = $\frac{\text{Net Income}}{\text{Average total equity}}$
20. Return on common Equity = $\frac{\text{net income}-\text{preferred div.}}{\text{average common Equity}} = \frac{\text{EAFESH}}{\text{Equity}}$

Liquidity:

21. Current Ratio = $\frac{\text{Current Assets}}{\text{Current Liabilities}}$
22. Quick Ratio = $\frac{\text{CA+marketable securities+receivables}}{\text{Current Liabilities}}$
23. Cash Ratio = $\frac{\text{cash+marketable securities}}{\text{Current Liabilities}}$
24. Defensive Interval = $\frac{\text{cash+marketable securites+receivables}}{\text{average daily expenditures}}$
25. Cash conversion cycle = Days sales outstanding + Days of inventory on hand – Days of payable

Solvency:

26. Debt-to-Equity = $\frac{\text{Total Debt}}{\text{Total shareholders equity}}$

27. Debt-to-Capital = $\frac{\text{total debt}}{\text{total debt+total equity}}$

28. Debt-to-Assets = $\frac{\text{total Debt}}{\text{Total Assets}}$

29. Financial leverage = $\frac{\text{Average Assets}}{\text{Average Equity}}$ = A/E

30. Interest coverage = $\frac{\text{Earning Before Interest \& Taxes}}{\text{interest payments}}$

31. Fixed charge coverage = $\frac{\text{EBIT+lease payments}}{\text{interest+lease payments}}$

DuPont System of Analysis:

1. ROE = $\frac{\text{Net Income}}{\text{Sales}} \times \frac{\text{Sales}}{\text{Asset}} \times \frac{\text{Assets}}{\text{Equity}}$
2. ROE = $\frac{\text{PAT}}{\text{PBT}} \times \frac{\text{PBT}}{\text{EBIT}} \times \frac{\text{EBIT}}{\text{SALES}} \times \frac{\text{SALES}}{\text{ASSETS}} \times \frac{\text{A}}{\text{E}}$

Dividends:

3. G = RR ×ROE
4. Retention Rate = 1 - Dividend Payout Ratio
5. Dividend Payout Ratio = $\frac{\text{Dividends}}{\text{Net income available to common shareholder}}$

Inventories
Analysis of Inventories

1. Cost of Goods Sold (COGS) = Beginning inventory + purchases – ending inventory
2. FIFO COGS = LIFO COGS – (ending LIFO reserve – beginning LIFO reserve)
3. Weighted Average Cost –

   Cost per unit is calculated using this formula =

   $\frac{\text{Total Cost of Goods Available for sale (Opening Inventory + Purchases)}}{\text{Total Quality Available for sale}}$
4. Ending Inventory = Beginning Inventory + Purchases – COGS

Long Lived Assets
Analysis of Long-Term Assets

1. SL Depreciation expense = $\frac{\text{Original Cost} - \text{Salvage value}}{\text{Depreciable life}}$

2. DDB depreciation in year = $\left(\frac{2}{\text{useful life}}\right)$ (Cost – Accumulated Depreciation)

3. Unit – of – production depreciation =

   $\frac{\text{Original Cost} - \text{Salvage value}}{\text{Life in output units}} \times \text{output units in the period}$

4. Average Age = $\frac{\text{Accumulated Depreciation}}{\text{Annual Depreciation Expense}}$

5. Total Useful Life = $\frac{\text{Historical Cost}}{\text{Annual Depreciation Expense}}$

6. Remaining Useful Life = $\frac{\text{Ending Net PP\&E}}{\text{Annual Depreciation Expense}}$

Income Taxes
Analysis of Income Taxes

1. Income tax Expense = taxes payable + ΔDTL - ΔDTA

2. DTA = Tax expense < Tax payable

3. DTL = Tax expense < Tax payable

4. Interest Expense = (the market rate at issue) x (the balance sheet value of the liability at the beginning of the period)

5. Effective Tax Rate = $\frac{\text{Income Tax Expense}}{\text{Pretax Income}}$

Non-Current Liabilities (Long Term)
Topics in Long-Term Liabilities and Equity

1. CR = MR (At par)

   CR > MR (Premium)

