Management of Commercial Banking
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Lecture 20
Commercial Bank Risk - IV

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After the discussion on the different type of risks, what the commercial bank face. Let us today we can discuss about the how the risks specifically are measured. What are those different kind of risk measures which are available in the quantitative way? And what is the advantage of using the quantitative measures to measure the risk. So, this is basically today's discussion.

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So, today we will be discussing these three things. One is the concept which is related to sensitivity. Then we have volatility, then you have the value at risk. These are the three concepts what always we use whenever we deal with any kind of risk in the market. So, here whenever we talk about the banking perspective, in the banking perspective, we are facing credit risk, we are facing addressing market risk, we are also facing the liquidity risk and all.

But all type of the particular ways of measuring the risk like sensitivity, volatility, value at risk and all these are mostly used for any aspect either you can measure the credit risk through that or you can also measure the market risk through that. So, that is why these are the commonly used concept whenever the risk analysis we discuss from any prospective, whether it is from the commercial banking perspective or any other financial institutions perspective, that does not matter. But these are the important concepts which are always used in the risk management area.

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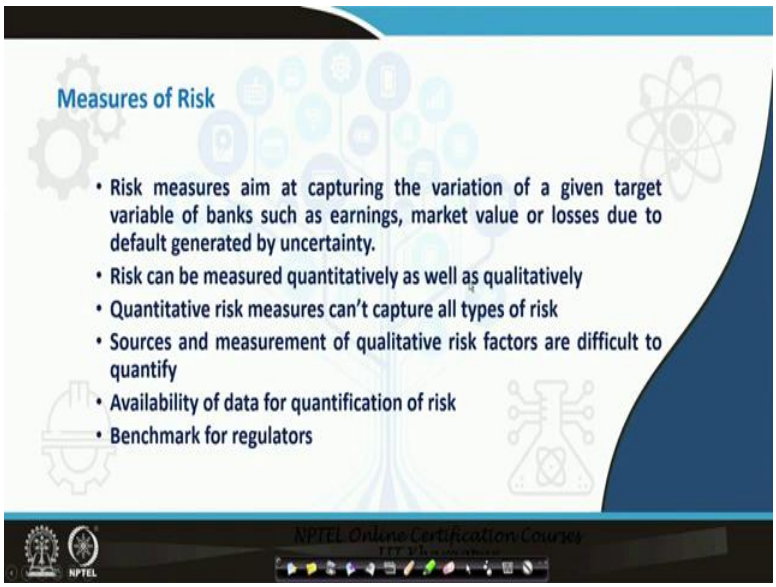

So, let us see what do you mean by the risk measures? So, whenever we talk about the risk measures, the basic objective of the risk measure is to capture the variation of a given target variable. If we are talking about banks, then obviously the variables like earnings, the market value of equity and all these things. And how the particular things is deviated from this particular target, what is the variation?

From a particular target, how this particular values are deviating? It can be the earnings, it can be market value of equity, it can be losses due to any kind of default generated by any kind of uncertainty.

So, anything you can take a target variable and through this particular target variable using certain kind of technique, you want to see that how this particular target is deviated from that actual value or how the actual value is deviated from the target. Basically it is the difference between the actual value and the target value. And here we are talking basically about the variation, but basically we are getting over the time between the actual value and the target value in actual sense.

So, if we are largely deviating from the target value, we are exposed to more risk and if the deviation between the target and the actual is relatively less, then we can say that we are exposed to less risk. So, the variance is high, then it is basically we are exposed to high risk, if the variations are low, then we are exposed to low risk. Remember it is not the only differences, it is the variation of the differences. So how that particular variation is happening with respect to that particular differences, that is basically captured through the risk.

And again and again I am telling this can be used for any kind of risk for the particular finance institutions or the commercial banks are facing. So, whenever we talk about the risk, the risk can be measured quantitatively and as well as qualitatively. But whenever we talk about qualitative measures, the qualitative measures are mostly the judgmental measures, subjective measures. So, whenever we talk about subjective measures, then it is relatively difficult.

Because the subjective measures whenever we talk, the perception or the judgment for that particular parameters or variables, what we use it to make the judgment that may vary from one individual to another individual. So, from one perspective it may be good, for others perspective it may not be good. So, because of that, basically the risk analysts mostly rely on the quantitative risk measures. But one thing you remember the quantitative risk measures cannot capture all type of risk.

I will give one example for example, somebody is giving a loan, let the commercial bank is giving the loan and whenever they provide the loan, they try to measure the credit risk involved in that. So, to measure the credit risk, they basically try to measure at 99 percent confidence level or 95 percent confidence level, they measure this. But even if it is a 99 percent, still there is 1 percent chance, that chance the commercial banks are not able to measure that is number one.

And number two, whenever we are giving the loan we try to use the financial data from that particular entity to examine whether that person is really able to repay the loan or not. So

through that may be probably or default and all these things we consider to measure the credit risk. But whenever we are talking about this, we are forgetting another aspect, whether the particular person is ready to repay the loan or not, which is nothing but the willingness to pay and that willingness to pay is a quantitative aspect.

