Rates and Returns

2. INTEREST RATES AND TIME VALUE OF MONEY

The Time Value of Money

Cash now is preferred over future cash.

Interest Rate (r)

is used to compare financial instruments with varied payment timings.

Interest Rate Interpretations Ways:

1. **Required Return:** The minimum expected return on an investment.
2. **Discount Rate:** Used for calculating present value from future values.
3. **Opportunity Cost:** The foregone return from spending rather than saving or investing.

Determinants of Interest Rates

***r** = Real Risk-free rate + Inflation Premium + Default risk Premium + Liquidity premium + Maturity Premium*

1. **Real Risk-Free Rate:** Interest rate in a no-inflation, risk-free scenario.
2. **Inflation Premium:** Adjustment for expected inflation.
3. **Default Risk Premium:** Compensates for the issuer's potential default.
4. **Liquidity Premium:** Covers risks related to quick asset liquidation.
5. **Maturity Premium:** Accounts for increased risks in long-term investments.

3. RATES OF RETURN

Two types of financial asset returns are:
1) periodic income (cash dividends or interest payments)
2) capital gain or loss (changes in the price of a financial asset).

Holding Period Return (HPR)

Measures the return over a specific period.

Calculated as:

$$R = \frac{(P_1 - P_0) + I_1}{P_0}$$

For periods longer than a year, HPR is compounded annually.

Arithmetic Mean Return

Sum of all returns divided by the total observations.

Advantages: Easy to compute, commonly used, and facilitates standard deviation calculations to assess variability.

Geometric Mean Return

Compound growth rate over multiple periods.

Suitable for a "buy-and-hold" strategy.

Calculated as:

$$\overline{R}_{Gi} = \sqrt[T]{(1 + R_{i1}) \times \ldots (1 + R_{iT})} - 1$$

Advantage: Provides a more accurate measure of long-term investment returns.

Harmonic Mean Return

Sum of all returns divided by the total observations.

Used in cost averaging strategies, where fixed amounts are invested periodically.

Advantage: Harmonic mean is lower than geometric & arithmetic means when data is variable.

Additional Means for Handling Data Variability

Trimmed Mean: Excludes a small % of the extreme values from both ends of a dataset before calculating the mean.

Winsorized Mean: Assigns specified values to the extreme ends of a dataset before averaging, mitigating the impact of outliers.

4. MONEY-WEIGHTED AND TIME-WEIGHTED RETURN

Metric	Money-Weighted Return (MWR)	Time-Weighted Return (TWR)
Definition	Compound growth rate of all funds over the entire evaluation period	Compound rate of growth for one unit of initially invested money over a specified evaluation period
Formula	$\sum_{t=0}^{T} \frac{CF_t}{(1+IRR)^t} = 0$	Time weighted return = $r_{twr} = [(1 + rt,1) \times (1 + rt,2) \times \ldots \times (1 + rt,n)]^{1/N} - 1$
Representation	Internal Rate of Return (IRR)	Actual rate of return earned by the portfolio manager
Consideration of Cash Flows	Takes into account the timing and size of cash flows	Does not consider the timing and size of cash flows
Comparative Analysis	Can be used to compare different investments with varying cash flow patterns	Cannot be used to compare different investments
Common Usage	-	More commonly used to evaluate portfolio manager performance
Sensitivity to Cash Flows	Sensitive to timing and size of cash flows	Not sensitive to timing and size of cash flows
Comparative Capability	Can compare performance of different investments	Cannot compare performance of different investments
Limitations	Cannot compare returns between different individuals or investment opportunities	Requires determining account value for each cash flow, potentially incurring costs

5. ANNUALIZED RETURN

Annualized Return

- Return that would have been earned if a given investment was compounded over a one-year period.
  $r_{annual} = (1 + r_{period})^c - 1$
- Converts short-term returns to an annual basis,
- Standardizes return comparisons across time and investment types.
- Compounded differently based on the period (monthly, quarterly, weekly, daily)
- **Limitation:** Assumes constant reinvestment at similar rates.

Continuously Compounded Rates of Return

- Returns that would have been earned if an investment was compounded continuously, rather than at discrete intervals.
- For Single Period:
  $r_{t,\ t+1} = \ln(1 + \text{holding period return})$ *or*
  $r_{t,\ t+1} = \ln(\text{price relative}) = \ln(S_{t+1} / S_t)$
- For Multiple Period:
  $R_{0,T} = \ln(S_T / S_0)$
- Continuously compounded returns are always lower than associated holding period returns
- Offers a refined view of returns, especially valuable in financial modeling and analysis.

6. OTHER MAJOR RETURN MEASURES AND THEIR APPLICATIONS

Gross and Net Return

Gross Return: Total return minus direct trading expenses. It is used to evaluate investment skills.

Net Return: Gross return minus all managerial and administrative expenses. Net return reflects the actual return earned by investors.

Pre-Tax and After-Tax Nominal Return

There is different taxation for capital gains and income returns. Long-term capital gains typically receive favorable tax treatment

After-Tax Nominal Return: is calculated by subtracting taxes on dividends, interest, and realized gains from the total return.

Tax minimization strategies include selecting tax-favored securities and reducing trading turnover

Real Returns

Real returns:

- accounts for inflation and risk premium.
- provide a more accurate gauge of purchasing power

Real Return = $(1 + r)$ = $(1 + r_{rF}) \times (1 + \pi) \times (1 + RP)$

After-Tax Real Return are useful for comparing returns across different periods and countries.

Leveraged Return

Amplifies underlying security returns through futures contracts or borrowing funds.

Magnifies returns but heightens risk. - Impact varies based on leverage method.

The Time Value of Money in Finance

1. INTRODUCTION

- **Financial Choices:** Individuals face decisions related to savings, borrowing, and cost assessment.
- **Money's Time Value:** Money received today is more valuable than the same amount in the future.

2. TIME VALUE OF MONEY IN FIXED INCOME AND EQUITY

Fixed-Income Instruments

- **Cash flow timing** affects instrument value, with earlier inflows being more valuable.
- **Discount Rate (r):** Determines the present value (PV) of future cash flows.
- **PV and FV relationship:**
  FV with regular compounding: $FV_t = PV(1+r)^t$
  FV with continuous compounding: $FV_t = PV\, e^{rt}$
  PV in terms of FV: $PV = \frac{FV_t}{(1+r)^t}$ or $PV = FV\, e^{-rt}$ *for continuous time*

Types of Fixed-Income Instruments

a) **Discount Instrument:** Investor buys at PV, receives FV at maturity. PV = $\frac{FV_t}{(1+r)^t}$

b) **Coupon Instrument:** Involves periodic interest payments (PMT).

$$PV = \frac{PMT_1}{(1+r)^1} + \frac{PMT_2}{(1+r)^2} \cdots \frac{PMT_N + FV_N}{(1+r)^1}$$

c) **Annuity Instruments:** Involve regular uniform payments (A). $A = \frac{r(PV)}{1-(1+r)^{-t}}$.

d) **Perpetual Bonds:** Have no maturity date. PV= PMT/r

Equity Instruments

Equity investments offer ownership in a company, attracting investors to potential dividends.

- They have no set maturity date, existing until company events like sale, restructuring, or liquidation.

Types of Equity Instruments

Three common valuation approaches based on dividend cash flows are:

1. **Constant Dividends:** Investor buys stock and receives a consistent dividend.
$$PV_t = \frac{D_t}{r}$$
2. **Constant Dividend Growth Rate:** A stock is bought at a price, and the dividend starts from one period and grows consistently at a rate g.
$$PV_t = \frac{D_t(1+g)}{(r-g)}$$
3. **Changing Dividend Growth Rate:** Dividends initially grow rapidly but slow down over time as the company matures.
   - Two-stage model: High growth rate for a few years, followed by a slower, constant rate.
$$PV_t = \sum_{i=1}^{n} \frac{D_t(1+g_s)^i}{(1+r)^i} + \frac{E(S_{t+n})}{(1+r)^n}$$

3. IMPLIED RETURN AND GROWTH

Implied Return is the return that an investor expects to earn on an investment over time.

$$Implied\ Return = \frac{\text{PV of all future cash flows from investment}}{\text{Current market price of investment.}}$$

Implied Return for Fixed-Income Instruments

- Implied return for fixed income instruments is its yield-to-maturity (YTM)
- YTM equates PV of all future cash flows to the current market price.
- For Discount Bond r =

$$r = \left(\frac{FV_t}{PV}\right)^{1/t} - 1$$

- For Coupon Bond: YTM requires iterative methods using equation:
- PV (Coupon Bond) = $\sum_{i=1}^{N} \frac{PMT_i}{(1+r)_i}$

Implied Return & Growth for Equity Instruments

Stock prices reflect both the required return and growth in cash flows.

- Implied Return r = $\frac{D_t(1+g)}{PV_t} + g$
- Implied Growth $g = r - \frac{D_{t+1}}{PV_t}$

Price-to-Earnings Ratio (P/E)

- links share price to EPS.
- $\frac{PV_t}{E} = \frac{D_t}{E_t} \times \frac{(1+g)}{r-g}$, indicating the dividend payout ratio
- can determine r or implied dividend growth rate, given the other factor.

Forward P/E Ratio relates share price to projected earnings for the next period.

$$\frac{PV_t}{E_{t+1}} = \frac{\frac{D_{t+1}}{E_{t+1}}}{r-g}$$

Forward P/E Ratio is

- ***positively*** influenced by higher expected dividend payout and higher growth
- ***negatively*** influenced by higher required r.

4. CASH FLOW ADDITIVITY

Cash Flow Additivity Principle:

- States that the PV of a series of future cash flows is equal to the sum of the PV of each individual cash flow.
- Ensures market prices prevent riskless profit without transaction costs.

Implied Forward Rates Using Cash Flow Additivity

- Used in risk-free discount bonds to compare different investment strategies.
- Ensures that forward rates are set to prevent arbitrage profits.
- **Example**: Calculating the implied forward rate for a two-year bond from one-year and two-year bond yields.

$$FV_{2\ yrs} = FV_{1\ yr}\left(1 + F_{1,1}\right)$$

Forward Exchange Rates Using No Arbitrage

- Applies the cash flow additivity principle to calculate forward exchange rates in currency markets.

$$F = S_0 \times \frac{(1 + r_U)}{(1 + r_J)}$$

- Interest Rate Parity (IRP) relationship ensures no arbitrage opportunities in the foreign exchange market.
- **Example:** Calculating forward exchange rate for Japanese yen against the US dollar.

Option Pricing Using Cash Flow Additivity

- Establishes no-arbitrage pricing for options by creating replicating portfolios that match future cash flows with a risk-free asset.
- The hedge ratio helps in determining option prices.
- **Example:** Pricing a call option involves calculating and summing the PVs of the call option's payoffs across various scenarios, considering stock price, strike price, expiration time, and stock volatility.

Statistical Measures of Asset Returns

1. INTRODUCTION

Data is vital in investment analysis but transforming it into useful information is a complex task.

2. MEASURES OF CENTRAL TENDENCY AND LOCATION

The Arithmetic Mean

Sum of all values divided by the no. of values in the dataset.

- The sum of the deviations around the mean is always equal to 0.
- It is sensitive to extreme values and can be skewed by outliers.
- **Advantages:** Uses all information, easy computation.
- **Limitations:** Highly affected by outliers.
- **Outlier Handling:** Do nothing, delete outliers, replace outliers.

The Median

- Divides a population or sample in half.
- It is not affected by extreme values.
- Time-consuming to calculate and doesn't consider the magnitude of all observations.

The Mode

The most frequent value in data.
Useful for nominal data

Unimodal - 1 mode
Bimodal - 2 modes
Trimodal - 3 modes

Other Concepts of Mean

Weighted Mean

$$\bar{X}_w = \sum_{i=1}^{n} w_i X_i = (w_1X_1 + w_2X_2 + \cdots + w_nX_n)$$

Arithmetic mean in which observations are assigned different weights.

Geometric Mean

$$G = \sqrt[n]{X_1X_2X_3 \ldots X_n}$$

- used to compute multi-periods return
- GM return over time: $R_{Geom} = [(1 + \mathrm{R}_1)(1 + \mathrm{R}_2) \ldots (1 + \mathrm{R}_n)]^{1/n} - 1$

Harmonic Mean

$$\bar{X}_H = \frac{n}{\sum_{i=1}^{n}(\frac{1}{X_i})}$$

- Effective for cost averaging strategies
- Equal $ investment at different times.

Other Means

Trimmed Mean: Excludes a percentage of the highest and lowest values.

Winsorized. Mean: Adjusts extreme values to a certain percentile value

Other Measures of Location: Quantiles

Quantiles: $L_y = [n + 1]\frac{y}{100}$

- **Quartiles**: Divide data into 4 equal parts.
- **Quintiles and Deciles**: Divide data into 5 and 10 parts, respectively.
- **Percentiles**: Divide data into 100 parts for detailed analysis.
- **Interquartile Range (IQR)**: Measures the middle 50% of data, indicating dispersion.

