Lesson 1: Economic theory of choice

(Instructor: Prof. Abhinava Tripathi)

Introduction

In this lesson, we will cover the following topics:

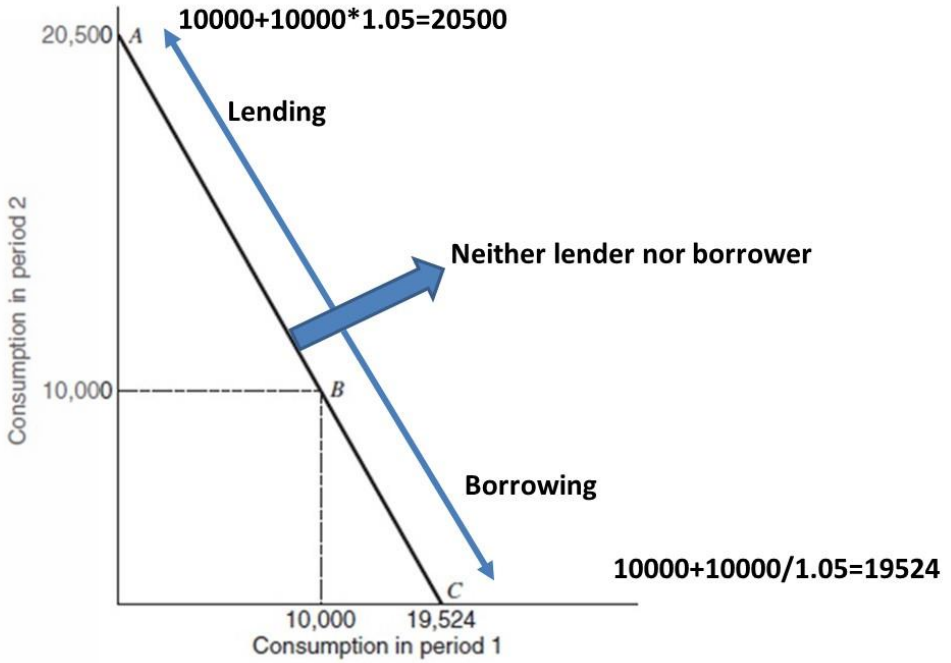
- Economic theory of choice and interest rates
- Indifference curves and utility of wealth
- Risk-return framework in financial markets
- Expected return and actual returns
- Measures of risk and their computation

Economic Theory of Choice Under Certainty

Economic Theory of Choice Under Certainty

What should be the consumption pattern of an investor?

- Consider the example of an investor who will receive $10000 at the end of years 1 and 2. Also, assume that only investment available offers 5% rate and only borrowing available is at 5% rate.

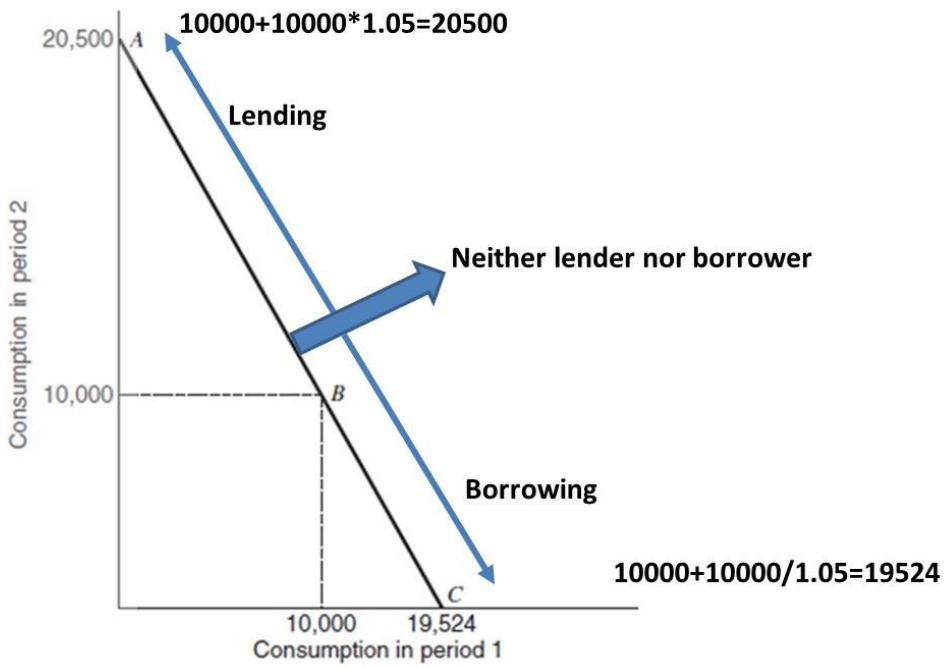


- Let us define his opportunity set.
- One extreme of the options available is to consume $10000 in each period and save nothing.

Economic Theory of Choice Under Certainty

What should be the consumption pattern of an investor?

- Invest the income in period 1, which will be received in period 2. Then, consume all in period 2: 10000 + 1000 × 1.05 = $20500

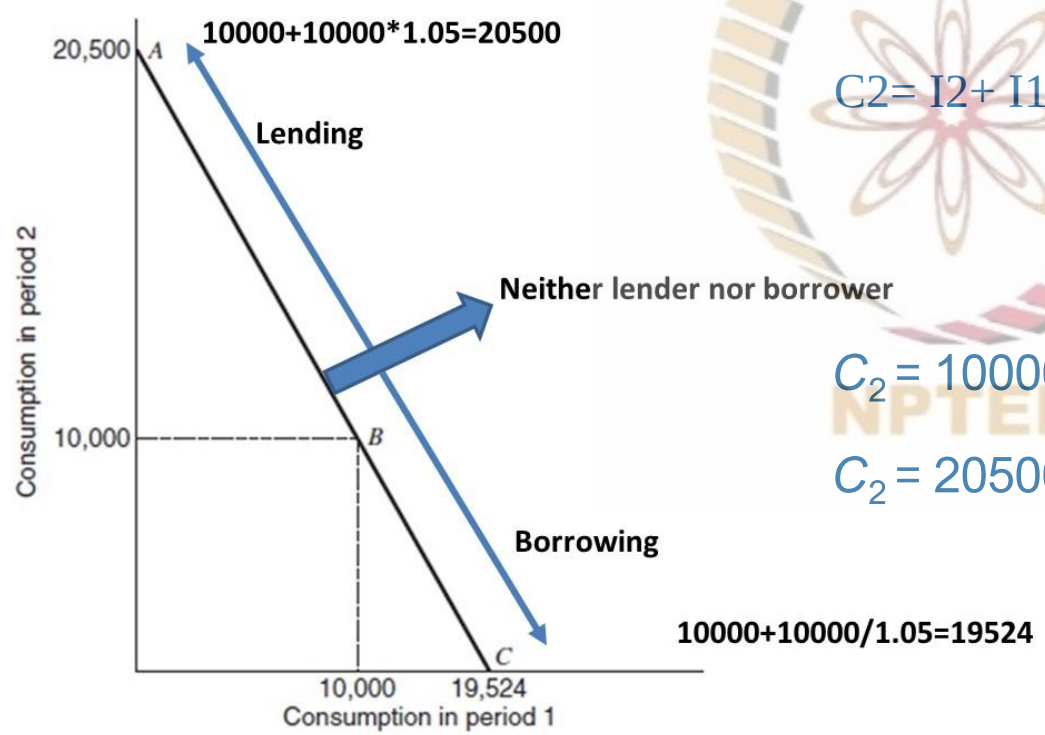


OR

- Another extreme is to borrow an amount against the income in period 2, and consume all in period 1: 10000 + 10000/1.05 = $19524

Economic Theory of Choice Under Certainty

And so it appears that all the choices available to the investor can be represented on this straight line (AC)



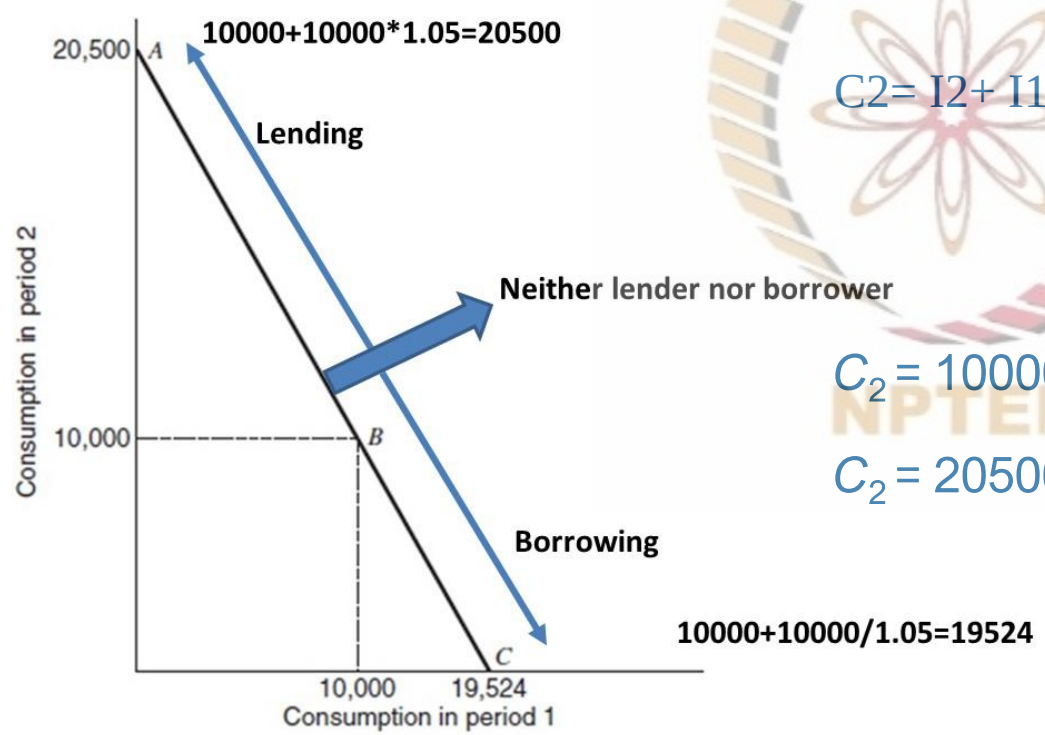
C2= I2+ I1*1.05-C1*1.05, here I1=I2=10000

$C_2 = 10000 + (10000 - C_1) \times 1.05$ (Eq. 1)

$C_2 = 20500 - 1.05C_1$ (Eq. 2)

Economic Theory of Choice Under Certainty

Easy to understand that the consumption of the investor is constrained by his income



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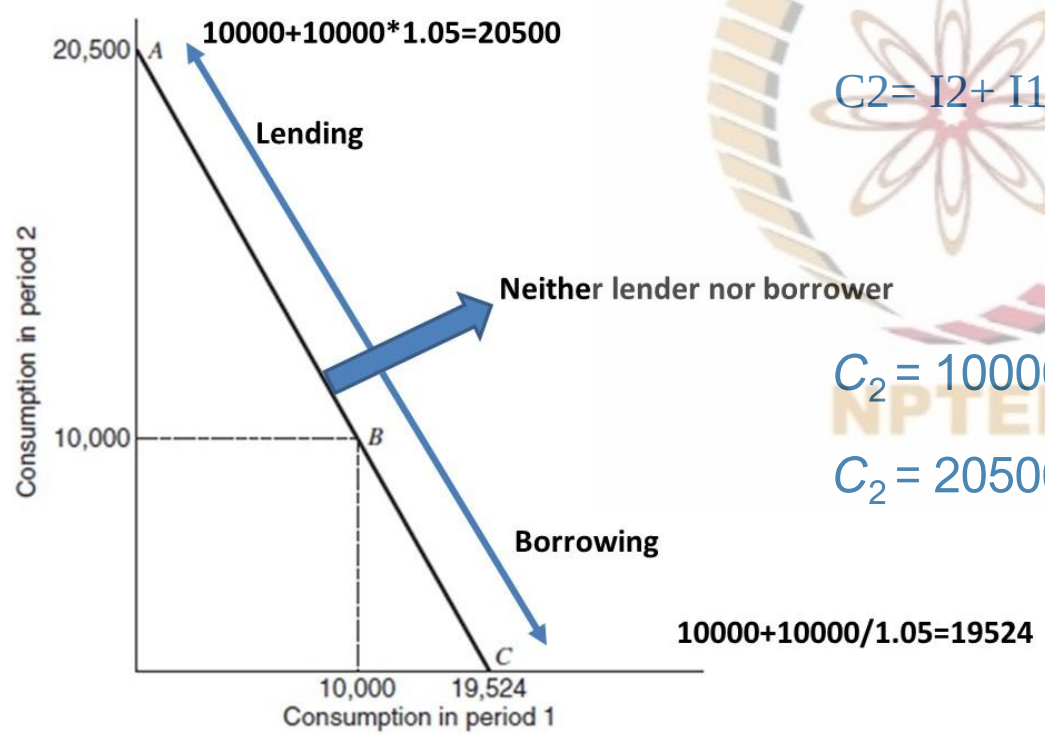
Elton, Gruber, Brown, Goetzmann, *Modern Portfolio Theory and Investment Analysis* , 9th edition (Chapter 1)

