Quantitative Finance

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Module - 08

Lecture - 44

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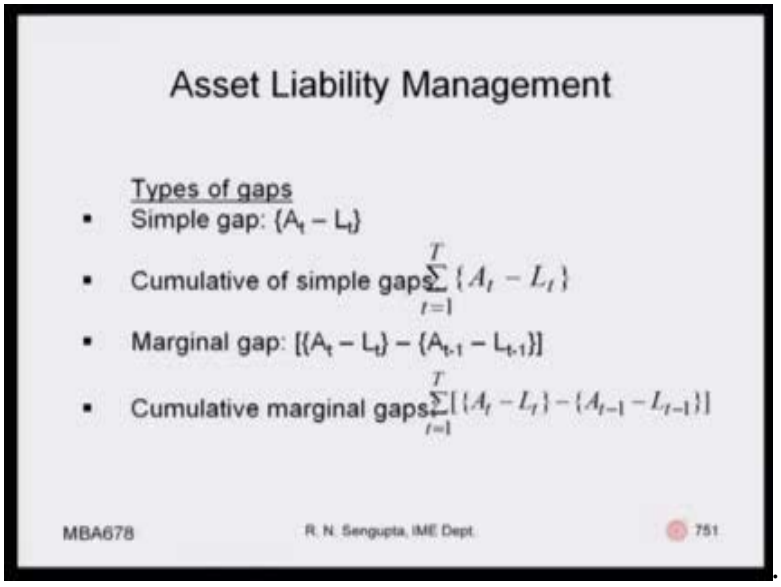

So, welcome to this quantitative finance almost the last fag end of few lectures. So, as we are discussing about the gaps. Gaps are basically either static or dynamic; static means that they are not dependent on time, dynamic they are dependent on time. So, if you see the graph which we discussed, the difference between the asset and liabilities would give you how the balancing of the inflow and outflow can be done. So, type of gaps are simple gaps cumulative of simple gap that you find on that overall gap and then you find out whether it is positive or negative and the marginal gaps are rate of change of the gap with respect to time.

So, you can also understand it is basically a cyclicity is there, if there is some if you remember we did even though that may not be related to ALM, we did the different type of trend analysis seasonality and all these things. So, if they can be brought into the picture, you can also find out all the gaps change with respect to time, and you can also find out the cumulative of the marginal gaps. Cumulative of the marginal gaps would be

someway give you the rate of change of the marginal rates. That would also give you some information of the d 2 y d x 2 which is the second derivative

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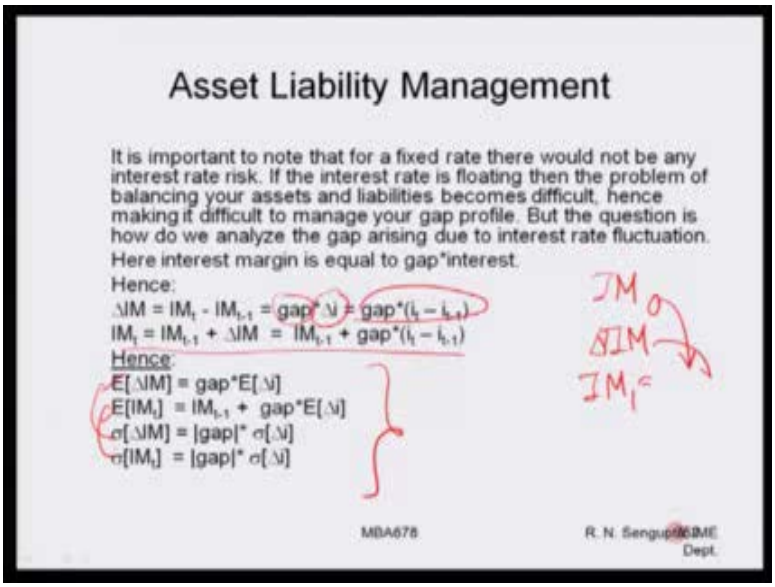

So, it is important to note that for a fixed rate there would be there not be any interest rate risk, the interest rate is floating then the problem of balancing asset with respect to interest rate risk this will comes into the picture. So, if I want to find out the marginal differences or if you want to find out the interest rate fluctuations, then obviously, it is given by the gap is given and the rate. So, the gap is given multiplied by the difference in the interest rates. So, that will give you the total interest margin based on which you have to basically face the problem or it may be a the asset also depending on the LM model we do. Now you can find out the rate of change on the of the interest rate margin that will give you how the interest rate is changing.

So, if you have say for example, IM 0 which is or the interest rate margin or difference at time, t is equal to 0, we can find the del del IM which is the rate of change and similarly you can find out del IM 1 which will be a summation of both these things. So, if we as we proceed we can find out the rates. Then if you want to find out say for example, from the expected value variance, because the expected value in variance will give you lot of information on how it is the work is done. So, that will also help you in trying to analyze the overall asset liability concepts based on expected value of rate of change of IM interest margin, expected value of the rate of the change of the IM at any particular point

of time, similarly you can find out the standard deviation for the first one and standard deviation of the second one.

