

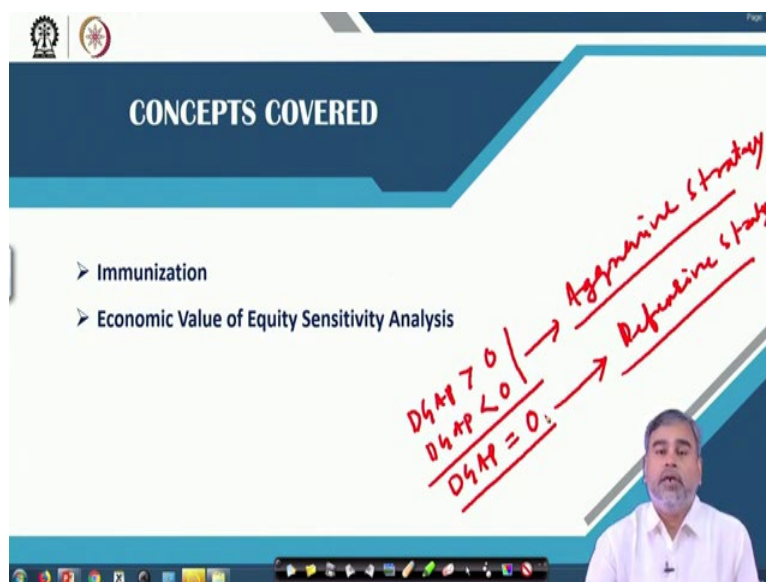
**Management of Commercial Banking**  
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**Lecture 25**  
**Duration Gap Analysis II**

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So, in the previous class we discussed about the duration gap analysis so what basically we have observed that on the basis of the gap particularly the duration gap the asset liability management of the particular Bank can be made in such a way by that the interest rate risk can be minimized or can be managed.

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So, today will be discussing two concepts what will be covering up today. One is your immunization and here the concept is what do you mean by the immunization and how the

commercial banks are able to immunize their portfolios from the interest rate risk in the market and as well as will also discuss about the sensitivity analysis of the economic value of equity in the different scenarios.

So, here for example whenever we talk about the immunization why that immunization concept is important. In this contest if you remember we have said that we have three things one is either your duration gap is greater than 0 or your duration gap is less than 0, positive or negative or your duration gap is equal to 0. But the question here is that these are two things which basically comes under the aggressive strategy.

But whenever you talk about duration gap is equal to 0 this is basically a part of the defensive strategy. Here what is the objective, the objective is if the particular company wanted to maximize their net worth then depending upon the situations, depending upon the interest rate movements and depending upon the duration gap existing with that particular company they can go for this aggressive strategy and they can make their duration gap or they can make their asset and liability management in such a way by that the maximization of the net worth can be possible.

But in many of the cases as you know that the interest rate prediction is relatively difficult and the forecasting of interest rate is one of the riskiest strategy in the market. So most of the banks can go to immunize that particular portfolio of that particular bank from the interest rate fluctuations in the market. So, if they want to immunize that particular portfolio then what is the basic objective, the basic objective is the duration gap they want to make it 0.

So, if your duration gap is equal to 0 then what we can say that any fluctuations in the interest rate in the market is not going to affect the value of the net worth of that particular bank. So, that is the basic objective of the immunization where we are trying to make the duration gap of that particular commercial bank equal to 0.

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**Immunization**

- Duration Gap (DGAP) should be zero ✓
- Bank should operate with average asset duration slightly below its average liability duration
- The value of equity remains constant as both the value of asset and liability change due to change in interest rate
- The target variable is the economic value of equity

*Handwritten notes:*  
 $TA = TL + Eqn$   
Assets: Loans, Investment, TA  
Liabilities: Deposits, CDs, Eqn

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So, let us see that the concept of duration how basically it works or the duration gap which was already I have explain to you that whenever you talk about immunization that means your objective is you are going to make your duration gap equal to 0.

So, if you want to make your duration gap equal to 0 then if you go back our previous example whatever we have discussed your assets and liabilities if you talk about. If your assets and liabilities structure if you talk about then your asset side you have the loans you have the investments and all this things.

