Advanced Financial Instruments for Sustainable Business and Decentralized Markets
Prof. Abhinava Tripathi
Department of Management Sciences
Indian Institute of Technology – Kanpur

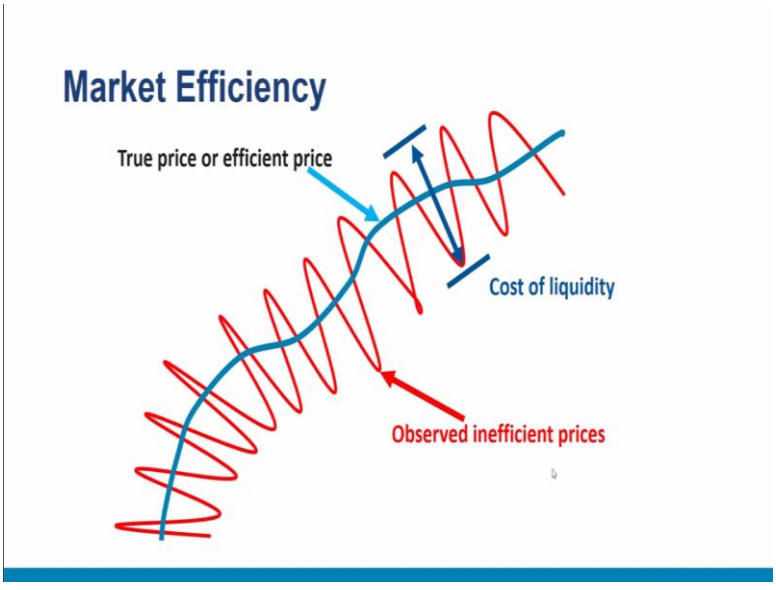
Lecture – 6
Week 2

One needs financial markets to channelize the savings of our economy towards productive and efficient sectors. This is often referred to as financial intermediation. Conventionally banks have played this role. However, financial intermediation by banks is further issued such as bureaucratic hassles and principal agent problems. In contrast, financial markets allow investors to directly participate in the process of choosing the best investment themselves and avoid issues such as principal agent problem.

To this end an economy needs efficient and liquid markets. In this lesson we will discuss what is an efficient and liquid market, we will also examine the risk preferences of individual investors and how these risk preferences affect their investment decisions, we will introduce and discuss various market microstructures and provide theoretical underpinnings to the financial market operations.

We will conclude the discussion with a very important market microstructure that is limit order books. We will also discuss the computation of the key parameters of limit order books such as spread and impact cost.

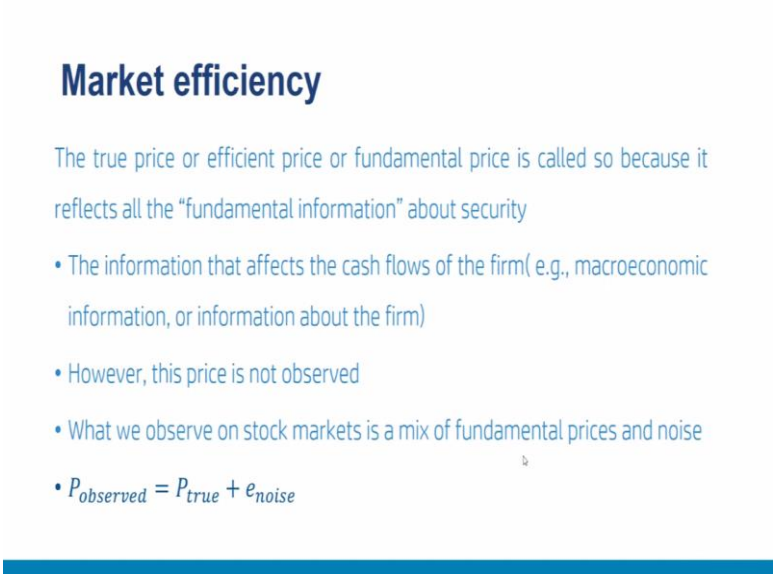
(Refer Slide Time: 01:23)



Please observe the diagram shown here. You have red one red curve which is very fluctuating which represents the actual prices which are more volatile. These are the observed prices that we observe in financial markets while the blue one is the unobserved efficient prices or fundamental prices. What is a fundamental price? Price that captures all the information that is fundamental to the security and effect cash flow is called fundamental price.

Now, the actual observed price includes all the component of this fundamental price as well as some noise or sentiment which is not fundamental to a security. Thus, actual price which is observed is fluctuating and continuously fluctuates around this fundamental price.

(Refer Slide Time: 02:16)



The true price or efficient price or fundamental price is called so because it captures all the fundamental information about security. This kind of information can be macroeconomic information, information about the firm all that information that affects the cash flows and therefore if one discount those cash flows one should get that actual fundamental price. However, in financial markets we do not observe this price.

What we observe is a mix of fundamental price and noise that is Price $_{observed}$ = Price $_{true}$ +e $_{noise}$ and therefore this price is heavily fluctuating.

(Refer Slide Time: 02:52)

This noise that we discuss which is not so fundamental to the security is many times a small and not so significant component, but at times it becomes significantly large and therefore prices become very inefficient. During these times arbitrages and speculators try to exploit this inefficiency in prices and make profit. There is something called riskless arbitrage trading.

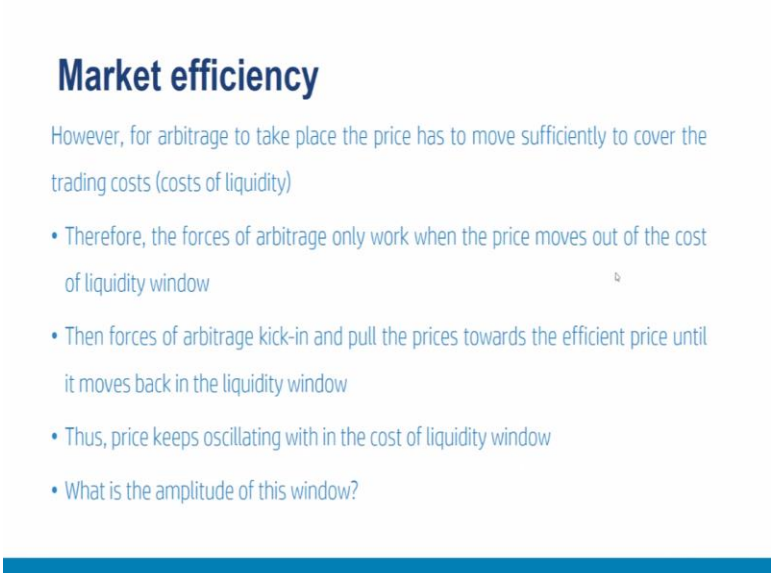
Riskless arbitrage trading is there when a stock or security which is traded in different markets and that security has same underlying a common underlying asset maybe a company, maybe a commodity and so on. If that security takes different prices in these different markets for example if it over valued in the equity market and undervalued in derivative market and vice-versa.

Then these riskless arbitrages traders who take counter riskless position that means they take long position in one market, in short position in another market attempt to exploit this inefficiency and make profits. The opportunity to make these profits is particularly higher than the price deviate too much from that fundamental efficient value that means they deviate with respect to each other and these market considerably.

And that is the point when informed traders they start conducting this arbitrage activity that is buying the stock where it is undervalued in the market where it is undervalued and selling the stock in the market where it is overvalue and thus benefitting from the inefficiency because we are taking long and short position in different markets affectively their position is riskless. Although, practically in financial markets there is no such thing as riskless arbitrage.

There are always certain limits to arbitrage, for example, due to liquidity cost, transaction cost and taxes etcetera.

(Refer Slide Time: 04:47)



For this arbitrage move to be successful this profit or inefficiency should be sufficient enough to provide or cover all these trading cost or what we call cost of liquidity. These are like security transaction taxes, brokerage charges and various other transaction cost. Therefore, the forces of arbitrage will work only when prices are much away from these cost of liquidity.

When we aggregate all these cost of liquidity they create a certain window or amplitude as long as the prices are within that window or amplitude of liquidity cost or transaction cost there is no opportunity for these arbitrages to make profits only when prices deviate sufficiently away from these illiquidity cost or amplitude of liquidity and various other transaction cost and taxes then only these arbitrages can make profit.

These forces of arbitrage only work and they work like elastic pulling different ends of elastic when it is stretched towards its mean when the prices are sufficiently away from the fundamental value. When they are away from the fundamental value forces of arbitrage kick in and they try to pull these prices towards that efficient price until it is back to that liquidity window.

Overall, in financial markets prices keep oscillating within that cost of liquidity window that we just discussed without these forces of market efficiency and forces of arbitrage to become

effective. Only when the prices move beyond this amplitude of liquidity cost then prices move towards this efficient price.

(Refer Slide Time: 06:35)

What is this amplitude that we are talking about? This amplitude is effectively the cost of liquidity that is aggregate of all the transaction cost and charges that are there while making transaction or trading in security markets. At times prices move beyond this amplitude and exhibit high fluctuations. In that case we say that prices are volatile generally this happens during crisis periods or events of negative news when prices are too volatile.

And they are further away much away from their efficient values. A higher volatility particularly means that prices have deviated or diverted from their true values. Different markets exhibit different levels of volatility depending upon the level of efficiency. It is said that markets that are more efficient they are less volatile and prices remain closer to their efficient values.

While it is said that markets that are less efficient prices are more volatile and they are much away from their efficient values.

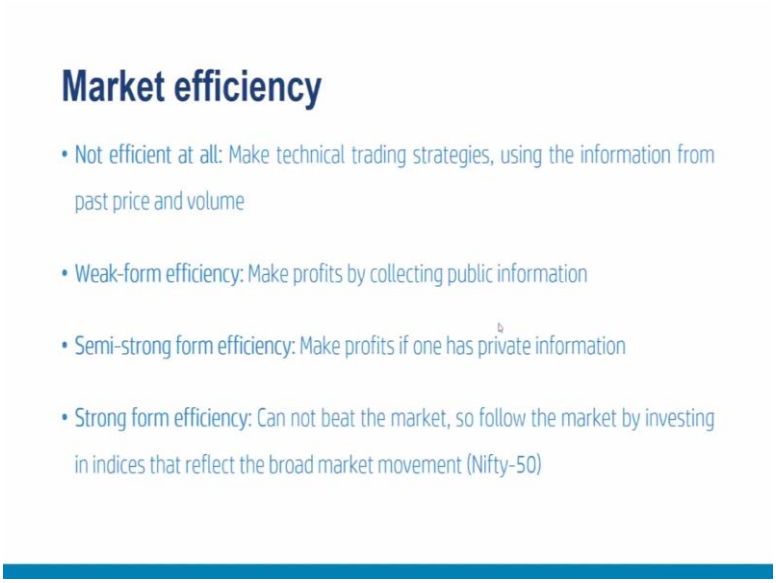
(Refer Slide Time: 07:39)

In financial markets we define three kinds of efficiency. One is weak form of efficiency when a trader cannot make profit using information contained in past prices then the market are said to be weak form efficient. Any kind of trading strategy that is based upon past trading information such as price volume should not be profitable than only the market is said to be weak form efficient.