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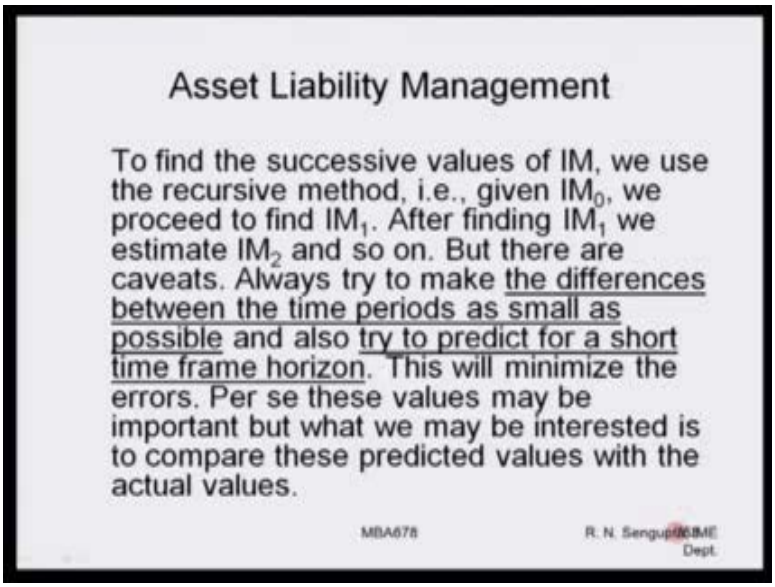

To find the successive values of interest margin, we use the recursive method; that means, we go 1 step forward or backward depending on what is the overall significance how many states depend. So, if interest rate is dependent on the 2 states backwards, so obviously, it will be dependent on 2 states process. So, we would not be going to details, but what I am trying to explain is that how they can be done. So, given IM 0 which we had discussed we proceed to find IM 1; that means, only the first information is needed; that means, if you have least IM 1 you will find out only set of information needed is IM 0, but say for example, if you reached IM 1; that means, you are trying to find out the interest rate margin and you think, that it is dependent on function of 2 states IM 0 and IM minus 1. So obviously, it will be 2 stage dependents.

But there are caveats warnings. Always try to make the difference between the time periods as small as possible, because if you remember again let us say the volatility or external noise is dependent on variance is dependent on time t or standard deviation is a function of square root of t, so that means, as you increase the time difference the volatility increases. So, try to predict for a small time frame horizon this will minimize the errors per say these values may important, but what we may be interested is to compare predicted values with the actual values

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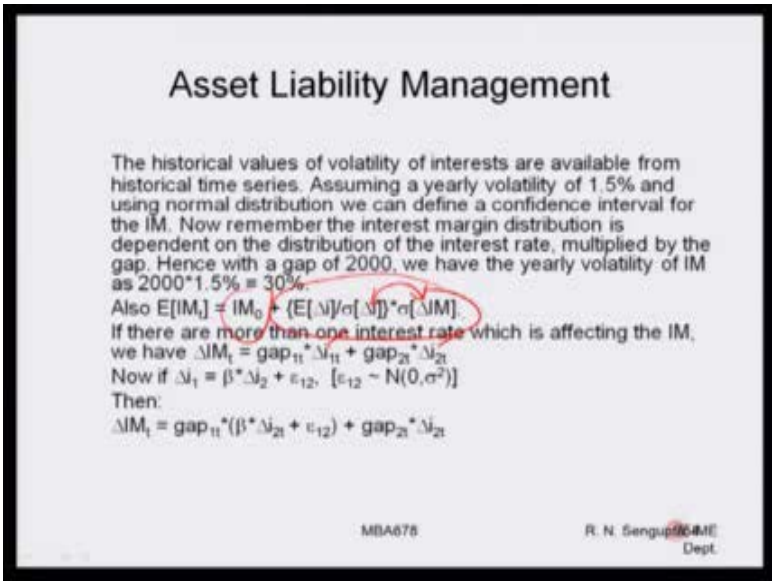

So, the historical values of volatility of interest rates are available from historical time series consuming a yearly volatility of 1.5 percentage based on whatever you have done using normal distribution, we can define a confidence interval for interest margin and also you can find out what is the probability of a company making being default or not being default.

Hence with a gap of 2000, we have the yearly volatility given by 2000 into 1.5 percentage whatever it calculates. So, you can find out the expected value, so the expected value would be given. So, what you are doing is that, you have IM 0 and here you have the ratios. So, the ratios are basically the expected value of the interest rate divided by the standard deviation, and then you basically multiply the ratio which is this. So, what you are interested is to find out what is the ratio of the interest rate margin with respect to the interest rate change. So, though both are differences that will give you a lot of good information, because interest rate margin is dependent on many functions, where its effect is being given on to the picture of interest margin. So, if you look at interest rate margin only it has many functions amongst to it interest rate is the most important factor. So, very technically very simple IM is equal to the rate of change of or delta of r into the gap. So, gap is fixed it only depends on interest rate, if gap is not fixed it is a function of dependence between 2 factors or more.

So, if there are more than one interest rate, you can basically find out by the simple summation, but the problem is this is a random variable this is a random variable, that is interest rate one is basically also dependent on interest rate 2 or vice versa. So, these are random variables means you have co variants. So, if you have the covariance's, then you need to find out what is the variance covariance metrics, but in general find on the variance covariance metrics for interest rate or such variables becomes difficult for us. So, what you need to do is that you basically have to express interest rate one or interest rate 2 in functional form of the other interest rates. So, if you have 3 interest rates you will try to basically express 2 of them as functions of the first, and then try to solve your problem accordingly rather than go basically going into the covariance variance metrics.