   CR < MR (Discount)

2. Ending Book value = Beginning book value + Interest expense – coupon
3. Interest expense = BV of bond at inception (issuance) × market rate at the time of issuance
4. Balance Sheet Liability:

   BV Ending = BV Beginning + (Interest Expense – Coupon)

5. Interest Expense = Market Rate at Issue × Balance Sheet Value at Liability at beginning of the period.
6. **Leverage Ratios:**
   - Debt/ Asset Ratio = $\frac{\text{Total Debt}}{\text{Total Assets}}$
   - Debt/ Capital Ratio = $\frac{\text{Total Debt}}{(\text{Total Debt}+\text{Total Equity})}$
   - Debt to Equity Ratio = $\frac{\text{Total Debt}}{\text{Total Equity}}$
   - Financial Leverage Ratio = $\frac{\text{Average Total Assets}}{\text{Average Total Equity}}$
7. **Coverage Ratios:**
   - Interest Coverage = $\frac{\text{EBIT}}{\text{Interest Payments}}$
   - Fixed Charge Coverage = $\frac{\text{EBIT}+\text{Lease payments}}{\text{Interest payments}+\text{lease payments}}$
   - Debt Coverage = $\frac{\text{CFO}}{\text{Total Debt}}$
   - Reinvestment = $\frac{\text{CFO}}{\text{Cash paid for long}-\text{term assets}}$
   - Debt Payment = $\frac{\text{CFO}}{\text{Cash long}-\text{term debt repayment}}$
   - Dividend Payment = $\frac{\text{CFO}}{\text{Dividend Paid}}$
   - Investing and Financing = $\frac{\text{CFO}}{\text{Cash outflows from Investing and Financing activities}}$

Corporate Finance

Working Capital Management

1. Current Ratio = $\frac{\text{Current Asset}}{\text{Current Liabilities}}$
2. Quick Ratio OR Acid Test Ratio= $\frac{\text{Cash + Short Term marketable Securities+receivables}}{\text{Current Liabilities}}$
3. Receivable Turnover = $\frac{\text{Credit Sales}}{\text{Avarage Receivables}}$
4. No of days of receivable = $\frac{365}{\text{Receivables turnover}} = \frac{\text{Average Recoverables}}{\text{Average Day's credit sales}}$
5. Inventory turnover = $\frac{\text{COGS}}{\text{Average Inventory}}$
6. No of days of inventory = $\frac{365}{\text{inventory turnover}} - \frac{\text{Average Inventory}}{\text{Average day's of COGS}}$
7. Payables turnover ratio = $\frac{\text{Purchases}}{\text{Average trade payables}}$
8. No of days of payable = $\frac{365}{\text{payable turnover ratio}} = \frac{\text{Average payables}}{\text{Average Day's of purchases}}$
9. Operating cycle = days of inventory + days of receivables
10. Cash conversion cycle = (Average days of receivables) + (Average days of inventory) – (Average days of payables)
11. Discount basis yield (Bank Disc yield) = $\left(\frac{\text{Face Value}-\text{Price}}{\text{Face Value}}\right) \times \frac{360}{\text{days}}$
12. Money Market Yield = $\left(\frac{\text{Face Value}-\text{Price}}{\text{Face Value}}\right) \times \frac{360}{\text{days}}$ = HPY x $\frac{360}{\text{days}}$
13. Bond Equivalent Yield = $\left(\frac{\text{Face Value}-\text{Price}}{\text{Face Value}}\right) \times \frac{365}{\text{days}}$ = HPY x $\frac{365}{\text{days}}$
14. Cost of trade credit = $\left(1 + \frac{\%\text{ discount}}{1-\%\text{ discount}}\right)^{\frac{365}{\text{days past discount}}} - 1$

    Or, $\left(\frac{P_1}{P_0}\right)^{365/n} - 1$

    (Day past discount = no of days after the end of discount period)

Equity Investments

Equity Valuation: Concepts and Basic Tools

1. Dividend discount model:

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

2. Preferred stock value = $\frac{D_P}{(1+K_P)^1} + \frac{D_P}{(1+K_P)^2} + \cdots \ldots + \frac{D_P}{(1+K_p)^\alpha} = \frac{D_P}{K_P}$