And if we cannot measure that part, still we are exposed to more risk. So, whatever risk basically we are considering that particular risk is not exactly the total risk what is the commercial bank face. So, that is why the quantitative risk measures cannot capture all type of risk, but these are very much inevitable, the reason is the data which is available, this is basically conducive for us to measure the risk in the quantified manner. Although we are not able to measure the ability to pay, but still we are measuring ability to pay, but we are not able to measure the willingness to pay.

So, that is why the quantification of ability to pay at least gives the idea that whether the loan should be given or not. So, even if the ability to pay is not able to be measured, so, availability of the data that is why the quantified measure of the risk is widely used. And another thing also it helps the regulator or other stakeholders who are basically judging that how the bank is performing.

So, if any kind of information related to this particular risk is available, then they can always judge which is basically helpful for the market participants to give their opinion, how that particular company or particular bank is going to perform in the future, considering the different level of risk what are they facing which are measured in the quantified manner.

So that is why these are the importance or maybe we can make a tradeoff between qualitative versus the quantitative risk. Both the risk should be considered that is why it should have an integrated approach. But sometimes what happens that, most of the cases we are not able to measure the qualitative risk. That is why completely rely on the quantitative risk part of the particular commercial bank.

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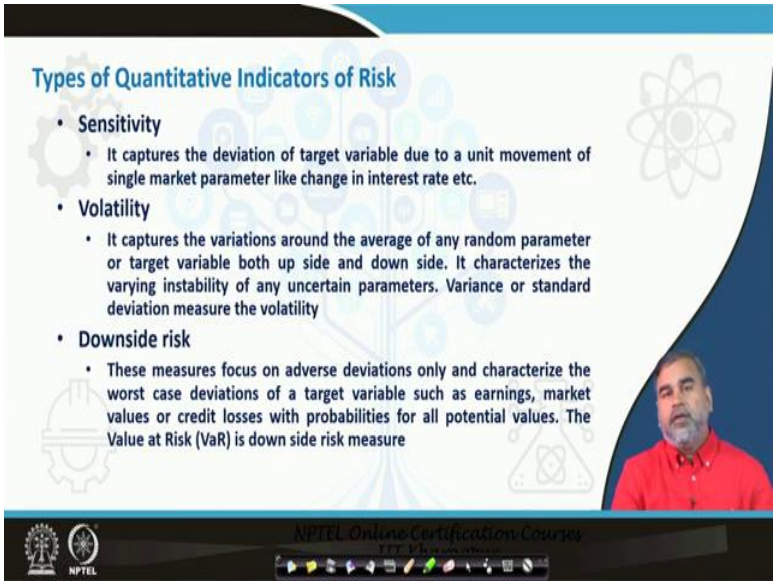

So, whenever we talk about the quantitative risk, there are different type of indicators what we use? The different indicators are basically what? The indicators are related to sensitivity or it can be related to volatility or it can be related to downside risk. What exactly the sensitivity means? Basically, sensitivity captures the deviation of the target variable due to a unit moment of single market parameter like changes in interest rate.

For example, you take net interest margin for the commercial bank. So, if your interest rate will change by 1 percent, then how the commercial banks total interest income, total interest expenses are going to be affected? So, if total interest income and common total interest expenses are affected, then obviously your net interest margin gets affected. So, because of that the sensitivity is basically kind of scenario buildings what we make?

And we are trying to measure that how this particular target variables are going to be changed if there is a 1 percent or unit change in the other variable, which are basically the market related variables like interest rate inflation etc. Then the other aspect of quantitative indicator is the volatility which is popularly used and what the volatility basically captures? It captures the variations around the mean basically, or the average of any random parameter or the target variable both in the lower side or the up side and the downside.

Maybe it consider in the both sides, the variations in the downside and variation in the upside. So, mostly it characterizes the varying instability of any uncertain parameters. So, if I am talking about a particular target, I may not get the target I may exceed the target or I may go

below the target. So, how this particular variable is moving in a particular point of time is deviating from the target in both the sides that basically is measured through the volatility.

And all of you know that the variance of the standard deviation are the popular measures of volatility in the financial market. But the question here is, we are not concerned about the upside part. If it is increasing it is fine, we should not concerned much and we want that the price should increase or the profits should increase.

If it is increasing, it gives a good signal and we are not considering that is a risk for me. But if there is a probability of declining that means the price can go down or the return can go down. In that particular context we are basically very much concerned about that.

So, that is why we give more emphasis on the downside risk than the upside risk. So, whenever we talk about the downside risk, it basically focus on the adverse deviations and characterize the worst case deviations. What is the maximum loss I can incur? What is the worst loss I can incur?

So, if I am giving a loan, then what is the probability or how much maximum loss I can incur if the loan will be given to a particular individual or a particular organization in that particular point of time that basically will be measured through the downside risk.