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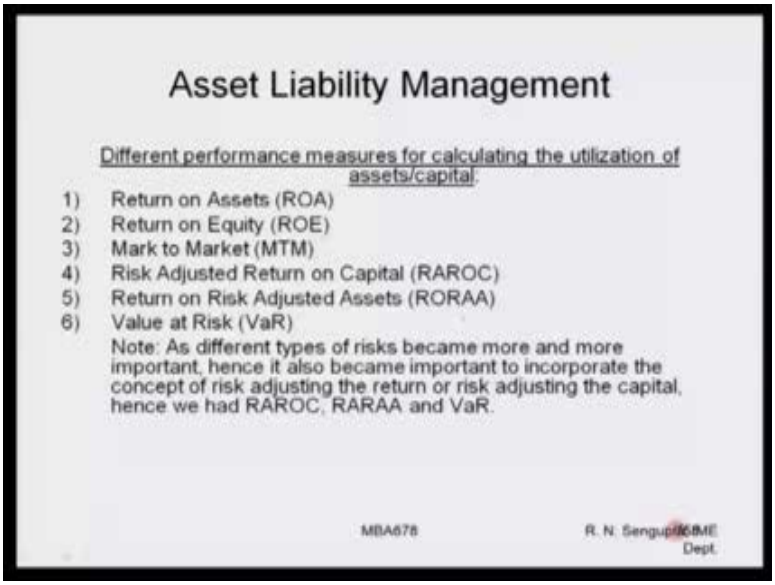

So, different performance measures used for calculating or utilizing the assets liabilities are return on assets, return of equity, market to mark, to market concept, mark to market concept is almost the same thing, which we have done for the options that the in the chapter of options, we have basically had a market and the market and the future and forwards will be sold and bought.

So, in order to basically reduce the overall risk we had a margin account. So, the margin accounts the values, which we are changing as the prices change the margin account values also changes. So, you have the initial margin mark to market concept was used, there also mark to market is exactly the same thing; that means, you change your overall

risk, and the input and output in that account is made in whatever account, you are considering whether it is a buyer or seller or person going in a long or short position that depends on how the price fluctuations are happening in the market, and how those price fluctuations are effecting the margin account how amount of money is being either input or taken out in order to basically make it exactly according to what is the state of fs as of now we also have this risk adjusted return capital. So, the return on the capital is also at also considered considering the different types of interest rate, and how they are adjusted accordingly you also have the concept of value at risk. So, we will leave space on the value at risk in a in 1 or 2 lectures coming soon.

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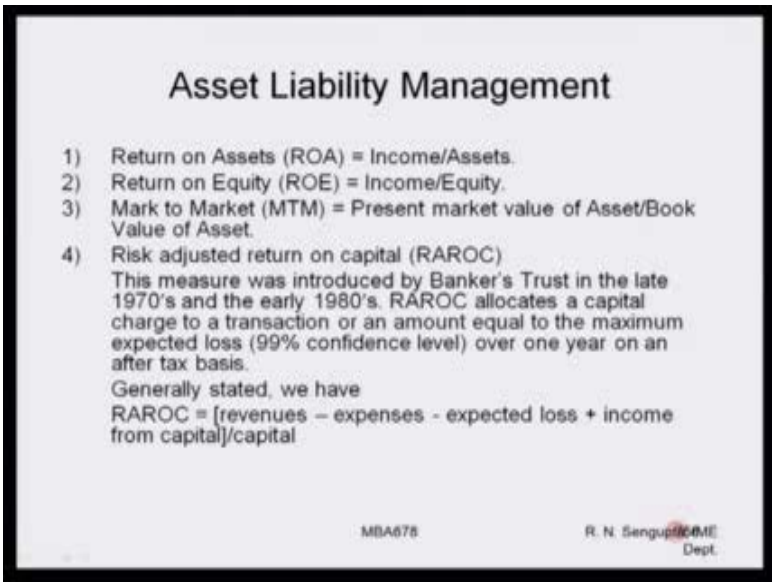

So, other important factors are returns of assets which is basically income to assets return to equity income to equity; these concepts are very heavily used in asset liability management. You have the mark to market concept the risk adjusted return to capital these measures are introduced by bankers trust in the late 1970's, and the early 1980's risk adjusted return O capital allocates a capital charge to a transaction or an amount equal to the maximum expected loss. So, now the concept of maximum loss, you can face which has some simplification with the war concept also we discussed.

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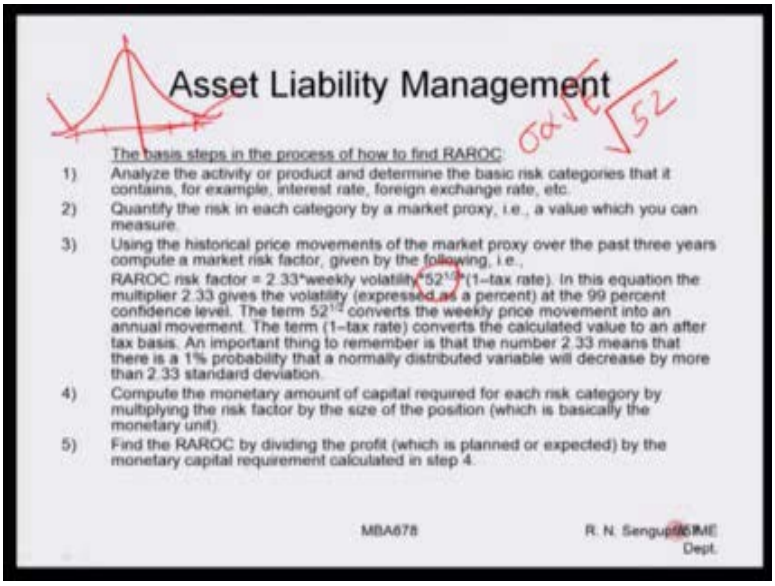

So, the basic steps in the process of how to find out the RAROC or analyze activity of product will determine the basic risk activities quantify the risk in each category by a market proxy, there is a value which you can measure. So, measure can be interested can be risk free interested can be said for example, currency can be dollar to yen can be dollar to rupees whatever it is it can be the price index. So, all these things can be considered where they give you the actual picture, how things are happening, it can be the share price also it can be the profit and loss accounts.