A market is said to be semi strong form efficient when the trader cannot make profit using the information contained in past prices and public information as well. So, the semi strong form efficiency includes another level of a layer which is called public information. So, if one cannot make profit using public information as well as past trading history such as past prices and volume then market is said to be semi strong form efficient.

Strong form efficiency is called when not only public information and historical price data one cannot using the information contained in private information as well. So, now we have added three layers. One is past prices, public information as well as private information. If using all these three inputs one cannot make profits then the prices are said to be strong form efficient.

(Refer Slide Time: 08:52)



What should one do if market is inefficient or efficient at different levels? For example if market is not efficient at all not even weak form efficient then one can make profit simply using technical trading strategy that is making technical trading strategies using past information from prices and volume. What about if market is weak form efficient then one cannot make profits using past prices and other trading day history data.

Then one can make profits using public information if the market is only weak form efficient then one can make profits using public information. What about semi strong form efficiency? If market is semi strong form efficient one has to use only private information because one cannot make profit using public information now. However, trading based on private information or insider trading is often not only unethical, but also illegal.

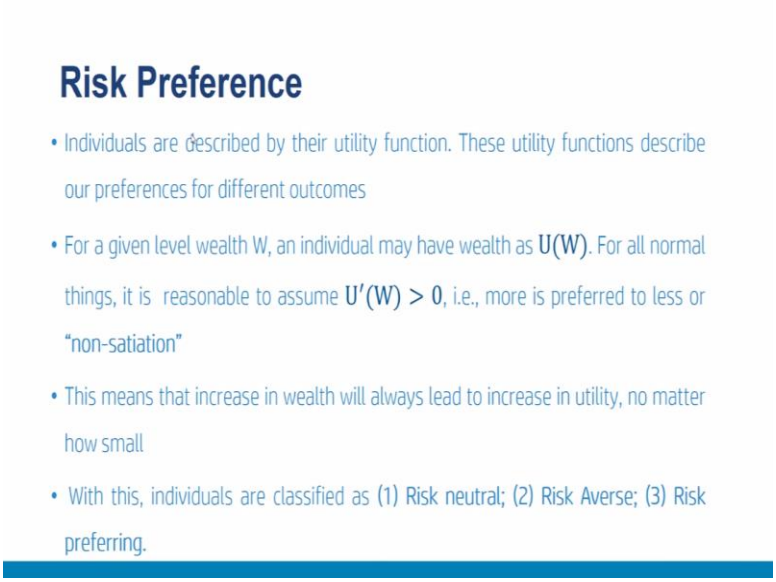
Therefore, this is more of a theoretical construct. Lastly, if market is strong form efficient then one cannot beat the market whether one uses private information, public information or any other such information and therefore one has to stay put in the market by investing in broad market analysis such as Nifty Fifty. The idea is that if a market is strong form efficient then market is best judge of a company about information.

And therefore one should stay put in index like Nifty Fifty. Including to some rise in this video we discussed what do we observe in financial markets, what is efficient and inefficient price, what is fundamental price and what is observe price? We found that what we observe in financial market is not so fundamental price it include certain noise component also. The actual fundamental price which contains only fundamental information is not observed.

The observed price fluctuates around that fundamental price, market have three kinds of efficiency weak form efficiency, semi strong form efficiency and strong form efficiency. When one cannot make profits using all the historical price another trading data the market are said to be weak form efficient. In semi strong form efficiency we add another layer and say that not only historical price volume data.

But also if one cannot make profit using public information then market is semi strong form efficient. The last performance and the highest form is strong form efficiency if there are three levels of efficiency that is semi strong, strong and weak form efficiency that is historical price, public information and private information then if one cannot make profits using all these three layers then it is said that market is semi strong form efficient.

(Refer Slide Time: 11:41)

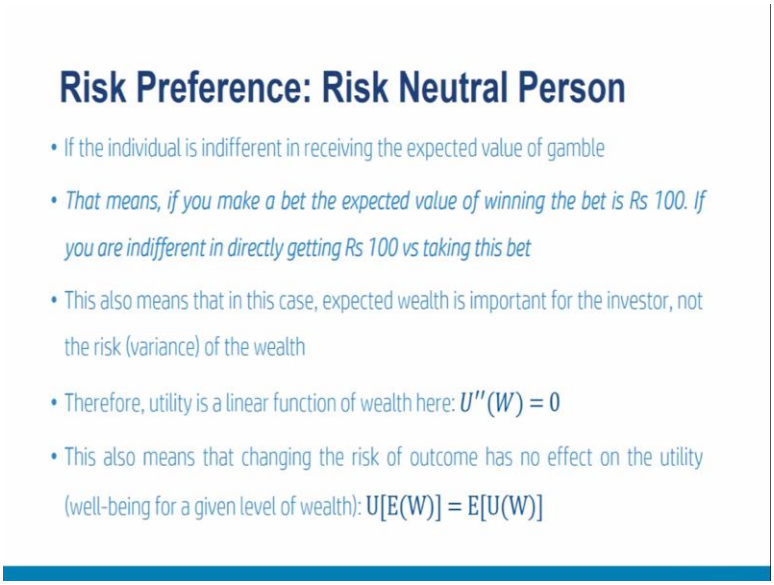


Individuals are described by their utility functions. These utility functions describe are preferences for different outcomes. For a given level of wealth W an individual may have the utility of wealth as U(W). For all normal things like wealth it is reasonable to assume that U'(W) > 0 that is for each incremental unit more is preferred to less this is called non satiation. This may not be true in the case of normal goods and services. For example after eating a certain amount of ice cream the incremental benefit of ice cream or utility of ice cream maybe negative as well.

However, for wealth and money generally the hypothesis of non-satiation is applicable that means U'(W) >0 that means increase in wealth will always lead to an increase in utility no

matter how small. With this, individuals are classified as risk neutral, risk averse and risk preferring.

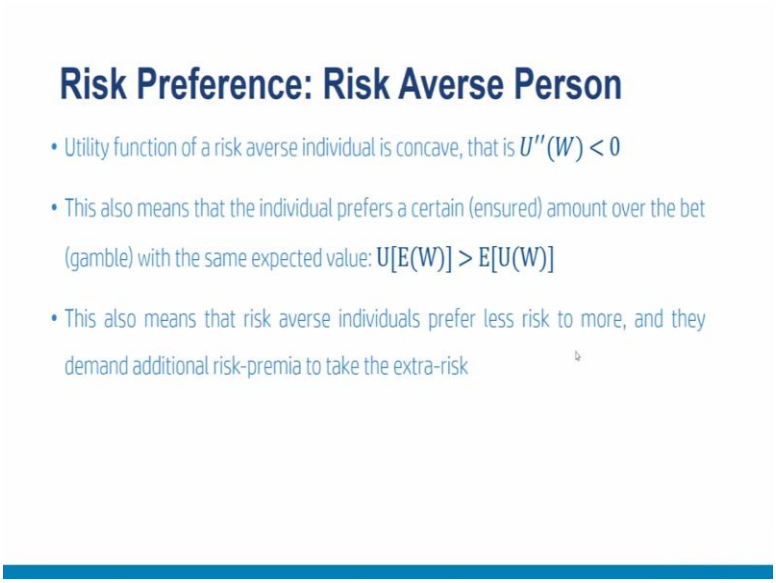
(Refer Slide Time: 12:49)



Risk neutral individuals if the individual is indifferent in receiving the expected value of a gamble for simple average or probabilistic average in case of different outcomes have different probabilities or the gamble itself, for example, if you make a bet and the expected value of winning the bet is rupees 100. If you are indifferent indirectly getting rupees 100 without playing this gamble vis-a-vis taking this bet or gamble which includes different probabilities of different outcomes including losses.

This also means that in the case expected wealth is important for you not the variance or variability of this wealth or the risk of outcomes. Therefore, utility is a linear function of wealth for you as a risk neutral individual and this means U''(W) = 0 that means double differential of utility of wealth function or double differences is equal to 0. This also means that changing the risk of outcome has no effect on the utility or well-being for a given level of wealth that means utility of expected wealth is equal to expected utility of wealth which we will see shortly. U[E(W) = E[U(W)]

(Refer Slide Time: 14:06)

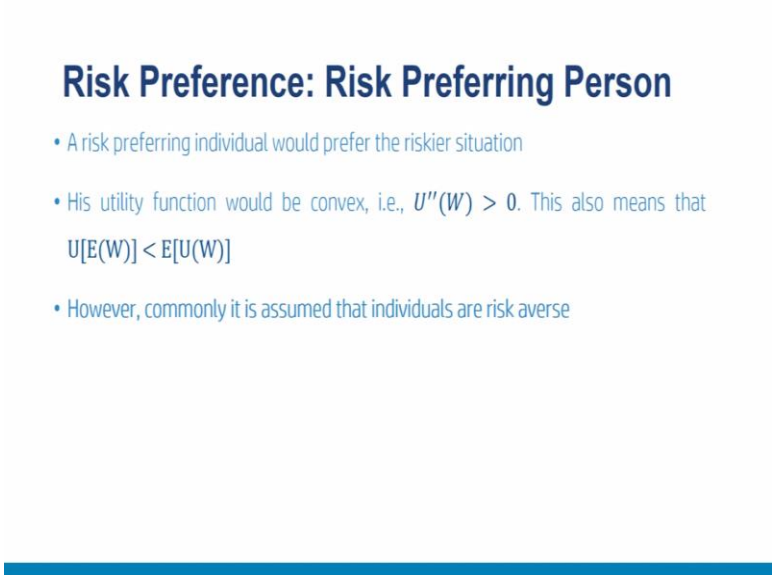


Then we have risk averse individual. For this risk averse individual the utility function of a risk averse individual is concave that means U''(W) < 0 as we will see. This also means that the individual prefers a certain ensured amount of bet or gamble with the same expected value that is utility of expected wealth is greater than expected utility of wealth.

U[E(W)] > E[U(W)]

This means that this individual prefers a certain value over a gamble. This also means that risk averse individuals prefer less risk to more and they demand additional risk premia to take on that extra risk.