So, if there is a worst case deviation of a target variable like your earnings, market values, credit losses, all these things. Then we can say that it has some sense because this is considered as a true risk. Because we are thinking about the downside moments of that particular target variable. And for that, we are using the value at risk method which is quite popular in the market. Whenever we talk about or we are measuring the downside risk for a financial institutions.

So, this is what basically there are three indicators of risk mostly all the indicators are the quantitative indicators.

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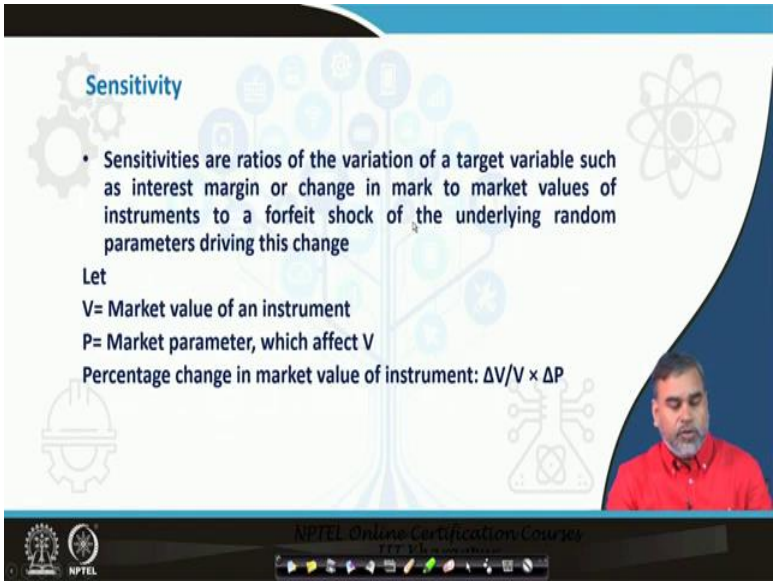

So, one by one if you see whenever we talk about the sensitivity, how in the practical sense the sensitivity is basically used? The sensitivity is basically nothing but the ratio of the variation of a target variable like interest margin or market value of equity and all to a forfeit shock of underlying random parameters driving this change.

For example, if you were putting a shock in terms of interest rate, if the interest rate is decreasing or interest rate is increasing, then how the target variable like earnings and value of equity gets affected? So, if you change the interest rate by 1 percent, what is the change of the net interest margin or the stock price? So, these are basically measured through the sensitivity analysis.

If you see that V is the market value of instrument, P is the market parameter which basically affect V like interest rate, then your percentage change in the market value of instrument if you talk about then your delta V, the change in the market value divided by the market value multiplied by the change in the interest rate. So, this is the way basically the sensitivity analysis works in the financial system.

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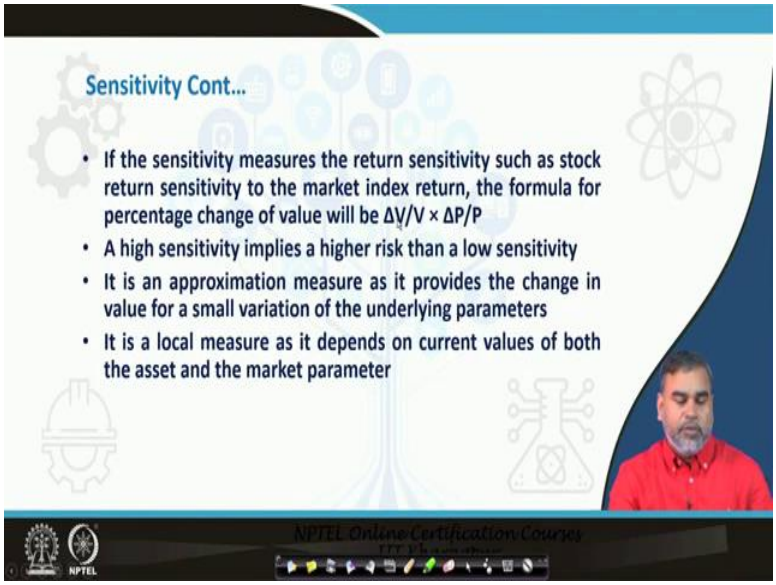

But if we are not basically concerning about the absolute value of that particular asset, and we are concerned about the return, the change in the asset value. Then if the sensitivity is basically measured for a return kind of variable like stock return and all these things, then your formula will be

$$\frac{\Delta V}{V} \times \frac{\Delta P}{P}$$

So, if the sensitivity measures the return sensitivity, so that stock return sensitivity to the market index return, for example, if the market index return will change by a certain percentage or one percentage then how this particular stock price is going to be changed?

Then this particular case, the percentage change of the value will be delta V by V into delta P by P, delta V is equal to change in the value of that particular asset, V is equal to the actual value of the asset, delta P is equal to the change in the market parameters like interest rate and P is basically the original interest rate or original market parameter which was there before.