3. MEASURES OF DISPERSION

- Variability around the central tendency.
- Measure of risk.

Range

- Max Value – Min Value
- Easy to compute
- Doesn't tell anything about the shape of the distribution.

Mean Absolute Deviation (MAD)

- Average of absolute deviations from mean $= \frac{\Sigma|X-\bar{X}|}{n}$
- MAD is superior relative to range
- MAD is difficult to compute relative to range.

Sample Variance & Sample Standard Deviation

Sample Variance

$$s^2 = \frac{\Sigma(X-\bar{X})^2}{n-1}$$

Sample Variance

$$s = \sqrt{\frac{\Sigma(x-\bar{x})^2}{n-1}}$$

Dispersion & Relationship b/w Arithmetic & Geometric Means

$$\bar{X}_G \approx \bar{\bar{X}} - \frac{s^2}{2}$$

Downside Deviation & Coefficient of Variation

- Downside deviation is a risk measure that focuses on returns that fall below a minimum threshold.
- **Target Semi deviation** is the measure of dispersion of observations below the stated target.

$$s_{Target} = \sqrt{\sum_{for\ all\ X_i \le B}^{n} \frac{(X_i - B)^2}{n-1}}$$

Coefficient of Variation

- Coefficient of Variation (CV) measures the amount of risk (S.D.) per unit of mean value.

$$CV = \left(\frac{S}{\bar{\bar{X}}}\right)$$

- The greater the value of CV, the higher the risk

4. MEASURES OF SHAPE OF A DISTRIBUTION

Symmetrical/Normal Distribution

- Identical on both sides of the mean.
- Intervals of losses & gains exhibit the same frequency.
- Mean = Median = Mode.

Skewness

Describes a non-symmetrical distribution.

Kurtosis

Measure that tells when distribution is more or less peaked than a normal distribution.

Sample Skewness

Sum of cubed deviations from mean divided by number of observations & cubed standard deviation.

$$s_k = \frac{1}{n} \frac{\Sigma(x - \bar{x})^3}{s^3}$$

Negatively Skewed

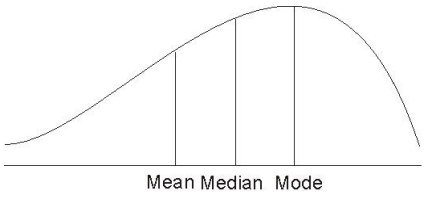
- Longer tail towards left.
- More outliers in the lower region.
- More – ve deviations.
- Mean < Median < Mode

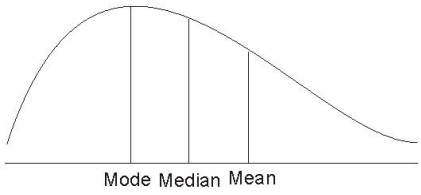
Hint

- **Median is always in the center.**
- **Mean is the direction of skew.**

Positively Skewed

- Longer tail towards right.
- More outliers in the upper region.
- More + ve deviations.
- Mean > Median > Mode.





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The Shape of the Distributions: Kurtosis

Kurtosis

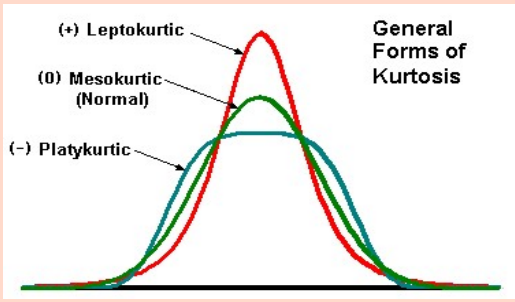
- Measure that tells when distribution is more or less peaked than a normal distribution.
- Kurtosis of normal distribution is 3.
- **Excess kurtosis** = sample kurtosis-3

$where, sample\ kurtosis\ for\ large\ n = \frac{1}{n}\frac{\Sigma(X-\bar{X})^4}{S^4}$

- Kurtosis is free of scale

Distribution	Excess Kurtosis
Leptokurtic	$\Rightarrow > 0$
Mesokurtic (Normal)	$\Rightarrow = 0$
Platykurtic	$\Rightarrow < 0$

In Leptokurtic distribution there is a higher frequency of extremely large deviations from the mean.



5. CORRELATION BETWEEN TWO VARIABLES

- **Correlation** measures the linear relationship between two variables.
- The sample covariance is calculated as: $s_{XY} = \frac{\sum_{i=1}^{n}(X_i-\bar{X})(Y_i-\bar{Y})}{n-1}$
- **Correlation coefficient** measures the *direction and strength* of linear association between two variables. $r_{XY} = \frac{covariance\ of\ X\ and\ Y}{\left(\begin{matrix}sample\ S.D\\ of\ X\end{matrix}\right)\left(\begin{matrix}sample\ S.D\\ of\ Y\end{matrix}\right)}$

Properties of Correlation

- Correlation coefficient can range from -1 to +1.
- Two variables are perfectly positively (negatively correlated if correlation coefficient is +1(-1).
- Correlation coefficient = 0 means no linear relationship.
- The closer the correlation coefficient is to +1 or -1, the stronger the relationship.

Limitations of Correlation Analysis

- Linearity
- Outliers
- No proof of causation
- Spurious Correlations
- Knowing two variables' means, S.D, and correlation is not enough.

Probability Trees and Conditional Expectations

2. EXPECTED VALUE AND VARIANCE

1. **Expected Value:** Probability-weighted average of all possible outcomes of a random variable.
2. **Variance:** It represents the expected value of squared deviations from the random variable's expected value.
   - Variance is always ≥ 0.
   - A variance of zero indicates no dispersion or risk.
   - Higher variance signifies greater dispersion or risk.
3. **Standard Deviation:** Positive square root of variance, providing a measure that is in the same units as the random variable, making it easier to interpret.

$$\sigma^2(X) = E\{[X - E(X)]^2\}$$

4. **Conditional Expected Values:** Expected value of a random variable X given a specific event or scenario S.

$$E(X|S) = P(X_1|S)X_1 + P(X_2|S)X_2 \ldots + P(X_n|S)X_n$$

5. **Conditional Variance:** Variance of a random variable given a certain event or scenario.

3. PROBABILITY TREES AND CONDITIONAL EXPECTATIONS

The Total Probability Rule for Expected Value:

$$E(X) = E(X|S)P(S) + E(X|S^C)P(S^C)$$

$$E(X) = E(X|S_1)P(S_1) + E(X|S_2)P(S_2) + \ldots + E(X|S_n)P(S_n)$$

where,

$E(X|S_i)$ = Expected value of X given Scenario i

$P(S_i)$ = Probability of Scenario i

$S_1, S_2 \ldots, S_n$ are mutually exclusive and exhaustive scenarios or events.

2. BAYES' FORMULA

Bayes' formula, also known as inverse probability, is a method for updating the probability of an event based on new information. The formula is:

$$P(Event \mid Information) = \frac{P(Information \mid Event)}{P(Information)} P(Event)$$

- The updated probability is called the posterior probability.
- If prior probabilities are equal, they are termed diffuse priors.
- When priors are equal, the probability of information given an event equals the probability of an event given the information.

Portfolio Mathematics

2. PORTFOLIO EXPECTED RETURN AND VARIANCE OF RETURN

Expected Value and Expected return on the portfolio

Expected Value: $E(w_iR_i) = w_i\ E(R_i)$

wi = weight of variable i
Ri = random variable i

Expected return on the portfolio is the weighted average of the expected returns of its components.

$E(R_p) = E(w_1R_1 + w_2R_2 + \ldots + w_nR_n)$
$= w_1E(R_1) + w_2E(R_2) + \ldots + w_nE(R_n)$

Covariance

- Measures how two assets move together.
- $Cov(R_i, R_f) = \Sigma_{i=1}^{n}[p(R_i - ER_i)(R_j - ER_f)]$
  - Positive Covariance: Returns move together.
  - Negative Covariance: Inversely related returns.
  - Zero Covariance: Unrelated returns.
- **Covariance with itself:** $Cov(R, R) = \sigma^2(R)$
- **Symmetry:** $Cov(R_i, R_j) = Cov(R_j, R_i)$
- **Covariance Matrix:** Covariance presented in square format.

Portfolio Variance

Portfolio Variance: $\sigma^2(R_p) = \sum_{i=1}^{n}\sum_{j=1}^{n}\omega_i\omega_j Cov(R_i, R_j)$

- **Diversification Benefits**: Higher with lower covariance.
- **Independent Returns**: Zero covariances lead to simple SD calculation.
- **Estimations Needed**: For n number of securities, we need n (n - 1)/2 distinct covariances. n distinct variances.

Properties of Variance

- Variance of Constant Multiplied Random Variable: $\sigma^2(w \times R) = w^2 \times \sigma^2 \times (R)$
- Variance of Constant: Zero.
- Variance with Constant Addition: Same as the variance of the random variable.
- Covariance with Constant: Zero.

Correlation

- **Calculation**: $\rho(R_i, R_j) = Cov(R_i, R_j) \div \sigma(R_i)\sigma(R_j)$.
- **Range**: Between -1 and +1.
- **Interpretations**:
  - 0: No linear relation.
  - Positive: Positive linear relation.
  - Negative: Negative linear relation.
  - +1: Perfect positive linear relation.
  - -1: Perfect negative linear relation.
- **Linear Dependency**: Indicated by the sign of correlation coefficient.
- **Limitation**: Only indicates linear relationships.

3. FORECASTING CORRELATION OF RETURNS: COVARIANCE GIVEN A JOINT PROBABILITY FUNCTION

Joint Probability Function:

$$Cov(R_A, R_B) = \sum_i \sum_j P(R_{A,i}, R_{B,j}) \left(R_{A,i} - ER_A\right)\left(R_{B,i} - ER_B\right)$$

Independent Random Variables:

Two random variables X and Y are independent *if and only if*:

P(X, Y) = P(X) P(Y).

Multiplication Rule for Expected Value of the Product of Uncorrelated Random Variables X and Y:

E (XY) = E(X) E(Y)

4. APPLICATIONS OF THE NORMAL DISTRIBUTIONS

Mean-Variance Analysis, Safety-First Rule and Sharpe Ratio

Mean-Variance Analysis:

- Assumes normal distribution of returns.

Safety-First Rule:

- Focuses on minimizing shortfall risk.
- Optimal portfolio minimizes the probability of the portfolio return falling below a specified threshold level (Roy's safety-first criterion).
- $SFRatio = [E(R_P) - R_L]/\sigma_P$
- Higher SFRatio value is preferred.

Sharpe Ratio:

- Represents the ratio of excess portfolio return to volatility.
- Portfolio with the highest Sharpe ratio minimizes the probability of the portfolio

Managing Financial Risk

Value at Risk (VAR):

- Provides the minimum expected losses over a specified time period at a given probability level.
- VAR assumes normal distribution of returns.

Stress Testing/Scenario Analysis:

- Involves techniques to estimate losses in extreme event combinations.
- Evaluates potential losses beyond typical scenarios.
- Assumes normal distribution of returns.

Common Probability Distributions

2. LOGNORMAL DISTRIBUTIONS AND CONTINUOUS COMPOUNDING

Lognormal Distributions

- A random variable is lognormally distributed if the natural logarithm of the variable is normally distributed.
- Lognormal distributions cannot take negative values, as the logarithm of a negative number is undefined.
- This distribution is positively skewed and is characterized by two parameters: mean and variance of the natural logarithm of the variable.
- **Mean (μ_L)** of a lognormal random variable = exp ($\mu + 0.50\sigma^2$).
- **Variance (σ_L^2)** of a lognormal random variable = exp ($2\mu + \sigma^2$) × [exp (σ^2) – 1].

Continuous Compounding

- Continuously compounded rates of return follow that if the return is normally distributed, the future stock price will be lognormally distributed.
- $S_T = S_0 \exp(r_{0,T})$ relates the future stock price *ST* to the current price S_0 and the continuously compounded return
- Price relative is calculated as the ending price over the beginning price, and the continuously compounded return for a holding period is the natural logarithm of the price relative.
- Continuously compounded returns are always less than the equivalent holding period returns.

Independently and identically distributed (IID).

- If one-period returns are IID with a mean μ and variance σ^2, then the expected value and variance of the *T*-period continuously compounded return are μT and $\sigma^2 T$, respectively.
- The sum of one-period returns is approximately normal due to the Central Limit Theorem, even if the individual returns are not normally distributed.

Volatility

Volatility measures the deviation of returns from their mean and is commonly estimated from historical data of continuously compounded daily returns.

Annualized volatility = sample S.D. of one period continuously compounded returns × $\sqrt{T}$

3. MONTE CARLO SIMULATION

Definition and Uses

Monte Carlo simulation involves generating random samples from a probability distribution using computer software.

Widely used for risk and return estimation in investment analysis and valuing complex securities.

Steps in Model Sensitivity Analysis

1. Specify underlying variable(s) and initial values.
2. Define the value of the option at maturity (CiT) for each simulation trial.
3. Specify the time period and distributional assumptions for key risk factors.
4. Use a model to estimate underlying variables based on random observations.
5. Calculate the option value at maturity (CiT) and discount it to obtain Ci0.
6. Repeat the process for a specified number of trials.