(Refer Slide Time: 14:45)

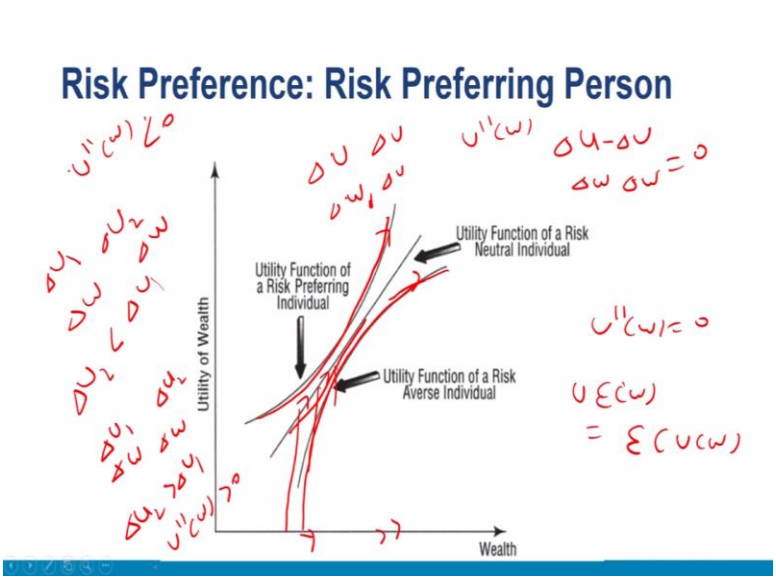


Lastly, we have risk preferring person a risk preferring person or individual would prefer the riskier situation, his utility function would be convex that is U''(W) > 0 as we will see and this

will also mean that utility of expected wealth is less than expected utility of wealth this we will see shortly. However, in general it is assumed that individuals are rational and risk averse.

U[(E(W)] < E[U(W)]ΔΔ

(Refer Slide Time: 15:10)



Just have a look at this diagram we will examine this in some detail. If you look at the curve of utility curve of risk neutral individual which is the straight line notice that for each increment for each amount of increment in wealth for each increment the change or increase in the utility is same that means Δ of utility for each amount of change in wealth is same if ΔW is same then across the wealth ΔU will remain same.

So, the double differential U''(W) or ΔU – ΔU for a change from ΔW to ΔW = 0 and this is what we said about this individual that U''(W) = 0 and for this individual whether you give him the gamble or you give him the expected value in a sure shot certain amount it does not matter to you that means utility of expected wealth of W is equal to expected utility of wealth. U(E(W)) = E(U(W))

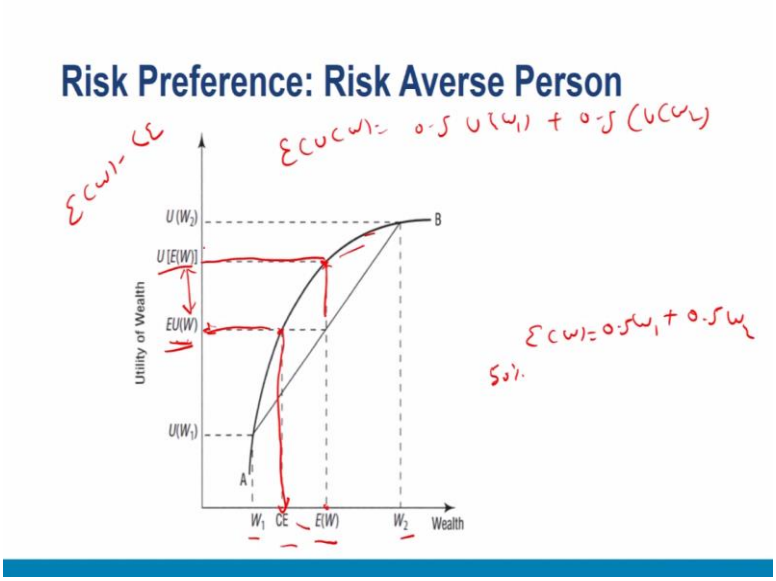
Now compare this to risk averse individual for which this kind of curve is there the curve is more concave in nature. Notice that as we give him more and more wealth the utility of wealth U for each incremental unit is declining in nature which means that for same amount of Δ W earlier the utility maybe Δ U 1 and for next set of ΔW the utility maybe ΔU 2.

And there ΔU2 < Δ U 1 that means his Δ''W is expected to be less than 0 and therefore we arrive at the result that his double differential or double change in utility of wealth is negative.

Contrast this convex kind of function here where for this person the utility is exponentially almost exponentially increasing.

And therefore for change in wealth that is Δ W additional change in wealth Δ W and let us say their incremental utility is ΔU1 and ΔU2. For this ΔU2 > ΔU1 which also means that double differential of utility of wealth is greater than 0. This is for risk preferring individual because he prefers more risk to less. So, if you want to take a gamble probably his expectation of wealth or return from this gamble would be even less if the risk is more.

(Refer Slide Time: 17:57)



Now, let us take an example of a simple gamble and assume that there are two possible outcomes W1 and W2 as shown here. Notice, if these two events of wealth events of W1 W2 they have 50 % probability then in that case the expected wealth E(W) expected wealth will be equal to 0.5 x W1 + 0.5 x W2. This value will certainly lie here this E(W) = 0.5 x W1 + 0.5 times W2 it will be somewhere midway between W1 and W2.

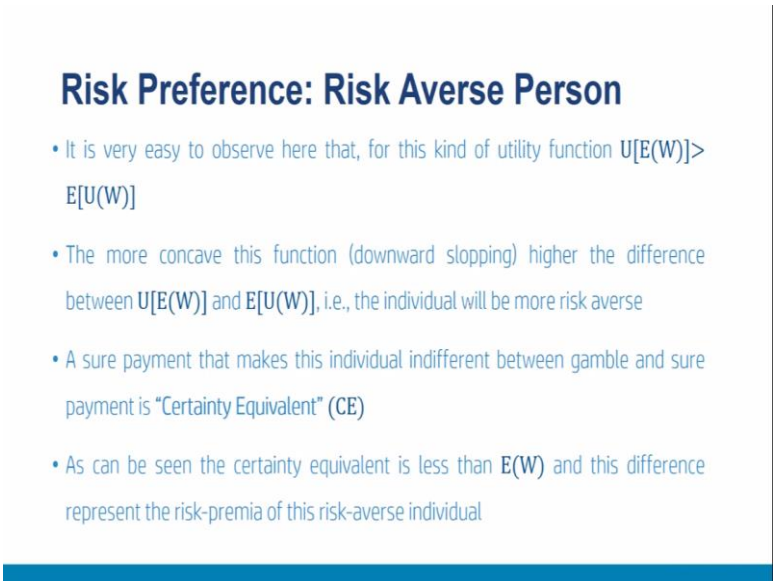
However, if you look at this graph and we try to generate the expected utility of this wealth we can easily find that on the curve for this individual. If it is a risk averse person we can find the utility of this expected wealth to be at this point which can be easily observed. Now, for this individual we can also find the expected utility of wealth which is this amount which is expected utility of wealth which is simply 50% x (U(W1)) + 50% x (U(W2)).

Notice, that this expected utility of wealth is somewhere midway U(W1) and U(W2). If I want this individual to give a certain amount for which he or she can leave the gamble what would

be that certain amount? Now, it is not too difficult to find, we can find the corresponding amount matching to this expected utility on this curve which is here and take a perpendicular which is CE.

CE is the certain amount if I give that to this individual he is willing to forgo the gamble and notice the gap here. This expected to be more than this certainty equivalent that means this certainty equivalent is less than expected value that means in order to replace this gamble or withdraw from this gamble I need to give him a lower amount. The difference between these two amounts that means E(W) – CE certainty equivalent is the risk premium that individual is willing to give or take in order to take that risk or leave that risk.

(Refer Slide Time: 20:35)

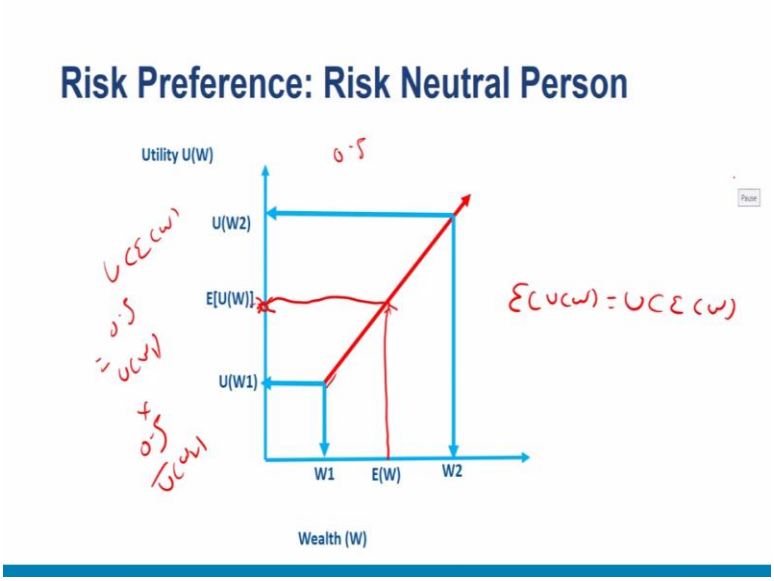


Also notice that for this U utility of expected wealth is greater than expected utility of wealth U[E(W)]>E[U(W)] for this kind of utility function that is for risk averse person the more concave the nature of this curve that is downward sloping higher the difference between utility of expected wealth U[E(W)] and expected utility of wealthE[U(W)] which is this gap that is individual the more risk averse he or she is the higher risk gap.

Also a sure shot payment that make this individual indifferent between the gamble that sure shot payment what we are calling as certainty equivalent or CE. As can be seen here the certainty equivalent is obviously less than expected wealth and this difference represents the risk premia for this risk averse individual that is the individual is willing to take on extra risk if additional compensation is given and derive the same expected utility from the risky outcome only if he has given the expectation of outcome a certain amount CE.

And the gap between them is expected value of wealth minus CE this is the risk premia only if he has given that additional amount he is willing to take the more risk and generate same utility.