Economic Theory of Choice Under Certainty

If the consumption in period 2 is C2, and in period 1 is C1, we can write a simple equation that defines the relationship between income (I1, I2) and consumption (C1, C2)



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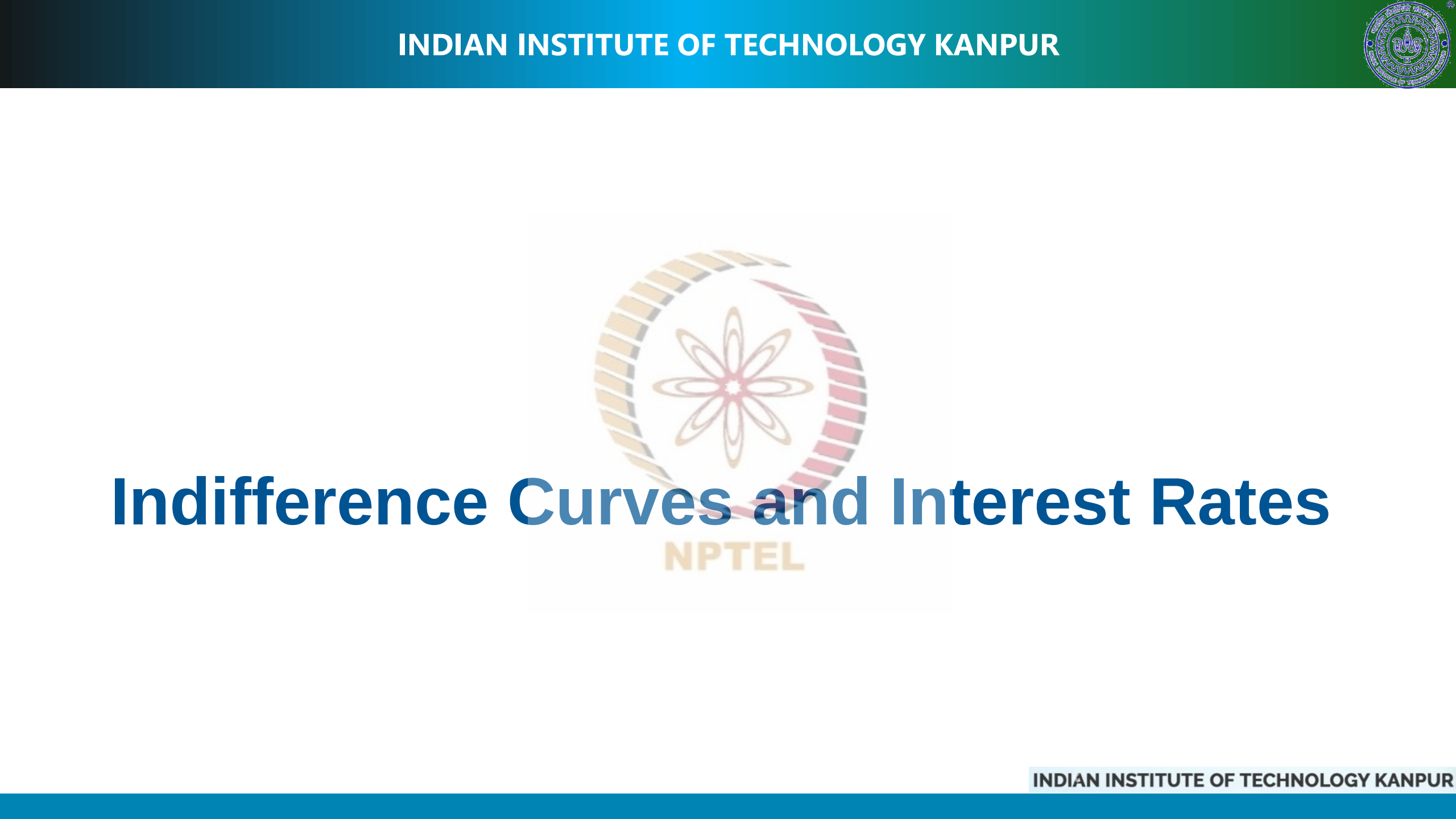
$$C_2 = 10000 + (10000 - C_1) \times 1.05 \qquad \text{(Eq. 1)}$$

$$C_2 = 20500 - 1.05C_1 \qquad \text{(Eq. 2)}$$

Economic Theory of Choice Under Certainty

The consumption pattern or opportunity set of the investor is defined by a simple straight line equation given in (Eq. 1).

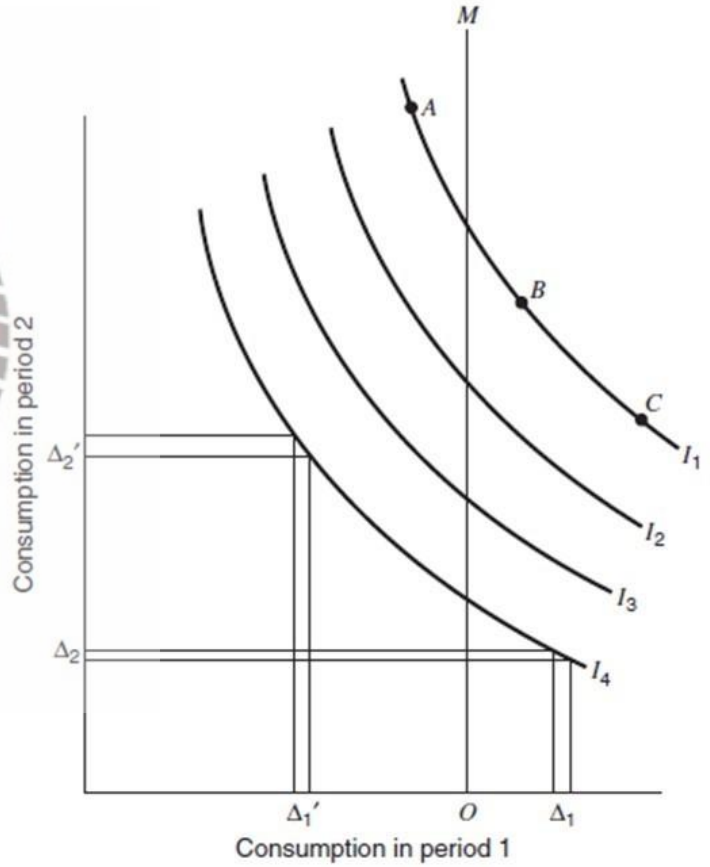
- Slope of −1.05 is because of the interest rate of 5%.
- If one delays a consumption of 1 unit today, he gets to consume 1.05 more in the next period.
- But the happiness/utility of consuming 1 unit today may or may not be the same as 1.05 in the next period! How?



Indifference Curves and Interest Rates

Indifference or Utility Curves

- Indifference curves, also called utility functions, represent those points on the consumption region where the consumer derives the same utility moving on a curve.
- For an investor, utility curves are drawn, i.e., I_1, I_2, I_3, and I_4. That investor on the curve I_1 is equally happy or has the same utility whether he is on *A*, *B*, or *C*.



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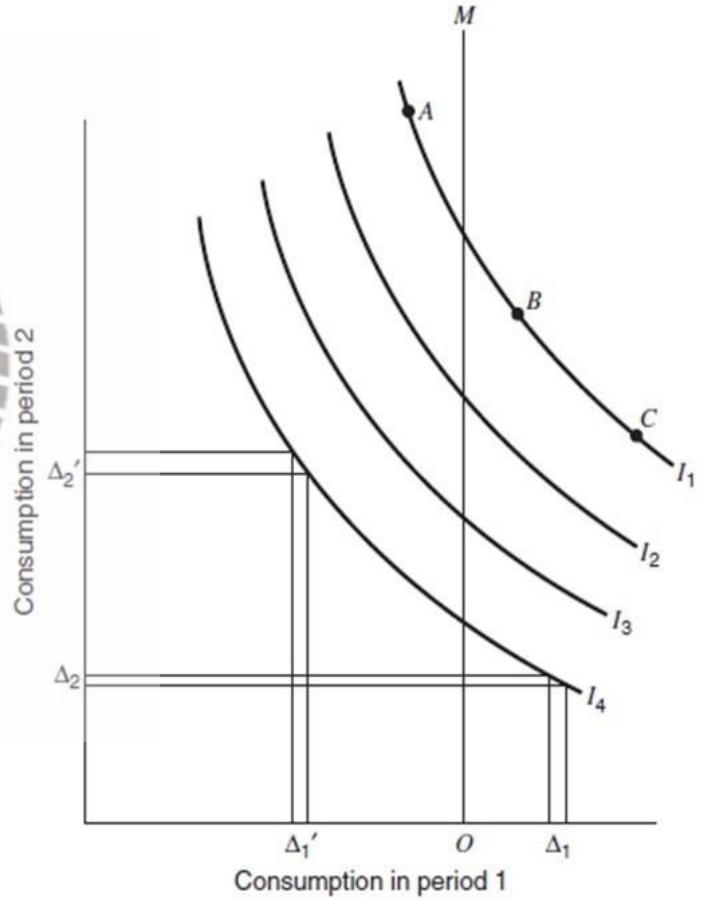
Indifference or Utility Curves

- However, if he moves to I_2, his utility is reduced. If he moves to I_3, his utility is further reduced. This ordering $I_1 > I_2 > I_3 > I_4$ assumes that more is preferred to less.
- Also, please remember if we are consuming more and more in a period, then the marginal utility of consumption in that period, as compared to the other period, comes down.



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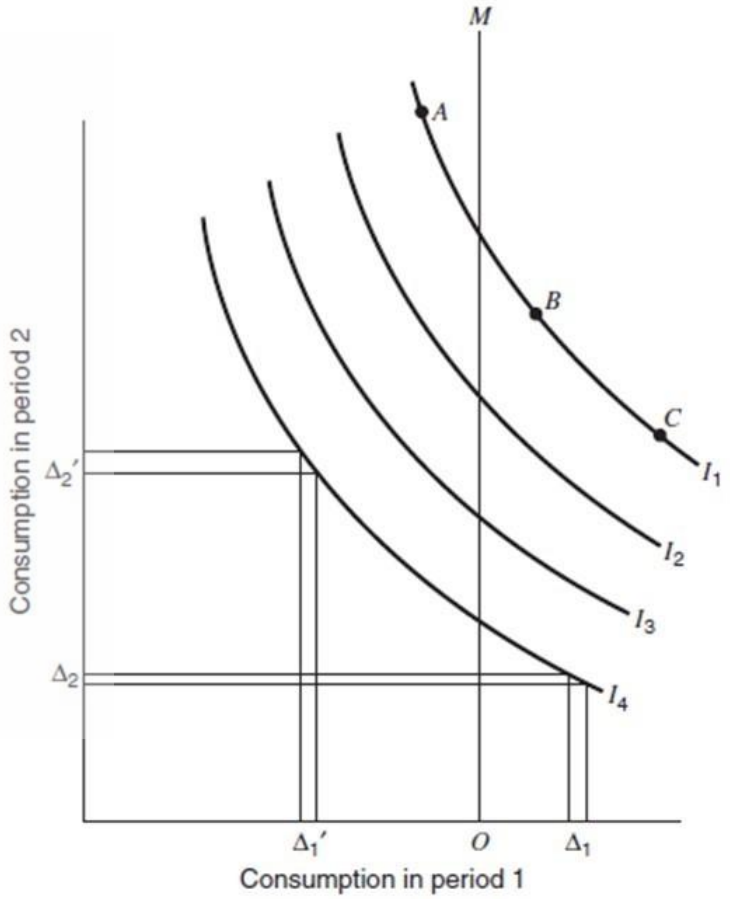
Indifference or Utility Curves

For example, consider a situation when we are heavily consuming in period 1.

- If we increase or decrease the consumption by Δ_1, then the corresponding change in period 2 to maintain the same utility is much lower.
- Similarly, if we are consuming much less in period 1, then any increase or decrease in consumption by Δ_1' in period 1 would require a much higher or lower decrease or increase in period 2.