Say for example, the total amount or dividend which is being given. So, or what is the total concept of liability or what is the total amount of working capital or what is the total amount of… Say for example, long term loans. So, all these things can be taken considered on a individual or collective basis to find out how the asset liability overall structure is being done considering the RAROC concepts. So, his using historical price movements of the market proxy over the last 3 years compute a market risk factor given by the following example.

So, RAROC would be calculated this 2.33 weekly volatility and this 52 and a half means, because this is the number of weeks. So, 52 is the weeks. So, and if you remember volatility or standard deviation is proportional to square root of time, hence this square root of time is coming; that is 52 power half and this weekly factor and this 2.33 would technically mean that it would take you plus and minus, if you remember

standard the deviation and the concept of the normal distribution. So, you have the normal distribution is the mean.

So, if you move 1.67 on to the right and left or 1.9 or 2.3 on to the right, and left it will basically be covering 2 sigma or 4 sigma or 6 sigma of the overall spread. So, 2.33 is depending on the level of confidence you want to put, then obviously you multiply by the 1 minus the tax rate, because the tax amount has to be taken out of this total concept. So, if the tax rate is say for example, thirty percent that would be 1 minus tax rate would be 0.7. So, in this equation the multiplier 2.33 gives the volatility express the percentage at a 99 percent confidence level. So, that what our time in…

So, if you consider 99 percent. So, overall standard deviation movement in the normal distribution would be 3 sigma on to the right and 3 sigma on to the left. So obviously the total coverage would be 6 sigma an important thing to remember is the number 2.33 means that there is 1 percent probability; that means, 99 percent means on percent on to the left and to the right. So, if you consider a symmetric distribution and the normal distribution, then the overall area on to the right and left totally add up to 1 percent.

So, they are symmetric it will be equally distributed; that means, 0.5 percent on the right, 0.5 percent on the left. So, 2.33 means that this 1 percent probability that are normal distributed variable will decrease by more than 2.33 standard deviation come to it the monetary the capital required find the RAROC by dividing with the profit, which is planned or expected whatever it is and then you find it. So, if you repeat the steps and you can find out the rar using the concept of RAROC, you can find out the RAROC value, and then find out the rest just overall concept for the ALM model.

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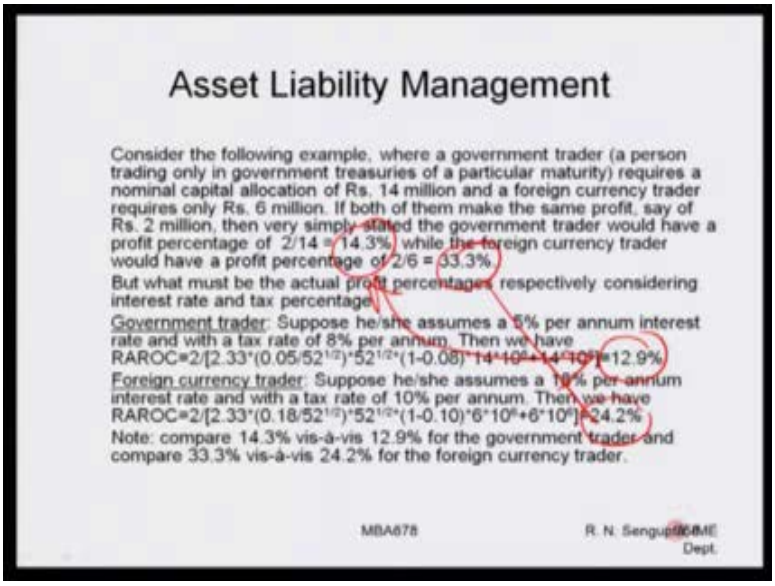

Consider the following example where a government trader a person trading only in government treasuries requires a nominal capital allocation of 14 million and foreign currency trader requires about 6 million. If both of them make the same profit say 2 million, then very simply can stated the government trader would have a profit percentage of 14.3, and the foreign currency of 33.3 percent, but what is the actual profit percentage, if we use the concept using the interest rate the actual risk adjusted concepts. So, the government trader suppose 5 percent per annum is the interest rate, and the tax rate is 5 percent, and while the foreign currency assume 18 percent per annum and the tax rate is 10 percent, then if you calculate you will find out it is 12.9 for the government 24.2 for the foreign.

So, note that if you will be comparing 14.3 with this respect to 12.9. So, the increase which is happening this 1, with this 1 decrease or increase, if you consider this one with this one there, you will find there is lot of difference even though the values would be different with respect of comparing the foreign trader with the government one, but still the increase and decrease is happening at a much more pronounced level considering that you are considering the risk adjusted concept considering the interest rate and the all the concepts of raroc.