3. FCFE = Net Income + Depreciation – Increase in working Capital - Fixed Capital Investment – debt principal repayments + new debt issues

4. $P_0 = \frac{D_1 + P_1}{1 + K_e}$

5. $P_0 = \frac{D_1}{K_e - g} = \frac{Do\ (1+g)}{K_e - g}\ [K_e > g]$

   g = constant growth rate

   Also, $K_e = \frac{D_1}{P_0} + g$

   K_e = investor required rate

6. Gordon growth model:

$$V_0 = \frac{D_0(1+g_c)}{1+K_e} + \frac{D_0(1+g_c)^2}{(1+K_e)^2} + \frac{D_0(1+g_c)^3}{(1+K_e)^3} + \cdots + \frac{D_0(1+g_c)^\infty}{(1+K_e)^\infty}$$

7. $P_0 = \frac{D_1}{1+K_e} + \frac{D_2}{(1+K_e)^2} + \frac{D_3}{(1+K_e)^3} + \frac{\frac{D_4}{K_e - g}}{(1+K_e)^3};\ \frac{D_4}{K_e - g} = P_4$

   when the growth rate of dividend is constant:

$$V_0 = \frac{D_0(1+g_c)}{K_e - g_c} = \frac{D_1}{K_e - g_c}$$

8. Multistage dividend discount model:

   Value = $\frac{D_1}{1+K_e} + \frac{D_2}{(1+K_e)^2} + \cdots + \frac{D_n}{(1+K_e)^n} + \frac{P_n}{(1+K_e)^n}$

   Where , $P_n = \frac{D_{n+1}}{K_e - g}$

9. $\frac{P_0}{E_1}$ = leading /expected PE Ratio

   $\frac{D_1/E_1}{K_e - g}$ [Dividend Payout Ratio $= D_1/E_1$]

   $\left[{}^{P_0}/_{E_0} - \text{lagging / historical PE ratio}\right]$

10. Sustainable growth = ROE x (1 – dividend payout ratio)

11. P/BV ratio (Price / book Value Ratio) = $\frac{\text{market value of equity}}{\text{book value of equity}} = \frac{\text{market price per share}}{\text{book value per share}}$

    Book value of equity = (total assets – total liabilities) - preferred stock

12. P/S Ratio (Price to Sale Ratio) = $\frac{\text{Market Value of Equity}}{\text{Total Sales}}$

13. Enterprise Value = Market value of stocks + Market value of debt – Cash and short term investments.

Market Organization and Structure

1. Margin call price = $P_0 \left(\frac{1-\text{Initial margin}}{1-\text{maintenance margin}}\right)$ P_0 = Initial purchase price

Security Market Index

1. Return index: $R_P = [(1+R_{S1})\,(1+R_{S2})(1+R_{S3})\ldots..(1+R_{SK})]-1$
2. Price weighted Index = $\left[\frac{\sum P_1}{n}\right]$
3. Equal weighted Index = $\left[\frac{\sum\left(\frac{P_1}{P_0}-1\right)}{n}\right]$
4. Market Capital weighted Index = $\left[\frac{\sum P_1 Q_1}{\sum P_0 Q_0}-1\right]$
5. Current index value = $\frac{\text{current total market value of index stocks}}{\text{base year total market value of index stocks}} \times \text{base year index value}$
6. Free float Adjusted Market Capital wtd Index = $\left[\frac{\sum P_1 Q_1 ff}{\sum P_0 Q_0 ff}-1\right]$

Overview of Equity Securities

1. ROE = $\frac{NI_t}{(BV_1+BV_{t-1})/2}$

   ROE = $\frac{NI_t}{BV_{t-1}/2}$
2. DDM: $R_e = \frac{D_1}{P_o} + g$
3. CAPM: $R_F + (R_m - R_F)\,\beta$
4. Market Price $\frac{C_1}{(1+r)} + \frac{C_2}{(1+r)2} + \ldots\ldots$

Fixed Income

Fixed-Income Instrument Features
Fixed-Income Cash Flows and Types

1. Conversion Ratio = $\frac{\text{Par Value of the Bond}}{\text{Conversion Price}}$
2. Conversion Value = Conversion Ratio $\times$ Current Market Price of a Common Share