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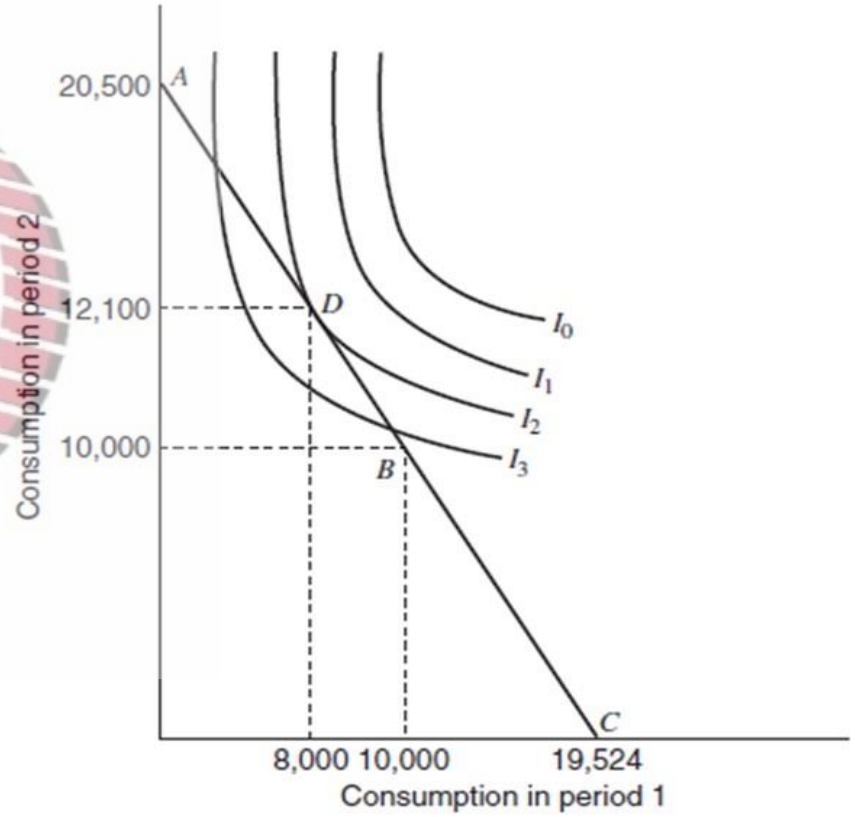
Indifference or Utility Curves: Solution

- On the opportunity set, we aspire to achieve maximum utility. This is obtained at point *D*, which is at the point of tangency between the opportunity set and indifference curves.
- One interesting observation is to be made here. If the optimum consumption is closer to point *A*, that is, higher consumption in period 2, then the investor is effectively a lender at 5%.



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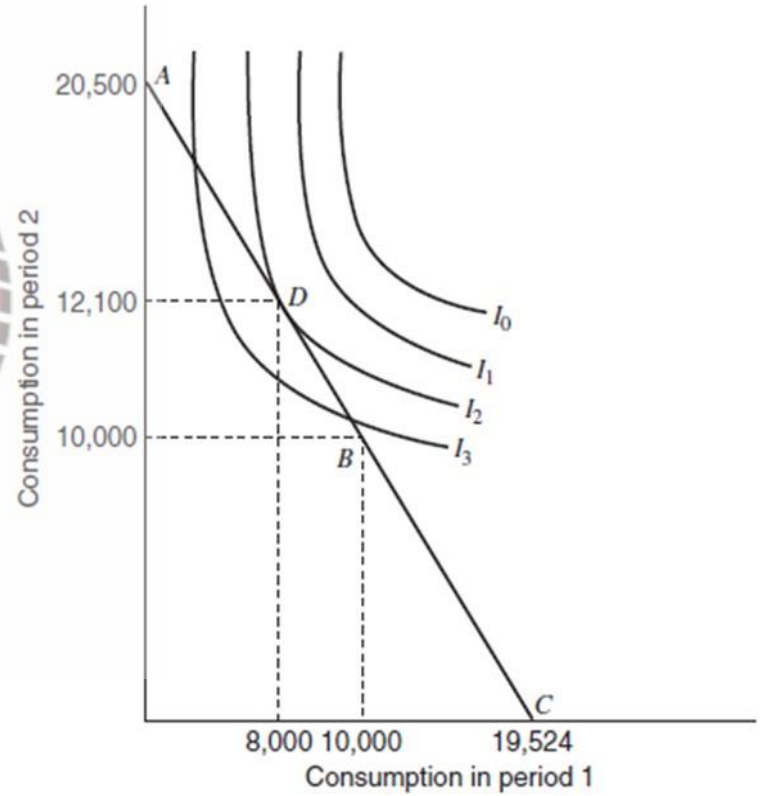
Indifference or Utility Curves

- Similarly, if the optimum consumption point is closer to point *C*, then the investor is a borrower at 5%.
- Somewhere in between (say point *B*) investor is neither a borrower or lender at 5%.
- Now, summing across all the investors who wish to lend provides one point on the supply curve.



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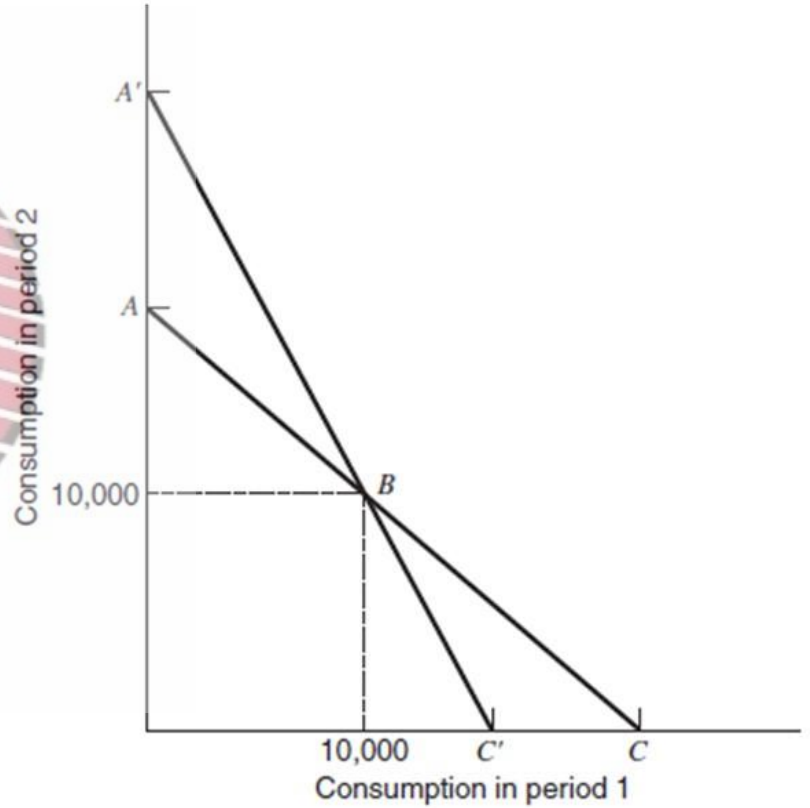
Indifference or Utility Curves

- Similarly, summing across all the investors who wish to borrow provides one point on the demand curve.
- As interest rates vary, full demand and supply curves are generated. Thus, the equilibrium interest rate is obtained when the amount supplied is equal to the amount demanded – called as market clearing condition.
- Therefore, two key factors, i.e., investors' income and "taste and preferences," lead to the determination of interest rates in the market.

Problem with Multiple Securities and Interest Rates

What if there were two assets?

- The first asset had 5% rate (for lending and borrowing), whereas the second asset had 10% rate.
- Now, investors would prefer to lend at 10% and borrow at 5%.



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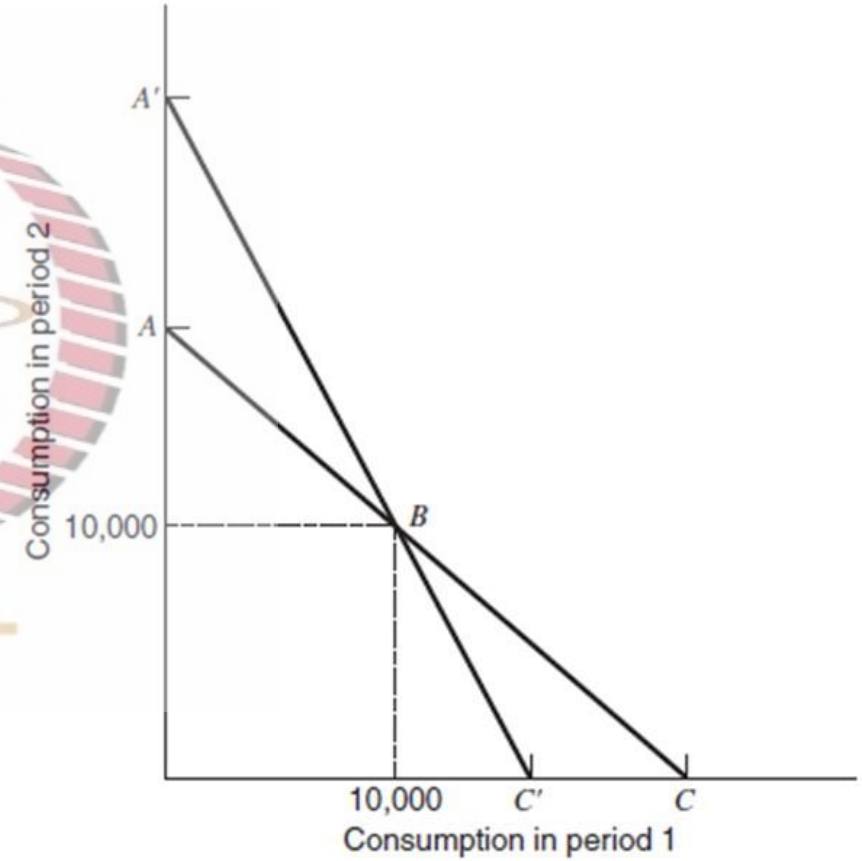
Problem with Multiple Securities and Interest Rates

What if there were two assets?

- Common sense would suggest that this situation is unstable. Nobody would like to invest at 5% and borrow at 10%.
- However, we do observe different interest rates. This has to do with the risk associated with different interest rate instruments.



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Expected and Actual Returns

Risk and Return in Financial Markets

How do we understand the framework of risk and return in financial markets?

- How much return we should expect from SBI-FD (Government Bank) vs Mutual Funds.
- You would expect a higher returns from Mutual fund as compared to a FD in government bank. Why?
- Government FD is a safer instrument, with a lot of surety about the principal and interest amount.
- Mutual funds are risky.

Risk and Return in Financial Markets

How do we understand the framework of risk and return in financial markets?

- Computation of returns: (1) interest income, and (2) capital appreciation
- $\text{Return} = \frac{\text{Capital appreciation} + \text{Interest income}}{\text{Initial investment}}$
- Consider a stock at price P_0 = 10, held for 1 year. The price at the end of the year is P_1 = 15. Also, during the year, it gave a dividend of 5.
- Return : $\frac{5+(15-10)}{10}$=1, or 100% annual return.

Risk and Return in Financial Markets

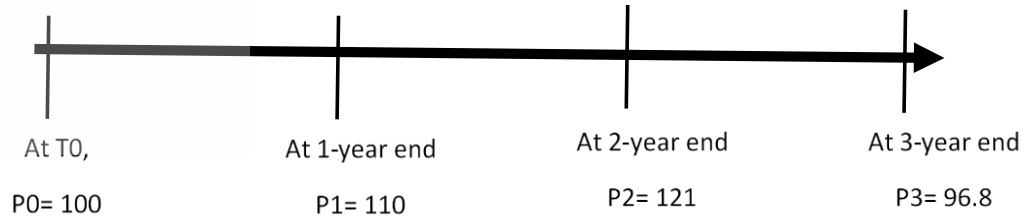
How do we understand the framework of risk and return in financial markets?

- Stock A offers 10% return and stock B offers 20% return
- Which one is the better investment?
- Do we need some more information

Risk and Return in Financial Markets

Arithmetic averages and geometric averages

- Consider an investment (e.g., stock) that is held for three years with the following closing prices (no interest/dividend is offered)
- Let us see what are the returns for different holding periods, i.e., T0–T1, T1–T2, and T2–T3
- R_{T0-T1} = (110 − 100)/100 = 10%
- R_{T1-T2} = (121 − 110)/110 = 10%
- R_{T2-T3} = (96.8 − 121)/121= −20%



Risk and Return in Financial Markets

Arithmetic averages and geometric averages

- Average return from the investment = $\frac{10\% + 10\% - 20\%}{3} = 0\%?$
- The intuition that he is wrong comes from the fact that you are left with 96.8, which is 3.2 less than your original investment
- Total return from the investment = $\frac{96.8-100}{100} = -3.2\%.$
- This return is for three years, should we divide it by 3

Risk and Return in Financial Markets

Arithmetic averages and geometric averages

- So we move to our friend that is compounded returns
- So we move to our friend that is compounded returns: $(1 + \bar{R})^3 - 1 = -3.2\%$, here $\bar{R}$ is the average return.
- $\left(1 + \left(-\frac{1.07825}{100}\right)\right)^3 - 1$ should be equal to 0.968
- $\bar{R}$ works out to be $= -1.07825\%$.
- Also the negative return seems fair

Returns: Expected Returns

Different from actual returns: builds an expectation of future

- A more general way to represent the expected returns would be like this
- $E(R_{i,t}) = \sum_{t=1}^{T} P_t \times R_t$.

S. No. (t)	Probabilities (P_i)	Expected Returns
1	0.1	40%
2	0.2	20%
3	0.3	0%
4	0.2	−20%
5	0.2	−30%

Returns: Expected Returns

Different from actual returns: builds an expectation of future

- What is our expected outcome in this game?
- *E* (return from the game)
- $= 0.1 \times 40\% + 0.2 \times 20\% + 0.3 \times 0\% + 0.2 \times (-20\%) + 0.2 \times (-30\%) = -2\%$
- A more general way to represent the expected returns would be like this: $E(R_{i,t}) = \sum_{t=1}^{T} P_t \times R_t$
- Here, $R_{i,t}$'s are the returns of a security 'i' for the period 't' with a probability of P_t

Returns: Expected Returns

What if we do not have these probabilities, and we only have past returns and all returns are equally likely?