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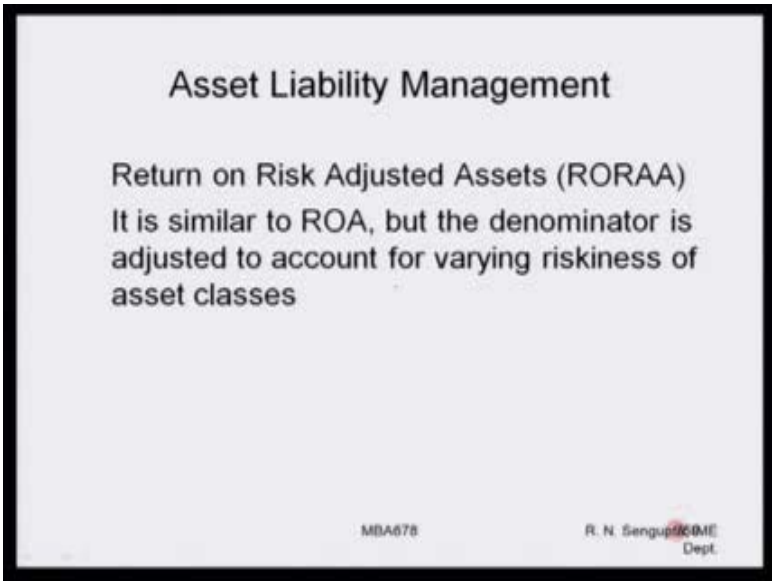

So, return on risk adjusted assets is similar to ROA, but denominator adjusted according to the varying riskiness of asset class, if they are asset class, which are very risky less risky, you will basically multiply by a factor accordingly.

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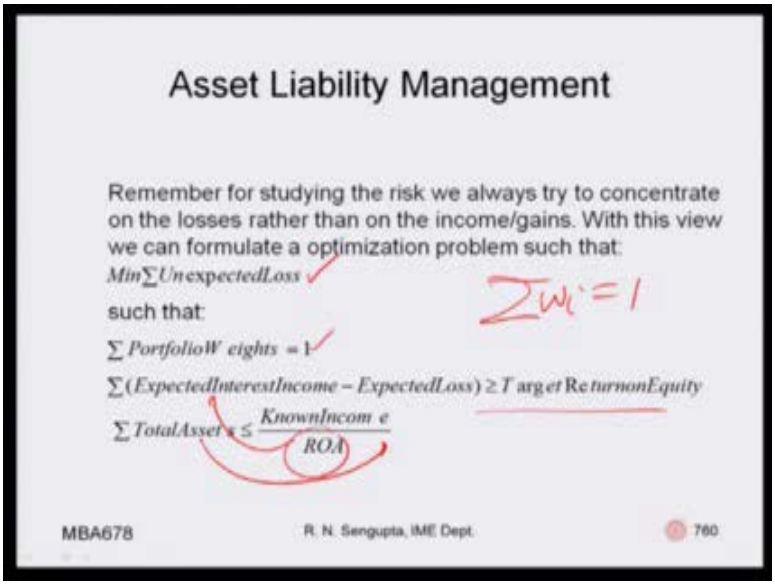

So, remember for studying the risk, you always try to concentrate on the losses rather than the gains. So, now concentrated for the LMA is that try to concentrate on the loss try to minimize that. So, what you actual concept of formulation would be very subjectively would be minimize sum of unexpected loss, such that the portfolio weights

equal to 1, this is the same thing. If you remember in the initial classes, we have done expected loss which is multiplied by the expected income, expected losses should be greater than the target it done. So, whatever that I have written is your difference in the incomes and outflows should basically be more, and total assets should be if you want to find out the ratios. So, if it is basically written on assets. So, if you take the return assets on this left hand side, and known income divided by the total assets that will give a ratio, such that it to on asset should be what is the projected 1, whatever you are putting you try to basically be it that make it more.

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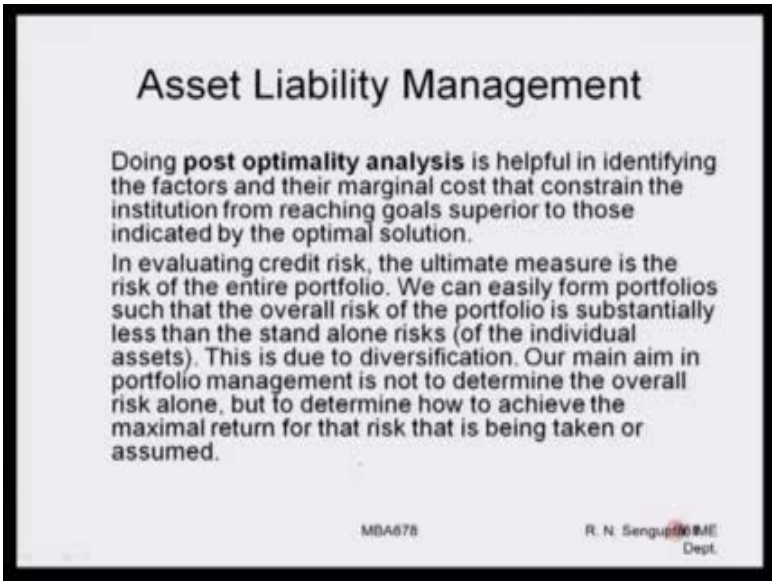

Doing post optimality analysis is helpful in identifying the factors, and their marginal cost that constrained the institution from reaching goals superior to those indicated by the optimal results. So, there are different types of these when evaluating the credit risk the ultimate measure is the risk of the entire portfolio. So, in order to do that you have to basically diversify in order to find out the minimum risk, our main aim is to port in portfolio management is not to determine the overall risk alone, but to determine the collectively what is the maximum return and what is the maximum risk level you are going to basically be able to withstand; obviously, the returns are good, but commensurate to that risk is also there. So, you always try to analyze what is the overall level of risk you will be able to sustain.