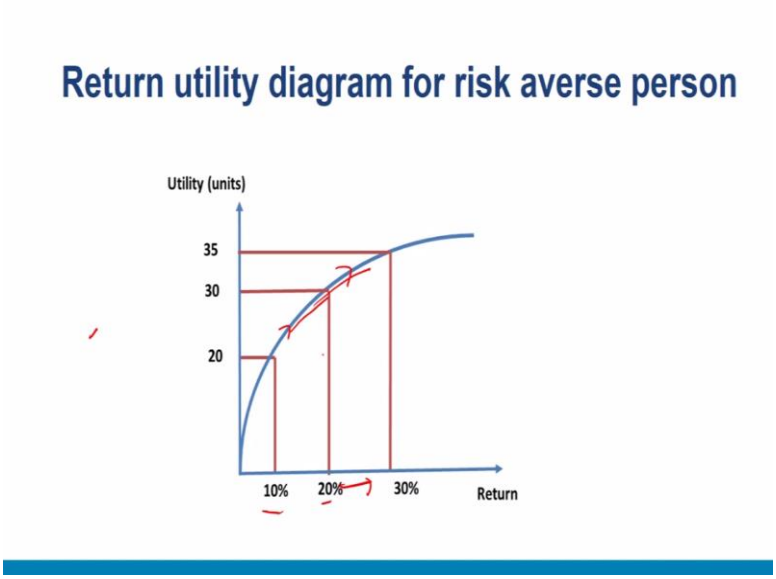
(Refer Slide Time: 21:58)



Now, look at this diagram and we can derive the implications for a risk neutral person in a similar manner. For this person the expected value of wealth which is this is exactly in midway and if I drop the perpendicular here the expected utility of wealth will be here. If I compute the utility of expected wealth please notice because of the nature of this utility curve it will also fall here exactly here because we assume that there are 50-50 % probabilities of getting the outcome of this wealth W1 and W2.

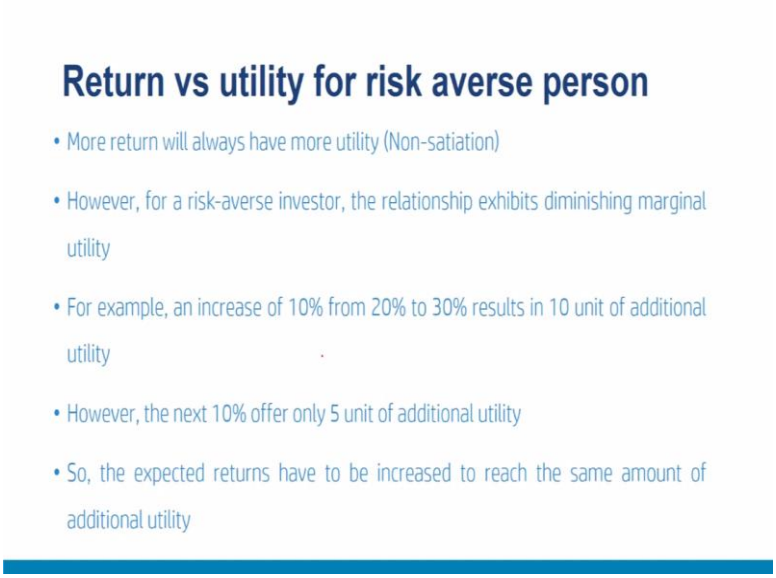
And therefore this value utility of expected wealth which is similarly nothing, but 0.5 x U[W1] x 0.5 x U[W2] will be exactly midway here at expected value of utility of wealth and therefore we can easily say because of the nature of this utility curve that expected value of this U[W] equal to utility of expected wealth.

(Refer Slide Time: 23:11)



Now, let us derive the implications for risk that is standard deviation and return for this risk averse individual. For this risk averse investor the relationship between return and utility will look something like as shown in the figure.

(Refer Slide Time: 23:25)



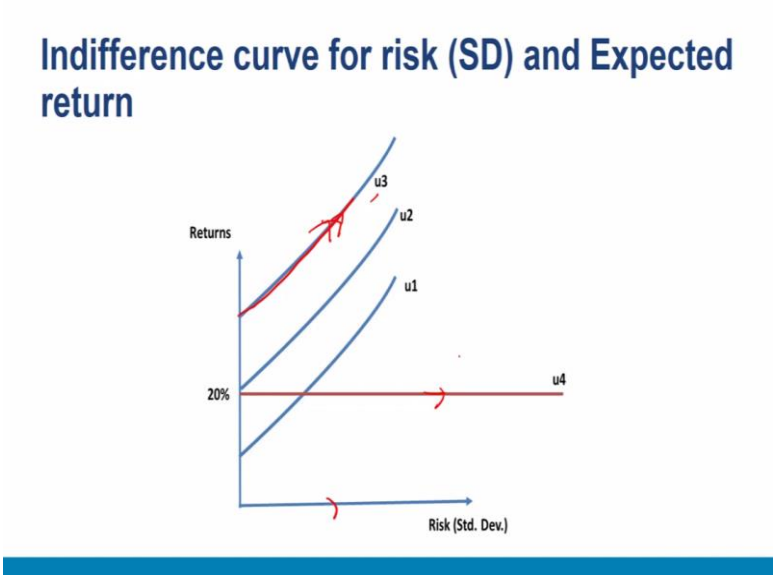
More return will always have more utility which is called non satiation. However, for risk averse investor the relationship exhibits diminishing margin utility as we can see in this concave kind of utility curve. For example, an increase of 10% from 20% to 30% in returns here will lead to increase in five utility points that is change in utility of 5 points.

However, if you contrast this from 10% to 20% this reflects a change in 10 utility that means initially they generate a higher change in utility, higher increase in utility, but as more and more wealth is generated the utility is decreased. The chances are that this is happening because in

order to generate or find additional return the fund manager or portfolio manager may need to take more risk or find opportunities that are difficult to find or not so easily available.

And therefore more risk is desired and because of that additional risk the utility of that same amount of wealth is lower.

(Refer Slide Time: 24:38)

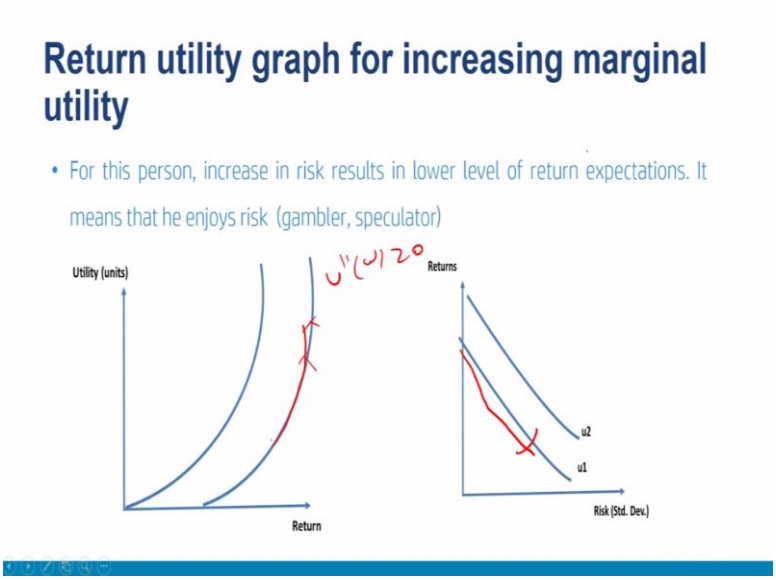


Look at this indifference curve for different individuals u1, u2, u3 these are indifferent curves for individuals and for each of these individuals as we can see u3 is greater than u2 is greater than u 1 that means as we are moving up on the indifference curve that is increasing the level of risk it would require also increasing the level of expected returns to maintain the same level of utility.

Notice this the nature of curve it is increasing. So, when we are increasing the risk in order to maintain the same utility because we are on the same iso-utility curve u3 we need more returns and this is certainly a person who is risk averse he wants higher returns for increasing risk. Contrast this to u4 which is a horizontal line. For this kind of individual the utility remains the same despite the increase in risk.

That means he is indifferent to increase in risk and his utility is same as long as the returns remains the same and therefore this kind of individual would be called a risk neutral individual.

(Refer Slide Time: 25:47)



Now let us look at this another individual for him the risk versus return plot is like this it is downward sloping the Iso utility curve u1 and u2 are downward sloping that means for increasing risk his utility remains same with lower returns that means this person is more of a risk loving person risk preferring person. So, when he is given more risk he is even satisfied and generate same utility if the returns are lower.

And look at this utility versus return or wealth diagram it is upward sloping which clearly suggest that for him additional utility of wealth with increasing wealth is increasing exponentially and therefore this kind of person probably he is more risk loving person because additional opportunities for wealth are difficult to come by and the portfolio investor or portfolio managers needs to take more risk to generate the same amount of wealth.

And this person when additional amount of risk is extra risk is taken to generate same wealth probably he is more happier and therefore his utility is increasing that means U‘‘(W) > 0. So, this is a risk loving or risk preferring person. To summarize, in this video we discuss that individuals are classified based on their utility functions in three types. First risk averse individuals; individual who prefer less risk to more.

And therefore in order to force them to gamble or take part in risk events some additional compensation is required. Next, we discuss another class of individual called risk neutral individuals. These are the individuals who are indifferent to risk and therefore a gamble for which certain expected wealth is given with certainty or through gamble they are indifferent to taking gamble or taking that sure shot outcome.

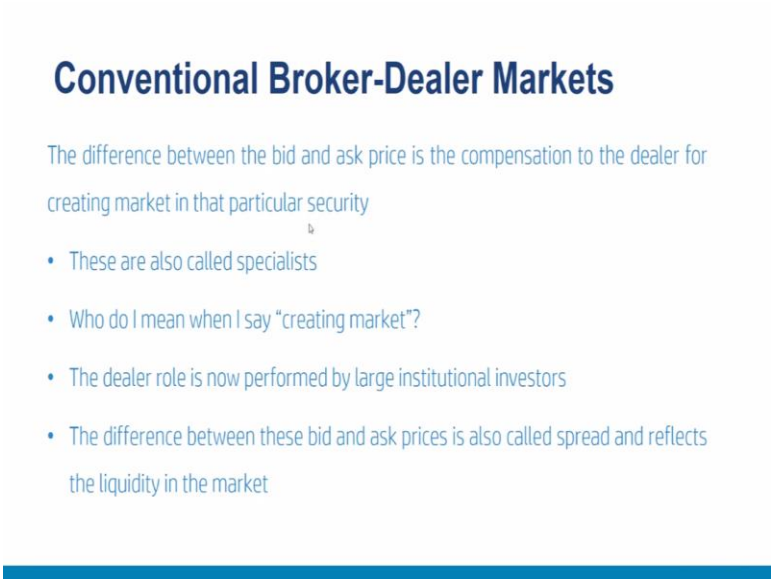
The third class is describe as risk loving or risk preferring person and they are willing to take a gamble with even lesser amount of expected wealth as compared a sure shot amount of wealth which is same as this expected wealth.

(Refer Slide Time: 28:08)

We begin with conventional broker dealer markets or often referred to as quote driven markets. The conventional markets were often referred to as broker dealer markets or quote driven markets. These markets involve brokers who routed the orders of their clients to the exchange in lieu of certain brokerage. More importantly these markets involve dealers who are engaged by exchanges to make a market in a given set of securities for which these market makers will also be called as jobbers or specialist.