- I.e., $P_1 = P_2 = P_3 = P_4 \ldots\ldots = P_T$. Since we know that $\sum_{i=1}^{T} P_i = 1$ Therefore, $P_1 = P_2 = P_3 = P_4 \ldots\ldots = P_T = \frac{1}{T}$
- $E(R_i) = \bar{R}_i = \frac{1}{T}\sum_{t=1}^{T} R_t$
- This suggests that averaging of observed returns to obtain expected average return is a special case, where all the return outcomes are assigned equal probabilities

Returns: Expected returns

Different from actual returns: builds an expectation of future

- A more general way to represent the expected returns would be like this
- $E(R_{i,t}) = \frac{1}{T}\sum_{t=1}^{T} R_t = (1/5) \times (40\% + 20\% + 0\% - 20\% - 30\%) = 2\%$

S. No. (t)	Expected Returns
1	40%
2	20%
3	0%
4	−20%
5	−30%

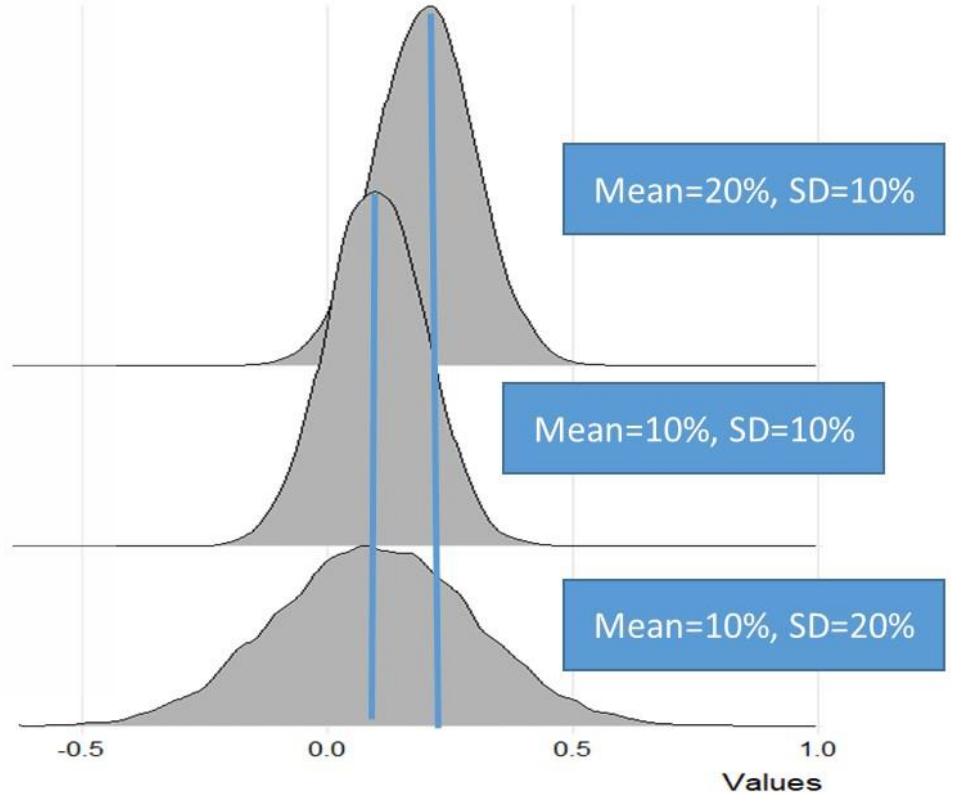
- But what are these expectations based upon? Risk

Risk: What Is Risk and How to Measure It?

Distribution of Returns

Between investments 1, 2, and 3, which on to choose

- Between 1 & 2, 1 is preferred: compare the risk
- Between 2 & 3, 3 is preferred: compare the expected returns



Risk: What Is Risk and How to Measure It?

Risk in financial markets:

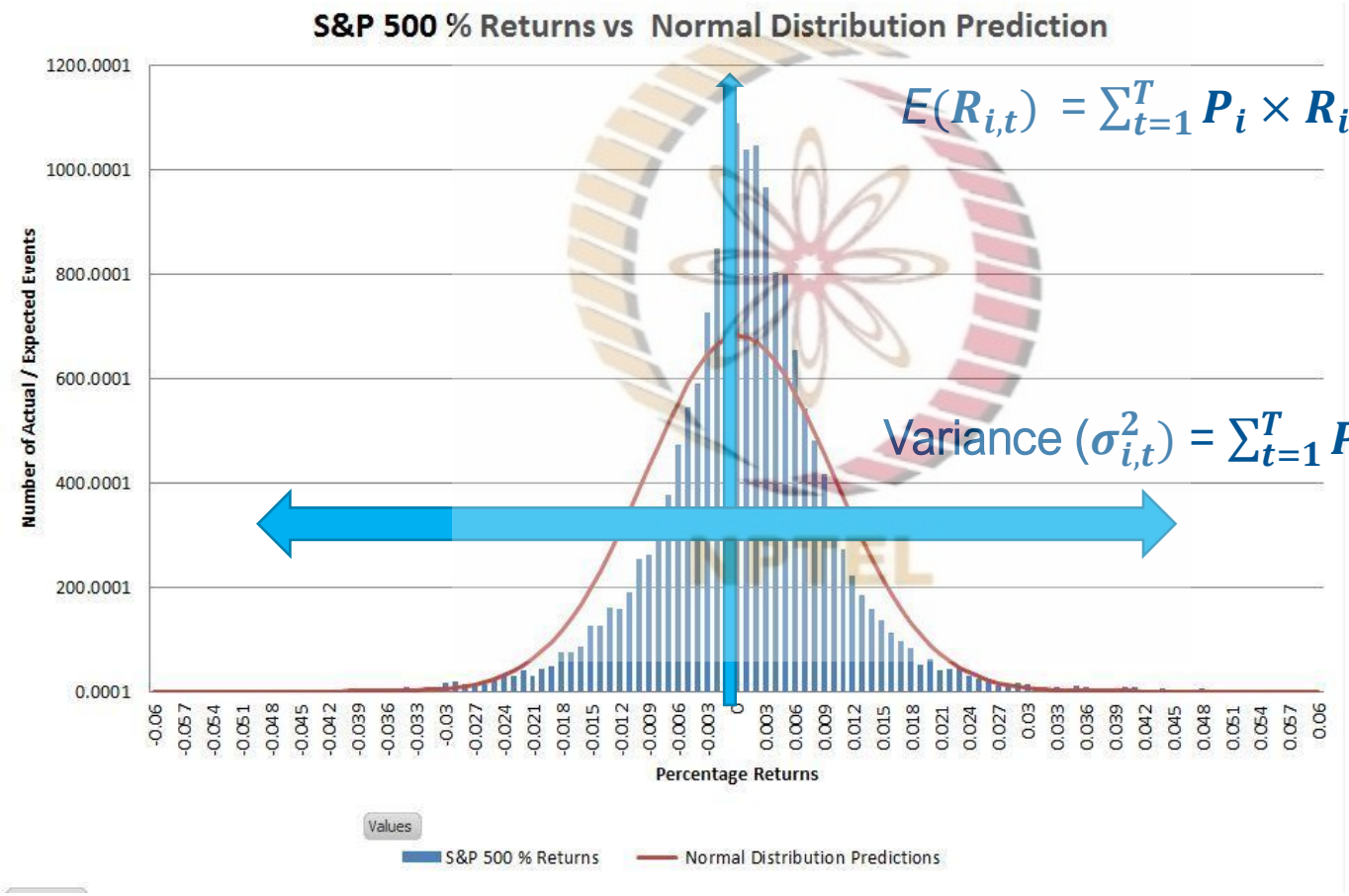
- Uncertain outcomes lead to risk. If the outcome is certain (SBI FD), then there is no risk. Risk-free assets.
- A person can be risk-averse, risk-taking, and risk-neutral.
- How to measure risk: variance $(\sigma_{i,t}^2)$ or standard deviation $(\sigma_{i,t})$
- $E(\sigma_{i,t}^2)$= Variance $(\sigma_{i,t}^2)$= $\sum_{t=1}^{T} P_i(R_{i,t} - \bar{R}_i)^2$

Risk: What Is Risk and How to Measure It?

E($\sigma_{i,t}^2$)= Variance ($\sigma_{i,t}^2$)= $\sum_{t=1}^{T} P_i(R_{i,t} - \bar{R}_i)^2$

- Again, for past observations that are equally likely
- I.e., $P_1 = P_2 = P_3 = P_4 \ldots \ldots = P_T$. Since we know that $\sum_{i=1}^{T} P_i$ = 1. Therefore, $P_1 = P_2 = P_3 = P_4 \ldots \ldots = P_T = \frac{1}{T}$
- Variance ($\bar{\sigma}_i^2$)= $\frac{1}{T}\sum_{t=1}^{T}(R_{i,t} - \bar{R}_i)^2$
- Often, while working with samples, we use $\bar{\sigma}_i^2 = \frac{1}{T-1}\sum_{t=1}^{T}(R_{i,t} - \bar{R}_i)^2$.

Risk: A Few Words on Normal Distribution



$$E(R_{i,t}) = \sum_{t=1}^{T} P_i \times R_{i,t}$$

$$\text{Variance } (\sigma_{i,t}^2) = \sum_{t=1}^{T} P_i (R_{i,t} - \overline{R_i})^2$$

https://seekingalpha.com/article/3959933-predicting-stock-market-returns-lose-normal-and-switch-to-laplace

Risk: What Is Risk and How to Measure It?

- Let us go back to our example "Game" for which we computed expected returns with given probabilities. Now, we will compute the expected variance for the same example using probabilities.
- $E(\sigma_{i,t}^2)$ = Variance $(\sigma_{i,t}^2) = \sum_{t=1}^{T} P_i(R_{i,t} - \bar{R}_i)^2$

S. No. (t)	Probabilities (P_i)	Expected Returns (Mean $\overline{R_i}$ = −2%)
1	0.1	40%
2	0.2	20%
3	0.3	0%
4	0.2	−20%
5	0.2	−30%

Risk: What Is Risk and How to Measure It?

Probabilities (P_i)	Expected Returns (Mean $\overline{R_i}$ = −2%)	Mean deviation $(R_i - \overline{R_i})$	Squared Deviation $(R_i - \overline{R_i})^2$	Probability × Squared Deviation $P_i \times (R_i - \overline{R_i})^2$
0.1	40%	42%	0.1764	0.01764
0.2	20%	22%	0.0484	0.00968
0.3	0%	−2%	0.0004	0.00012
0.2	−20%	−18%	0.0324	0.00648
0.2	−30%	−28%	0.0784	0.01568

- $E(\sigma_{i,t}^2) = \sum_{t=1}^{T} P_i(R_{i,t} - \bar{R}_i)^2$ = 0.01764 + 0.00968 + 0.00012 + 0.00648 + 0.01568 = 0.0496
- The value of standard deviation = $\sqrt{E(\sigma_{i,t}^2} = \sqrt{0.0496}$ = 0.2227 or 22.27%

A Short Note on Compounding of Interest

A Short Note on Compounding of Interest

Interest rates can be sometimes misleading:

- One should carefully examine the frequency of the interest payment and compounding period of interest rates.
- For example, you borrow from a bank at 12%. These quoted rates are usually annual percentage rates (APR)
- Your bank tells you that you have to pay 1% monthly installments. Now, your effective rate becomes $(1.01)^{12} - 1 = 12.6825\%$.

A Short Note on Compounding of Interest

As a general rule, for payment (compounding frequency) of "m" times per year with a quoted APR of r%, the following formula can be used to compute the effective interest rate: $\left(1+\frac{r}{100\times m}\right)^{m}-1$

- Here, r is in %. As the period of compounding becomes smaller, the effective interest becomes longer.
- For a special case, when m becomes infinitely large, then this value converges to $e^{r/100}$.
- For a period of "t" years, the effective amount will be $e^{rt/100}$ and effective interest will be $e^{rt/100}-1$.

A Short Note on Compounding of Interest

- For a special case, when *m* becomes infinitely large, then this value converges to $e^{r/100}$.
- For a period of "*t*" years, the effective amount will be $e^{rt/100}$ and effective interest will be $e^{rt/100} - 1$.
- This is called continuous compounding. In financial markets research, mostly continuous compounding is employed in the computation of returns.
- For example, if opening price $P_0 = 15$ and closing price $P_1 = 20$, then returns under continuous compounding will be computed as follows: $\ln\left(\frac{P_1}{P_0}\right)$.

Example on Compounding of Interest

Compounding Frequencyz
1 year = 1.12
6 months (2 times)
4 months (3 times)
3 months (4 times)
1 month (12 times)
1 day (365 times)
Very small period (less than a day – continuous compounding)

Example on Compounding of Interest

Compounding Frequency	Effective Interest Rate	Excess Over 12%
1 year = 1.12	1.12 – 1 = 12%	0%
6 months (2 times)	$1.06^2 - 1$ = 12.36%	0.36%
4 months (3 times)	$1.04^3 - 1$ = 12.4864%	0.4864%
3 months (4 times)	$1.03^3 - 1$ = 12.551%	0.551%
1 month (12 times)	$1.01^{12} - 1$ = 12.6825%	0.6825%
1 day (365 times)	$(1 + 0.12/365)^{365} - 1$ = 12.7475%	0.7475%
Very small period (less than a day – continuous compounding)	$e^{.12}$ = 12.75%	0.75%

Summary and Concluding Remarks

Summary and Concluding Remarks

- Financial markets provide the conduit for individuals to optimize the time pattern of their consumption.
- The demand and supply of funds determine the efficient clearing prices, and, therefore, the interest rate environment prevails in the economy.
- Expectations of interest rate from security are determined based on the risk of the security.