Accuracy

Precision depends on the number of trials; more trials increase accuracy.

Random Number Generation

Generate a uniform random number (T) between 0 and 1.

Use the inverse of the cumulative distribution function F(x) to obtain a random observation on variable X.

Role in Analysis

Monte Carlo simulation provides statistical estimates, not exact results. Used as a complement to analytical methods in modeling and analysis.

4. BOOTSTRAPPING

Resampling:

- A technique for statistical inference of population parameters by repeatedly drawing samples from the observed data.
- Used in situations where traditional analytical formulas are difficult or impossible to apply.

Bootstrapping:

- A specific type of resampling that draws samples (with replacement) from the observed data.
- Allows for statistical inference without relying on traditional formulas.
- Mimics random sampling from a population using the observed sample as the population itself.

Differences between Bootstrapping and Monte Carlo Simulation

Source of random variable:

- Bootstrapping: Drawn from the original data.
- Monte Carlo Simulation: Drawn from a known probability distribution.

Purpose:

- Bootstrapping: Infer statistical distribution parameter values (e.g., mean, variance) based on the observed data.
- Monte Carlo Simulation: Generate random data based on known statistical distribution parameters.

Steps in Implementing Simulation using Bootstrapping:

1. Define the quantity of interest and set starting values.
2. Specify the time grid and subperiods.
3. Determine the data generation method based on observed stock price changes or returns.
4. Simulate stock prices by drawing random values and converting them to a sequence of stock prices.
5. Compute the average stock price and the contingent claim's value, then calculate its present value.
6. Repeat steps 3 and 4 multiple times to obtain summary values and statistics.

The mean value from all trials is the bootstrap estimate for the contingent

Estimation and Inference

1. INTRODUCTION

Sample - subset of the population.
Sampling - process of obtaining a sample from the population.

2. SAMPLING METHODS

Parameter: A measure that describes a whole population.
Sample Statistic: A measure that describes a sample drawn from a population.

Benefits of Sampling:

- Saves time and resources.
- Economically efficient, as testing every individual in a population is often impractical.

Types of Sampling Methods:

1. **Probability Sampling:**
   - Provides equal chance to all population members.
   - Representative of the population.
   - For example, Simple random sampling, Stratified random sampling
2. **Non-Probability Sampling:**
   - Selection depends on factors other than probability.
   - Non-representative of the population.
   - Probability sampling is more accurate and reliable.

1 Simple Random Sampling

- Every possible sample of a given size has an equal chance of selection.
- Can use a random number table for selection.
- Prone to sampling error.

2 Stratified Random Sampling

- Population is divided into homogeneous subgroups.
- Samples are drawn proportionally from each subgroup.
- More precise than simple random sampling but only approximately random.

3 Cluster Sampling

4 Non-Probability Sampling

5 Sampling from Different Distributions

Sampling should represent a homogenous distribution to avoid misleading statistics.

Continue

3 Cluster Sampling

- Population is divided into clusters; some clusters are chosen randomly to form a sample.
- **One-stage:** All members of chosen clusters are selected.
- **Two-stage:** Subsamples are randomly selected from chosen clusters.
- Less accurate but more time and cost-efficient compared to stratified sampling.
- Advantages: Time and cost-efficient.
- Disadvantages: Lower accuracy as a sample may not fully represent the

4 Non-Probability Sampling

- Depends on researcher's capabilities.
- Two types: Convenience and Judgmental Sampling.
  - ***Convenience:*** Selection based on accessibility.
  - ***Judgmental***: Elements picked based on researcher's knowledge.
- Advantages and disadvantages of.
  - ***Convenience:*** cost & time efficient but limited level of sample accuracy.
  - ***Judgmental:*** researchers may select a more accurate representative sample, but sample may not represent the entire population

3. CENTRAL LIMIT THEOREM AND INFERENCE

The Central Limit Theorem

- States that the distribution of sample means approximates a normal distribution as the sample size gets larger, regardless of the population's distribution.
- A sample size n of 30 or more is generally considered sufficient for the sample mean to be normally distributed.
- Sample mean $\bar{X}$ = Population mean ➔ $\mu_{\bar{X}} = \mu$
- The variance of the sample mean distribution is $\frac{\sigma^2}{n}$ and its standard deviation, known as the standard error, is $\frac{\sigma}{n}$

Standard Error of the Sample Mean

- Standard Error (SE) is the standard deviation of a sample statistic.
- SE of the Sample Mean when population standard deviation (σ) is known: σ/√n.
- SE of the Sample Mean when σ is unknown: s/√n, where s is the sample standard deviation.
- **Note:** S.D. measures data dispersion, while standard error gauges inaccuracy of population parameter estimates due to sampling.

4. BOOTSTRAPPING AND EMPIRICAL SAMPLING DISTRIBUTIONS

Bootstrapping

A resampling technique using repeated sampling with replacement from the observed data to make statistical inferences.

- It allows for the estimation of the standard error, confidence intervals, and other statistics.
- Offers a more accurate inference method without relying on parametric assumptions.

Jackknife

- A resampling technique where samples are drawn by systematically leaving out one observation at a time.
- Aims to reduce bias and estimate standard error and confidence intervals.
- Requires n repetitions for a sample size of n, unlike bootstrapping, which allows the researcher to choose the number of repetitions.

Hypothesis Testing

1. INTRODUCTION

- **Statistical inference** → making judgments about population on the basis of information obtained from a sample.
- Two branches of Statistical inference include:

Hypothesis testing	Estimation
Statement about one or more populations	Estimate the value of unknown pop. parameter using info. obtained from a sample.

2. HYPOTHESIS TESTING

- It is based on sample statistics & probability theory.
- It is used to determine whether a hypothesis is a reasonable statement or not.

Steps in Hypothesis Testing

1. State the hypothesis.
2. Identify the appropriate test statistic and its probability distribution.
3. Specify the significance level.
4. State the decision rule.
5. Collect the data & calculate the test statistic.
6. Make the statistical decision.
7. Make the economic or investment decision.

Two Types of Hypothesis

Null Hypothesis H_0
- Tested for possible rejection.
- Always includes '=' sign.

Alternative Hypothesis H_a
Hypothesis is accepted when the null hypothesis is rejected.

One Tailed Test
Alternative hypothesis having one side.
- Upper Tail
  $H_0: \mu \leq \mu_0$ vs $H_a: \mu > \mu_0$.
- Decision rule
  Reject H_0 if TS > TV
- Lower Tail
  $H_0: \mu \geq \mu_0$ vs $H_a: \mu < \mu_0$.
- Decision rule
  Reject H_0 if TS < TV

Two Tailed Test
- Alternative hypothesis having two sides.
- $H_0: \mu = \mu_0$ vs $H_a \mu \neq \mu_0$.
- Reject H_0 if
  TS > TV or TS < –TV

Test Statistic
- is used to decide whether or not to reject the null hypothesis.
- $\frac{\text{Sample statistic} - \text{Value of the population parameter}}{\text{Standard error of the sample statistic}}$

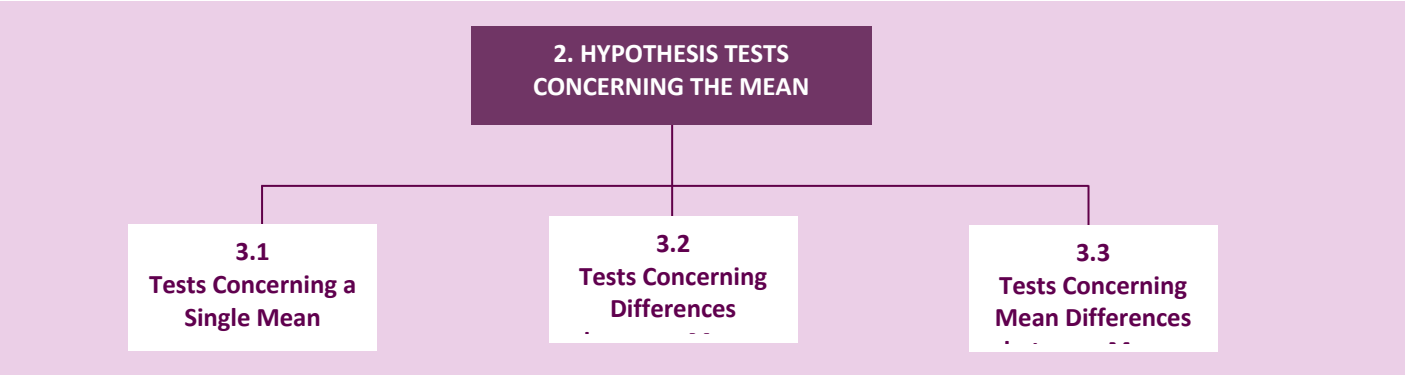
Confidence Interval Approach
It gives the range within which parameter value is believed to lie given a level of confidence.

p- value
- The smallest level of significance at which null hypothesis can be rejected.
- Reject H_0 if p-value < α.

Two Types of Errors

Type I Error
Rejecting a true null hypothesis.

Type II Error
Failing to reject a false null hypothesis.



Testing	Conditions	Test Statistics	Decision Rule
Population Mean	• σ^2 known • N. dist.	$z = \frac{\bar{x} - \mu_0}{\sigma/\sqrt{n}}$	• $H_o: \mu \leq \mu_0$ vs $H_a: \mu > \mu_0$ Reject H_0 if TS > TV • $H_o: \mu \geq \mu_0$ vs $H_a: \mu < \mu_0$ Reject H_0 if TS < –TV • $H_o: \mu = \mu_0$ vs $H_a: \mu \neq \mu_0$ Reject H_0 if TS > TV or TS < –TV
	• n ≥30 • σ^2 unknown	$z = \frac{\bar{x} - \mu_0}{s/\sqrt{n}}$ or $t^*_{n-1} = \frac{\bar{x} - \mu_0}{s/\sqrt{n}}$ *(more conservative)	
	• σ^2 unknown • n<30 • N. dist.	$t_{n-1} = \frac{\bar{x} - \mu_0}{\sigma/\sqrt{n}}$; df = n-1	
Equality of the Means of Two Normally Distributed Populations based on Independent Samples.	Unknown variances assumed equal.	$t_{(n_1+n_2-2)} = \frac{(\bar{x}_1 - \bar{x}_2) - (\mu_1 - \mu_2)}{s_P\sqrt{\frac{1}{n_1} + \frac{1}{n_2}}}$ where; $s_P = \sqrt{\frac{(n_1-1)s_1^2 + (n_2-1)s_2^2}{n_1 + n_2 - 2}}$ df = n_1+n_2 - 2	• $H_o: \mu_1 - \mu_2 \leq 0$ vs Ha: $\mu_1 - \mu_2 > 0$ Reject H_0 if TS > TV • $H_o: \mu_1 - \mu_2 \geq 0$ vs Ha: $\mu_1 - \mu_2 < 0$ Reject H_0 if TS < -TV • $H_o: \mu_1 - \mu_2 = 0$ vs Ha: $\mu_1 - \mu_2 \neq 0$ Reject H_0 if TS > TV or TS < –TV
	Unequal unknown variances.	$t = \frac{(\bar{x}_1 - \bar{x}_2) - (\mu_1 - \mu_2)}{\sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}}}$ $d.f = \frac{\left(\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}\right)^2}{\frac{\left(\frac{s_1^2}{n_1}\right)^2}{n_1} + \frac{\left(\frac{s_2^2}{n_2}\right)^2}{n_2}}$	

3. TESTS OF RETURN AND RISK IN FINANCE

Tests Concerning a Single Variance

Testing Variance of a normal population

chi-square test statistic: $\chi^2 = \frac{(n-1)s^2}{\sigma_0^2}$ where S^2 is sample variance

Chi-Square Distribution

- Asymmetrical.
- Bounded from below by zero.
- Chi-Square values can never be –ve.

Tests Concerning the Equality (Inequality) of Two Variances

are based on an **F-test** and **F-distribution**. F-test is a ratio of sample variances.

$F = \frac{S_1^2}{S_2^2}$; $S_1^2 > S_2^2$

F- Distribution

- Right skewed.
- Bounded by zero.

Relationship between the chi-square and F-distribution:

$F = (\chi_1^2 / m) \div (\chi_2^2 / n)$

χ_1^2 → m degrees of freedom.
χ_2^2 → n degrees of freedom.