Therefore, they were also called as designated market makers. These dealers provided continuous liquidity to the market in the form of continuous buy and sell sided quotes and that is why the name quote driven markets. They charge a certain ask price to the incoming buyers and offered bid price to incoming sellers.

(Refer Slide Time: 29:02)



The gap between ask and bid prices also known as spread is the profit to these market makers. These process of offering both buy and sell sided quotes is often referred to as liquidity provisioning. Thus, these market makers ensured that a well-functioning market is made in a given set of security so that incoming buyers and sellers would feel confident about their ability to trade in that security.

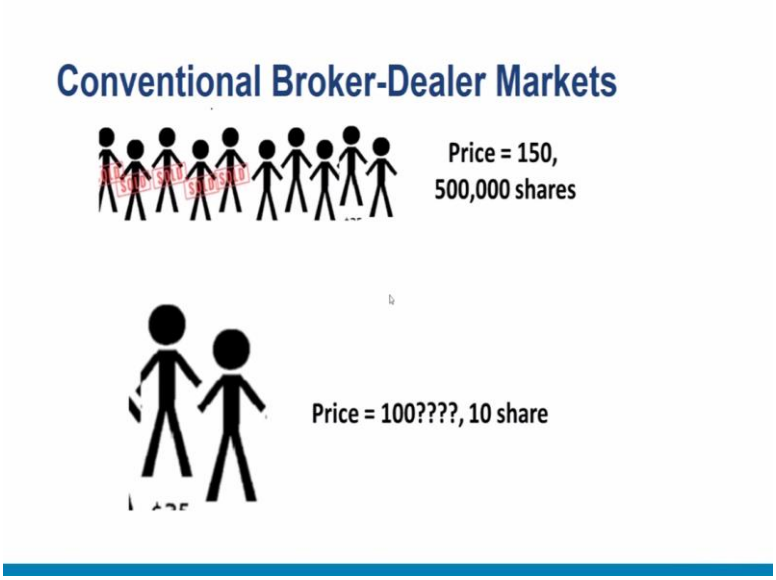
Importantly the spread reflected a very important dimension of the market for any security which is called liquidity. Essentially liquidity is the ability of a trader to trade large volumes of quantity in a very small timeframe with incurring the least transaction cost or least impact on prices.

(Refer Slide Time: 29:51)

If there are a large number of buyers and sellers in a security that means trading is taking place in large volumes. It is expected that such security will have low spread. This is so because the market maker can charge lower spread and still make a sufficient amount of profits to cover his cost. What are these cost we will have more to say about this in subsequent discussions.

Such market is often referred to as deep and liquid market. Prices observed in such markets are expected to be more reliable and efficient. Contrast this with a market where trading volumes are very low, spreads are expected to be higher in this market. Moreover, this market is expected to be shallow and less efficient. Prices prevailing in this market are expected to be less reliable and less efficient and much further away from efficient prices. Also the market maker may charge a higher spread in this market to cover his cost.

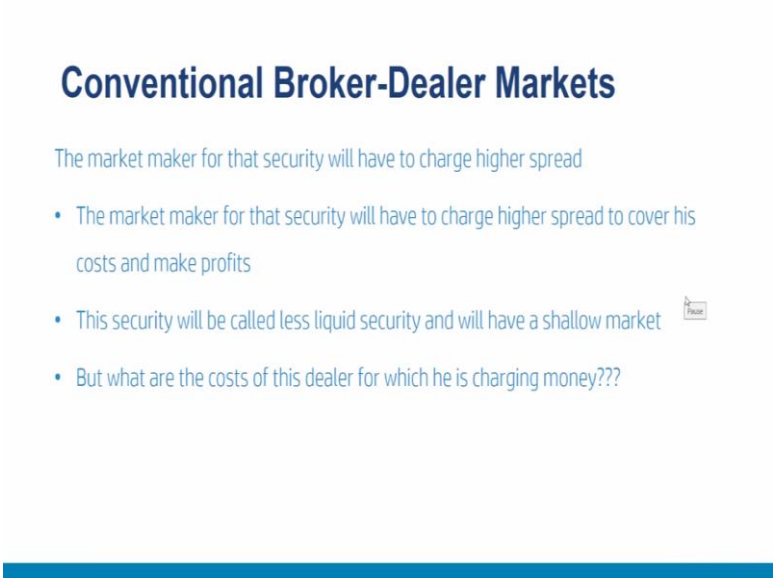
(Refer Slide Time: 30:46)



For example, consider the figure shown here we have two markets where one 5 lakh shares are traded at a price of 150 and one where 10 shares are traded at a price of 100 which one would you consider least reliable? The answer is quite obvious where only 10 shares are traded any incoming trade at even substantially different prices like rupees 20 or rupees. 30 or closer to 100 would change the price.

It does not require too much quantity because already a very small amount of shares are traded in this market. In contrast to the other market where 5 lakh shares are traded in order to change or substantially shift the prices a sizable volumes of trade is needed to do that and therefore the prices that are prevailing in market where 5 lakh shares are traded will be considered as more reliable and more efficient.

(Refer Slide Time: 31:43)



Now this market maker will charge a higher spread in a market where there are much less shares available because his profit for per trade is much less and therefore he would need a higher spread to compensate for different cost incurred by him in this market making activity. Also therefore this security where there are less shares are traded will be called less liquid because not only there are less number of shares spread is higher and therefore it will have a shallow market.

As of now we are yet to unravel what are these cost for this dealer for which he is charging the spread why is he charging the spread?

(Refer Slide Time: 32:25)

The another type of market microstructure is limit order books. Unlike the quote driven markets or broker dealer markets we have just discussed these order driven markets do not involve these designated market makers. These are run based on electronic limit order books and they predominantly involve two kinds of orders limit orders and market orders. In these markets these limit order suppliers act as liquidity suppliers.

And therefore we are often referred to as de factor market makers. These limit orders they reside inside the limit order books these are electronic signals and patiently wait for incoming market orders for execution. In contrast market orders they consume liquidity and they are executed as soon as they are transmitted and therefore it is said that market orders consume liquidity which is provided by limit orders.

(Refer Slide Time: 33:19)

Another type of classification is primary versus secondary markets. New issue of securities take place in primary markets, for example, IPOs or issuance of fresh government security through auctions these are called primary market trading. Securities that are already issued in primary markets their trading takes place in secondary markets at exchanges. This is only for the purpose of nomenclature there is no such physical space or market as such.

It is only based on the mode of trading, for example, in India fresh auctions of RBI would be called as selling and primary markets while secondary trading will take place exchanges. It is desired that we have deep and liquid secondary markets to create appropriate environment for primary issuances. So, it is like a chicken egg problem if there are no good secondary markets

that are liquid and deep probably issuers would not be looking at such markets for primary issuance in a favorable manner.

(Refer Slide Time: 34:21)

Next, we have call and continuous auction markets. The normal trading ask in which trading takes place at electronic limit order books a continuous kind of matching of buy and sell orders take place this is called continuous order matching or continuous auction markets. In this kind of market there is a continuous trading and continuous matching of buy and sell orders.

In call auction markets or call markets trading takes place at certain intervals in this individuals have the auction to sent their orders and also in a certain period they can revise, modify and cancel their orders in a certain window after which the orders are matched like batch auctions.

(Refer Slide Time: 35:10)

One such example of this kind of batch auction or call auction as pre open session as national stock exchange of India which follows the call auction framework. All global markets employ some kind of call auction framework at opening and closing sessions for efficient price discovery. At NSE there is a session that has a duration of 15 minutes. During the first phase from 9 o'clock to 9:08 this is called the first phase.

One can submit orders, limit orders and revise, modify and cancel them during the first eight minutes of trading that is from 9 to 9:08. After that orders are matched and price discovery takes place. The prices at which maximum amount of trading takes place is considered as opening or clearing price, often this price is considered to be more efficient as it incorporates the information of large number of market participants.

This is the price at which shares are allotted in pre open session. This facility is provided to safeguard the interest of uninformed traders from being picked up by more inform traders. This may happen because there is lot of information accumulation over the overnight period. This is due to the fact that there is lot of information accumulation at overnight period when trading is not taking place.

These informed traders may not have a fair idea of this information and may place poorly informed orders and make losses. This is unlike prices during the day when trading is on. During the day any new information is incorporated in prices very quickly through trading activity and therefore prices are considered to be rather efficient. Hence, the probability of uninformed traders being picked off by informed traders and making losses is very low.

(Refer Slide Time: 36:52)

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

Let us discuss an example of this order matching and price discovery in pre open call auction as discussed here. Notice the price schedule so we have a share price schedule which is provided in the first column here. We have accordingly the buy and sell order book built up here. Now looking at this buy and sell order book we can estimate the demand for given buy quantities and supply for given sell quantities we can estimate that.

How to do that? For example if you want to estimate the buy schedule at 103 rupees notice almost all these orders on the buy side would be willing to buy at this price and therefore their cumulative buy volume is provided here. If you are looking at 104 rupees starting from this quantity and all the other higher quantities would be available to buy at this rupees. Conversely, if you are looking at 108 rupees all these sell orders starting from this one, this one, this one all these sell orders will be willing to sell.

And therefore supply is the accumulated order here. Similarly, if you are looking at the supply at 107 starting from 11,598 and so on up till 12,500 all these orders we will be willing to sell their orders at this price and thus we can prepare demand and supply schedules at all the prices. Now, if the matching takes place the price at which maximum quantity is traded will be considered as the opening price.

If we notice in this case at 105 rupees maximum order quantity can be traded which is 27,500 and therefore 105 will become the clearing price and opening price for the session. Thus, we arrive at the maximum tradable quantity. You may ask why not based on maximum revenue

from market efficiency perspective it is important that maximum people, maximum market participants engage and therefore fair and efficient prices emerge.

For this to happen maximum tradable quantity or the price at which maximum quantity is traded that should be selected and based on that logic this 105 rupees is selected as the opening price because at this price maximum quantity is traded. To summarize, in this video we discussed different market microstructures, we discussed conventional the broker dealer markets where there was a central designated market maker entity which provided continuous buy and sell side liquidity and ensured smooth functioning of the market.

We also discussed limit order books which run on electronic limit orders and market orders. These limit orders provide liquidity which is consumed by market orders. We also discussed continuous markets which are like limit order book electronic markets which run continuously by matching buy and sell orders then we also discussed call auction markets or batch auction markets where trading or matching of order takes place over certain time horizon or intervals or time window.

For example national stock exchange of India where call auction takes place from 9 o'clock to 9:15. We also discussed primary versus secondary markets. Primary markets are markets where primary issuance of securities takes place those securities that are already issued in primary markets their secondary trading take place at secondary markets.