Summary and Concluding Remarks

- Risk of security represents the increased uncertainty in outcomes; the wider the possible outcomes the more the risk.
- For a given level of risk, investors prefer instruments with higher expected returns, and for a given level of expected returns, investors prefer instruments with lower risk.


Thanks!
NPTEL

Lesson 2: Introduction to Market Microstructure

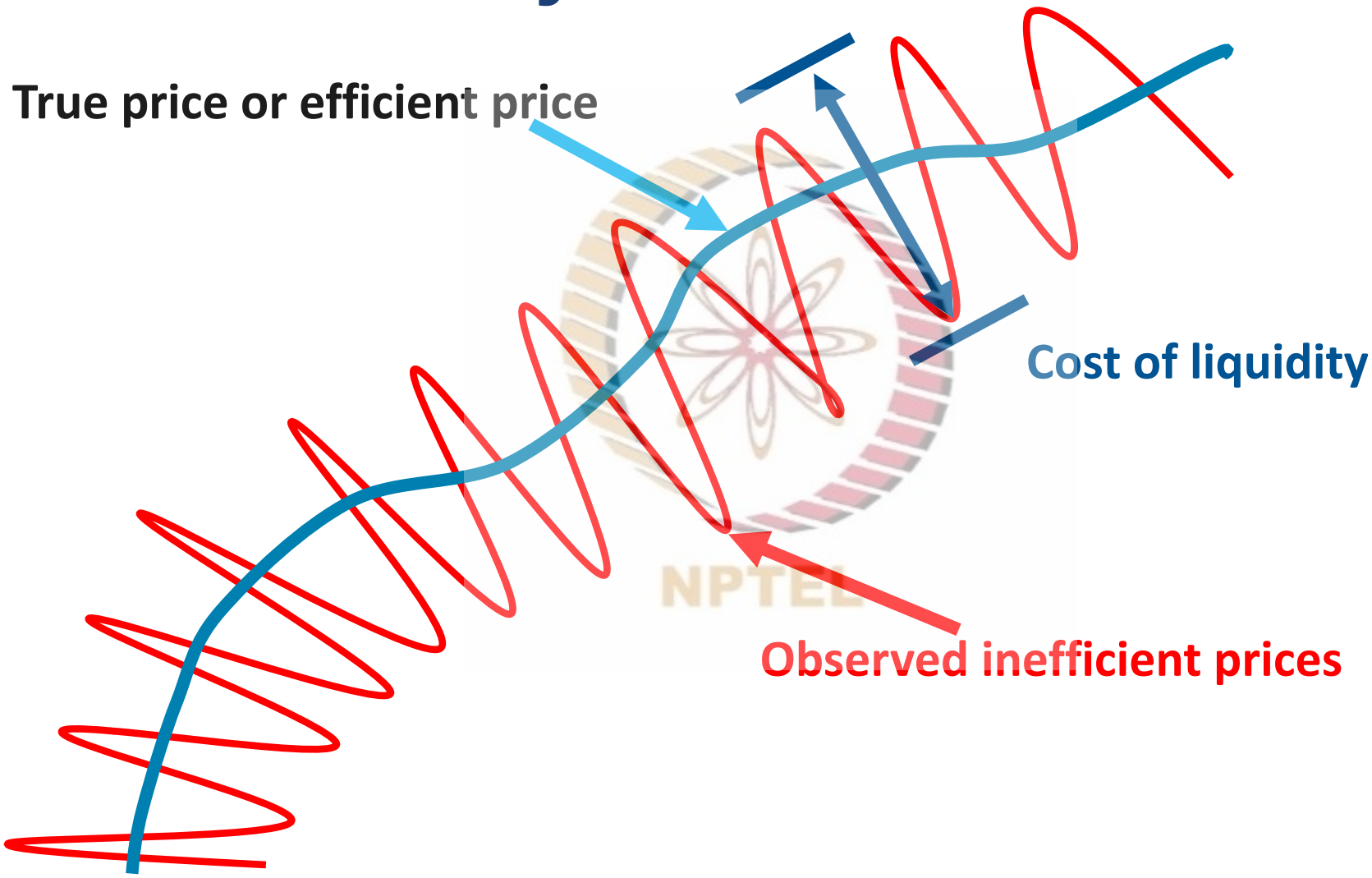
(Instructor: Prof. Abhinava Tripathi)

Introduction

- To channel the savings of an economy towards productive and efficient sectors: Financial Intermediation
- Banks conventionally play this role
- However, financial markets allow investors to directly participate in the process of choosing the best sector for himself
- Thus less bureaucratic hassles or principal-agent problem
- To this end, an economy needs efficient and liquid markets
- What is efficient and liquid ?

Market Efficiency

Market Efficiency



Market efficiency

The true price or efficient price or fundamental price is called so because it reflects all the "fundamental information" about security

- The information that affects the cash flows of the firm(e.g., macroeconomic information, or information about the firm)
- However, this price is not observed
- What we observe on stock markets is a mix of fundamental prices and noise
- $P_{observed} = P_{true} + e_{noise}$

Market efficiency

This noise, though a small component, is at times sufficient for informed traders to conduct arbitrage trading (Speculation?)

- Riskless Arbitrage trading: Same stock is traded in different markets (BSE vs NSE, Cash vs Future)
- If price in one of the markets deviates too much from its true value, informed traders start selling/buying the stock in that market and take opposite position in the other market (buying/selling)
- Since they are not taking any risk, this is called riskless arbitrage (In practical life, no arbitrage is riskless)

Market efficiency

However, for arbitrage to take place the price has to move sufficiently to cover the trading costs (costs of liquidity)

- Therefore, the forces of arbitrage only work when the price moves out of the cost of liquidity window
- Then forces of arbitrage kick-in and pull the prices towards the efficient price until it moves back in the liquidity window
- Thus, price keeps oscillating with in the cost of liquidity window
- What is the amplitude of this window?

Market efficiency

This amplitude reflects cost of liquidity

- At times prices move-beyond this amplitude and exhibit high fluctuations
- Then we say that prices are volatile
- This happens during some crisis periods or negative news
- A higher volatility means that prices divert away from their true values
- Different markets exhibit different levels of volatility depending upon the level of efficiency

Market efficiency

- **Weak-form efficiency:** When a trader can not make profit using the information contained in past prices, markets are said to be weak-form efficient
- **Semi-strong form efficiency:** When a trader can not make profit using the information contained in past prices and public
- **Strong form efficiency:** When a trader can not make profit using the information contained in past prices, public information, as well as private information

Market efficiency

- **Not efficient at all:** Make technical trading strategies, using the information from past price and volume
- **Weak-form efficiency:** Make profits by collecting public information
- **Semi-strong form efficiency:** Make profits if one has private information
- **Strong form efficiency:** Can not beat the market, so follow the market by investing in indices that reflect the broad market movement (Nifty-50)

Risk Preference

Risk Preference

Individuals are described by their utility function. These utility functions describe our preferences for different outcomes

- For a given level wealth W, an individual may have wealth as $U(W)$. For all normal things, it is reasonable to assume $U'(W) > 0$, i.e., more is preferred to less or **"non-satiation"**
- This means that increase in wealth will always lead to increase in utility, no matter how small
- With this, individuals are classified as **(1) Risk neutral; (2) Risk Averse; (3) Risk preferring.**

Risk Preference: Risk Neutral Person

If the individual is indifferent in receiving the expected value of gamble

- *That means, if you make a bet the expected value of winning the bet is Rs 100. If you are indifferent in directly getting Rs 100 vs taking this bet*
- This also means that in this case, expected wealth is important for the investor, not the risk (variance) of the wealth
- Therefore, utility is a linear function of wealth here: $U''(W) = 0$
- This also means that changing the risk of outcome has no effect on the utility (well-being for a given level of wealth): $\mathrm{U[E(W)] = E[U(W)]}$

Risk Preference: Risk Averse Person

Utility function of a risk averse individual is concave, that is $U''(W) < 0$

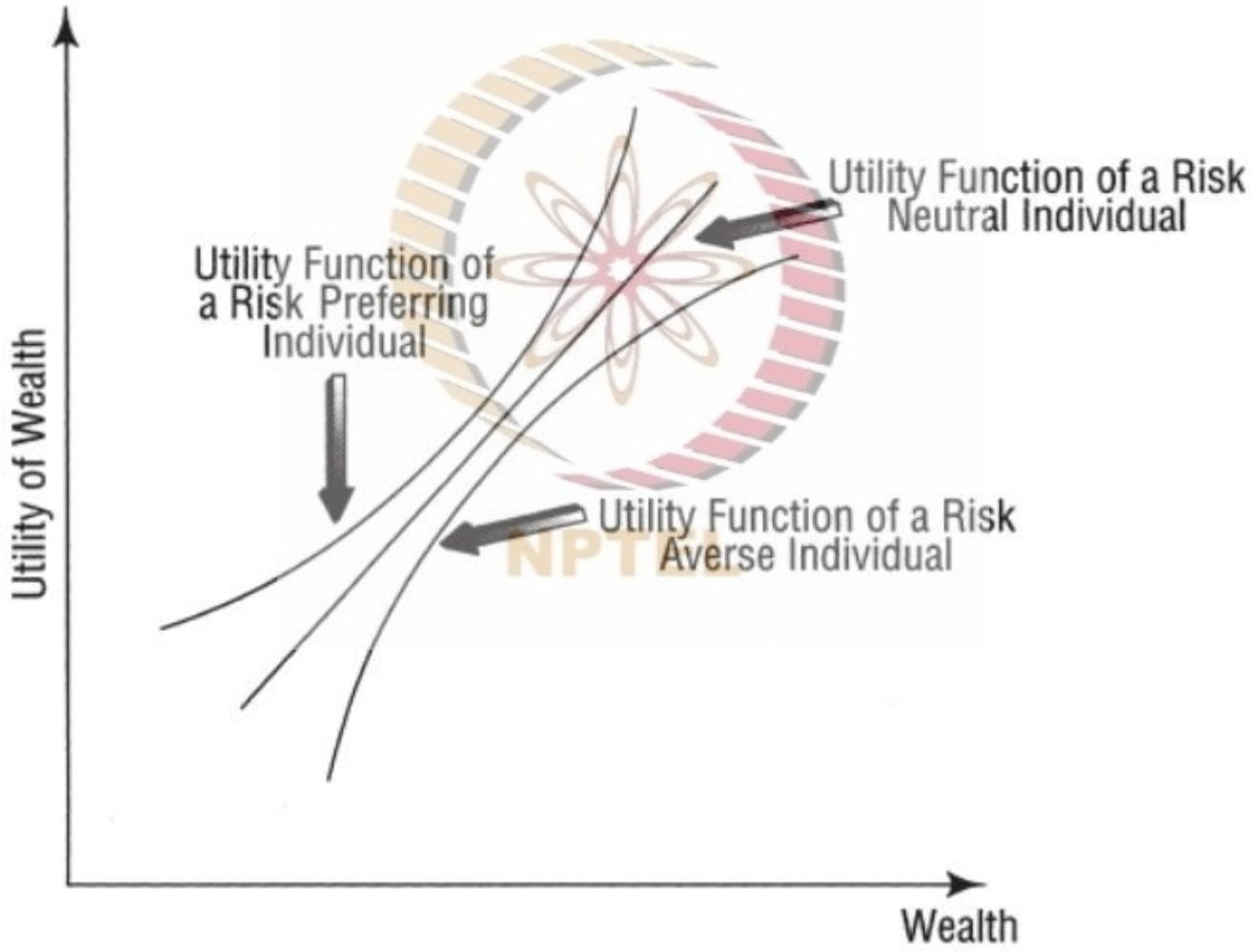
- This also means that the individual prefers a certain (ensured) amount over the bet (gamble) with the same expected value: $\mathrm{U[E(W)] > E[U(W)]}$
- This also means that risk averse individuals prefer less risk to more, and they demand additional risk-premia to take the extra-risk