Tests Concerning Correlation

For two normally distributed variables:
Null: $H_0 \rightarrow \rho = 0$
(Correlation in population is 0)
Alternate: $H_a \rightarrow \rho \neq 0$
(Correlation in population is not 0)

Two tailed test is appropriate

t statistic = $t = \frac{r\sqrt{n-2}}{\sqrt{1-r^2}}$

4. PARAMETRIC VS. NONPARAMETRIC TESTS

Parametric Test

- Specific to population parameter.
- Relies on assumptions regarding the distribution of the population.
- Robust test

Non-Parametric Test

- Do not consider a particular population parameter or have few assumptions regarding population.
- Useful when data are not normally distributed

	Parametric	Nonparametric
Tests concerning a single mean	t-test z-test	Wilcoxon signed-rank test
Tests concerning differences between means	t-test Approximate t-test	Mann-Whitney U test
Tests concerning mean differences (Paired comparisons tests)	t-test	Wilcoxon signed-rank test Sign test

5.1 Tests Concerning Correlation: The Spearman Rank Correlation Coefficient

This test is used when population does not meet the assumptions

Steps of Calculating r_S:

1. Rank observations on X in descending order.
2. Calculate difference, d_i, b/w the ranks of each pair of observations on X & Y.
3. Spearman rank correlation is calculated as: $r_S = 1 - \frac{6\sum_{i=1}^{n} d_1^2}{n(n^2-1)}$

5.2 Nonparametric Inference Summary

- Nonparametric test can be used on ranked data.
- Frequently, nonparametric test is used with parametric test to check how sensitive the conclusion is to the assumptions.

Parametric and Non-Parametric Tests of Independence

1. INTRODUCTION

- Correlation coefficient significance tests assess whether the relationship between two variables is due to chance.
- Parametric and non-parametric methods are used for correlation

2. TEST CONCERNING CORRELATION

Parametric Test of a Correlation

Pearson Correlation Coefficient (r):

Measures linear relationship strength and direction between two continuous variables.
Ranges from -1 to +1 .
Calculated as

$$r_{XY} = \frac{s_{XY}}{s_X s_Y}$$

with
s_{XY} being sample covariance and s_X & s_Y the standard deviations.
If variables are normally distributed, to test H_0: = 0, use
$t = \frac{r\sqrt{n-2}}{\sqrt{1-r^2}}$ where df = n-2.

Non-Parametric Test of Correlation: The Spearman Rank Correlation Coefficient

Spearman Rank Correlation Coefficient (r_S): Suitable when assumptions for Pearson's coefficient are not met.

Ranks observations and calculates Spearman rank correlation

$$r_S = 1 - \frac{6\sum_{i=1}^{n} d_1^2}{n(n^2-1)}$$

For small samples, use tables to find rejection points; for large samples (n > 30 \)), use t-test with (df = n - 2).

$$t = \frac{(n-2)^{1/2} r_S}{(1-r_S^2)^{1/2}}$$

3. TEST OF INDEPENDENCE USING CONTINGENCY TABLE DATA

- Tests relationship between categorical variables.
- Utilizes a chi-square statistic for independence testing.
- Contingency table organizes data in rows and columns, showing frequencies.
- Chi-square statistic formula: $\chi^2 = \sum_{i=1}^{m} \frac{(O_{ij} - E_{ij})^2}{E_{ij}}$, where O_ij is observed frequency, and E_ij is expected frequency.
- Expected frequency E_{ij} calculated assuming independence: E_{ij} = (Total row i) × (Total row j) / Overall Total.
- Degrees of freedom (df) = (r - 1) × (c - 1) in the contingency table.
- Critical value from chi-square distribution tables.
- Comparison of test statistic with critical value determines acceptance or rejection of the null hypothesis regarding variable independence.
- Reject H_0 if test statistic is greater than critical value, indicating a relationship.

Simple Linear Regression

1. SIMPLE LINEAR REGRESSION

Regression Analysis: A tool used to examine whether a variable is useful to explain another variable

Simple Linear Regression (SLR): A regression that summarizes the relation b/w dependent and one independent variable through estimation of a linear relationship.

2. ESTIMATING THE PARAMETERS OF A SIMPLE LINEAR REGRESSION

The Basics of Simple Linear Regression

Simple Linear Regression is described as:

$$Y_i = b_0 + b_1 X_i + \varepsilon_i$$

$\varepsilon_i = Y_i - \hat{Y}_i$

Estimating the Regression Line

In a regression model, we use estimated values $\hat{b}_0$ *and* $\hat{b}_1$.

Value of dependent variable for the ith observation $\hat{Y}_i$

$\hat{Y}_i = \hat{b}_0 + \hat{b}_1 X_i$

Error Term: $\varepsilon_i = Y_i - \hat{Y}_i$

Sum of Squares Error or residual sum of squares SSR:

- Measures unexplained variation in the dependent variable.
- SSE = $\sum_{i=1}^{n}(Y_i - \hat{Y}_i)^2 = \sum_{i=1}^{n}(\varepsilon_i)^2$

Interpreting the Regression Coefficients

1) ***Slope Coefficient (b_1):*** Change in dependent variable for a 1 unit change in independent variable.
2) ***Intercept (b_0):*** Predicted value of dependent variable when independent variable is set to zero

Cross-Sectional vs. Time-Series Regressions

1) **Time-series:** Many observations from ***different time periods*** for the ***same*** company, asset class or country etc.

2) **Cross-sectional:** Many observations for the ***same time period*** of ***different*** companies, asset classes or countries etc.

3. ASSUMPTIONS OF THE SIMPLE LINEAR

Assumption 1: Linearity

'Relation between the dependent variable and independent variable is linear.'

Assumption 2: Homoskedasticity

'The variance of residuals is the same for all observations.

Assumption 3: Independence

'The observations are independent of each other, Therefore the residuals are uncorrelated across observations

Assumption 4: Normality

'The regression residuals must be normally distributed.'

4. HYPOTHESIS TESTS IN THE SIMPLE LINEAR REGRESSION MODEL

Breaking down the Sum of Squares Total into Its Components

- **SST (total sum of squares):** Measures total variation in the dependent variable.
- **SSE (error sum of squares):** Measures unexplained variation in the dependent variable.
- **SSR / RSS (regression sum of squares):** Measures variation in the dependent variable explained by the independent variable.
- SST = SSE + SSR

Measures of Goodness of Fit

Goodness of fit can be measured using several methods such as:

1. **Coefficient of determination R^2** = $\frac{Explained\ Variation (SSR)}{Total\ Variation\ (SST)}$
2. **F-statistic** is calculated as the ratio of mean square regression (MSR) to mean squared errors (MSE).

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

3. **Standard error of regression S_e** measures the degree of variability of the actual y-values relative to the predicted y-values from a regression equation.

$$S_E = \sqrt{MSE} = \sqrt{\frac{SSE}{n-k-1}} = \sqrt{\frac{\sum(y_i - \hat{y})^2}{n-k-1}}$$

ANOVA and Standard Error of Estimate in Simple Linear Regression

Analysis of Variance Table for Simple Linear Regression

ANOVA	df	SS	MS	F
Regression	1	$SSR = \sum_{i=1}^{n}(\hat{y}_i - \bar{y})^2$	$MSR = \frac{SSR}{k}$	$F = \frac{MSR}{MSE} = \frac{SSR/1}{SSE/(n-2)}$
Error	n-2	$SSE = \sum_{i=1}^{n}(y_i - \hat{y})^2$	$MSE = \frac{SSE}{n-2}$	
Total	n–1	$SST = \sum_{i=1}^{n}(y_i - \bar{y})^2$		

4. HYPOTHESIS TESTING OF LINEAR REGRESSION COEFFICIENTS

Hypothesis Tests of the Slope Coefficient

t-statistic is used to test the significance of the individual coefficients (e.g., slope) in a regression.

Test statistic $t = \frac{\hat{b}_1 - B1}{s_{\hat{b}_1}}$

Standard Error of Slope Coefficient $\left(s_{\hat{b}_1}\right)$**.** It is the ratio of standard error of estimate S_e to the square root of variation of independent variable. for simple linear regression:

$$s_{\hat{b}_1} = \frac{S_e}{\sqrt{\sum_{i=1}^{n}(X_i - \bar{X})^2}}$$

Hypothesis Tests of the Intercept

Standard error of the intercept

$$s_{\hat{b}_0} = \sqrt{\frac{1}{n} + \frac{\bar{X}^2}{\sum_{i=1}^{n}(X_i - \bar{X})^2}}$$

The test is whether the intercept is different from the hypothesized value B_0 , using the following formula.

$$t_{intercept} = \frac{\hat{b}_0 - B_0}{s_{\hat{b}_0}} = \frac{\hat{b}_0 - B_0}{\sqrt{\frac{1}{n} + \frac{\bar{X}^2}{\sum_{i=1}^{n}(X_i - \bar{X})^2}}}$$

Hypothesis Tests of Slope When Independent Variable Is an Indicator Variable

Indicator variable (or dummy variable) is a variable that takes on a value of either 1 or 0

Test of Hypothesis: Level of Significance and p-Values

p-value is the smallest level of significance at which the null hypothesis can be rejected.

The smaller the p-value, the smaller the chance of making type I error.

5. PREDICTING USING SIMPLE LINEAR REGRESSION AND PREDICTION INTERVALS

Prediction intervals are used to realize how sure we are about the predicted results.

Standard error of forecast = $s_f = s_e \sqrt{1 + \frac{1}{n} + \frac{(X_f - \bar{X})^2}{\sum_{i=1}^{n}(X_i - \bar{X})^2}}$

Prediction interval for a forecasted value of a dependent variable is created by using equation $\hat{Y} \pm t_c s_f$

where, $s_f^2 = {s_e}^2 \left[1 + \frac{1}{n} + \frac{(X_f - \bar{X})^2}{(n-1)s_X^2}\right] = {s_e}^2 \left[1 + \frac{1}{n} + \frac{(X_f - \bar{X})^2}{\sum_{i=1}^{n}(X_i - \bar{X})^2}\right]$

1. The better the fit of the regressions, the smaller will be the s_e and therefore, the smaller will be the s_f.
2. The larger the n, the smaller will be the s_f.
3. The closer the X_f is to $\bar{X}$, the smaller will be the s_f.

6. FUNCTIONAL FORMS FOR SIMPLE LINEAR REGRESSION

- Economic and financial data often exhibit nonlinear relation.
- Many functional forms are used to apply linear relation on such data.
- Three common model that involve log transformation are as follows.

The Log-Lin Model

- $\ln Y_i = b_0 + b_i X_i$
- Dependent variable is in logarithmic form, but the independent variable is in linear form.

The Lin-Log Model

- $Y_i = b_0 + b_i \ln X_i$
- Independent variable is in logarithmic form, but the dependent variable is in linear

The Log-Log Model

- $\ln Y_i = b_0 + b_i \ln X_i$
- Both the dependent and independent variables are in logarithmic form.

Selecting the Correct Functional Form

Selection of the suitable functional form depends on examining the goodness of fit measures (R^2, F-statistic & S_e) as well as patterns in the residuals.

Introduction to Big Data Techniques

1. INTRODUCTION

Fintech (finance + technology) is playing a major role in the fields of:

- investment management industry
- investment advisory services
- financial record keeping, blockchain and distributed ledger technology (DLT)

2. HOW IS FINTECH USED IN QUANTITATIVE INVESTMENT ANALYSIS?

2. WHAT IS FINTECH

Some salient fintech developments related to the investment industry include:

- **Analysis of large data sets:**
  - traditional data sources include economic indicators, financial statements
  - non-traditional data sources (such as social media, sensor networks) to generate profits.
- **Analytical tools:** artificial intelligence (AI) helps identifying complex, non-linear relationships among gigantic datasets.
- **Automated trading:** lower transaction costs, market liquidity, secrecy, efficient trading etc.
- **Automated advice:** Robo-advisors or automated personal wealth management are low-cost alternates for retail investors.
- **Financial record keeping:** DLT provides advanced and secure means of record keeping and tracing ownership of financial assets on peer-to-peer (P2P) basis.

3.BIG DATA CHALLENGES

Big data typically have the following features:

- Volume
- Velocity
- Variety

Sources of Big Data

Main sources of alternative data are data generated by:

1. **Individuals:** Data in the form of text, video, photo, audio or other online activities (customer reviews, e-commerce).
2. **Business processes:** data generated by corporations or other public entities e.g. sales information, corporate exhaust.
3. **Sensors:** data connected to devices via wireless networks.

Big Data Challenges

In investment analysis, using big data is challenging in terms of its:

- quality (selection bias, missing data, outliers)
- volume (data sufficiency)
- suitability

continue

3. BIG DATA

Traditional		Non-traditional (alternate)	
Sources	Institutions, Businesses, Government, Financial Markets	Sources	Social media, Sensor networks Company-used data, Electronic devices, Smart phones, Cameras, Microphones, Radio-frequency identification (RFID)
Forms of Data	Annual reports, Regulatory filings, Sales & earnings, Conference calls, Trade prices & volumes	Forms of Data	Posts, Tweets, Blogs, Email, Text messages, Web-traffic, Online news sites

3. ADVANCED ANALYTICAL TOOLS: ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING

Artificial intelligence (AI) technology in computer systems is used to perform tasks that involve cognitive and decision-making ability similar or superior to human brains.

Machine learning (ML) algorithms are computer programs that perform tasks and improve their performance overtime with experience.

ML divides data into two sets:

- **Training data:** that helps ML to identify relationships between inputs and outputs through historical patterns.
- **Validation data**: that validates the performance of the model by testing the relationships developed (using the training data).