So, how you can interpret this? The high sensitivity implies a higher risk than the low sensitivity that means sensitivity at risks basically are directly related. So, it is basically consider as an approximation measure, why it is considered as approximation measure? Because it provides the change in the value for a small variation of the underlying parameters. So, we are talking about the interest rate will change by 1 percent. The interest rate may not change by 1 percent, it may change by 5 percent also.

So in that particular context, the sensitivity analysis may not give you accurate kind of findings that how this change in the 5 percent of interest rate is going to affect the market value of that particular asset. So, people also consider it is a local measure, because it depends on the current value of both the asset and the market parameter without considering the other external parameters, which are existing in the system.

So, this is only depends upon the current values of the assets and as well as the market parameters without considering the other factors which have or which may play the role in the price fluctuations or the return fluctuations of that particular asset. So, this is what basically and deeply we can consider sensitivity analysis, which talks about the 1 percent change in the market parameters how it is going to affect the value of the outcome variable or the target variable of the commercial bank?

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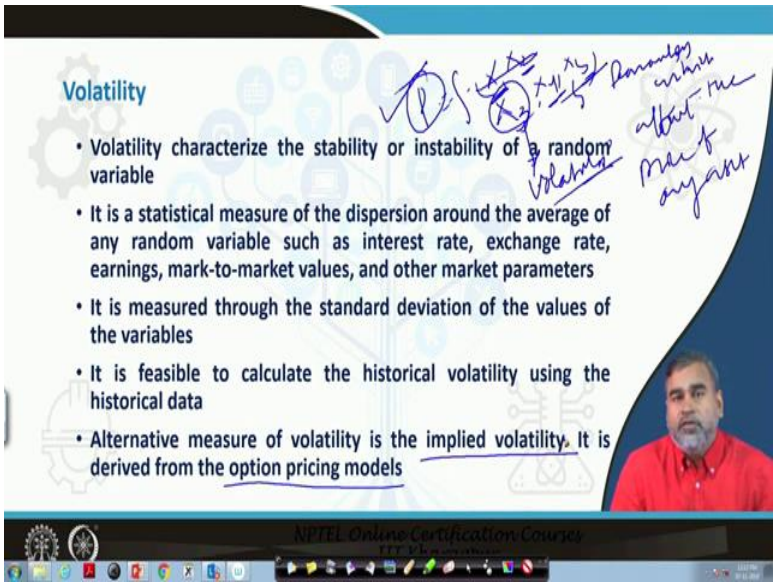

Volatility which is much more popular, so volatility basically characterized the stability or instability of a random variable. Whenever we talk about the volatility mostly, always we think of the concept like standard deviation or the variance. So, volatility is a statistical measure of the dispersion around the average of any random variable like your interest rate, exchange rate, earnings, market value and like other parameters, anything how basically, this particular variables are fluctuating over the time and fluctuating around this target variable. That basically gives you the idea that what kind of total risk we are facing in terms of the fluctuations of that particular asset.

So, it is measured through the standard deviation of the values of the variables. And generally in the market, we always observed there are two ways it is measured. One is we are measuring a historical volatility or historical standard deviation. And another way is basically we are measuring volatility, which is basically popularly called the implied volatility. So, it is basically derived from the different kind of pricing models mostly the option pricing models.

And what do you mean by the implied? So, here what is happening, we are measuring the volatility depending upon the actual price, but in certain cases what happens, let there are five parameters, which affect the price of any asset. So, if I know the price is a function of let X_1, X_2, X_3, X_4 and X_5. So, if I know X_1, I know X_2, I know X_4 I know X_5 and I have to find out the X_3 and I also know the P, the price of the asset.

So then in that particular point of time you assume that this X_3 is basically your volatility. For example, we are thinking here we have given the example of option price. You have many models like Black Swan model and other models where there are many factors which affect the price of the options, the many factors like volatility of the underlying asset, you have the time to maturity, you have the strike price, all kinds of concepts or all kind of data which are used to calculate the price of the options.

But if I know the price of the option and I know the other data like maturity period, like your strike price and price of the underlying asset and all, then one of the variable is I have written in a simplified way, but in the formula all these variables are used to calculate the price of options.

So, if I know all the variables and as well as the price of the option, then I can calculate the standard deviation of the volatility from that. And that particular point of time, we define it implied volatility, because it is implied upon that particular formula what we have used to calculate that. Instead of using the historical data for that actual variable, we are basically relying upon the other data which is basically always used for calculating the implied volatility in the market.

So that is why there are two types of volatility we always observed. One is your implied volatility and other one is the historical volatility, let us see that how those particular things work in the particular system.