Fixed-Income Bond Valuation: Prices and Yields
Yield and Yield Spread Measures for Fixed-Rate Bonds
Yield and Yield Spread Measures for Floating-Rate Instruments
The Term Structure of Interest Rates: Spot, Par, and Forward

1. Full price = flat price + accrued interest
2. Cash price = quoted price + accrued interest
3. Dirty price = clean price + accrued interest
4. G-spread = $YTM_{Bond} - YTM_{Treasury}$
5. Option value = Z-spread – OAS
6. An annual-coupon bond with N years maturity:

   Price = $\frac{\text{Coupon}}{1+\text{YTM}} + \frac{\text{Coupon}}{(1+\text{YTM})^2} \dots\dots\dots \frac{(\text{Coupon} + \text{principal})}{(1+\text{YTM})^N}$

7. A semiannual-coupon bond with N years maturity:

   Price = $\frac{Coupon}{1+\frac{YTM}{2}} + \frac{Coupon}{(1+\frac{YTM}{2})^2} \dots\dots\dots \frac{(Coupon + \text{principal})}{(1+\frac{YTM}{2})^{N\times 2}}$

8. No arbitrage price = $\frac{CF_1}{1+S_1} + \frac{CF_2}{(1+S_2)} \dots\dots\dots \frac{(\text{CF} + \text{principal})}{(1+\text{Sn})^n}$
9. Simple Yield = $\frac{\text{coupon} \pm \frac{\text{discount/premium}}{n}}{\text{Bond price}}$ $\rightarrow$ Does not matter quarterly or semi-annually
10. Current Yield = $\frac{\text{anual coupon payment}}{\text{Bond price}}$
11. Option Value = Zspread – OAS (Option Adjusted Spread)

Fixed-Income Securitization
Asset-Backed Security (ABS) Instrument and Market Features
Mortgage-Backed Security (MBS) Instrument and Market Features

1. Debt-to-service = $\frac{\text{NOI}}{\text{debt service}}$; where debt service = principal + interest
2. Loan-to-value = $\frac{\text{current mortgage amount}}{\text{current appraised value}}$
3. Annualized Conditional prepayment rate (CPR) = $1 - (1\text{-SMM})^{12}$
4. Single month mortality (SMM) = $1 - (1\text{-CPR})^{1/12}$

Interest Rate Risk and Return
Yield-Based Bond Duration Measures and Properties
Yield-Based Bond Convexity and Portfolio Properties
Curve-Based and Empirical Fixed-Income Risk Measures

1. Macaulay's Duration = wtd. Average of time, where W= PV of CF = $\frac{\Sigma wx}{\Sigma w}$

   Modified Duration = $\frac{\text{macaulay's duration}}{1+\text{ytm}/m}$ ⟶ Compounding frequency
2. Modification Duration ≅ E.D. [only for option free bonds]
3. Effective Duration (E.D.) = $\frac{P_2 - P_1}{2\Delta Y\, P_0}$; ΔY= change in YTM
4. Effective Convexity (E.C.) = $\frac{P_2 + P_1 - 2P_0}{P_0\, (\Delta Y)^2}$
5. Convexity adjustment = $\frac{1}{2}$ x EC x $(\Delta Y)^2$
6. Money duration = annual modification duration x full price of bond position
7. Portfolio duration = $\Sigma w_i d_i$; W_i= market value rates
8. Change in full bond price = (-E.D. x ΔY) + $\frac{1}{2}$ x Ec x $(\Delta Y)^2$
9. Duration gap = Macaulay's duration – investment horizon
10. Price Value of a Basis Point (PVBP) = $\frac{P_2 - P_1}{2}$

Credit Risk
Credit Analysis for Government Issuers
Credit Analysis for Corporate Issuers

1. Expected loss = exposure × prob of default (default risk) x loss severity (1-RR)
2. Credit risk = default risk + loss severity (1-RR)
3. Yield Spread = $YTM_{\text{Credit risky bond}} - YTM_{\text{risk free bond}}$ Or,