Types of Machine Learning

Two main types of machine learning are:

- **Supervised leaning:** uses labeled training data and process that information to find the output. Supervised learning follows the logic of 'X leads to Y'.
- **Unsupervised learning:** does not make use of labelled training data and does not follow the logic of 'X leads to Y'. There are no outcomes to match to, however, the input data is analyzed, and the program discovers structures within the data itself.

Deep Learning Nets (DLNs): Some approaches use both supervised and unsupervised ML techniques. DLNs use neural networks often with many hidden layers to perform non-linear data processing.

ADVANCED ANALYTICAL TOOLS: ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING

Data Processing Methods

Five data processing methods are:

i) **Capture:** Data capture refers to how data is collected and formatted for further analysis.
ii) **Curation:** Data curation refers to managing and cleaning data to ensure data quality.
iii) **Storage:** Data storage refers to archiving and storing data.
iv) **Search:** Search refers to how to locate requested data.
v) **Transfer:** Data transfer refers to how to move data from its storage location to the underlying analytical tool.

Data Visualization

Data visualization refers to how data will be formatted and displayed visually in graphical format. Data visualization for:

- **traditional structured** data can be done using tables, charts and trends.
- **non-traditional unstructured** data can be achieved using new visualization techniques such as:
  - interactive 3D graphics
  - visualization techniques using colors, shapes, sizes etc.
  - tag cloud,
  - mind map

Text Analytics and Natural Language Processing

Text analytics is a use of computer programs to retrieve and analyze information from large unstructured text or voice-based data sources.

Natural language processing (NLP) is a field of research that focuses on development of computer programs to interpret human language. NLP field exists at the intersection of computer science, AI, and linguistics.

The Firm and Market Structures

1. INTRODUCTION

Topics covered in this module include:

- **Demand Concepts**: Own-price, cross-price, and income elasticity.
- **Supply Concepts**: labor supply, labor product, labor cost, and income.
- **Market Structure:** Different market structures are also covered, such as monopolies, oligopolies, and perfect competition.

The concepts covered in the module are used to analyze the profitability of firms in different market structures.

2. PROFIT MAXIMIZATION: PRODUCTION BREAKEVEN, SHUTDOWN AND ECONOMIES OF SCALE

Revenue under conditions of Perfect & Imperfect Competition

Under perfect competition:

- Demand curve is horizontal.
- TR curve is linear with slope equal to price per unit.

Under imperfect competition:

- Demand curve is –vely sloped.
- TR curve rises in the range where MR is +ve & demand is elastic & then falls in the range where MR is –ve & demand is inelastic.

Profit-maximization, Breakeven & Shutdown Points of Production

Firm maximizes profit by producing Q where P = SMC & SMC is rising.

Breakeven Analysis

B.E.P →TR = TC, a point where a firm earns normal economic profit.

The Shutdown Decision

- Sunk costs must be ignored to continue to operate in the SR.
- A firm, covering its variable cost, should operate in the SR.
- Shutdown point→ min. AVC.
- Breakeven point:→min.ATC.

Rev. cost relation	SR Decision	LR Decision
TR = TC	Stay in mkt.	Stay in mkt.
TR = TVC but < TC	Stay in mkt.	Exit mkt.
TR < TVC	Shutdown production	Exit mkt.

Understanding Economies & Diseconomies of Scale

- **Short-run**: time period during which *at least one* of the factors of production is variable.
- **Long-run:** time period during which all factors of production are variable.

Short & Long run Cost Curves

- **SR avg. total cost curve (SATC):** Avg. total cost curve when some costs are fixed.
- **LR avg. total cost curve (LATC):** Avg. total cost curve when no cost is fixed.

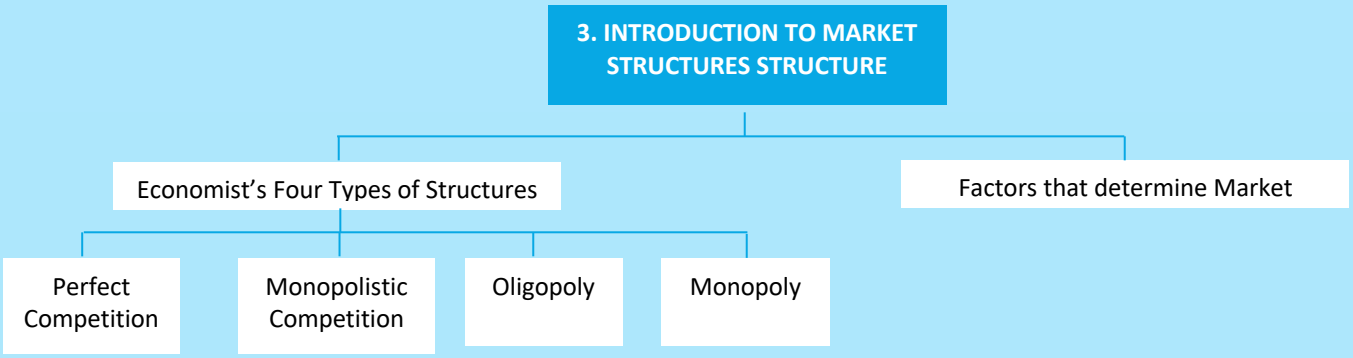
Defining Economies & Diseconomies of Scale

Economies of scale:

- ↓ in per unit cost by ↑ in production.
- LRAC curve with a –ve slope.

Diseconomies of scale:

- ↑ in per unit cost by ↑ in production.
- LRAC curve with a +ve slope.



Market Structure	Number of Sellers	Degree of Product Differentiation	Barriers to Entry	Pricing Power of Firm	Non-Price Competition	Firm's Demand	Non-price competition	Allocative/ productive efficiency	Long-run profits
Perfect Competition	Many	Homogeneous/Standardized	Very Low	None	None	Perfectly elastic	None	Highly efficient	0
Monopolistic Competition	Many	Differentiated	Low	Some	Advertising and Product Differentiation	Elastic over some price ranges and inelastic over others	Considerable	Less efficient than perfect competition.	0
Oligopoly	Few	Homogeneous/Standardized	High	Some or Considerable	Advertising and Product Differentiation	Kinked demand	Considerable for a differentiated oligopoly.	Less efficient than perfect competition.	Positive
Monopoly	One	Unique Product	Very High	Considerable	Advertising	Inelastic	Somewhat	Inefficient	High

4. MONOPOLISTIC COMPETITION

Characteristics:
i) Many Buyers & sellers
ii) Differentiated Products
iii) Low cost Entry & Exit
iv) Firms have some control over

Demand Analysis in Monopolistically Competitive Markets

- Monopolistic Competition firm has a downward sloping demand curve due to product differentiation
- Price > MC
- Price = ATC → Long-run
- MR < Price

Monopolistically Competitive Firm in the Short Run:

- Profit is maximized where MR = MC
- No well defined supply schedule
- Output level is determined at a point

SR-Economic Profit encourages new firm to enter the market resulting in:

- ↑ number of products offered.
- Reduction in demand faced by firms already in the market
- Incumbent firm's demand curve shift to the left.

SR-Economics losses encourage firms to exit the market:

i) Decrease in number of products offered
ii) Increase in demand faced by remaining products.
iii) Shift the remaining firms' demand curve to the right
iv) Increase the remaining firms' profit

Differences between Monopolistic Competition & Perfect

- In perfect competition, there is no excess capacity in the long-run, firms produce at their efficient scale.
- In monopolistic competition, output is at less than efficient scale of perfect competition

- For competitive firm P = MC
- For monopolistically competitive firm P > MC

- Unlike perfect competition, in monopolistic competition explicit cost include advertising or marketing cost

5. OLIGOPOLY

Demand Analysis and Pricing Strategies

- Demand depends on degree of pricing inter dependence
- In case of price collusion, aggregate market demand curve is composed of individual production participants
- In case of non-collusion, each firm faces an individual demand curve

- Duopoly: It is an oligopoly with only two producers in the market.

Characteristics:

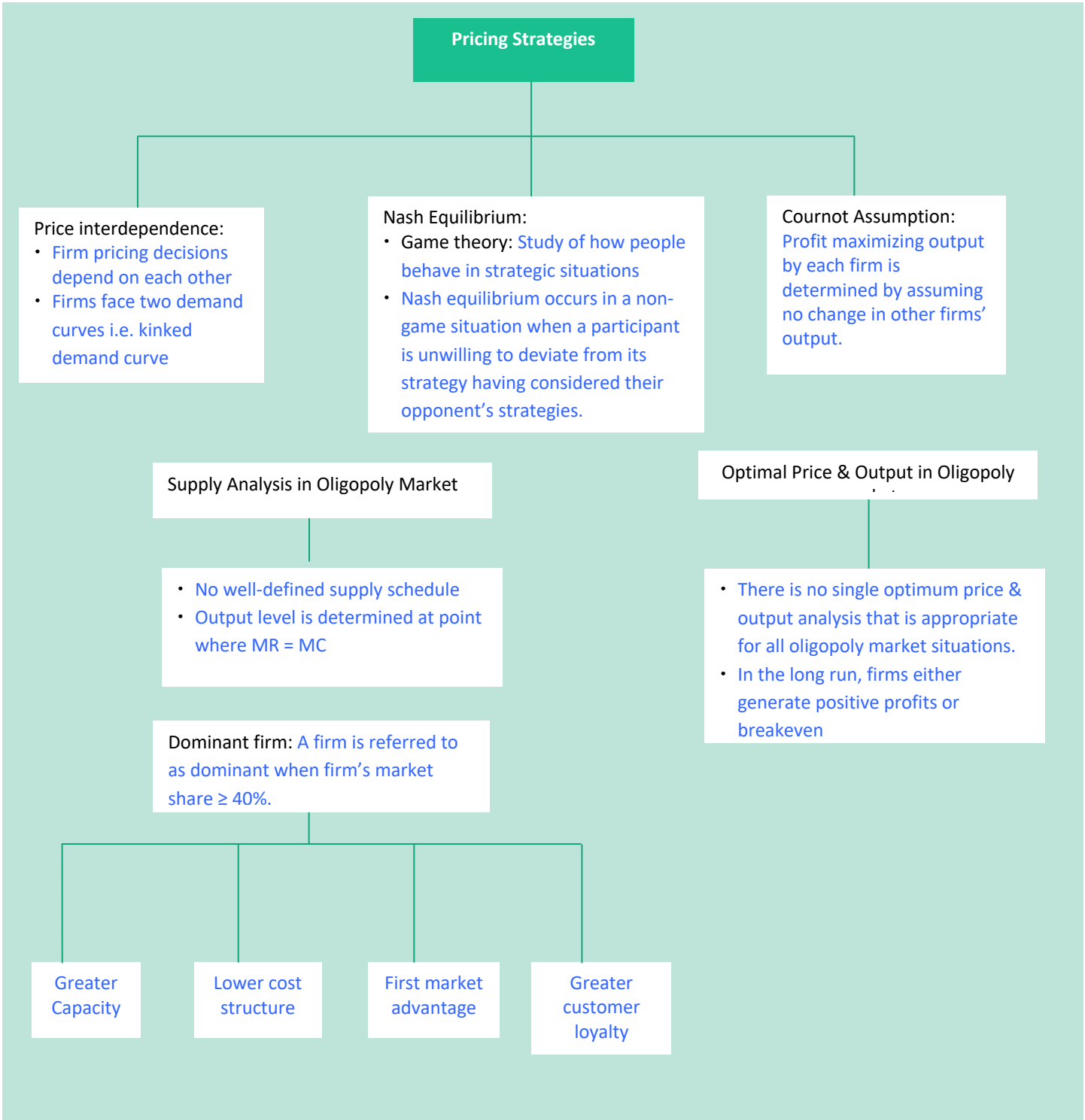
i) Few sellers
ii) Industry dominated by small number of large firms
iii) Product offered by each seller is close substitutes for the products offered by other firms
iv) Independent firms
v) Barrier to entry & exit are high
vi) Firms have substantial control over price
vii) Products are differentiated through advertising & other non-price strategies.