And the liability side we have the deposits then you have the issuance of certificate of deposits and all these things then as well as you have the equity. So, your total assets should be equal to your total liability plus equity. So, that means if you compare between the total assets and total liabilities then the liabilities will be apart from equity, if you are talking about the other liability then that value will be less than the total equity.

So, because of that whenever we want to make this duration gap is equal to 0 then what basically we have to do we have to make the asset structure and liability structure in such a way that the average asset duration will be slightly lower than the average liability duration.

If the total assets duration is different from the total liability duration in general sense we can say that there is some kind of duration gap may be positive may be negative but in exact sense if you want to make it exactly equal to 0 because the total assets in total liabilities difference is in terms of equity then if you want to make it 0 that means your duration gap if

you want to make it 0 then your average duration assets should be little bit lower than the average liability duration.

That actually you have to keep in the mind and the value of equity remains constant why the value of equity remains constant because both the value of the assets and liability change due to the change in the interest rate. So, we are assuming your equity value remains constant and only we are changing the structure of the assets and liabilities or the value of the assets and liabilities.

And obviously whenever we are going for this kind of strategy the basic thing is or the basic objective of the bank is always to maximize the net worth or the economic value of the equity. So our target value variable is the net worth or the value of equity and obviously we want to make this asset liability management in such a way that your average asset duration will be little bit lower than the average liability duration. So, this is what basically the basic things what basically how to keep in the mind.

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Example

Assets	Market Value (Rs. Million)	Rate (%)	Duration	Liabilities and Equity	Market Value (Rs. Million)	Rate (%)	Duration
Cash ✓	100			1 year deposit ✓	620	5 ✓	1.00
3 Year loan ✓	700	12	2.69	3 year CDs ✓	300	7 ✓	2.81
6 year bond ✓	200	8	4.99	Total Liabilities	920		
Total	1000 ✓		2.88	Equity	80		
DGAP	2.88	$(920/1000) 1.59$	$-1.42$				1.59

Handwritten calculations on the slide:

- $620 \times 1 + 300 \times 2.81 = 920$
- $0.1 \times 0 + 0.7 \times 2.69 + 0.2 \times 4.99 = 2.88$

Let us see one example how basically it works. For example this is simple asset liability structure of a particular bank let in the asset side we have taken cash. We have taken a 3 years loan then a 6 years bond. So, the values are in terms of the million rupees that cash was hundred million rupees 3 years loan is 700 million rupees and 6 years bond is 200 million rupees and rate of interest for the 3 years loan what is the bank is asking that is 12 percent and for 6 years bond what the bank is basically getting that is 8 percent.

And we have already the idea about the duration of these two assets because all of you know the duration of cash asset is equal to 0 and there is no duration as such for the cash because there is no such maturity value for this and the 3 years loan we have assume that the duration is 2.69 because already you know that the duration is always less than the maturity period and for 6 years bond let the duration is 4.99.

So, these are the duration which has been given and already you know that how you can calculate the portfolio duration let the portfolio duration here in this case is 1000 that means your  $0.1 \times 0 + 0.7 \times 2.69 + 0.2 \times 4.99$  if you calculate let you got the duration of the total portfolio of total assets will be 2.88.

So, then what basically you can see in the same case if you go to the liability side then let we have only two assets whatever or two instrument whatever we have consider as the liability. One is your deposit, second one is the certificate of deposits. Let the deposits maturity period is 1 year and the rate of interest is 5 percent and duration is 1.

And for 3 year certificate of deposits we have seen that there are 300 million rupees certificate of deposits worth interest rate is 7 percent and duration is 2.81 and you can now calculate your duration of the total liability if you say that already you know that it is nothing but  $620/920 \times \text{duration } 1$  +then we have the  $300/920 \times 2.81$ .