   Yield spread = liquidity premium + credit spread (will widen) affected by 2 factors:
   - credit wordiness ↓(credit migration / downgrade risk)
   - Market liquidity risk.
4. Enterprise Value = Equity + Debt – Cash and Marketable Securities
5. Leverage Ratios:
   - Debt/Capital
   - Debt/EBITDA
   - FFO/Debt
   - FCF after dividends/Debt
6. Coverage Ratios:
   - EBITDA/ Interest Expense
   - EBIT/Interest Expense

Derivatives

Derivative Instruments and Derivative Markets

1. Risk free Asset = Risky Asset + Derivatives

   Forward = Spot + Storage + Int – Benefit

   → Spot $(1+\mathrm{Rf})^t$ FV (storage - benefit)

   →{s+ PV (storage - benefit)} (1+Rf)

2. IM = $\mu + 3\sigma$

   μ ↓ Avg daily movement

   σ → Volatility of the movement

   $V_{swap} = V_{\text{Floating rate bond}} - V_{\text{Fixed rate bond}}$

Forward Commitment and Contingent Claim Features and Instruments

1. Forward Price = Spot + Interest Cost + Storage Cost -Benefits.

   $= \mathrm{Spot}(1+\mathrm{R_F})^{\mathrm{T}} + \mathrm{FV}(\mathrm{Storage} - \mathrm{Benefit})$

2. The forward price of an asset to be delivered at time T is:

   $\mathrm{F_0(T)} = \mathrm{S_0}(1+\mathrm{Rf})^{\mathrm{T}}$

3. The value of a forward contract is zero at initiation:

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

4. Payoff to FRA = $\frac{(\text{market rate} - \text{contracted rate}) \text{x NPx} \frac{n}{12}}{1 + (\text{market rate x } \frac{n}{12})}$ $* \frac{n}{360}$ if no. of days

5. U = up factor

   D = $\frac{1}{U}$

   Probability risk neutral = $\lambda u = \frac{(1+\mathrm{Rf})^{\mathrm{T}} - \mathrm{D}}{\mathrm{U} - \mathrm{D}}$

   $\lambda D = 1 - \lambda U$

   Call option value = $(\lambda u \times C_1^+) + (\lambda D \times C_1^-)$

   ∴ Today value = (co) = $\frac{\text{call option value}}{(1+\mathrm{Rf})}$

6. Option premium = intrinsic value + time value

7. Put call parity = $C_o + \frac{X}{(1+RF)^T} = P_o + S_o$

8. Put call forward parity = $C_o + \frac{X}{(1+RF)^T} = P_o + \frac{F}{(1+RF)^T}$

   $\rightarrow C_o - P_o = \frac{F-X}{(1+RF)^T}$

Introduction to Alternative Investments

1. Future Price = Spot Price x $\underbrace{\boxed{(1+\text{risk free rate}) + \text{Storage Costs}}}_{\text{Cost of carry}}$ - convenience yield

Net cost of carry

2. Contango = Cost of Carry > Benefit

   Backwardation = Cost of Carry < Benefit

3. Sortino Ratio = $\frac{R_P - R_{MAR}}{\sqrt{MSD}}$

   R_{MAR} → Mean acceptable return

   MSD → Mean square deviation

4. **Value of Real Estate**

Income Based Approach:

a) $\frac{\text{Net Operating Income (NOI)}}{\text{Cap Rate}}$ Cap Rate = $R_e - g$ → estimated growth rate

5. Value of REIT – Income Based

 Net Income

+Depreciation

-Gains from sold property

+Sales from property sold

Portfolio

Portfolio management: An Overview

1. Diversification Ratio = $\frac{\text{Risk of equally weighted portfolio of 'n' securities}}{\text{Risk of single security at random from 'n' securities}}$