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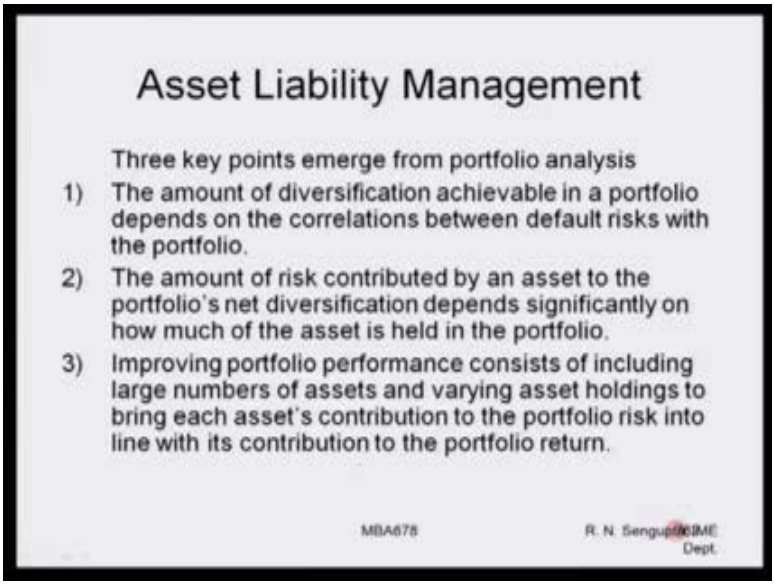

Three key points emerge from portfolio analysis from the ALM point of view; these are the amount of diversification achievable in a portfolio depends on the correlation between default risk. Now, if you remember I mentioned just 2 minutes back finding out the correlation coefficient between interest rate becomes difficult. So, if you find out different risk trying to find out the correlation coefficient covariance metrics between them becomes very difficult, because you do not have the data or you do not know the structural equation dependence between them the amount of risk contributed by an asset to the portfolios net diversification depends significantly on how much of the asset is held in the portfolio, which will also change dynamically.

And improving portfolio performance consists of including large number of assets, and varying asset holding bring each asset to the portfolio would basically mean you have to dynamically change. So, the first and the second and the third point are related. So, if they are dynamically changing 0.1 is are changing point 2 the covariance metrics also would change, because as you change the weights depending on what are the variables the variables are also dynamic dependent on time, if they also change the correlation coefficient also changes. So, rather than concentrating only on fixed value, you have to recalculate at each and every step in order to find out the covariance metrics or the correlation coefficient.

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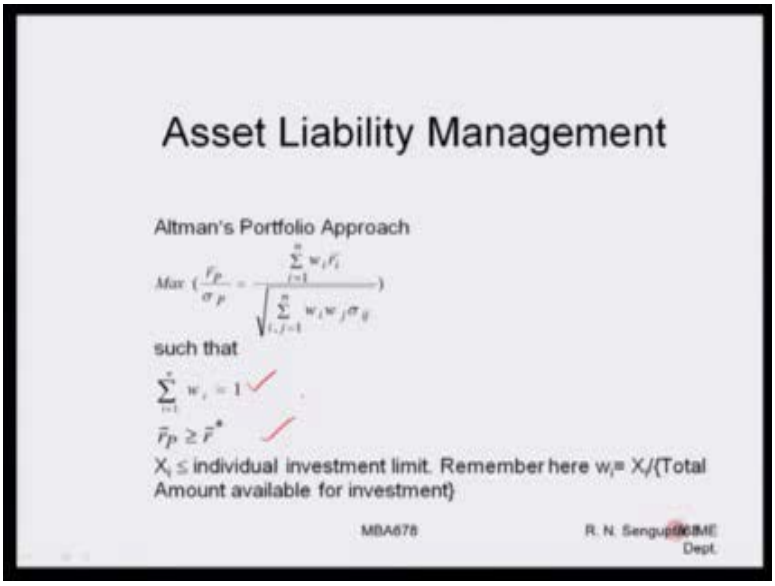

So, Altman if you remember Altman who had given that z score and all these things. So, Altman portfolio approach is simply the same thing, which you have done find out the ratio of the maximum of the return to the risk. So, what you are trying to do you are trying to find out the ratios of out output input, which is coming divided by the output and try to maximize and line them accordingly. So, again the same thing you want your with your weights step, you want and you want your total portfolio to be let it tends to be greater than some r star value.