Risk Preference: Risk Preferring Person

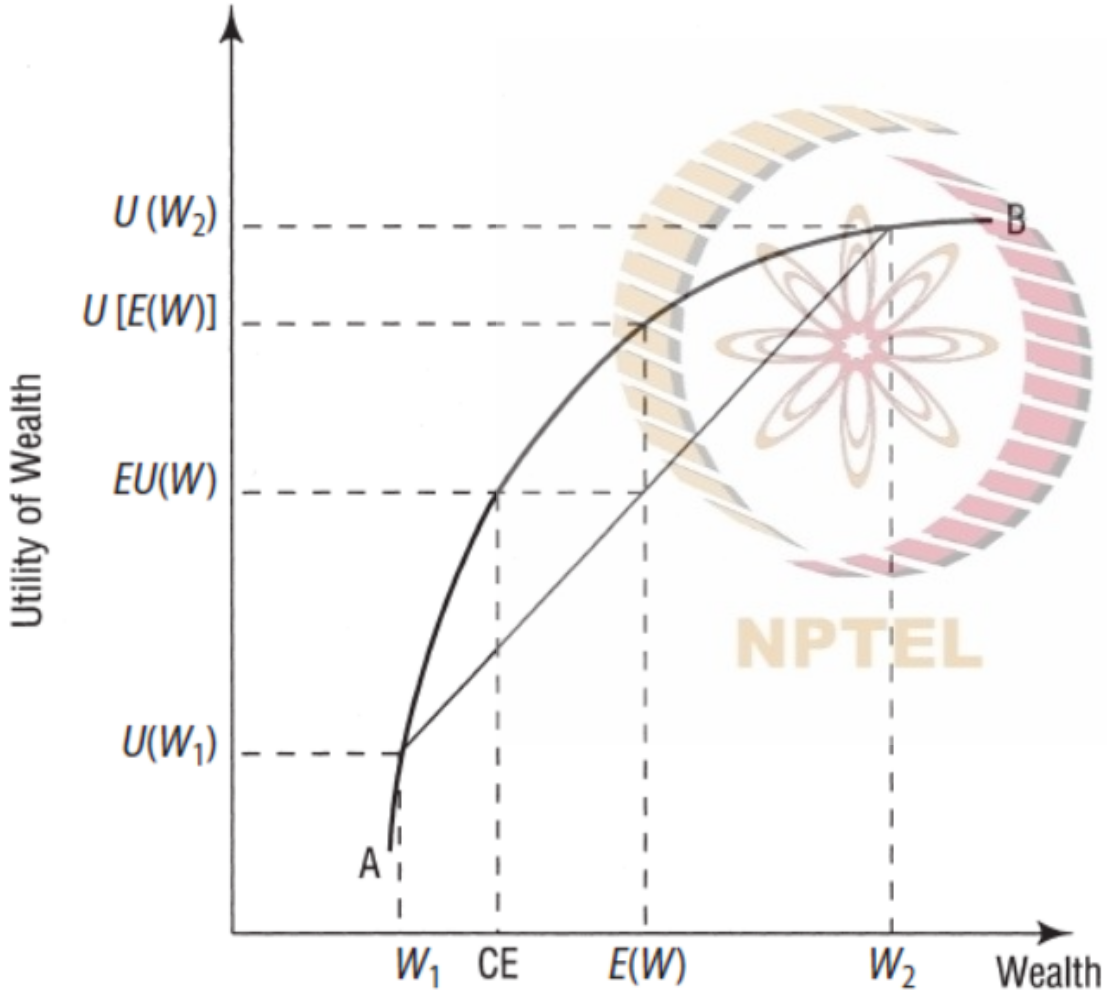
A risk preferring individual would prefer the riskier situation

- His utility function would be convex, i.e., $U''(W) > 0$. This also means that $\mathrm{U[E(W)]} < \mathrm{E[U(W)]}$
- However, commonly it is assumed that individuals are risk averse

Risk Preference: Risk Preferring Person



Risk Preference: Risk Averse Person



Risk Preference: Risk Averse Person

Assume a gamble with two possible outcomes for wealth W_1 and W_2, each with 50% probabilities

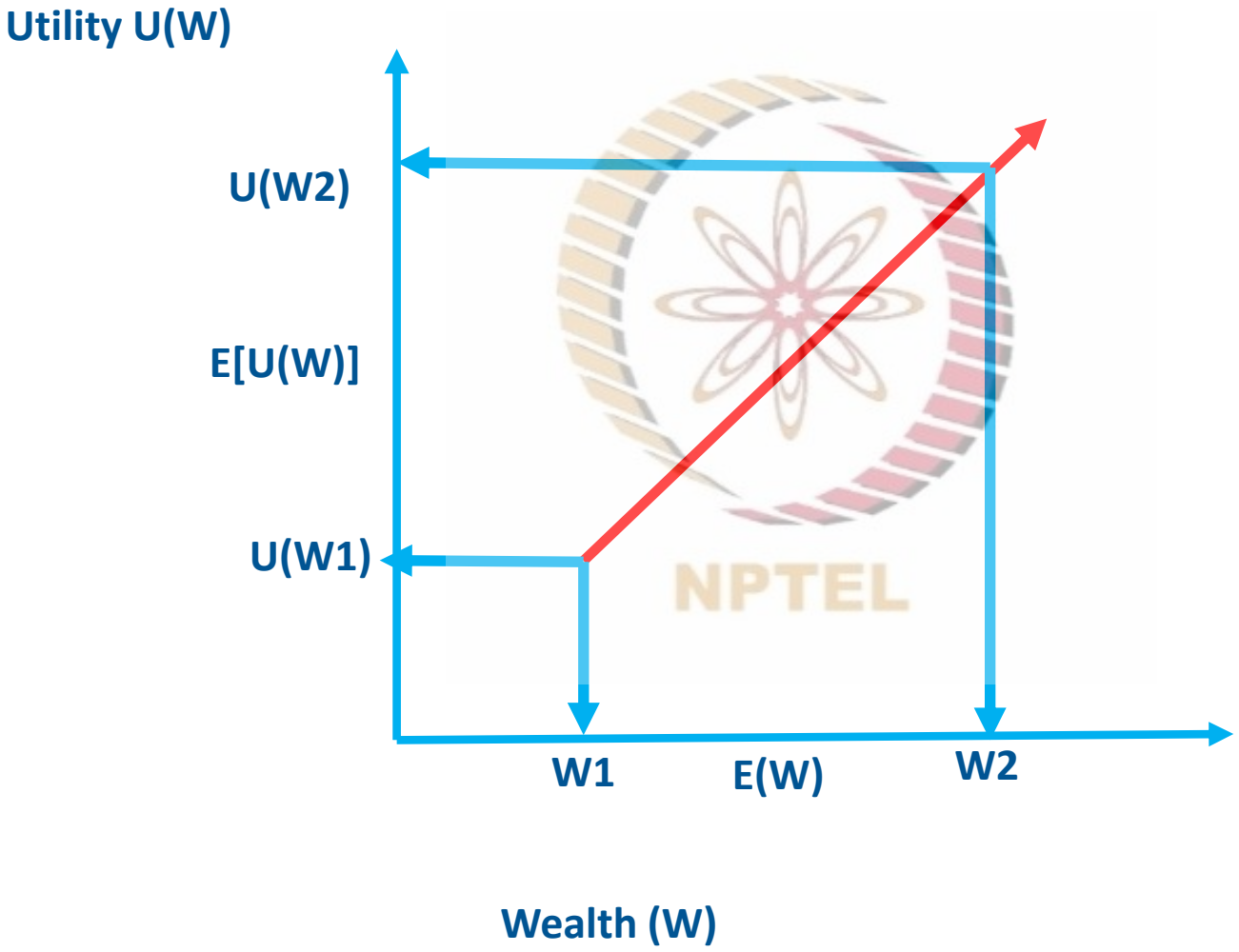
- Then the expected wealth from this gamble is $\mathrm{E(W)}=0.5*\mathrm{W_1}+0.5*\mathrm{W_2}$
- This will lie midway on the straight-line joining the points W_1 and W_2 on the curve
- Also, if one computes the expected utility wealth $\mathrm{E[U(W)]}$, the same will fall midway between $\mathrm{U}(W_1)$ and $\mathrm{U}(W_2)$
- However, as can be seen from the graph, to generate the same level of utility $\mathrm{E[U(W)]}$, a lower level of certain (ensured) wealth is required

Risk Preference: Risk Averse Person

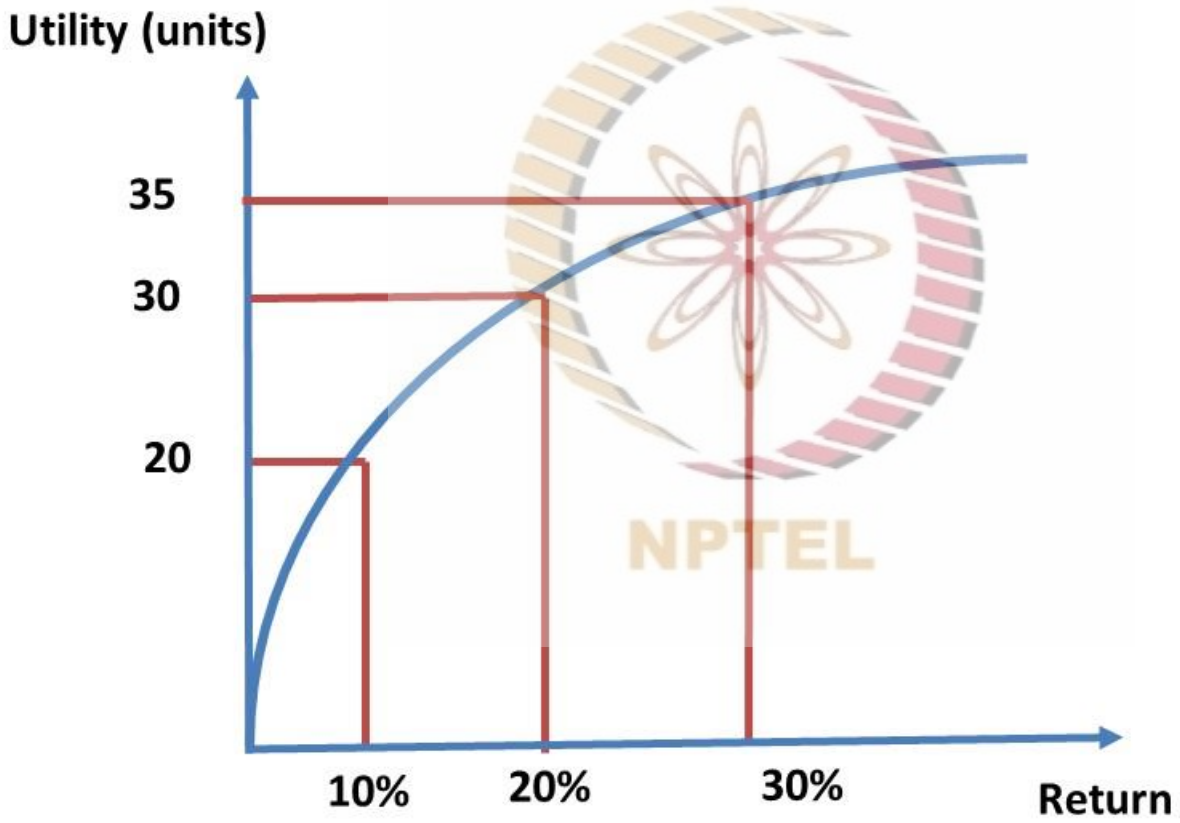
It is very easy to observe here that, for this kind of utility function $U[E(W)] > E[U(W)]$

- The more concave this function (downward slopping) higher the difference between $U[E(W)]$ and $E[U(W)]$, i.e., the individual will be more risk averse
- A sure payment that makes this individual indifferent between gamble and sure payment is **"Certainty Equivalent"** (CE)
- As can be seen the certainty equivalent is less than $E(W)$ and this difference represent the risk-premia of this risk-averse individual