(Refer Slide Time: 40:25)

In this video, we will talk about three types of traders that is noise and liquidity traders, informed traders and market makers. We will also discuss two key theoretical underpinnings that is inventory hypothesis and information asymmetry hypothesis in the context of market microstructure.

(Refer Slide Time: 40:44)

To begin with, there are broadly three kinds of traders in the market. Financial markets are characterized into three class of traders. First is noise and liquidity traders. Noise traders are those who do not have the proper information. However, they believe that their information is recent and they want to benefit from this information. Since the information is stale or incorrect their trade contributes in the form of noise in prices.

Next, we have liquidity driven traders that trade to obtain liquidity from financial markets again they do not have any new or fundamental information and their trades do not contribute to information, but put noise into prices. These traders constitute a majority of trading that is noise traders and liquidity traders they constitute majority of trading volumes and they are essential for trading to take place.

Next, we have informed traders these are generally large institutional investors who spent a considerable amount of money in the acquisition of information resources and analysis. As these traders deduct an opportunity to benefit from inefficient pricing they exploit this inefficiency using this information and analysis and trade in large volumes. While these traders comprise only a small fraction of financial markets their trading activity heavily contributes to the market in increasing their pricing efficiency and information efficiency.

We must note that any trader informed or uninformed instance his or her information into prices through trading activity particularly when he or she conducts large volume of trades. Since these informed investors or traders have correct and appropriate information to exploit inefficiency in the prices their trading activity incorporates this fundamental information in prices as they trade in large volumes.

Next, we have market makers as discussed already a market maker is somebody in the market who offers continuous buy and sell side quotes and ensures smooth functioning of the market in that particular security or set of security in which he or she deals with. In another words, this market maker provides liquidity to financial markets, it may be noted that he buys the security at mid price on sellers and sell the securities at the ask price to buyers.

The gap between this ask and mid prices is the profit to these market makers. In order to continuously provide buy and sell sided quotes this market maker has to maintain a certain optimum level of inventory. The inventory should not be too large or too small. At times there is a dominance of buy or sell sided trades which may cause deviations in his inventory from optimal levels.

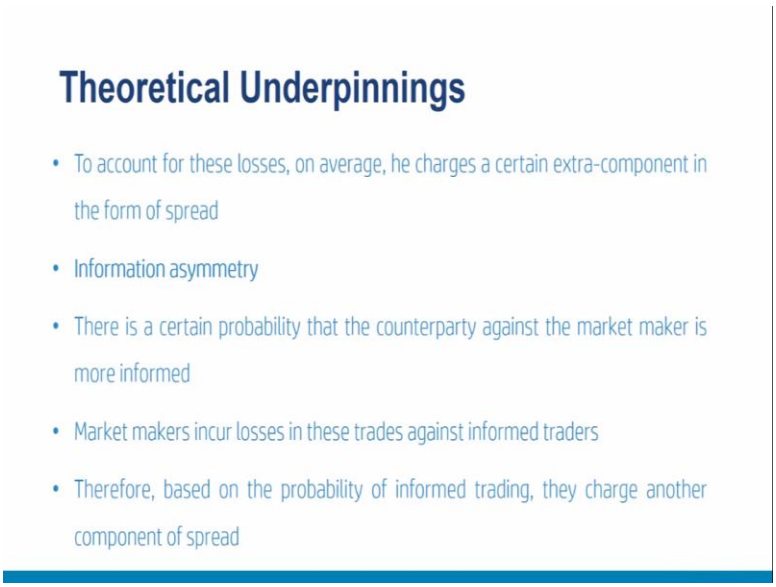
In order to achieve those optimum levels this market maker adjust his or her quotes to nudge the order flow so that optimum levels of inventory are achieved. Also this market maker tries to gauge the probability of information event throw the intensity of buy and sell sided trades. This is so because he or she incurs loss in trades against more informed traders. Therefore, depending upon his or her assessment of the probability of information event market maker increases or decreases the spread charged by them.

While the market maker incurs loses against the trade with informed traders they compensate themselves through higher spread charge in all the trades and averages out the losses.

(Refer Slide Time: 44:17)

Literature on market microstructure and market efficiency comprises two broad theories related to the cost of market makers. First is inventory considerations. Market makers maintain a certain optimum level of inventory as we discussed and therefore they are exposed to fall in security prices, they may have to liquidate this inventory of securities at lower prices than they were purchased maybe they were purchased at higher prices. To account for these losses a certain component will be charged in the form of spread.

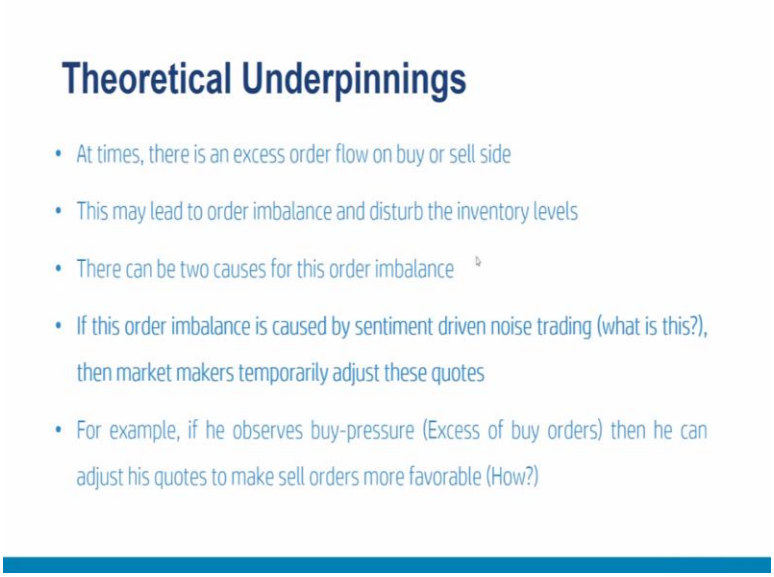
(Refer Slide Time: 44:52)



Next, we have information asymmetry hypothesis. There is a certain probability that the counter party against market maker will be more informed. Market makers incur losses in such trades. Based on their experience market makers will have a certain estimation of information events for example through examining order imbalances on buy and sell sides. Based on this they will have certain estimate of losses and to cover these losses they will charge a certain

extra component of spread in all the trades since they cannot identify who is the informed trader and who is not.

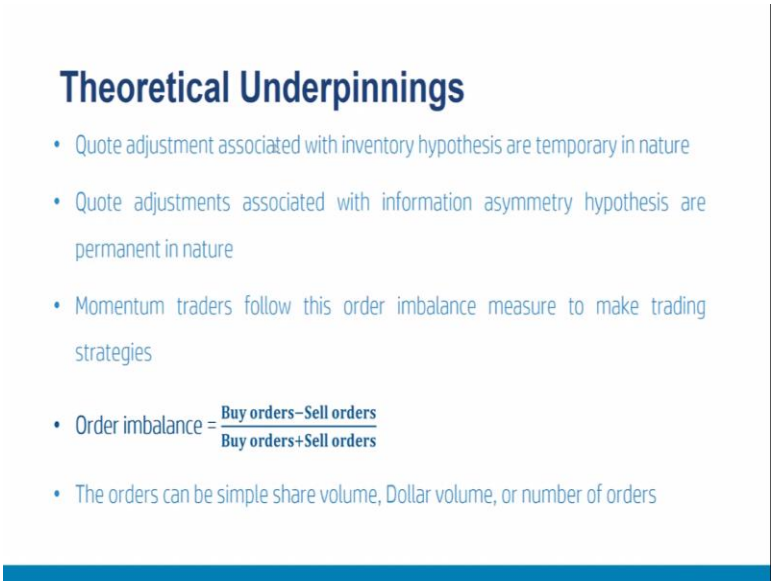
(Refer Slide Time: 45:25)



Market makers keenly observe ordering balances as these order imbalances affect their inventory from optimum levels. These order imbalances can be caused on account of sentiment driven noise trading and informed trading. If the order imbalances caused by sentiment driven noise trading such imbalances are expected to be temporary. Market maker adjust their quotes in temporary fashion to observe easing balances.

Once these order imbalances are observed the quotes revert to their original levels. In contrast, order imbalances driven by informed trading are more permanent in nature and therefore the quote adjustment made by market makers are more durable and permanent in nature.

(Refer Slide Time: 46:16)



Order imbalances can be easily measured with the formula provided here. Order imbalance equal to buy orders minus sell orders divided by buy order plus sell order. Here buy minus sell can be in terms of simple share volume, dollar rupee volume or number of orders. To summarize, in this video we discussed three class of market participants. First noise and liquidity traders who is trading activity in corporate, noise into prices.

$$Order\ imbalance = \frac{Buy\ orders - Sell\ orders}{Buy\ orders + Sell\ orders}$$

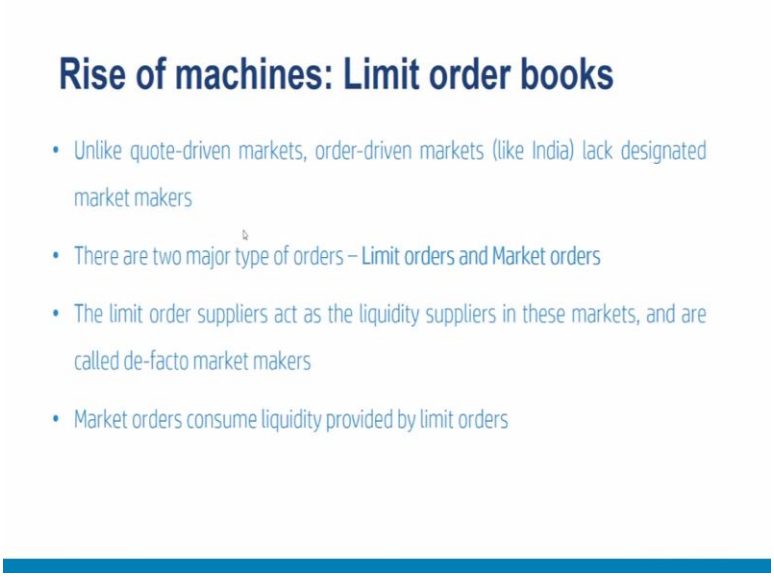
Then we discuss informed traders these are large institutional investors and they have some kind of updated information and their trading activity leads to more efficient, informational efficient prices. Third we discuss market makers whose responsibility is to provide buy and sell sided quotes and in order to cover their market making cost they charge a certain extra spread between buy and sell prices or bid prices.

Then we discuss two key theoretical underpinnings. One is inventory hypothesis which suggest that because of their inventory levels market maker charge a certain extra spread on account of their inventory cost and quote adjustments on account of inventory hypothesis are more temporary in nature. We also discussed information asymmetry hypothesis wherein we said that these market makers often incur losses in their trade against more informed traders.