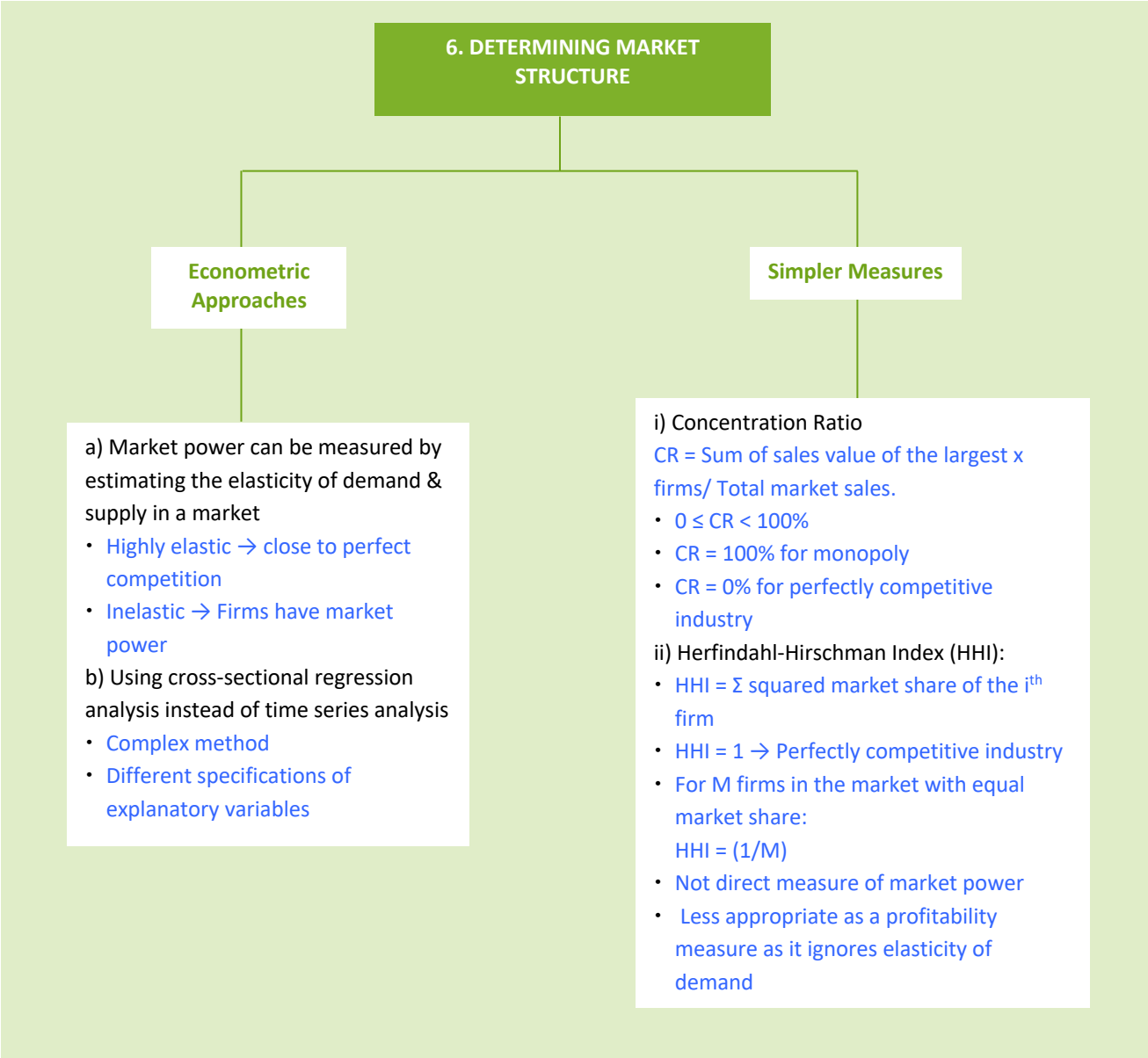
- Cartel: A collusive agreement that are made openly & formally

- Price Collusion: An agreement among firms on the quantity produced and price to charge.
  - Profit increases.
  - Uncertainty of cash flows reduces.
  - Provide opportunities to create barriers to entry

Factors necessary for a collusion to be successful

i) Small number of firms in the industry
ii) Products produced by firms are identical/same
iii) Similar cost structure
iv) Orders received by firms are small in size & are frequent
v) Severe threat of retaliation by other firms in the market
vi) Degree of external competition.





Understanding Business Cycle

2. OVERVIEW OF THE BUSINESS CYCLE

Phases of the Business Cycle

Two major segments are:
1) Expansion or upswing
2) Contraction or downturn

Two turning points are:
1. **Peak:** Highest point of a business cycle

Leads and Lags in Business and Consumer Decision Making

Turning points may exhibit leads and lags due to the behavior of businesses and

Market Conditions and Investor Behavior

Investors can benefit from forecasting changes in the business cycle.

1. Recovery phase
- Risky assets become more attractive for investors

2. Expansion phase
- Firms may ↑ production capacity and experience shortage of workforce.
- Economy may overheat.

3. Slowdown phase
- Higher stock prices.
- Bonds are available at lower prices

4. Contraction phase
- Investors prefer to invest in bonds. and stocks with stable cash flows

Types of Cycles

1. **Classical cycle** - Fluctuations in the level of economic activity measured by GDP in volume.
2. **Growth cycle** - Fluctuations in business activity around the long-term potential or trend growth level.
3. **Growth rate cycle** - Fluctuations in growth rate of economic activity.

Practical Issues

Definitions of business cycle are somewhat ambiguous and are used interchangeably.

Four Phases of the Cycle

Recovery
- Actual output is at its lowest
- Economic activity starts to ↑

Expansion
- Actual output > potential
- Spending ↑
- Production ↑
- Employment ↑
- GDP ↑
- Prices ↑
- Interest rates ↑

Slowdown
- Actual output is at its highest.
- Inflation and price level may ↓.
- Consumers are still optimistic

Contraction
- Actual output < potential
- Spending ↓
- Production ↓
- Employment ↓
- GDP ↓
- Business confidence ↓

3. CREDIT CYCLES

When economy is:
- strong/improving – lenders extend credit
- weak/weakening – lenders tighten credit

Applications of Credit Cycles

Loose credit conditions cause asset price and real estate bubbles.

Consequences for Policy

Identifying credit cycle stage helps investors in assessing business cycle expansions and contractions

4. ECONOMIC INDICATORS OVER THE BUSINESS CYCLE

The Workforce and Company Costs

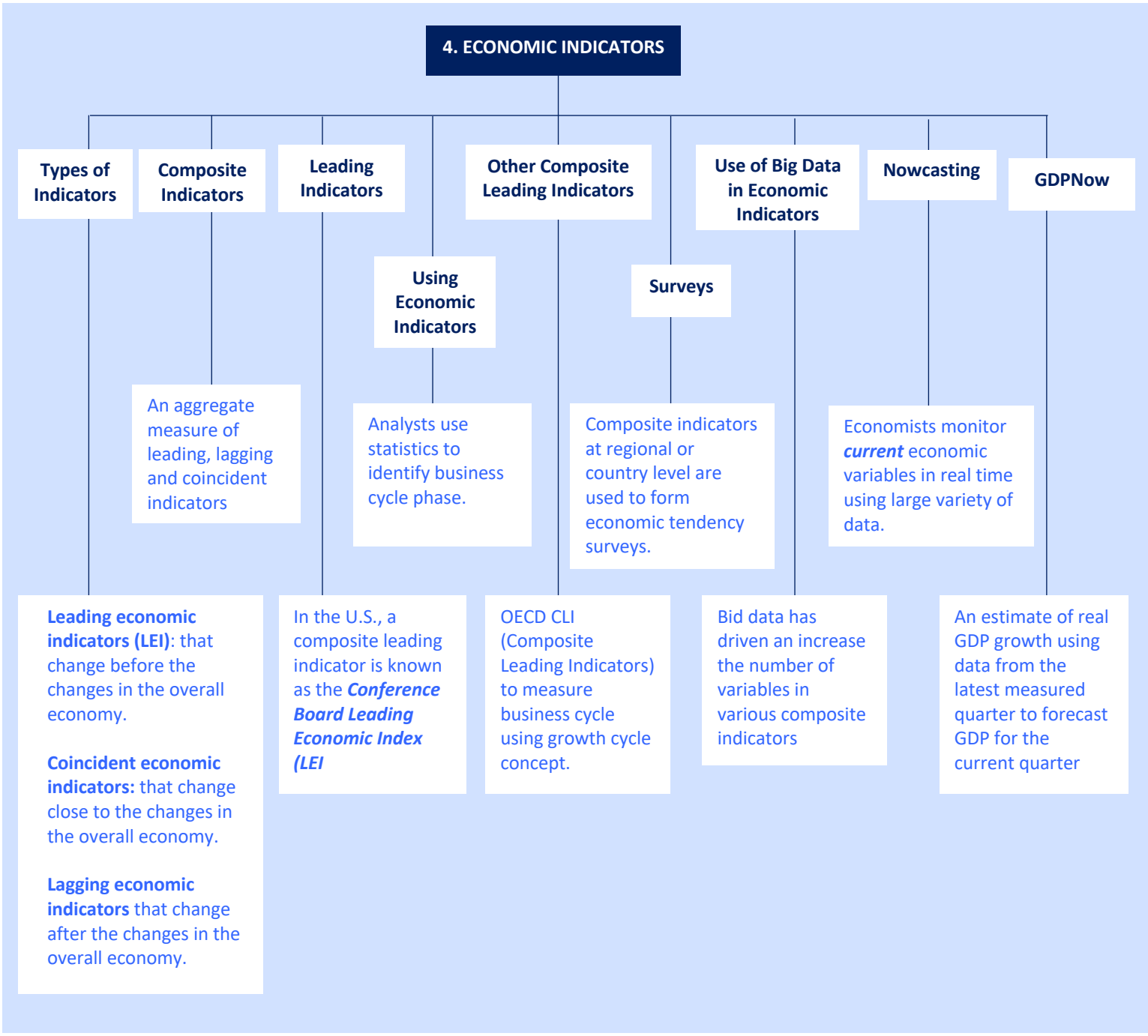
In Contraction Phase:
- Businesses retain workers.
- As the contraction phase prolongs, businesses liquidate inventories and cut advertising costs.

Fluctuations in Capital Spending

Capital spending decisions are driven by:
- expectations
- business conditions
- level of capacity utilization

Fluctuations in Inventory Levels

- Key indicator used to analyze fluctuations in inventory levels is ***inventory-sales ratio.***
- It reflects the outstanding inventories to the sales.


4. ECONOMIC INDICATORS
Types of Indicators
Composite Indicators
Leading Indicators
Using Economic Indicators
Other Composite Leading Indicators
Surveys
Use of Big Data in Economic Indicators
Nowcasting
GDPNow
An aggregate measure of leading, lagging and coincident indicators
Analysts use statistics to identify business cycle phase.
Composite indicators at regional or country level are used to form economic tendency surveys.
Economists monitor current economic variables in real time using large variety of data.
Leading economic indicators (LEI): that change before the changes in the overall economy.
Coincident economic indicators: that change close to the changes in the overall economy.
Lagging economic indicators that change after the changes in the overall economy.
In the U.S., a composite leading indicator is known as the Conference Board Leading Economic Index (LEI
OECD CLI (Composite Leading Indicators) to measure business cycle using growth cycle concept.
Bid data has driven an increase the number of variables in various composite indicators
An estimate of real GDP growth using data from the latest measured quarter to forecast GDP for the current quarter

Fiscal Policy

1. INTRODUCTION

- **Fiscal policy:** Government spending and taxes impact overall demand. Tools include transfer payments, infrastructure projects, and tax adjustments. Deficits occur when spending outpaces income.
- **Monetary policy:** Central bank activities to influence money and credit quantity.

2. INTRODUCTION TO MONETARY AND FISCAL POLICY

Government decisions exert substantial economic influence due to widespread public sector employment, significant spending responsibility, and extensive borrowing in global debt markets.

Two primary types of government policies are:

- **Monetary Policy:** Alters money and credit quantity through central bank actions.
- **Fiscal Policy:** Influences the macro economy by adjusting government spending and taxation.

3. ROLES AND OBJECTIVES OF FISCAL POLICY

Roles and Objectives of Fiscal Policy

Drive aggregate demand and economic activity for low inflation and high employment. Also, aim for fair income distribution and efficient resource allocation across sectors and economic agents.

Fiscal Policy & Aggregate Demand

Keynesians School
fiscal policy can have significant impact on AD, output, and employment when:

- potential GDP level is low
- capacity utilization rate is low

Monetarists: monetary policy is more effective tool than fiscal policy because fiscal policy can only have a ***temporary*** effect on AD.

Govt. Receipts & Expenditure in Major Economies

Government revenue = Tax revenues - transfer payments

- Budget Surplus when T > G_E
- Budget Deficit when T < G_E

Automatic Stabilizers: are features of fiscal policy that stabilize real GDP without

Deficits & the National Debt

- When inf and nominal GDP ↑, real value of the outstanding debt ↓. Thus, debt to GDP ratio ↓.
- When real growth < real i rate on debt → debt burden ↑ faster than the economy; hence, debt ratio ↑.

4 . ROLES AND OBJECTIVES OF FISCAL POLICY

Fiscal Policy Tools and the Macro Economy

Govt. Spending includes:
- Transfer payments
- Goods & services
- infrastructure

Govt. Revenues include direct and indirect taxes.

Tax Advantages:
- Generate revenue for government spending.
- Redistribute income and wealth.

Desirable Tax Policy:
- Simple:
- Efficient: .
- Fair:
- Revenue-sufficient:

Advantages & Disadvantages of Using the Different Tools of Fiscal Policy

Indirect taxes:
- **Pros:** Easy to adjust, influence spending quickly, cheap to administer.
- **Cons:** Can discourage good stuff (tobacco, alcohol alternatives).