So, if you calculate your duration of liability has become 1.59 and obviously you have to match both assets and liabilities your asset value was 1000 now your commanding this 1 year deposit and 3 years CDs it is 920 then you have the equity value that is 80 then we have the 1000. So, if you are trying to calculate the duration gap this is nothing but the duration of the assets multiplied by the weightage into duration of the liability so here 920 is the total liability and 1000 the total assets duration of the asset is 2.88 and duration of the liabilities 1.59.

So, if effectively you duration is coming 1.42 now there is a gap the duration gap is 1.42 because this is 2.88 it is 1.59. But now what basically we want our objective is? Our objective is to make this particular value 0. So, if you want to make this 0 then obviously this particular value should be more than this value by that if you multiply this one here then it will be equal to this and this is basically a fraction. If this is a fraction then this fraction multiplied by this value will be equal to this value then this particular duration gap will be equal to 0.

So, in this context what basically here we are trying to do let us now distribute or maybe rearrange these assets and liabilities of this particular bank or we can manage the asset and liability in such a way by that duration gap can be 0.

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Example Cont...

Assets	Market Value (Rs. Million)	Rate (%)	Duration	Liabilities and Equity	Market Value (Rs. Million)	Rate (%)	Duration
Cash	100			1 year deposit	340	5	1.00
3 Year loan	700	12	2.69	3 year CDs	300	7	2.81
6 year bond	200	8	4.99	Zero coupon CD	280	8	6.00
				Total Liabilities	920		
				Equity	80		
Total	1000		2.88		1000		3.11

$DGAP = 2.88 - 0.92(3.11) = 0$

So, now what basically have done here we have kept your asset sides as it is that your cash is 100 million dollar and 3 years loan is 700, 6 years bond is 200 and all these things remain same whatever thing we have we have kept here but whenever you come to the liability side what we have done we have basically reduce the 1 year deposits.

Then 1 year deposits from 620 we have made it 340 and we have added another liability let 0 coupon certificate of deposits where there is no cash flow involved in between. So, there we have embedded let 280. So, now if you go for now calculating the duration of assets duration of liability the duration of assets remain same because we have not changed anything with respect to the composition of the asset what the commercial bank has. But whenever you come to the duration of liability we have made this duration of liability 3.11 which was 1.59 before.

So, now what has happened if you calculate your duration gap now than 2.88 into 0.92 that means  $920/1000$  that is  $0.92 \times 3.11$  which is exactly equal to 0 that means here what we have done we have made some changes in the liability side of the commercial bank.

So, those whenever we have rearrange or restructure this liability side then duration gap become 0 in this structure the interest rate fluctuations in the market is not going to affect the net worth of that particular commercial bank. So, that is this process is basically called in

general sense what we call it that is the immunization where the value of that particular company always intact and we do not have to bother about the fluctuations in the interest rate.

(Refer Slide Time: 13:55)

Immunization Cont...

- Banks may choose other target variable like book value of interest income
- Duration of bank's equity equal to length of time horizon that the bank wishes to use in hedging net interest income
- Duration of equity:  $(MV \text{ of assets} * \text{Duration of assets} - MV \text{ of liabilities} * \text{duration of liabilities}) / \text{Economic value of equity}$

*MV = Market value*

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So, now otherwise there are some cases the bank instead of choosing the net worth bank can also target another some other kind of indicators within the system let they can target the book value of interest income instead of targeting the net worth they can also target the book value of interest income. So, if they want immunize this particular value of the book value of interest income with respect the fluctuations in the interest rate.

They want to immunize it with respect to the interest rate risk in the market then what is the condition they have to adopt the condition is that the duration of banks equity should be equal to the length of the time horizon that the bank wishes to use in hedging the net interest income, at what period the particular bank is willing or wishing to use this hedging from the net interest the length of the time horizon that has to be kept in the mind and the duration of the banks equity.

So, whenever you talk about the duration of banks equity that can be calculated in this way it is the market value of the assets MV means the market value. MV is equal to the market value. So, you have consider the (market value of the assets  $\times$  the duration of the assets -the market value of liabilities  $\times$ the duration of liabilities) /the economic value of equity.