Portfolio Risk and Return: Part I

1. Holding period return = $\frac{\text{end of period value}}{\text{beginning of period value}} - 1$
2. Arithmetic mean return = $\frac{(R_1+R_2+R_3+\cdots+R_n)}{n}$
3. Geometric mean return = $\sqrt[n]{(1+R_1)\times(1+R_2)\times(1+R_3)\ldots\times(1+R_n)} - 1$
4. Population variance: $\sigma^2 = \frac{\sum(x-\bar{x})^2}{n}$
5. Sample variance: $\sigma^2 = \frac{\sum(x-\bar{x})^2}{n-1}$
6. Cov = $\sum(X - E_x)(Y - E_y) \times P$
7. $R_p = \sum W_i R_i$ and $E_{R_p} = \sum W_i E_{R_i}$
8. $Cov_{1,2} = \frac{\sum(R_{t,1}-\bar{R}_1)(R_{t,2}-\bar{R}_2)}{n-1} = \frac{\sum(x-\bar{x})(y-\bar{y})}{n-1}$
9. $\rho_{x,y} = \frac{Cov(x,y)}{\sigma_x\sigma_y}$
10. $\sigma_P = \sqrt{\sigma_P^2} = \sqrt{\sum w^2\sigma^2 \sum w_i w_j Cov_{i,j}}$

$\sigma_P = \sqrt{w_1^2\sigma_1^2 + w_2^2\sigma_2^2 + 2w_1w_2\sigma_1\sigma_2 r_{1,2}}$

$\sigma_P = \sqrt{w_1^2\sigma_1^2 + w_2^2\sigma_2^2 + 2w_1w_2Cov_{1,2}}$

$\sigma_P = \sqrt{w_1^2\sigma_1^2 + w_2^2\sigma_2^2 + w_3^2\sigma_3^2 + 2w_1w_2Cov_{1,2} + 2w_2w_3Cov_{2,3} + 2w_1w_3Cov_{1,3}}$

11. P/L from securities <u>- Commission and other Brokerage Expenses</u>

    Gross Return <u>- Management and Administration Fees</u>

    Net Return

12. After tax return = Pre-tax return (1-t)
13. Leveraged Return = $\frac{\frac{\text{gain}}{\text{loss}}\text{on Total Investment}}{\text{Investor's Cash Investment}}$
14. Investor's Utility Function:

$U = E(R) - \frac{1}{2} A \ \sigma^2$

Utility

Return (+ve)

Risk Aversion (-ve)

Risk (-ve)

(-ve)	0	(+ve)
Risk Seeking	Risk Neutral	Risk Averse

Portfolio Risk and Return: Part II

1. $E(R_P) = (1 - w_m)R_f + w_m R_m$

   $= R_f + w_m (R_m - R_f)$

   $\sigma_P = \sqrt{(1-w_m)^2 \sigma R_f^2 + w_m^2 \sigma_m^2 + 2(1-w_m)\sigma_{Rf}\sigma_{Rm} r_{Rf}, R_m}$

   For R_f, $\sigma = 0$ and $Cov = 0$

   $\therefore \ \sigma_P = \sqrt{w_m^2 \sigma_m^2} = \sigma_m w_m$

   $\therefore w_m = \frac{\sigma_p}{\sigma_m}$

2. Capital market line:

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

3. $E(R_i) = R_f + \frac{E(R_m) - R_f}{\sigma_m^2} \times Cov_{i,m}$

   Or $E(R_i) = R_f + \frac{Cov_{i,m}}{\sigma_m^2}[E(R_m) - R_t]$

4. $\beta = \frac{Cov_{i,m}}{\sigma_m^2} = r\frac{\sigma_i}{\sigma_m}$

5. Market Model:

   $R_i = \alpha_i + \beta_i R_m + \varepsilon_i$

6. Total risk = systematic risk + unsystematic risk

7. Single factor model:

   $E(R_i) - R_f = \beta_i \times [E(R_m) - R_f]$

8. Risk free portfolio: $W_A = \frac{\sigma_B}{\sigma_A + \sigma_B}$

9. Security Market Line:

   $R_e = R_f + \frac{Cov_{i,mkt}}{\sigma_{mkt}^2}(R_m - R_f)$

10. M - Squared = $(R_p - R_f)\frac{\sigma_m}{\sigma_p} - (R_m - R_f)$

11. Sharpe Ratio = $\frac{R_p - R_f}{\sigma_p}$

12. Treynor measure = $\frac{R_p - R_f}{\beta_P}$

13. Jensen's Alpha = $R_p - CAPM$