Direct Taxes & Transfers:
- **Cons:** Harder to adjust quickly, capital spending slow to roll out.
- **Pros:** Future tax hikes hurt spending now, direct spending boosts economy more than tax cuts/transfers.
- Delayed impact of changes in capital spending

Modeling the Impact of Taxes & Govt. Spending: The Fiscal Multiplier

The Fiscal Multiplier
G – T + B = Budget surplus/ deficit

Disposable income
= Income – Net taxes
= (1 – t) Income

Fiscal Multiplier (no taxes)
= 1/(1 - MPC)

Fiscal multiplier (with taxes) = $\frac{1}{1-MPC\,(1-t)}$

The Balanced Budget Multiplier

Magnified effect of a ***simultaneous*** change in govt. spending and taxes on the AD that leaves the budget balance unchanged.

Equal Increase: Both autonomous govt. purchases &taxes ↑ equally. AD curve shifts right, leading to increased GDP.

Equal Decrease: Both autonomous govt. purchases & taxes ↓ equally. AD curve shifts left, leading to decreased GDP.

Ricardian Equivalence:

Consumer Behavior:
- Consumers view debt-financed tax cuts as future tax increase.
- No improvement in current well-being, leading to increased saving.
- Private saving rises, offsetting public saving decrease.

National Saving:
- National saving remains unchanged.

5. FISCAL POLICY IMPLEMENTATION

Deficits and Fiscal Stance

Deficit Causes:

- **Policy Decision:** Discretionary fiscal adjustments, e.g., tax rate changes.
- **Automatic Stabilizers:** Impact fiscal deficit without government policy decisions.

Cyclical vs. Structural:

- **Cyclical:** Temporary, linked to economic cycles.
- **Structural:** Persistent, remains even at full employment.

Structural Fiscal Deficit:

- Also called cyclically adjusted budget deficit.
- Calculated assuming economy at full employment.

Adjustments Needed:

- Consider nominal vs. real interest rates and inflation impacts.

Difficulties in Executing Fiscal Policy

Recognition lag:

- Unable to recognize needed changes

Action lag:

- Time taken by government in discussing, voting, & enacting policy

Impact lag:

- Policy takes time to stimulate economic activity

Monetary Policy

C.B. = central bank
Govt. = government
i-rate = interest rate
inf. = inflation
A.D = aggregate demand
Exp. = expected

1. INTRODUCTION

Three key tools central banks (C.B) use:

1. Open market operations
2. Refinancing rate
3. Reserve requirements

C.B success depends on three factors:

1. Independence
2. Credibility
3. Transparency

Fiscal and monetary policies impact aggregate demand differently

2. ROLES OF CENTRAL BANKS

The Roles of Central Banks

- Sole supplier of currency
- Banker to Government & bankers' bank
- Regulator and supervisor of payment system
- Lender of last resort
- Manage country's gold & foreign exchange reserves
- Conductor of Monetary Policy

The Objectives of Monetary Policy

- Controlling inf.
- Currency stability
- Full employment
- Positive sustainable economic growth
- Moderate i rates

3. MONETARY POLICY TOOLS AND MONETARY TRANSMISSION

Three Primary Monetary Policy Tools

C.B have three primary monetary policy tools:

- **Open Market Operations:** Adjusting bank reserves through Govt. bond transactions to control the money supply.
- **Policy rate/Refinancing rate or Discount rate:** Influencing bank lending rates and money supply through the cost of borrowing from the C.B.
- **Reserve requirements or Legal reserve ratio:** Modifying banks' reserve ratios to manage the amount available for lending.

The Transmission Mechanism

The process through which a central bank's interest rate gets *transmitted* through the economy and eventually affects the ↑ in the aggregate price level.

A change in policy rate by central bank will get transmitted through the economy via ***four*** interrelated channels.

1. Bank lending rates
2. Asset prices
3. Agents' expectations
4. Exchange rates

4. MONETARY POLICY OBJECTIVES

Inflation Targeting

It is used to control inf. and to maintain price stability.

Key concepts in inf. targeting includes:
a) C.B independence
b) Credibility
c) Transparency

Exchange Rate Targeting

Involves setting a fixed level of band of values for the exchange rate against a major currency.

Rationale: to import the inf. experience of a low inf. economy.

Problem: domestic *i*-rates and money supply can become more volatile.

Contractionary & Expansionary Monetary Policies & the Neutral Rate

Contractionary involves increasing interest rates and thereby reducing liquidity to slow down the economy and inflation.

Expansionary involves decreasing interest rates and thereby increasing liquidity to speed up economy and inflation.

Neutral interest rate = Real trend rate of economic growth + inflation target
Real trend rate ≈ Long-term sustainable real growth rate of an economy
Policy rate > Neutral rate → Contractionary Monetary Policy
Policy rate < Neutral rate → Expansionary Monetary Policy

Sources of shock to the Inf. rate:
Demand shock: When inflation ↑ due to ↑ in consumption and investment growth rates.
Supply shock: When inflation ↑ due to ↑ in the costs of production

What's the Source of the Shock to the inflation Rate?

- Demand Shock: Consumer/business confidence boosts spending & investment, leading to inf.
  - Response: Tighten monetary policy to cool demand.
- Supply Shock: Production cost increases drive inf.
  - Response: Avoid tightening monetary policy, as it can worsen unemployment.

Limitations of Monetary Policy

Problems in the Monetary Transmission Mechanism

C.B cannot easily control the
- bank deposits.
- willingness of banks to make loans.

Interest Rate Adjustment in a Deflationary Environment & Quantitative Easing as a Response

Deflationary trap:
Weak consumption growth
Falling prices
I↑ in real debt levels
Liquidity trap: Liquidity trap occurs when the demand for money becomes infinitely elastic

Quantitative easing (QE) refers to purchasing government or private securities by the central bank from the private sector and financing those purchases by printing money.

5. THE RELATIONSHIP BETWEEN MONEY AND FISCAL POLICY

Interaction of Fiscal and Monetary Policies

Where, Expansionary = easy and contractionary = Tight. and assuming wages and prices are rigid.

1. **Easy Fiscal Policy/Tight Monetary Policy:** Results in higher aggregate output, elevated interest rates, and a larger public sector.
2. **Tight Fiscal Policy/Easy Monetary Policy:** Leads to low interest rates and a larger private sector relative to the public sector.
3. **Easy Monetary Policy/Easy Fiscal Policy:** Results in higher aggregate demand, lower interest rates (if monetary impact dominates), and growth in both private and public sectors.
4. **Tight Monetary Policy/Tight Fiscal Policy:** Results in higher interest rates (if monetary impact is stronger) and reduced aggregate demand from both public and private sectors.

Factors Influencing the Mix of Fiscal and Monetary Policy

The dual objective of stabilizing the level of AD at close to the full employment level and increasing the growth of potential output can be best achieved by ***expansionary monetary policy and a tight fiscal policy.***

Policy conclusions:

A. **No monetary accommodation:** ↑ in AD leads to ↑ i rates immediately.
B. **Monetary accommodation** Fiscal multipliers are greater when loose fiscal policy is accompanied by loose monetary policy.

Quantitative Easing and Policy Interaction

Quantitative easing (QE) refers to purchasing govt. or private securities by the central bank.

Ultimate aim: recipient may later increase expenditure, lending or borrowing.
Printing on money is feared by many economists as the monetization of govt. deficit.

Cumulative multiplier = $\frac{\text{cumulative effect on real GDP over the two yrs}}{\%\ of\ GDP}$

The Importance of Credibility and Commitment

According to the **IMF model, high budget deficits** lead to:

- Higher real i rates.
- Crowding out effects.
- Decreased productive potential of an economy.
- Increasing inflation expectations and higher longer-term i rates if budget deficits are expected to persist.

Introduction to Geopolitics

1. INTRODUCTION

Geopolitics

study of how geography affects politics and international relations.

Geopolitical Risk

risk that arises from actions b/w actors that disrupt the normal flow of international relations.

Impact of Geopolitical Risk

- **macroeconomic level**: changes in economic growth, interest rates, volatility.
- **portfolio level:** portfolio's suitability risk tolerance, time horizon.

2. NATIONAL GOVERNMENTS AND POLITICAL COOPERATION

Active: are individuals, organizations, or governments that engage in political, economic, and financial activities.

State actors: directly control country's national security or resources such as Govts, leaders.

Non-state actors who participate in global political, economic, or financial issues such as enterprises.

continue

2. NATIONAL GOVERNMENTS AND POLITICAL COOPERATION

Features of Political Co-operation

- Relations b/w nations can be *cooperative* or *competitive*.
- Political Cooperation: degree to which countries agree on laws for interactions.
- Countries cane be cooperative or non-cooperative.

Motivations for Co-operation

- National Security or Military Interest
- Economic Interest

Resource Endowment, Standardization, & Soft Power

1. **Geophysical resource endowment** includes habitable geography, climate, food, and water.
2. **Standardization** is the process of making rules & protocols for selling products & services.
3. **Cultural Considerations & Soft Power**
   - **Cultural considerations:** cooperating for cultural reasons
   - **Soft power**: influencing other nations without force.

The Role of Institutions

Strong institutions

- promote internal & external political stability.
- strengthen a country in building cooperative connections.

Hierarchy of Interests and Costs of Cooperation

Governments are guided by the hierarchy of interests with survival-critical issues at the top.

Power of the Decision Maker

Decision makers' motivations affect a country's cooperation and non-cooperation. Political cycle length affects priority setting.

Political Non-Co-operation

Some countries are more cooperative than others in politics. Non-cooperation is uncommon.

3. FORCES OF GLOBALIZATION

Globalization

It is the integration of individuals, firms, & nations on a global scale.

Features of Globalization

Globalization features include:

- capital flows
- currency exchange
- trade of products and services
- cultural & information interaction

Motivations of Globalization

For non-state actors, three potential gains are:

- Increase in profits
- Access to resources & markets
- Intrinsic gain

Costs of Globalization and Threats of Rollback

- Unequal accrual of economic & financial gains:
- Lower environmental, social, and governance standards
- Political consequences
- Interdependence

4. INTERNATIONAL TRADE ORGANIZATIONS

IMF

- Promotes exchange stability & global trade growth.
- Provides temporary financial assistance to member countries.
- Assesses financial vulnerabilities & keeps market risk under control.

World Bank

- Reduces poverty & promotes sustainable growth in developing countries.
- Funds development projects & provides technical assistance.
- Encourages strong governance & financial systems for business growth

WTO

- Regulates & promotes free trade among countries.
- Settles trade disputes & eliminates trade barriers.
- Provides research & technical support to developing countries.
- Facilitates establishment & growth of multinational corporations.

Investment

- IMF helps manage country & systemic risks.
- World Bank assists developing countries' financial markets.
- WTO provides framework for multinational corporations, key for investment portfolios.

5. ASSESSING GEOPOLITICAL ACTORS AND RISK

1. Autarky

Autarky is characterized by little or no foreign trade or financing. State-owned companies govern domestic industry.

2. Hegemony

A hegemonic country is a regional or global leader and exerts control over other countries' resources.

3. Multilateralism

Multilateralism is characterized by economic cooperation and rule harmonization among countries.

4. Bilateralism

Bilateralism is the cooperation b/w two countries, involving political, economic, financial, or cultural cooperation.