To account for these losses they also charge another certain extra component of spread. The adjustment in quotes bid and ask quote on account of information asymmetry hypothesis are

more permanent and durable in nature. We will discuss a very important market microstructure which is electronic limit order books.

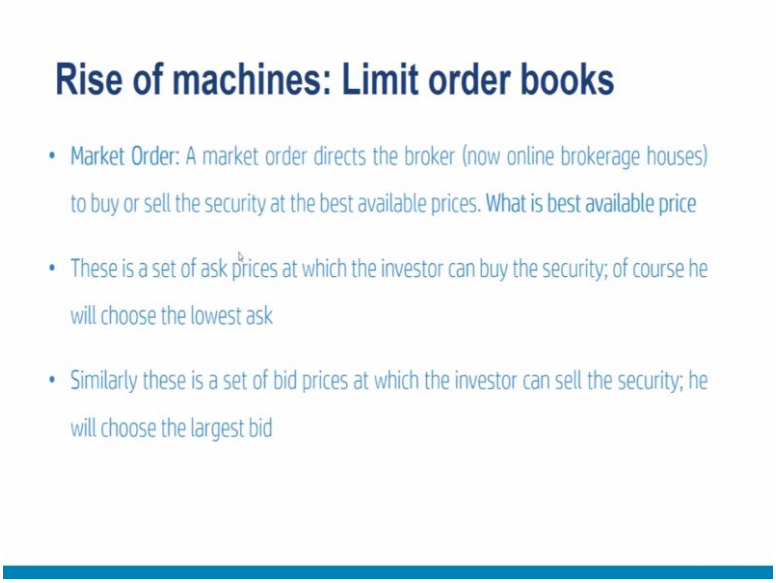
(Refer Slide Time: 47:55)



Unlike quote driven markets order driven markets like India lack designated market makers. These markets run predominantly based on two kinds of orders that is limit orders and market orders. Here the limit order suppliers act as liquidity providers because these are patient order that sit in limit order books and often refer to as de facto market makers because they are not specifically engaged by exchanges.

But they are individual orders limit orders that are sitting patiently in the limit order book waiting for execution and in that sense they provide liquidity to incoming market orders. Market orders are considered to be impatient as soon as they arrive in the order book they demand liquidity, they want to be executed, this liquidity is provided by limit orders. So, in a sense these market orders consume liquidity provided by limit orders.

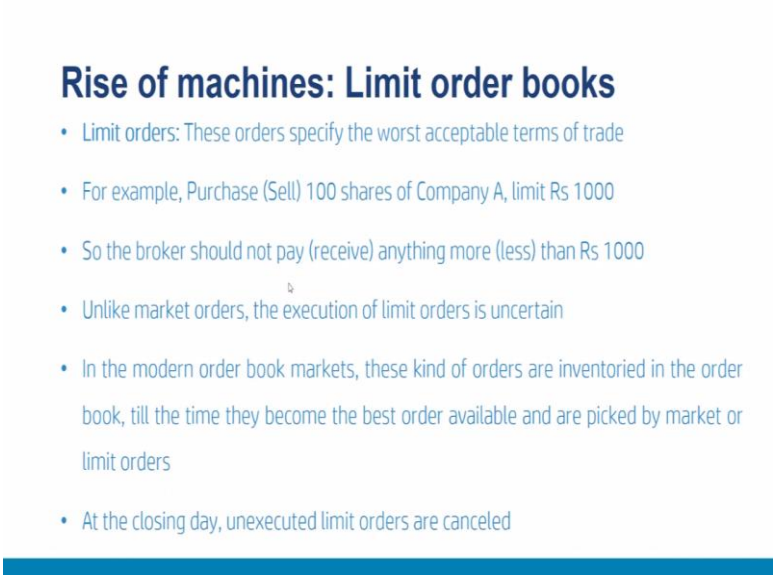
(Refer Slide Time: 48:50)



A market order is a rather impatient order which directs the broker or online brokerage houses to buy or sell security at the best available prices. What is this best available price? We will have more to discuss about this, but for now whatever the best possible terms and conditions in terms of pricing these market orders are executed. So, for example, there is a set of ask prices at which investor can buy the security.

Of course he will choose the lowest ask to buy this required security. Similarly, there is a set of mid prices at which investor can sell the security. However, he will choose the largest mid price to sell a security.

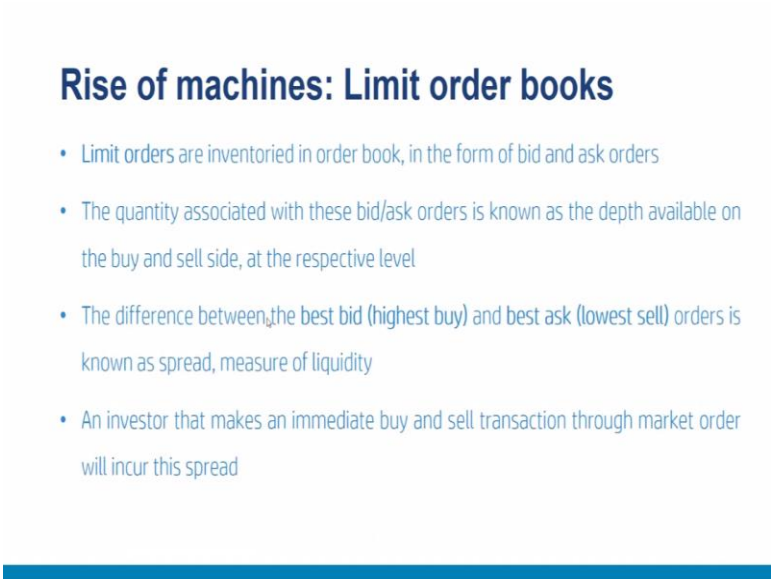
(Refer Slide Time: 49:32)



Coming to the limit orders. Limit orders specify the worst acceptable terms, for example, a purchase sell 100 shares of company A with limit 1,000. So, the broker should not pay or

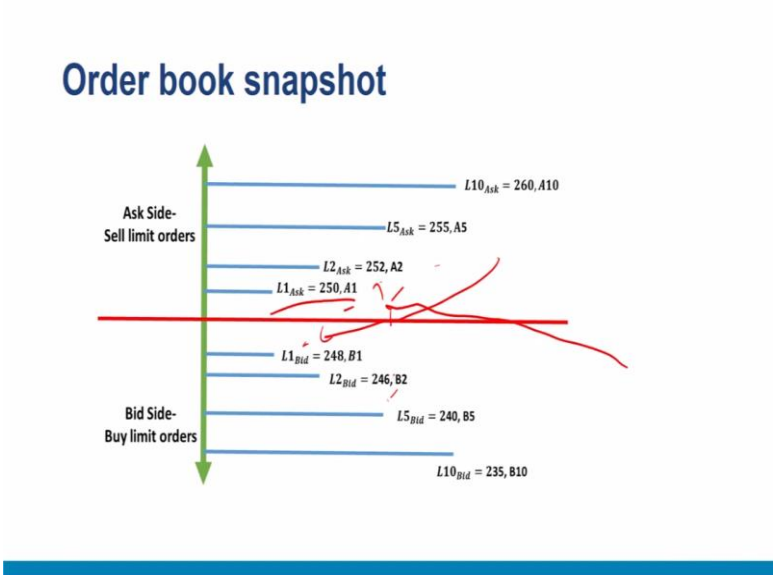
receive anything more than or less than rupees 1,000. The unexecuted limits orders are inventoried in the order book till the time they become best orders and are picked by market orders or markets in the limit orders. At the closing of the day unexecuted orders are often cancelled unless specified otherwise.

(Refer Slide Time: 50:05)



The most favorable ask order sell order with the lowest price is referred to as the best ask order and the most favorable bid order buy with the highest price is referred to as the best bid orders because of the reasons as we discussed earlier. The different between these ask and bid is called the spread and is an important measure of liquidity. The investor who makes an immediate buy and sell transaction through market order will incur this spread.

(Refer Slide Time: 50:34)

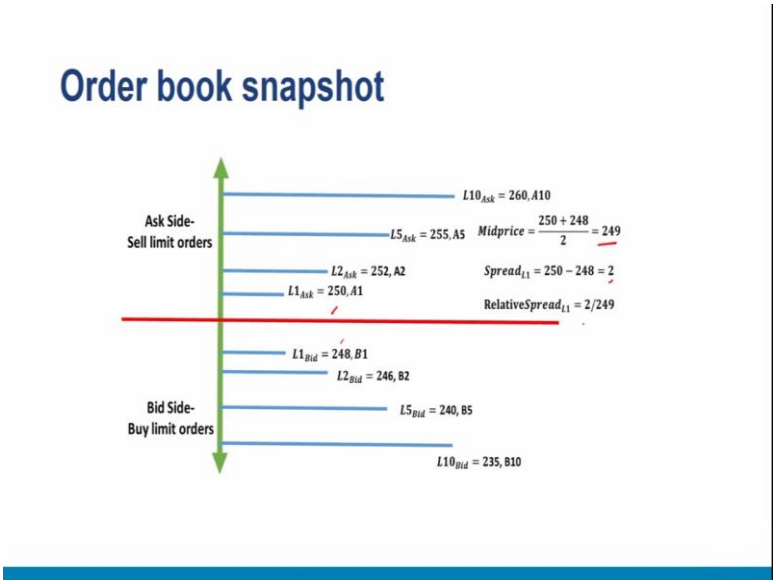


Let us examine a limit order book snapshot at a point in time I have shown here. Notice on the ask side the lowest ask price is L 1 ask this L 1 ask will be referred to as best ask price because incoming market order to buy will find this order most lucrative or best in terms of conditions. So, incoming market order to buy will first execute against this A 1 quantity which is the depth of this order book corresponding to the best ask price.

If there is further some amount left for the incoming market order then only it will have a look at L2 ask. Similarly, the incoming sell order will find the L1 bid price in coming market order will find this L1 bid price most favorable and therefore it will execute against this 248 rupees at quantity B1. So, B1 is the death of the bid side. Now, only if this B1 is exhausted then the incoming market order to sell will look at this L2 bid.

And so on so forth the bids in ask side is exhausted and matched against incoming market orders.