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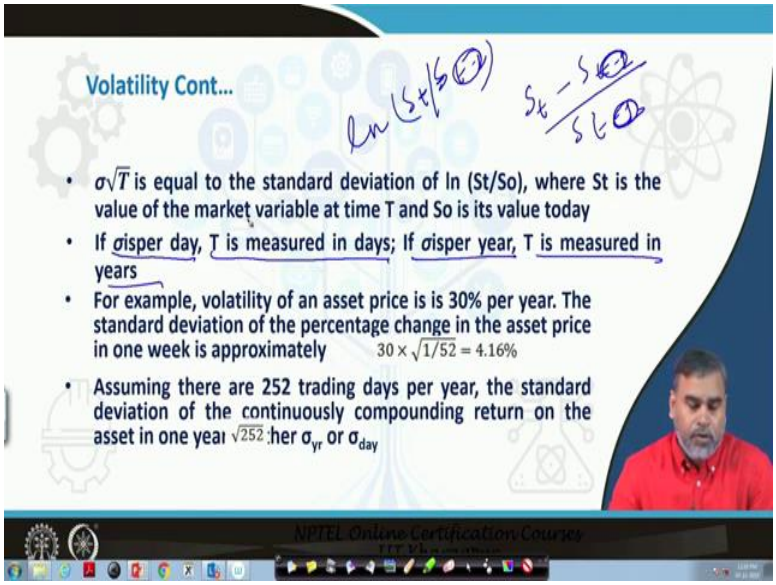

So, there are certain things you keep in the mind that whenever we are calculating the volatility, let you are calculating the volatility of the stock return. So, your stock return is nothing but by

$$ln\left(\frac{S_t}{S_0}\right)$$

So, St is the value of the market variable at the time and as you already know that there are two ways, the return can be calculated you can calculate in this way,

$$\frac{S_t - S_{t-1}}{S_{t-1}} or \frac{S_t - S_0}{S_0}$$

This also we can use for return, but you can calculate it is you length, St divided by St minus 1 or if you are talking about 0 here you can put 0 here. And here also you can put 0, St by S 0.

So, either of these two way you can calculate the return from the stock. So, for example, if you are calculating the stock return volatility or any assets return volatility which is also used by the banks, then how basically you calculate? It is $\sigma\sqrt{T}$ why basically you consider the route T, the route T is basically talks about at what frequency we are going to measure the volatility.

Whether you are measuring the volatility daily, you are measuring the volatility quarterly, you are measuring the volatility monthly etcetera. For example, if sigma is per day, you have the per day data available and T is measured in days, if sigma is per year, then time is also measured in years. What frequency of the data you are using? That you have to consider whenever you are calculating the variance or standard deviation of that particular variable.

For example, if you consider volatility of an asset price is 30 percent per year. And the standard deviation of the percentage change in the asset price in 1 week for example, per year the volatility is the 30 percent. If the per year the volatility is 30 percent then what is the per week volatility? The per week volatility will be $30 \times \sqrt{1/52}$, why? Because there are 52 weeks in a year and if you want to convert into the weekly volatility or weekly standard deviation, then obviously your yearly volatility will be $30 \times \sqrt{1/52}$ that will give you 4.16 percent.

So, if you are talking about the daily, assume that there are daily volatility, then in that case, you can consider that how basically whether you are considering the calendar year or you are considering the actual number of days, then accordingly also your volatility can be calculated from that and your T will be changed.

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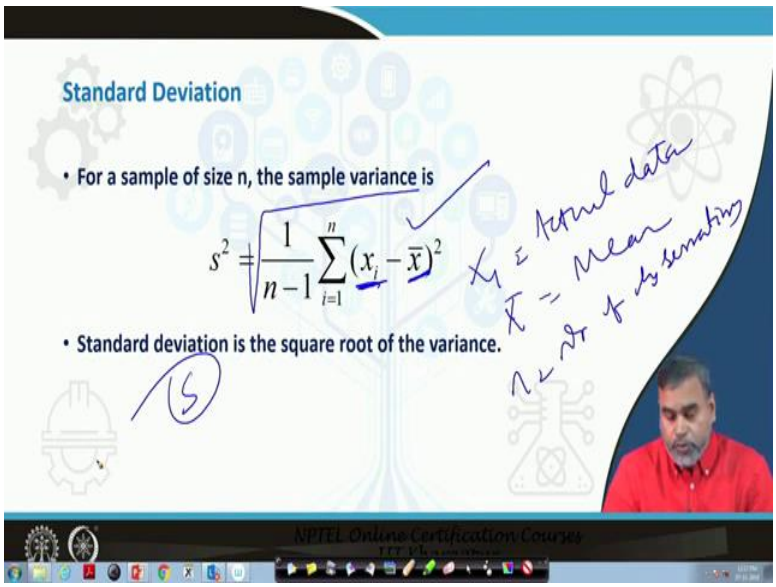

Then if you are going for a standard deviation calculation, simply how basically the standard deviation can be calculated? It is basically calculated from the variance and the square root of the variance of the standard deviation. If x is the data, individual data across the time, the next bar is equal to the mean.

So, X_i the actual variable actual data in a particular time and $\bar{X}$ is the mean, n is equal to the number of observations, then your variance will be

$$\frac{1}{n-1}\sum_{i=1}^{n}\left(X_i - \bar{X}\right)^2$$

And through this, you can calculate your variance and once the variance is calculated, you take the square root of that that will give you the standard deviation. So, this is the way the standard deviation is calculated.