Regionalism lies in b/w bilateralism & multilateralism

6. THE TOOLS OF GEOPOLITICS

National Security Tools

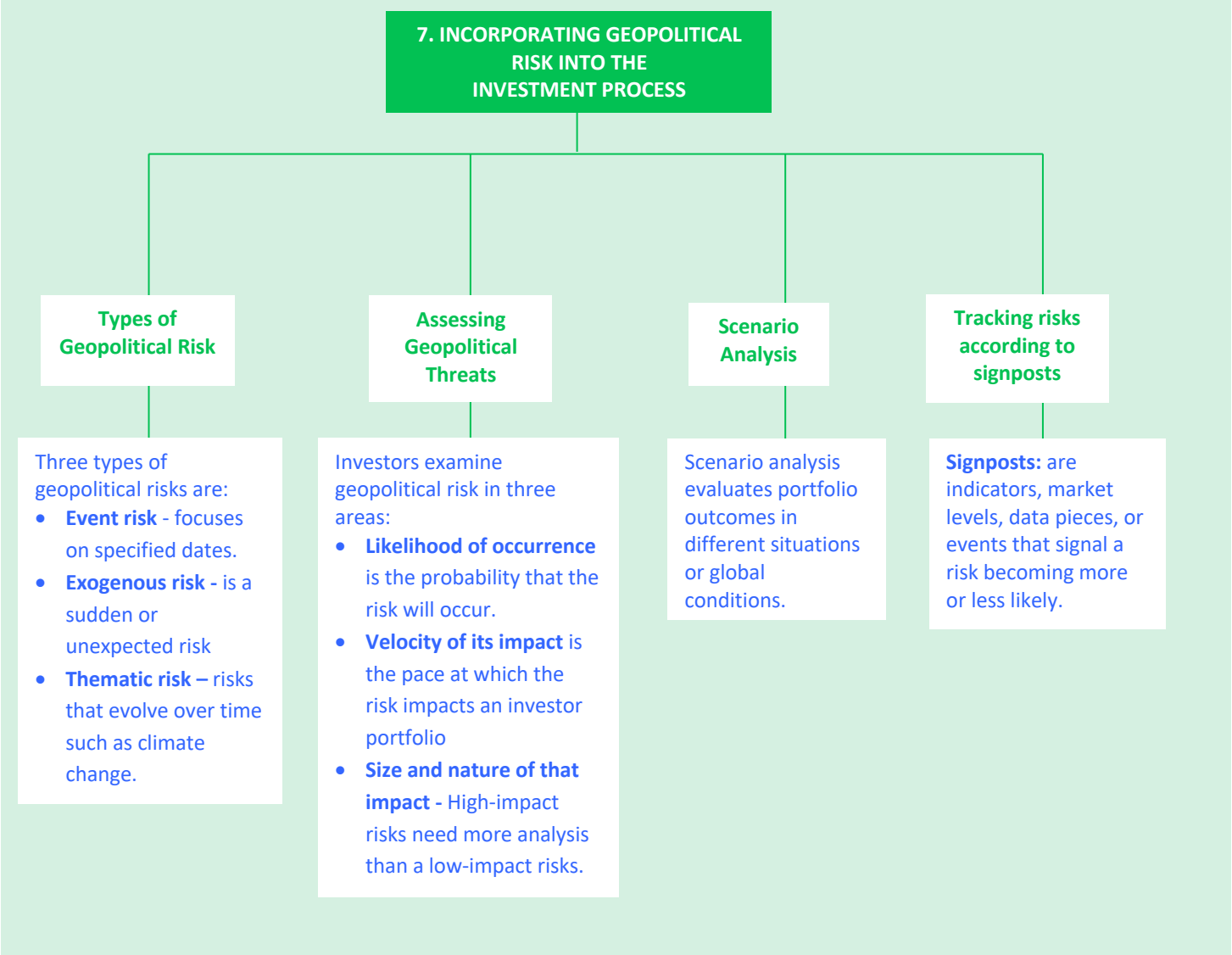
- tools that influence state actors through direct or indirect impact on resources, people, or borders.
- Can be active or inactive.

Economic Tools

- tools that support cooperative or non-cooperative stances through economic means.
- Example include, multilateral trade agreements, common markets, common currencies, nationalism, voluntary export limits, domestic content criteria.

Financial Tools

- tools that support cooperative or non-cooperative stances through financial means.
- Example include, limiting or promoting foreign investments and foreign currencies.



International Trade

1. INTRODUCTION

Trade policies matter as they

- Impact trade volume, value, and ultimately, ROI for global investors.
- Changes firm profits and growth

2 BENEFITS AND COSTS OF INTERNATIONAL TRADE

Benefits and Costs of International Trade

Advantages

- Gains from exchange
- Facilitates economic growth.
- access to larger capital and product markets.
- efficiency from increased competition.
- Facilitates specialization
- Facilitate flow of financial capital.
- Enhances productivity

Disadvantages

a) income inequality
b) destroy jobs in the industries that compete against imports.

3. TRADE RESTRICTIONS AND AGREEMENTS – TARIFFS, QUOTAS AND EXPORT SUBSIDIES

Tariffs

Tax on imported goods by Govt.

Objectives:
- to protect domestic industries
- to ↓ trade deficits

Disadvantages:
- price of imported goods ↑
- overall global welfare ↓

Net welfare effect = consumer's surplus loss + producer's surplus gain + govt. revenue

Deadweight loss: when loss in consumer surplus > gain in producer surplus + govt. revenue.

Quotas

Limiting the quantity of imported goods from a specific period.

Quota rents: Profits received by the import license holders.

Voluntary export restraint: is imposed by the exporter where all quota rent is captured by the exporting country.

Export Subsidies

Objective: to stimulate exports.

Disadvantage: They ↓ welfare by promoting businesses that aren't comparatively advantageous.

Countervailing duties: Duties imposed by the importing country against subsidized exports.

4. TRADING BLOCS AND REGIONAL INTEGRATION

Types of Regional Trading Blocs:

1) Free trade area:
No barriers at all b/w member countries.

2) Customs union:
Common set of restrictions against non-members.

3) Common Market:
Allowing free movement of factors of production among members.

4) Economic union:
Common institutions & coordination of economic policies among members.

5) Monetary union:
Adoption of single currency

Regional Trading Bloc: A group of countries who have removed tariffs and quotas, so trade freely among themselves.

Effects of forming a Regional Trading Bloc:

1) Trade creation: -↑ welfare- regional integration leads to replacement of high-cost domestic production by low-cost imports from other members.

2) Trade diversion: -↓ welfare - regional integration leads to the replacement of low-cost imports from non-members with higher-cost imports from member countries.

Trading Bloc:

Pros: More efficient trade, lower prices, stronger currencies, peace.

Cons: Job losses, less competition, problems spread between members.

Challenges: Cultural clashes, policy independence.

Currency Exchange Rates

1. INTRODUCTION

Money has a time value because a unit of money received today is worth more than a unit of money to be received tomorrow.

2. THE FOREIGN EXCHANGE MARKET AND EXCHANGE RATES

The Foreign Exchange Market (FX)

- Measures the flow of payments between individuals.
- Facilitates international trade and capital flows.
- World's largest market with 24-hour operation on business days.

Individual Currencies and Exchange Rates:

- Currencies identified by three-letter codes.
- Distinction between individual currency and exchange rate.
- Exchange rate: Price of one currency in terms of another.

Market Participants

- **Sell Side:** Large and small FX trading banks.
- **Buy Side:** Includes corporate, real money, leveraged, retail accounts, governments, and central banks.

Market Size and Composition

- BIS surveys show financial clients dominate FX flows.
- FX swaps are a significant portion of daily turnover.
- London, New York, and Tokyo are the largest trading centers.

Exchange Rate Quotations

- **Direct Quote:** Domestic price for a unit of foreign currency.
- **Indirect Quote:** Foreign price for a unit of domestic currency.
- **Direct Quote =** 1 / Indirect Quote
- **Two-sided Price:** Bid (buy) and ask (sell) rates from dealers.
- **Bid-ask spreads** represent dealer profits.

Nominal Exchange Rates:

- Involves two currencies; base and price.
- Example: USD/EUR = 1.356 means 1 euro buys 1.356 U.S. dollars.
- Changes signify currency appreciation or depreciation.

Purchasing Power Parity (PPP):

- Based on the law of one price.
- Predicts exchange rate changes based on relative price levels.
- Assumes homogeneity, no trade barriers, and no transportation costs.

3. EXCHANGE RATE REGIMES – IDEALS AND HISTORICAL PERSPECTIVE

The Ideal Currency Regime

1. Fixed currency value for stability.
2. Full currency convertibility for free capital flows.
3. Independent monetary policy for domestic goals.

Limitations: Incompatibility of the three properties in practice.

Floating Exchange Rate Regime:
Advantages:
- Flexibility in monetary policy.
- Elimination of trade barriers.
- Limitations: High exchange rate volatility.
- Potential harm to economic activity and financial transactions.
- Inefficient allocation of capital.

Limitations of Fixed Exchange Rates Regime:
- Loss of ability to conduct independent monetary policy.

Historical Perspective on Currency Regimes

Gold standard for fixed exchange rates and gold-backed currency.

Benefits: Price transparency, market competition, efficient allocation with common currency.

Drawbacks: Loss of exchange rate control and independent monetary policy.

A Taxonomy of Currency

Different exchange rate regimes are chosen for various reasons, influenced by market forces, legal frameworks, and government policies.

Arrangements with No Separate Legal Tender

Two arrangements include:
1. **Dollarization:** Using another country's currency.
2. **Currency Union:** Sharing currency with union members.

Advantages: Stability, fiscal discipline, economic growth.

Disadvantages: Loss of monetary policy independence, lender of last resort function, and seigniorage

Currency Board System (CBS)

Domestic currency backed by foreign currency.

Advantages: Seigniorage profits, price stability.

Disadvantages: Limited monetary policy, inability to be lender of last resort.

Fixed Parity

Currency pegged to a major currency or basket within narrow margins.
Advantages: Macroeconomic stability.
Disadvantages: Vulnerability to speculative attacks, limited monetary policy.

Target Zone

Maintains currency value within wider margins.

Offers more policy discretion than fixed parity.

Active and Passive Crawling Pegs

Passive: Frequent unannounced adjustments based on inflation or other factors.

Active: Pre-announced adjustments at fixed rates in response to specific measures.

Advantages: Avoid overvaluation, guide public expectations.

continue

Fixed Parity with Crawling Bands

Fixed rate with pre-announced widening bands over time.

Provides flexibility and enhances credibility compared to fixed parity.

Managed Float:

Market-determined rates with discretionary central bank intervention.

Advantages: Mitigates excessive fluctuations.

Disadvantages: Requires large reserves,

Independently floating Exchange Rates

Pure market-determined rates without intervention.

Advantages: Full monetary policy independence.
Disadvantages: Exchange rate volatility and its economic impacts.

Exchange Rates and the Trade Balance: Introduction

Trade deficit/surplus must be matched by a corresponding capital account surplus/deficit.

Key Equation: X - M = (S - I) + (T - G).

Capital flows and trade balance adjustments occur in the short-to-intermediate term and long-term, respectively.

4. CAPITAL RESTRICTIONS

Capital Restrictions

- Taxes or Price controls
- Quantity controls
- Outright prohibitions on international trade
- Administrative controls

Inward Capital restrictions: Restrictions/limits on foreigners to invest in domestic country.

Outward Capital restrictions: Limits imposed on purchase of foreign assets or loans.

Reasons for Restrictions

- Achieve employment or development goals.
- Strategic or defense objectives.
- Control over the external balance and monetary policy independence.
- Raise government revenue by retaining capital domestically.

Benefits of Free Capital

- Efficient capital investment and higher returns.
- Exceeds domestic savings rate, allowing greater investment.
- Higher growth rates and spillover benefits like technology and skills.
- Increases domestic competition and efficiency.

Drawbacks

Drawbacks of Free Capital Flows

- Risk of capital flight during economic crises.
- Domestic industries may suffer from increased foreign competition.

Drawbacks of Capital Restrictions

- High administrative costs.
- Discourage foreign investment and access to funds.
- Potential for economic decline and lower living standards.

Exchange Rate Calculations

1. INTRODUCTION

- **Trading advantage:** Currency exchange rates unlock global commerce and finance. Cross-rates let traders price indirect currencies, expanding opportunity.
- **Market dynamics:** Arbitrage relationships reveal how key factors interconnect and influence currency valuations.
- **Decision drivers:** Global entities trade currencies for diverse reasons. Understanding spot and forward rate drivers is crucial for informed trades.

2. CROSS-RATE CALCULATIONS

Currency Conversion

The exchange rate for one currency against another is calculated by multiplying the individual rates between them.

For example, CAD/EUR = CAD/USD x USD/EUR.

- **Bid Rate** (CAD per USD) is the reciprocal of Ask Rate (USD per CAD).
- **Ask Rate** (CAD per USD) is the reciprocal of Bid Rate (USD per CAD)

Triangular Arbitrage:

- Misquoted exchange rates create inconsistencies that can be exploited for profit.
- By taking advantage of inconsistent cross-rate quotes, traders can make "riskless" profits through a series of three currency conversions

3. FORWARD CALCULATIONS

Forward Exchange Rates

- Quoted in terms of points (pips).
- **Points on a forward rate quote** = forward exchange rate quote – spot exchange rate quote.
- Points are scaled to the last decimal in the spot quote and often quoted to more decimal places.

Forward Premium Discount

- **Positive** points indicate a forward premium for the base currency and a discount for the price currency.
- **Negative** points indicate a forward discount for the base currency and a premium for the price currency.

Swap Points

- Forward rates are shown as swap points at each maturity.
- Directly related to term to maturity and interest rate differentials.

Converting Forward Points

- Forward rate = Spot rate + (Forward points/10,000).
- Forward premium/discount (%) = (Spot rate + (Forward points/10,000))/Spot rate - 1.

Relationship between Spot, Forward & Interest Rates:

- Forward rates are influenced by the difference between domestic and foreign interest rates.
- Currency with a higher interest rate trades at a discount in the forward market.
- Forward rates can be calculated using the formula: $F_{f/d} = S_{f/d}\left(\frac{1+i_f}{1+i_d}\right)$

Interest rate Parity & Arbitrage

- Risk-free investments in different currencies should yield the same return.
- Arbitrage occurs when returns differ due to mispriced forward rates.
- Forward rate can be derived from spot rates and interest rate differentials

Factors affecting Forward Points

- Spot exchange rate
- Interest rate differential
- Forward contract horizon (approximately proportional)

Forward Rate Predictions:

- Forward rates are unbiased but poor predictors of future spot rates.
- They are influenced by interest rate differentials and yield curve shape.