Risk Preference: Risk Neutral Person



Return utility diagram for risk averse person

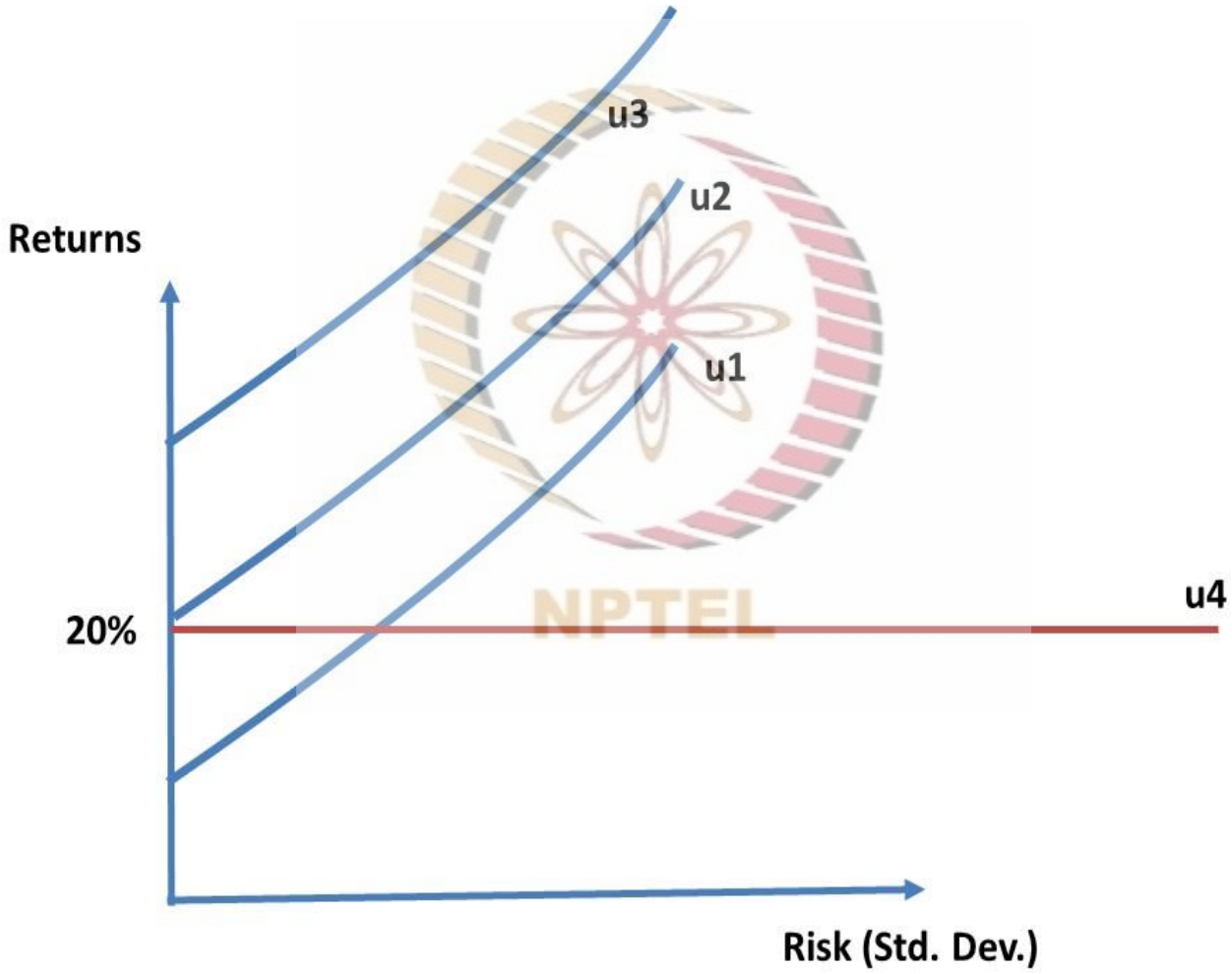


Return vs utility for risk averse person

More return will always have more utility (Non-satiation)

- However, for a risk-averse investor, the relationship exhibits diminishing marginal utility
- For example, an increase of 10% from 20% to 30% results in 10 unit of additional utility
- However, the next 10% offer only 5 unit of additional utility
- So, the expected returns have to be increased to reach the same amount of additional utility

Indifference curve for risk (SD) and Expected return



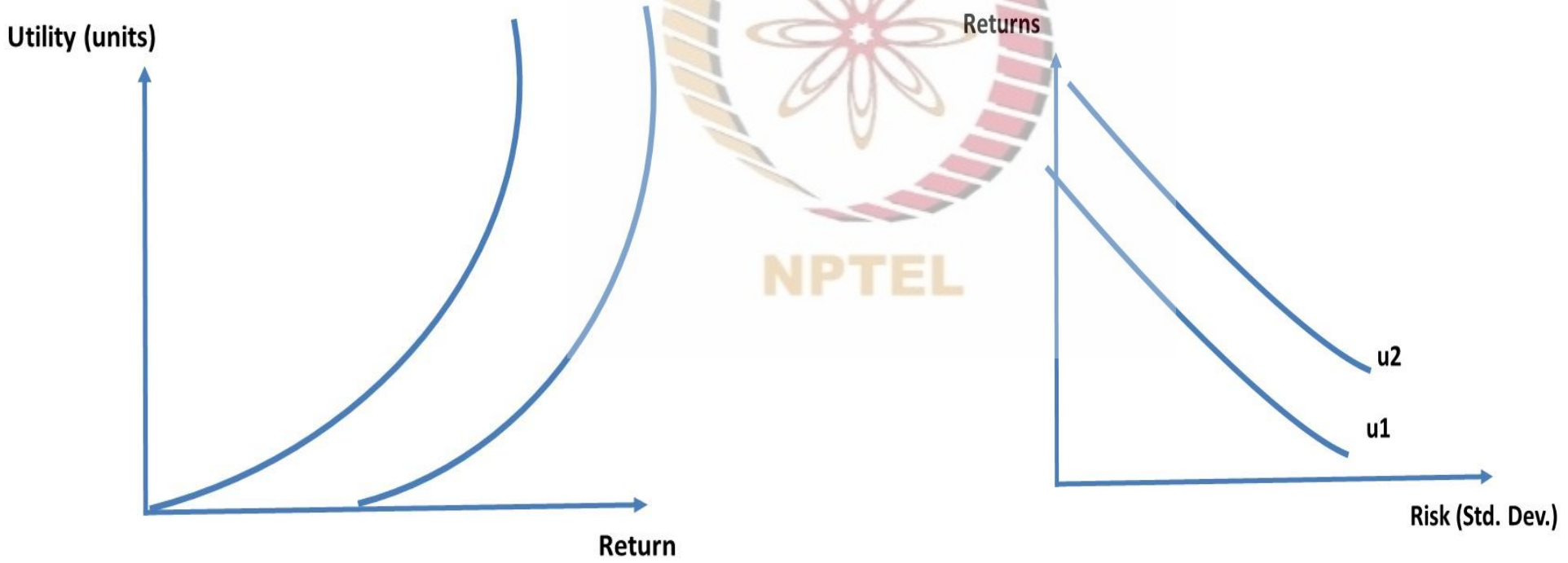
Indifference curve for risk (SD) and Expected return

In this graph, u1, u2, u3 are indifference curves for an individual

- This means increasing level of expected returns for same risk or same level of returns for lower risk lead to higher utility
- What is the nature of this person?
- However, u4 is horizontal. For this individual, utility remains same despite the increase in risk
- That is the marginal utility does not diminish with increasing risk
- What is the nature of this person?

Return utility graph for increasing marginal utility

For this person, increase in risk results in lower level of return expectations. It means that he enjoys risk (gambler, speculator)



Types of Markets

Conventional Broker-Dealer Markets

The conventional markets had a very important entity called broker-dealers

- Broker-dealer markets involved designated market makers
- They are called market makers because they provided continuous buy-sell sided quotes also called bid-ask prices
- Incoming buyer can buy at the ask prices and seller can sell at the bid prices
- This is also called liquidity provision

Conventional Broker-Dealer Markets

The difference between the bid and ask price is the compensation to the dealer for creating market in that particular security

- These are also called specialists
- Who do I mean when I say “creating market”?
- The dealer role is now performed by large institutional investors
- The difference between these bid and ask prices is also called spread and reflects the liquidity in the market

Conventional Broker-Dealer Markets

If there is a very high demand of a security (e.g., Apple, FaceBook) there will be many buyers and sellers

- Thus, the market maker can keep a small spread to generate sufficient profits and cover his costs
- The security will be called a liquid security have a deep market
- In contrast, a security that has a less demand in market will witness very infrequent trading

Conventional Broker-Dealer Markets

Price = 150,
500,000 shares

Price = 100????, 10 share

Conventional Broker-Dealer Markets

The market maker for that security will have to charge higher spread

- The market maker for that security will have to charge higher spread to cover his costs and make profits
- This security will be called less liquid security and will have a shallow market
- But what are the costs of this dealer for which he is charging money???

Limit order books

Unlike quote-driven markets, order-driven markets (like India) lack designated market makers

- There are two major type of orders – **Limit orders and Market orders**
- The limit order suppliers act as the liquidity suppliers in these markets, and are called de-facto market makers
- Market orders consume liquidity provided by limit orders

Primary vs Secondary Markets

New issue of securities takes place in primary markets

- Securities that are already sold are traded in secondary markets
- Governments through central banks (RBI) auction T-bills and dated securities in primary markets
- Deep and liquid secondary markets are desired to create the appropriate environment for primary issuances

Call Auction vs. Continuous Auction markets

In call markets trading takes place at specific intervals

- Generally global markets use some kind of call-auction at the opening/closing of trading Pre-trade
- Investors can change their orders/place new orders until this specified period of time
- Orders are generally matched as per the price-time priority rules

Example of call auction markets at NSE

Pre-opening session follows call market auction framework

- The session has a duration of 15-minutes from 9:00 AM to 9:15 AM
- The pre-open session is comprised of Order collection period (8 minutes) and order matching period
- During this period orders can be entered, modified and cancelled
- The equilibrium price in this period is obtained at which supply and demand leads to clearing of maximum shares
- The clearing price will be the equilibrium price and also the opening price as well

Example of call auction markets at NSE

	ORDER BOOK		DEMAND / SUPPLY SCHEDULE		
SHARE PRICE	**BUY**	**SELL**	**DEMAND**	**SUPPLY**	**MAXIMUM TRADABLE QUANTITY**
103	13500	11500	50500	11500	11500
104	9500	9800	37000	21300	21300
105	**12000**	**15000**	**27500**	**36300**	**27500**
106	6500	12000	15500	48300	15500
107	5000	12500	9000	60800	9000
108	4000	8500	4000	69300	4000

Theoretical Underpinnings

Theoretical Underpinnings

Types of traders

- Noise traders and Liquidity traders: These traders do not have proper information and their trading activity contributes to noise in prices
- Informed traders: These are large institutional investors that spend considerable amount of resources in information acquisition. Their trading activity increase the pricing efficiency
- Market makers: They provide liquidity to financial markets by offering both buy and sell sided quotes to incoming market participants

Theoretical Underpinnings

There are two key hypothesis that explain various financial market phenomena (e.g., spread)

- **Inventory considerations**
- These market makers maintain a certain level of inventory
- However, these inventories are affected by adverse price movements
- For example, falling prices of securities may affect the market makers who is making market in that security by maintaining inventory

Theoretical Underpinnings

Information asymmetry

- There is a certain probability that the counterparty against the market maker is more informed
- Market makers incur losses in these trades against informed traders
- Therefore, based on the probability of informed trading, they charge another component of spread

To account of these losses (informed trading and inventory costs) market make, on average, charges a certain extra-component in the form of spread

Theoretical Underpinnings

At times, there is an excess order flow on buy or sell side

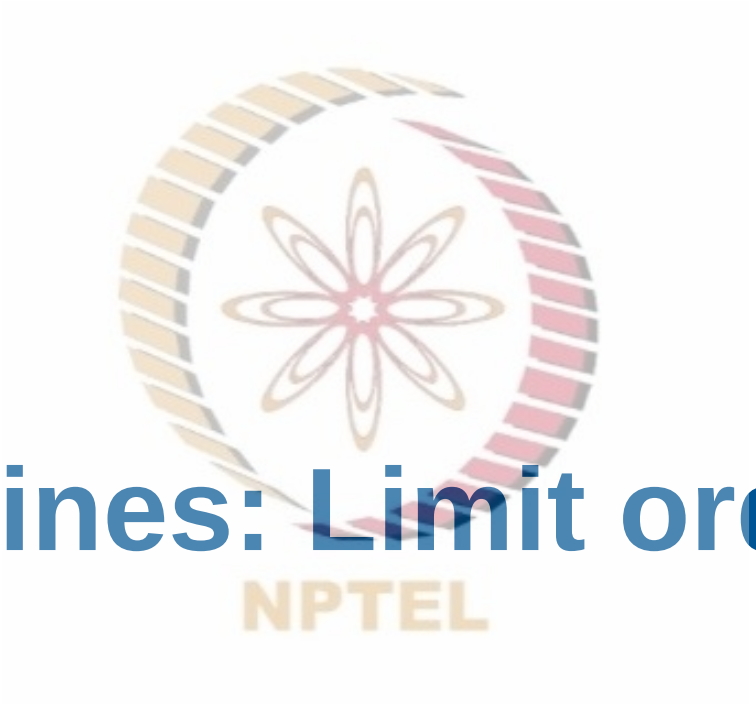
- This may lead to order imbalance and disturb the inventory levels
- There can be two causes for this order imbalance
- If this order imbalance is caused by sentiment driven noise trading (what is this?), then market makers temporarily adjust these quotes
- For example, if he observes buy-pressure (Excess of buy orders) then he can adjust his quotes to make sell orders more favorable (How?)