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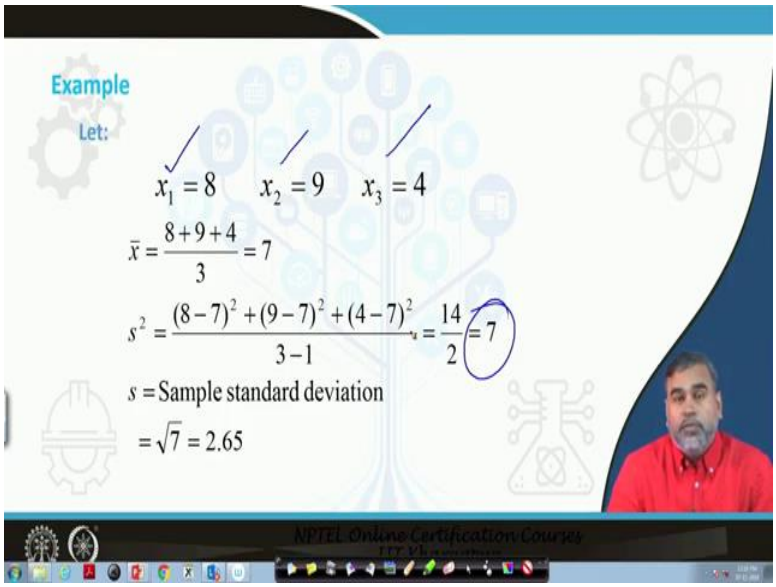

If you see a small example, you can get the idea that let X_1 is equal to a 8, X_2 equal to 9, X_3 is equal to 4, then your $\overline{X}$ is equal to 7, 8 +9+ 4, then your

$$S^2 = \frac{(8-7)^2 + (9-7)^2 + (4-7)^2}{3-1} = \frac{14}{2} = 7$$

In this case 1, 2, 3, your n is equal to 1, 2, 3, then 3 minus 1, then 14 by 2 that is 7, then your standard deviation will be $\sqrt{7}$, that is 2.65. So, this is the way basically the simple standard deviation can be calculated from the historical data.

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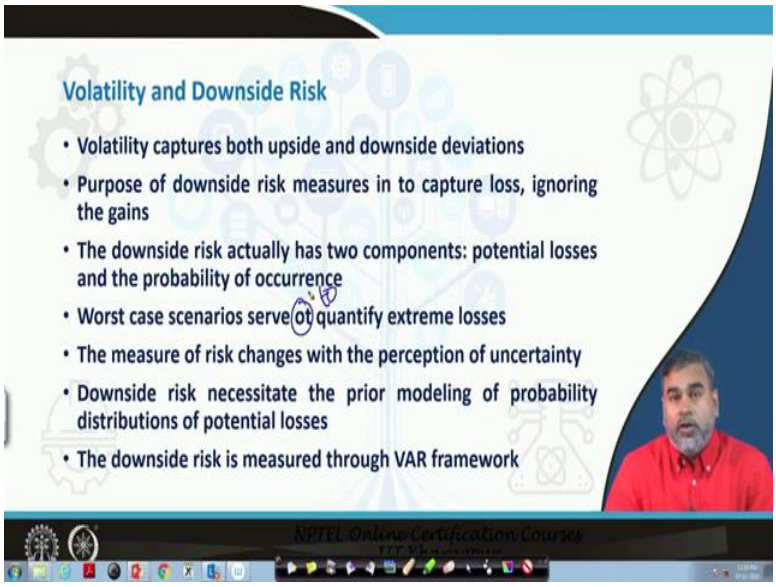

Then the other one is a downside risk, what if you see the volatility captures both upside and downside deviations. But whenever we use the downside risk measures, we basically try to capture the loss, we ignore the gains. And the downside risk has two components one is potential losses and the probability of occurrence, then the worst case scenarios or to you read it to quantify the extreme losses and the measure of risk changes with the perception of uncertainty.

And the downside risks basically necessitate the prior modeling of the probability distributions of the potential losses and the downside risk is measured through mostly by the VaR framework, which is quite popular.

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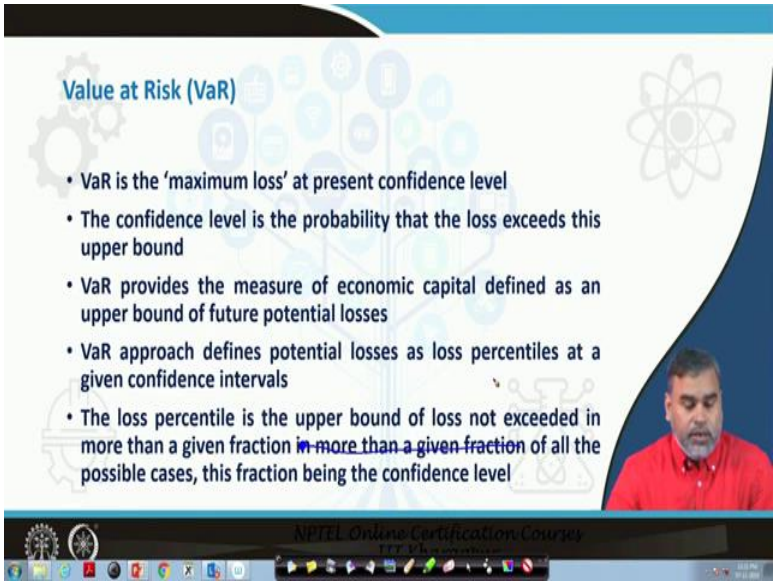