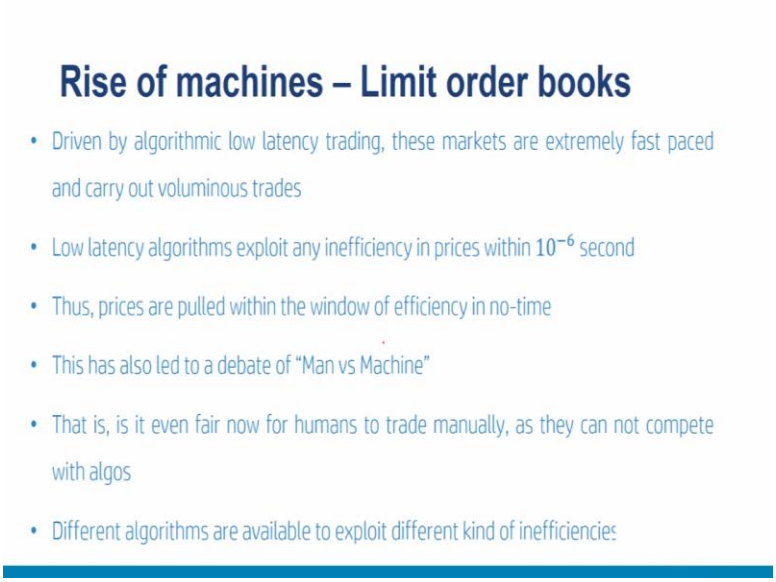
(Refer Slide Time: 51:43)



As we discuss a very important dimension of liquidity in the spread which is the difference between these bid and ask prices. However, across stocks with different sizes this absolute spread may not be comparable and therefore it is scaled by dividing it with mid price. In this case mid price is 249 rupees if we divide this rupee 2 by the 249 we get something called relative spread or ratio spread which is 2.249.

It is a very important measure of liquidity because it is properly scaled and therefore it can be compared across different stock as well.

(Refer Slide Time: 52:23)



Unlike quote driven markets these markets do not have designated market makers. Hence, these limit orders act as liquidity providers which is consumed by market orders. Therefore, these limit orders are also called as de facto market makers. These order driven market operate as electronic markets and also employ algorithmic trading. Algo traders execute orders as frequency is as low as micro seconds.

Huge amount of investments like millions of dollars in network connections is made in the market infrastructure to gain advantage of just few milliseconds. Given the speed of these orders these algo traders impact prices at an extremely fast pace. Any inefficiency in prices is exploited by these algotrades at extremely fast pace and therefore prices become efficient within a window of very fraction of seconds.

Therefore, the window efficiency has come down drastically and this has led to a debate of man versus machine that is whether it is fair for human traders to particular in trading against these algo traders. A large number of algorithms are available in market to exploit various kind of inefficiencies in prices.

(Refer Slide Time: 53:28)

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

Incoming order incoming limit and market orders are rated based on their time price priority. So, in order book any incoming order is compared or considered in sequence based on how favorable is in terms of prices and if prices are same it is compared in terms of time. So, if for example here on the ask side the two orders that is rupees 95 both of them are there. So, while in terms of prices both of them are equally favorable and best in this order book.

We have to go to their time and it appears the first this is 12 12:40 this order has come earlier and therefore it will be considered as the best order. Similarly, on the bid side notice the highest price at 98 since there is no other order at rupees 98 this 98 rupees limit order will be considered as the best and 90 rupee which is the lowest price will be considered as the worst.

(Refer Slide Time: 54:27)

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

Also a very important dimension of order book is impact cost is the impact of its own trade on prices. So, if a large trader comes to market his own trading activity will shift the prices whether on ask side or bid side and it will affect the prices. So, let us examine how to compute this impact cost.

(Refer Slide Time: 54:50)

The formula to compute impact cost is quite simple. What we need to do is we need to compute the weighted average buy or sell price we can compute the impact cost on buy side as well as sell side. So, we can compute the weighted average buy price, for example, whatever amount of trades on buy side their weighted average price divided by the mid-price we already know how to compute mid-price which is the average of best mid and ask prices minus 1 will give us the impact cost measure in ratio terms.

$$Relative\ Spread = \frac{Absolute\ spread}{Relative\ price} = \frac{1}{\frac{95+94}{2}} = 1.06\%$$

We can convert it into %age as well. Let us take an example so using the given data as we can see here in table we can arrange the prices as per their priority based on the time price priority as we discussed already.

(Refer Slide Time: 55:30)

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

So, it will appear something like this. Now, NSE defines a very simple measure of impact cost as the change in prices for 1 lakh rupees worth of trade. So, using these orders on both sides ask and bid side will have the price as well as quantity we need to establish how much trading has to take place in order to exhaust 1 lakh rupees worth of orders. So, we will compute the cumulative orders.

(Refer Slide Time: 55:56)

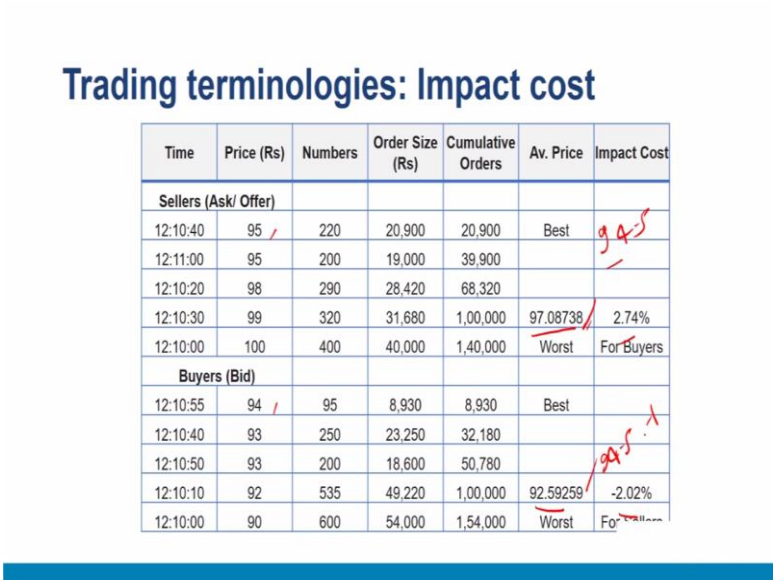
Trading terminologies: Impact cost

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	1,54,00(

And here we can see the cumulative order computation. For example, if this first order is fully exhausted trade worth 20,900 will take place on the ask side and so on so forth next is 19,000 and until we exhaust the trade worth 1 lakh will stop here. Similarly, on the bid side we also again see that at this fourth order 1 lakh rupees worth of trade are exhausted. So, we will compute the volume weighted average prices using the price information here.

And volume information here this will give us the volume weighted average price on the ask side. Similarly, we will use the price information here and volume information here to compute the volume weighted average price on the bid side.

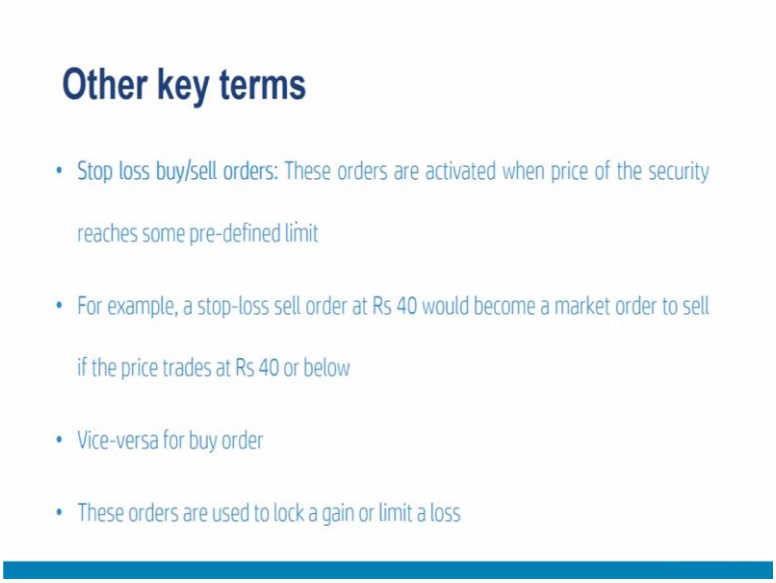
(Refer Slide Time: 56:39)



Now very simply these volume weighted average prices will be used. So, this is our volume weighted average price on the ask side. We will divide this price by the average which is on both side the average is (95 + 94) / 2 which is 94.5 so we will divide this price by 94.5 and substract from 1. Similarly, on this side this is the weighted average price since this is less than mid-price our measure is negative we will divide this also again by 94.5 and subtract from 1.

So, we will get in %age term – 2.02 %. Of course, since this volume weighted average price is less than mid-price the value is negative, but we are more interested in magnitude here.

(Refer Slide Time: 57:25)



Another important and interesting terminology here is stop loss buy and sell orders we will discuss this and close the video. So, these orders are executed and activated when the price of the security reaches some predefined limit. This is like a limit order which gets converted into market order as the limit is reached. For example a stop loss sell order at rupees 40 will become a market order to sell if the price trades as 40 or below and vice-versa for a stop loss buy order.

These orders are used to lock in gain or limit a loss, for example, if I purchase the share at rupees 60 and now I want to profit from price rises and I am hopeful for the same. However, I also want to ensure that my losses are limited although I feel there is a very low probability of fall in prices, but who knows. So, I place a stop loss at rupees 40 that is when prices reach 40 or below a market order to sell his place immediately.

To summarize in this video we discussed a very important market microstructure which is limit order book which runs on electronic orders of market orders and limit orders. Market orders are executed immediately at the best available prices while limit order await patiently in limit order book for execution against incoming market orders or market at the limit orders.

Lastly, we also saw the time price priority rule of limit orders execution and we also saw the computation of impact cost for mid side and ask side. To summarize this lesson deep liquid and efficient markets are desired in order for financial markets to perform the role of financial intermediation. Efficient prices are those that reflect all the fundamental information about the security that can affect its cash flows

However, what we observe in financial markets are inefficient prices and include noise. Market efficiency is categorized in three types. First weak form efficiency. Markets where investors cannot make abnormal risk adjusted profits using historical price information are called as weak form efficient. Second semi strong form efficiency, markets where investors cannot make abnormal risk adjusted profits using public information and historical price information about the security are called as semi strong form efficient.

And third strong form efficient. Markets where investors cannot make abnormal risk adjusted profits using private information, public information or historical price information are called as strong form efficient. Investors risk preferences can be categorized in three forms risk averse, risk loving and risk neutral. In real life, investors are risk averse that is they desire extra risk premium for bearing additional risk.

Modern financial markets predominantly involved broker dealers or limit order books to execute trade. These electronic limit order books are well capable of handling large volumes of trades in extremely fast manner. These limit order books function using two major kinds of orders that is market orders and limit orders. Theoretically, there are three types of market participants informed traders.

These are large institution investors that invest considerable time and resources in a querying information. Noise traders and liquidity traders who do not trade with any significant information and contribute to the noise and prices. Lastly, market makers conventionally dealers have played the role of these market makers who are willing to buy and sell large quantities of stock to ensure smooth operations in financial markets.

In modern electronic markets, limit orders perform this role of market making as they patiently await execution from incoming market orders.