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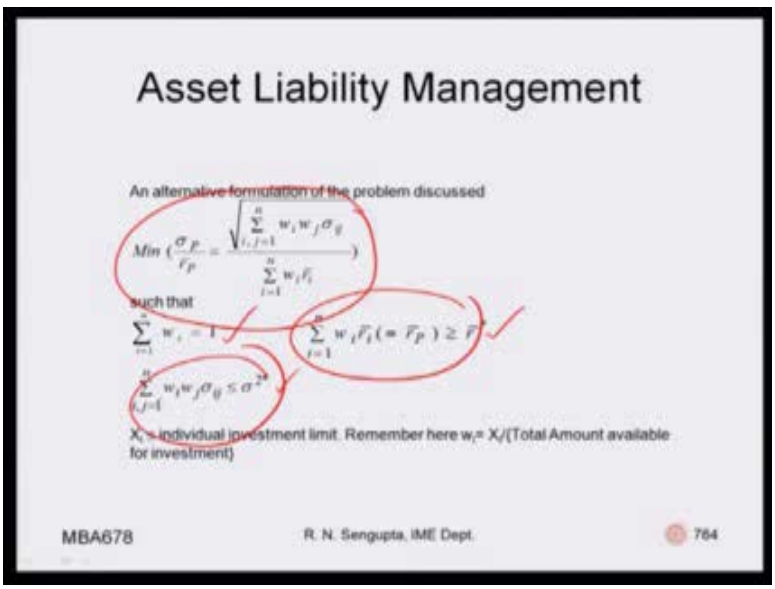

And again you can use the simple value that you can consider accordingly altively would be reverse objective function and objective function, you can basically now find out the minimization of the risk to the return. So, this one is just a ratio inverse ratio of the first one we had just discussed. So, this remains same, this is the same thing and this is being brought into the picture. So, in order to basically have 2 different constraints; one is respect to the return, one is respect to the risk.

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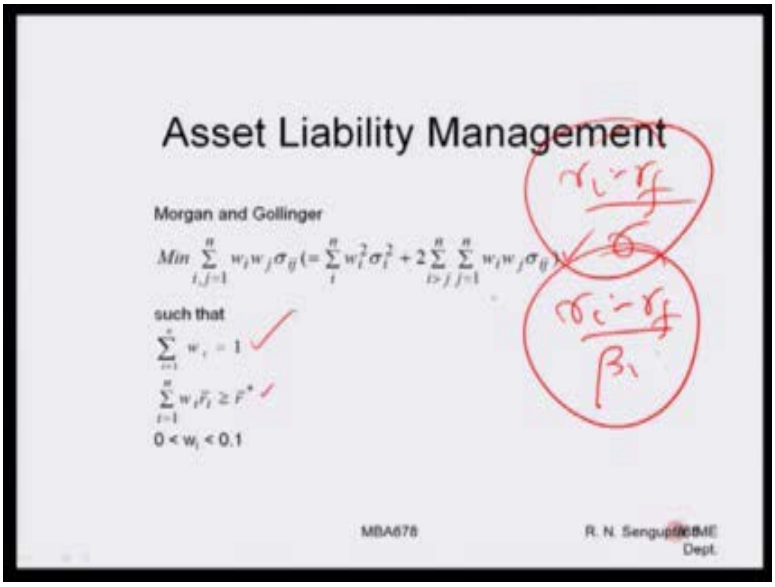

Another thing can be if you consider Morgan and Gollinger model there, you consider again it is basically concept of minimizing the risk only risk not the issues weights are 1, and the returns of the portfolio is greater than some r star. So, whatever you see this different tool different models of Altman or different Morgan and Gollinger; they are conceptual wise are exactly the same thing, which they have done. So, you have only 2 technically 2 metrices or metric; one is basically the return and one is the risk find out maximum returns solving your problem depending on different constraints or minimize your risk depend on different constraints or try to find out the ratios.

So, if it is returned to risk you ran them from maximum to minimum take the maximum, it is risk to return ran them from minimum to maximum take the minimum. So obviously, that conceptual framework is this, but then solving the techniques are all, and the ranking or whatever are done. And if you remember the ratios concept this one, you

have already done this one, you have already done. So, all these things are just a repetition trying to analyze the problem in the ALM concept.

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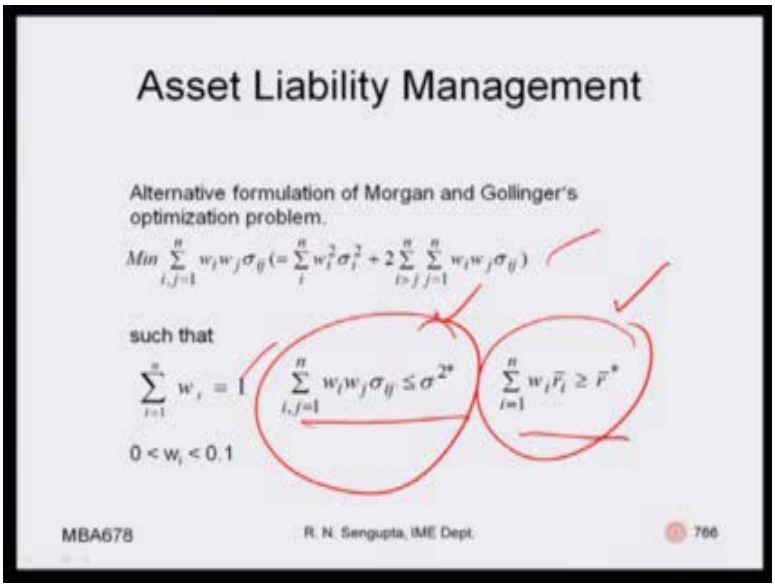

Alternative formulation would be same risk same thing constraints, but now it basically become 2 either you can consider this or you consider this or you can consider both of them together, but if you consider both of them together. Then obviously, the problem solution may be difficult, but it would give you much more compact results.