So, if you are using this formula then the duration of equity of that particular bank can be calculated or can be measured. So, what we are trying to do that the duration of equity should

be equal to the length of the time horizon what the bank basically willing to use in hedging the net interest income in that particular point of time that actually we have to keep in the mind.

(Refer Slide Time: 16:07)

**Immunization Cont...**

For a 1 year time horizon the duration gap will be:  
 $DGAP^* = MVRSA (1-DRSA) - MVRSL (1-DRSL)$

Where,  
MVRSA = Cumulative market value of rate sensitive assets  
MVRSL = Cumulative market value of rate sensitive liabilities

DRSA = Composite duration of RSAs for given time horizon ; equal to the sum of the products of each asset's duration with the relative share of its total market value of assets  
DRSL = Composite duration of RSLs for given time horizon ; equal to the sum of the products of each liability's duration with the relative share of its total market value of liabilities

The slide also features a video inset of a man in a white shirt, the NPTEL logo, and a navigation bar at the bottom.

So, now for example if you see that the bank basically for a 1 year time horizon if you want to calculate the duration gap your duration let we are representing as a duration gap star. The duration gap star is equal to your market value of the cumulative market value of rate sensitive assets into 1 minus the composite duration of rate sensitive asset at a given time horizon which is nothing but the sum of the products of the each asset duration with the relative share of the total market value of the asset that already know.

That is nothing but the portfolio duration minus the market value of the rate sensitive liabilities into 1 minus the DRSL that means the composite duration of RSL for a given time horizon which is nothing but the sum of the product of each liability duration with the relative share of their total market fund of the liabilities.

So, this is the way you can calculate the duration gap whenever your target variable or you are going to basically talk about the 1 year time horizon what is the duration gap of that particular bank and your objective is basically not to maximize the net worth our objective is to basically hedge the risk with interest rate risk with respect to net interest income of that particular bank.

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Gap Analysis Cont...

- If  $DGAP^* > 0$ , bank's NII will decrease when interest rates decrease and increase when interest rate increase
- If  $DGAP^* < 0$ ; the relationship is reversed
- If  $DGAP^* = 0$ , then interest rate risk eliminated

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So, what basically we have seen that if your duration gap star is greater than 0 then your NII will decrease when the interest rate decrease and it will increase when interest rate will increase the same logic whatever we have adapted for the dollar gap, here also the duration gap is also interpreted in same way whenever our target variable is net interest income.

If duration gap is less than 0 the relationship is reversed and obviously the duration gap star is equal to 0 then the interest rate risk is eliminated which is completely eliminated which basically we define in our talk that this is what do we call it that is the process of immunization.

So, this is what basically with respect to the duration gap analysis that how basically we can make our asset liability management in such a way by that we can make your duration gap equal to 0 if the duration gap will be equal to 0 then automatic any fluctuations in the interest rate in the market is not going to affect the value of the net worth or value of the net interest income of that particular company. That means you are completely hedging our interest rate risk and why that those kind of outcome variables are not going to be changed.

(Refer Slide Time: 18:52)

**Sensitivity Analysis of Economic Value of Equity**

- Extends the static DGAP analysis
- Conducting what if analysis of all the factors that affect EVE across a wide range of interest rate environments
- It is often known as net portfolio value (NPV) or market value of equity (MVE) analysis
- How volatile EVE might be compared with some base case or most likely scenario
- Consider seven rate environments beginning with the base case
- Consider the embedded options
- Greater the potential volatility, greater is risk

Handwritten diagram showing a sequence of interest rate changes: +1, +2, +3, -1, -2, -3, 0.

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But you remember those kind of things are basically static in nature are mostly we are discussing about the constant changes or a particular level of interest rate changes. But you can observe that there are many scenarios the interest rate can fluctuate in either of the ways the interest rate can increase the interest rate can decrease.

So, in that particular context like your dollar gap analysis we can also go for a sensitive analysis, sensitivity analysis for the duration gap to examine that in the different economic scenario or different interest rate scenario how the value of equity get disturbed whenever you are interest rate changes that basically the objective.