So, here, what do you mean by the value at risk? The value at risk is basically nothing but it is the maximum loss at a present confidence level. In the hypothesis testing, you might have idea about the confidence level and the significance level. And the confidence level is basically is the probability that the loss exceeds this upper bound generally. And the VaR provides the measure of economic capital which defined as an upper bound of the future potential losses.

And VaR approach basically defines the potential losses or loss percentiles at a given confidence intervals. The loss percentile is nothing but the upper bound of loss not exceeded or more than a given fraction in more than a given fraction of all possible cases, this fraction being the confidence level. The loss percentile basically is the upper bound of loss, not exceeded in more than a given fraction. You keep in the mind there is repetition of these words of all the possible cases and this fraction being the confidence level always we consider.

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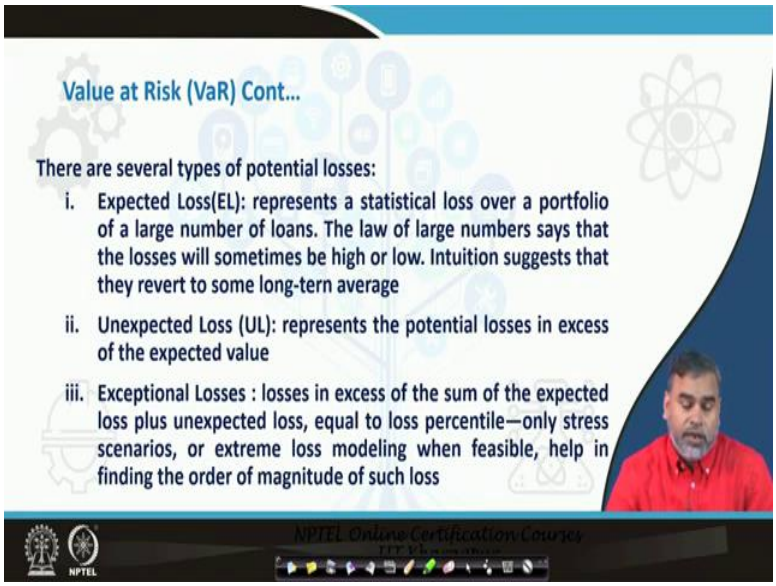

Then, if you are going to calculate this particular VaR using a particular example you can see it. But there are three types of losses always we observed, one is expected loss, one is unexpected loss, then we have an exceptional loss, which is not regular, but that may happen occasionally.

The expected losses is a statistical loss over a portfolio of large number of loans and the law of large numbers basically say that the losses will sometimes be high or low. And the intuition suggests that revert to some long run average. So, expected losses is nothing but the average losses whatever we have made for a long period of time that you can take it as a proxy.

And the unexpected losses is basically what? It represents the potential losses in excess of the expected value. And the exceptional losses are basically losses in excess of some of the expected loss on expected losses. Only the stress scenarios or extreme loss modeling when feasible help in finding the kind of losses if there is at all. So, to some extent, the expected losses can be measured, unexpected losses also to some extent can be predicted or the exceptional losses is basically not a regular loss what the system always face. And we can basically use certain kind of higher order modeling to find that.

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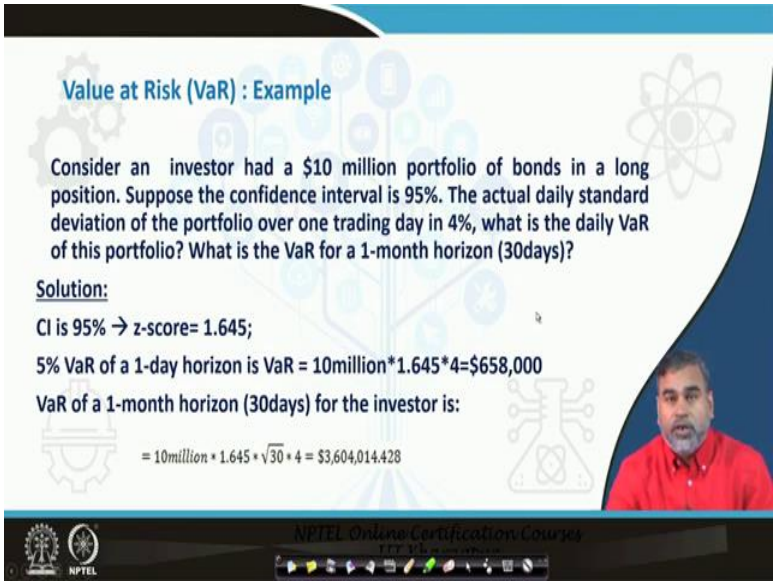

If you go for a value at risk calculation, if you see, consider one investor which are 10 million portfolio of the bonds in a long position, buying position, long position means the buying position. Suppose the confidence interval is 95 percent, then the actual daily standard deviation of the portfolio over the trading day is 4 percent, then what is the daily value at risk of this portfolio and what is the value at risk for one month horizon or the 30 days?