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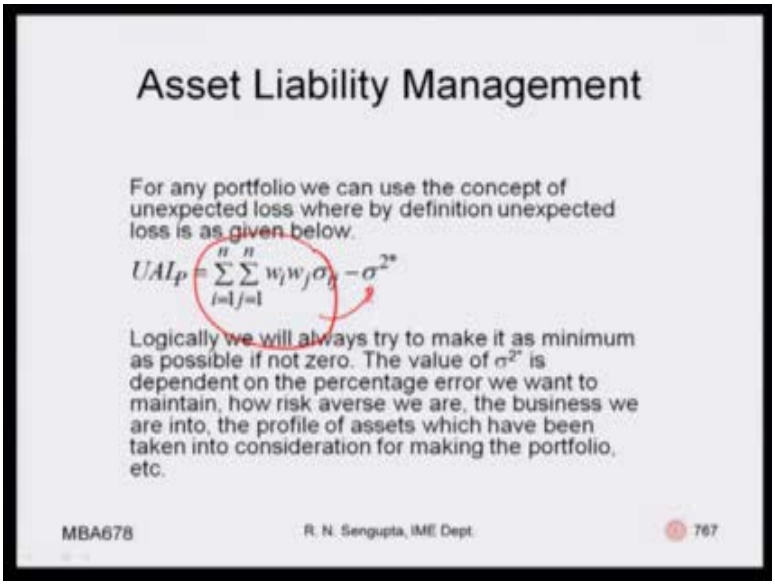

For any portfolio you can use the concept of unexpected loss. So, unexpected loss is basically the excess deviation about the standard deviation this value, which is the variance is greater than some star value of sigma square of the portfolio, which is we have already fixed, and your variance of the portfolio is coming out to be more than that in value terms. And obviously, that gap is the overall extra risk or unexpected loss, you have gone to fix logically, we will always try to make it as minimum as possible. If not 0 0 is best and if you basically are going on the other direction making the loss or the risk less than the stipulated value, it is very well and hence that is one tale, but your main concern. If you remember I said that we always try to analyze the risk perspective. So, you are always concentrating on excess risk and try to minimize it or make it 0.

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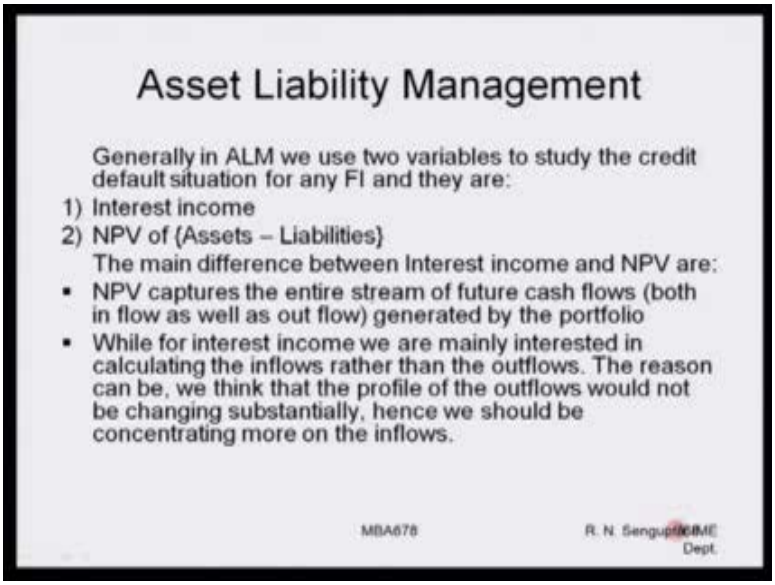

Generally in ALM you use 2 variables; one is interest income, one is net present values of asset minus liabilities which is the gap. So, you want to find out the net present value, the main difference between interest income and NPV, net present values is NPV captures the entire stream of future cash flows both positive, and negative while for interest income, we are mainly interested in calculating inflows rather than the outflows. So, we should always consider the fact of the inflows and outflows.

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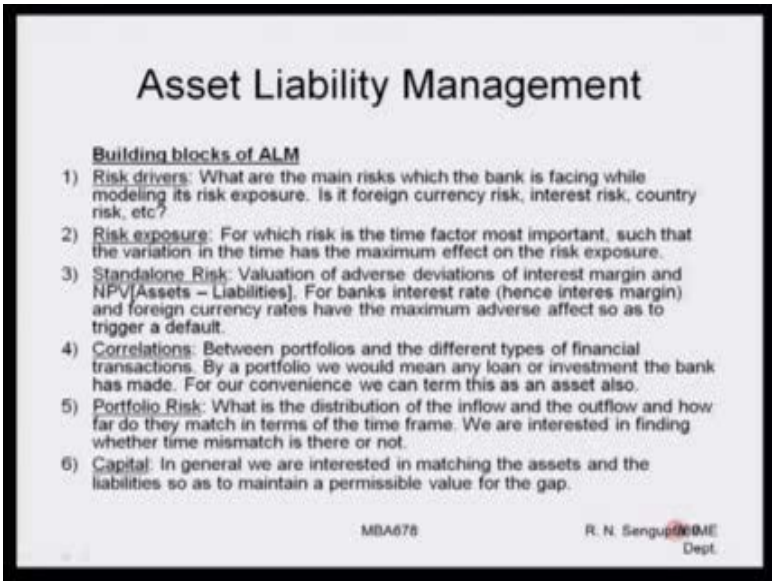

So, the building blocks are risk drivers, risk exposure, stand alone risk correlations portfolio risk and capital. So, I will continue discussing this and with this I will close today's class. In the next class I will again discuss this slide and go into the details. And then go into the concept of variance valued risk, conditional valued risk, and consider all these things later on.

Thank you.