Theoretical Underpinnings

- This quote adjustment would induce more sell orders and subsequently the order flow pressure will be absorbed
- Once the order flow pressure is absorbed, the market maker will revert this quotes back to normal levels
- If this order imbalance is caused by arrival of information, then market maker will make a more permanent quote adjustment
- For example, if there is information of new-discovery by the company, then he will increase both the buy and sell quotes , to reflect the increased value of the security: this quote adjustment is more permanent and durable in nature

Theoretical Underpinnings

- Quote adjustment associated with inventory hypothesis are temporary in nature
- Quote adjustments associated with information asymmetry hypothesis are permanent in nature
- Momentum traders follow this order imbalance measure to make trading strategies
- Order imbalance = $\frac{\textbf{Buy orders} - \textbf{Sell orders}}{\textbf{Buy orders} + \textbf{Sell orders}}$
- The orders can be simple share volume, Dollar volume, or number of orders



Rise of machines: Limit order books

Rise of machines: Limit order books

Unlike quote-driven markets, order-driven markets (like India) lack designated market makers

- There are two major type of orders – **Limit orders and Market orders**
- The limit order suppliers act as the liquidity suppliers in these markets, and are called de-facto market makers
- Market orders consume liquidity provided by limit orders

Rise of machines: Limit order books

Market Order: A market order directs the broker (now online brokerage houses) to buy or sell the security at the best available prices. **What is best available price**

- These is a set of ask prices at which the investor can buy the security; of course he will choose the lowest ask
- Similarly these is a set of bid prices at which the investor can sell the security; he will choose the largest bid

Rise of machines: Limit order books

Limit orders: These orders specify the worst acceptable terms of trade

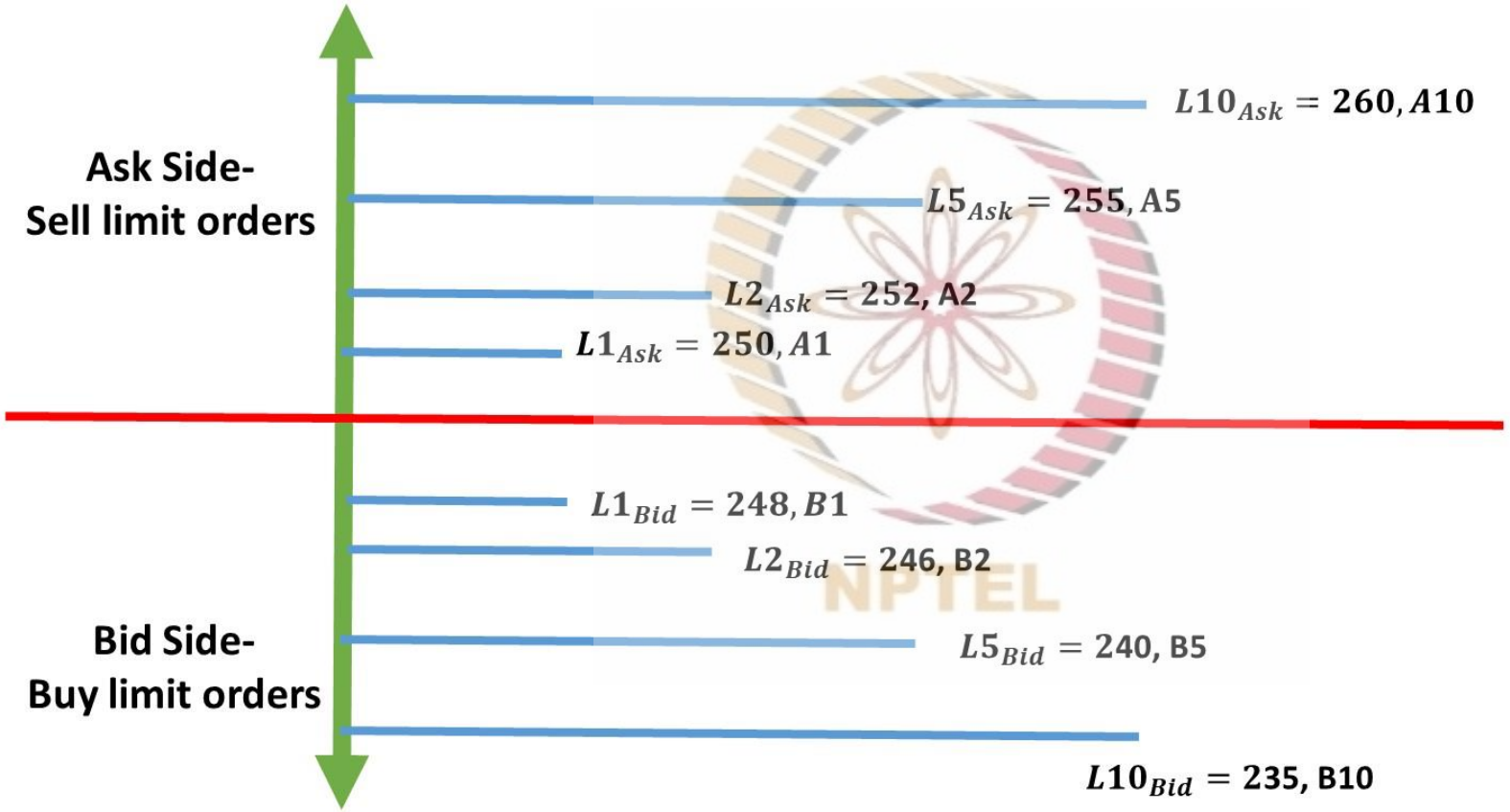
- For example, Purchase (Sell) 100 shares of Company A, limit Rs 1000
- So the broker should not pay (receive) anything more (less) than Rs 1000
- Unlike market orders, the execution of limit orders is uncertain
- In the modern order book markets, these kind of orders are inventoried in the order book, till the time they become the best order available and are picked by market or limit orders
- At the closing day, unexecuted limit orders are canceled

Rise of machines: Limit order books

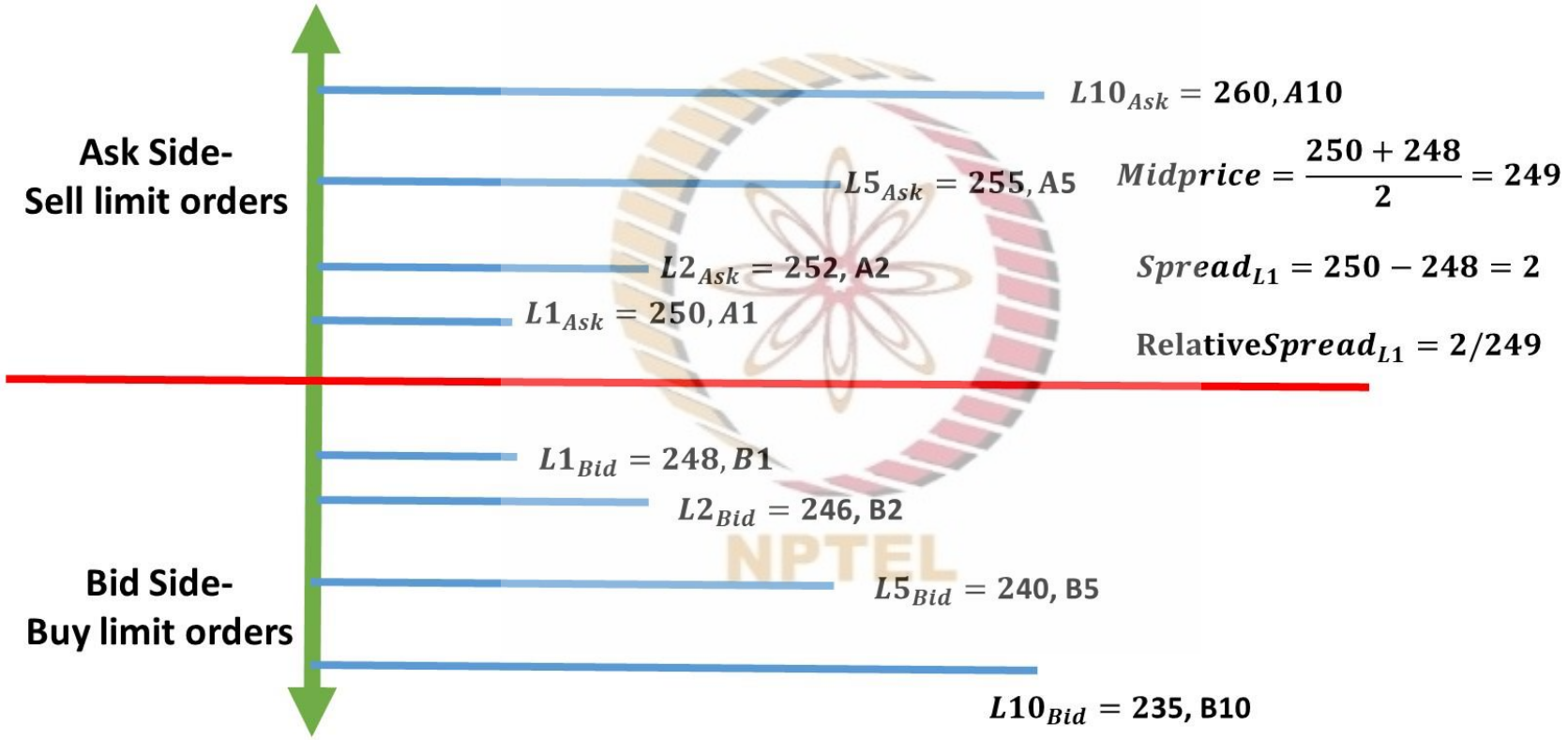
Limit orders are inventoried in order book, in the form of bid and ask orders

- The quantity associated with these bid/ask orders is known as the depth available on the buy and sell side, at the respective level
- The difference between the **best bid (highest buy)** and **best ask (lowest sell)** orders is known as spread, measure of liquidity
- An investor that makes an immediate buy and sell transaction through market order will incur this spread

Order book snapshot



Order book snapshot



Rise of machines – Limit order books

Driven by algorithmic low latency trading, these markets are extremely fast paced and carry out voluminous trades

- Low latency algorithms exploit any inefficiency in prices within 10^{-6} second
- Thus, prices are pulled within the window of efficiency in no-time
- This has also led to a debate of "Man vs Machine"
- That is, is it even fair now for humans to trade manually, as they can not compete with algos
- Different algorithms are available to exploit different kind of inefficiencies

Trading terminologies- Order flows

Time	Price (Rs)	Numbers	
Sellers (Ask/ Offer)			
12:10:00	100	400	Worst
12:10:30	99	320	
12:10:20	98	290	
12:11:00	95	200	
12:10:40	95	220	Best
Buyers (Bid)			
12:10:56	98	200	Best
12:10:57	95	420	
12:10:55	94	95	
12:10:40	93	250	
12:10:50	93	200	
12:10:10	92	535	
12:10:00	90	600	Worst

Trading terminologies- Impact cost

Time	Price (Rs)	Numbers
Sellers (Ask/ Offer)		
12:10:40	95	220
12:11:00	95	200
12:10:20	98	290
12:10:30	99	320
12:10:00	100	400
Buyers (Bid)		
12:10:55	94	95
12:10:40	93	250
12:10:50	93	200
12:10:10	92	535
12:10:00	90	600

Spread and Impact cost

- Best Ask= 95; Best bid=94
- Absolute spread = 95-94=1
- Relative spread= Absolute spread / Relative price= 1/ (95+94)/2=1.06%
- Impact cost as per NSE: % change in prices on account of Rs 1 lakh trade (either side: buy side and sell side)
- (Wt. Average Buy or Sell price/Mid Price)-1
- This takes place continuously and called of continuous auction trading

Trading terminologies: Impact cost

Time	Price (Rs)	Numbers
Sellers (Ask/ Offer)		
12:10:40	95	220
12:11:00	95	200
12:10:20	98	290
12:10:30	99	320
12:10:00	100	400
Buyers (Bid)		
12:10:55	94	95
12:10:40	93	250
12:10:50	93	200
12:10:10	92	535
12:10:00	90	600

Trading terminologies: Impact cost

Time	Price (Rs)	Numbers	Order Size (Rs)
Sellers (Ask/ Offer)			
12:10:40	95	220	20,900
12:11:00	95	200	19,000
12:10:20	98	290	28,420
12:10:30	99	320	31,680
12:10:00	100	400	40,000
Buyers (Bid)			
12:10:55	94	95	8,930
12:10:40	93	250	23,250
12:10:50	93	200	18,600
12:10:10	92	535	49,220
12:10:00	90	600	54,000

Trading terminologies: Impact cost

Time	Price (Rs)	Numbers	Order Size (Rs)	Cumulative Orders
Sellers (Ask/ Offer)				
12:10:40	95	220	20,900	20,900
12:11:00	95	200	19,000	39,900
12:10:20	98	290	28,420	68,320
12:10:30	99	320	31,680	1,00,000
12:10:00	100	400	40,000	1,40,000
Buyers (Bid)				
12:10:55	94	95	8,930	8,930
12:10:40	93	250	23,250	32,180
12:10:50	93	200	18,600	50,780
12:10:10	92	535	49,220	1,00,000
12:10:00	90	600	54,000	1,54,000

Trading terminologies: Impact cost

Time	Price (Rs)	Numbers	Order Size (Rs)	Cumulative Orders	Av. Price	Impact Cost
Sellers (Ask/ Offer)						
12:10:40	95	220	20,900	20,900	Best	
12:11:00	95	200	19,000	39,900		
12:10:20	98	290	28,420	68,320		
12:10:30	99	320	31,680	1,00,000	97.08738	2.74%
12:10:00	100	400	40,000	1,40,000	Worst	For Buyers
Buyers (Bid)						
12:10:55	94	95	8,930	8,930	Best	
12:10:40	93	250	23,250	32,180		
12:10:50	93	200	18,600	50,780		
12:10:10	92	535	49,220	1,00,000	92.59259	-2.02%
12:10:00	90	600	54,000	1,54,000	Worst	For Sellers

Other key terms

Stop loss buy/sell orders: These orders are activated when price of the security reaches some pre-defined limit

- For example, a stop-loss sell order at Rs 40 would become a market order to sell if the price trades at Rs 40 or below
- Vice-versa for buy order
- These orders are used to lock a gain or limit a loss

Thanks!