So, you know that the confidence interval is 95 percent, we consider the standard normal distribution, normal distribution where z-score is 1.645. There is the 5 percent bar of a one day horizon is nothing but the 10 million with the total portfolio value into 1.645 into 4, 4 is the standard deviation, then it is 658000. So, if you are talking about to 30 days, 1 month horizon, then obviously the same thing you can do, $4\times \sqrt{30}$ because it is for 1 day and this is for the 30 days, then your value becomes this.

So, this means, what is the interpretation of this value? The interpretation of this value 658000 means, the maximum loss the investor can make in a day using this data using this confidence

level during this time period, this particular investor can loss maximum or the worst loss the investor can have that is 6,58,000 dollar. So, that is what basically the VaR model tries to capture, that what is the maximum loss we can incur.

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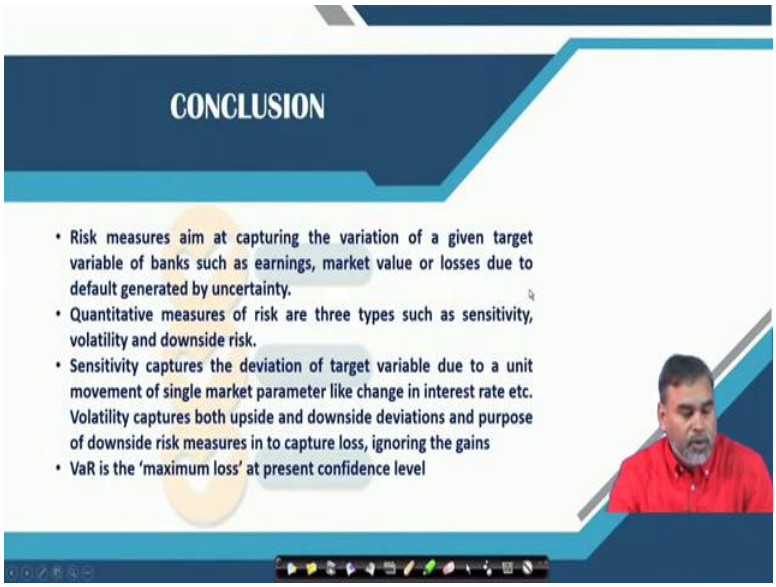

So, these are the conclusions what we have discussed today. The risk measures always aim at capturing the variation of a given target variable of the banks such as earnings, market value, equity and all these things. Quantitative measures of risk are three types like sensitivity, volatility and the downside risk. Sensitivity captures the deviation of the target variable due to the unit movement of single parameters like change in interest rate and all.

Volatility captures both upside and downside deviations. And the purpose of downside risk basically measures in to capture the losses, ignoring the gains. And VaR is the maximum loss at present confidence level. And it is the worst loss basically what we can say at a particular level the particular bank or the individual always can face in that particular time period with that particular confidence level and with that volatility. So, this is about the different measures which are used to measure the risk in the market.

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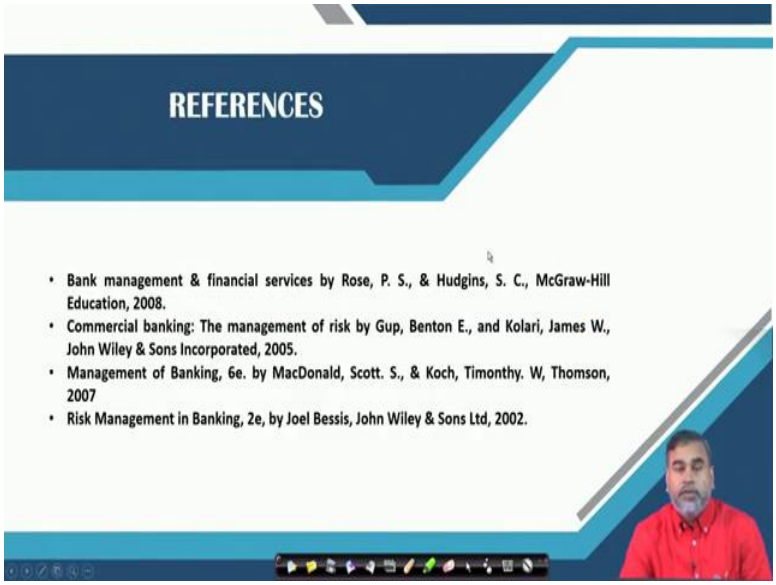

These are the references what you can go through for detailing of this. Thank you.