So, the static duration gap analysis can be extended by using a sensitivity analysis for this. So, in that context what you do if you remember there also we are doing the same thing that we go for what if analysis. That means if interest rate will increase or interest rate will decline then how the economic value of equity will be sensed in the different scenarios on the basis of the duration gap what the company has weather the bank has a negative duration gap or the positive duration gap does not matter.

But depending upon the duration gap the sensitivity analysis has to be carried out to examine that in the different economic scenario or different interest rate scenario how the net worth of the economic value of the company is going to be changed. So, therefore it is nothing but conducting what if analysis of all the factors that affect the economic value of equity across a wide range of interest rate environment.

It is also sometimes people call it that net portfolio value or the market value of equity analysis this kind of sensitivity analysis is popularly known as in net portfolio value or market value of equity analysis and here what basically you are trying to do we basically see that how the economic value of equity is fluctuating or volatile with respect to a best case or a base case which is a most likely scenario.

What is that most likely scenario that we have to identify in the most likely scenario if you can identify then depending upon the change in interest rate in either sides we have to check that how this net economic value of equity is going to be changed. If the net economic value of equity is going to be changed then automatically what you can say that what kind of way basically we can make the strategy or we have to adopt the strategy in such a way by that the interest rate risk in the market can be completely hedged out or can be completely minimized.

So, you remember that in the previous case also we have the 7 interest rate environments so we have taken plus 1 then plus 2 and plus 3 then we have the 0 then minus 1 minus 2 and minus 3.

So, these are the 7 scenarios what basically we consider. So, if interest rate will increased by 1 percent decrease by 2 percent, decrease by 3 percent or it can increased by 1 percent, increased by 2 percent, increased by 3 percent and we compare it with respect to the beginning value that is the 0<sup>th</sup> period what basically we can say so in that context we can predict that under different scenarios different circumstances how that particular economic value is going to be affected whenever the interest rate is changing.

But again as usual you have to remember that we have to consider certain embedded options like early mature of the loans early withdrawal of the deposits then maybe some kind of asset which has the call features such as port features and all this things. So, all kinds of considerations all kind of characteristics what basically is happening with respect to that also has to be considered whenever we are talking about the sensitivity analysis for a particular sensitivity analysis of the value of equity in the different interest rate scenario.

So, here if you observe that if the variability is more with respect to change a particular level of interest rate. If the variability of the net value of equity is economic value of equity and is changing it is more volatile that means we can say that particular bank is exposed to more risk in that particular point of time. So, lesser the volatility lesser will be the risk and greater

the volatility greater will be the risk that means the fluctuations with respect to base year should not be very high whenever there is a change in interest rate in the market.

So, if the fluctuation are high that means with respect to the rate sensitivity of the assets and net sensitivity of the liabilities we have to restructure this balance sheet in such a way by that the sensitivity can go can come down and the exposure towards the risk with respect to the market value of equity that also can be changed or can be modified.

So, that is what basically the sensitivity analysis of the economic value of equity talks about that means you have to build the different scenarios and in the different scenarios you have to see that how the net worth of the company is going to be changed whenever the interest rate in the market also changes.

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The slide is titled "Strengths of DGAP and EVE Sensitivity Analysis". It features a list of five bullet points: "Recognize the time value of cash flows", "Avoid the problem of choosing the appropriate time buckets", "Duration measures are additive in nature, so individual matching is unwarranted", "Provide greater flexibility for adjustment of assets and liabilities", and "Shareholder interest is taken care". The slide includes decorative icons of a gear, a tree, a lightbulb, and a molecular structure. A video inset in the bottom right corner shows a man in a white shirt speaking. The NPTEL logo is visible in the bottom left corner.

So, then we have some other issues like whenever we are using this duration gap or the economic value of equity sensitivity analysis it has certain strength and it has certain weakness also. There are certain strengths what always we observed whenever we go for this analysis and sometimes also will observe that there are certain kind of limitations what we cannot get rid of whenever we are using this duration gap or economic value of sensitivity analysis to reduce the interest rate risk in the market or to manage the interest rate risk in the market.

So, first of all if you talk about the importance whenever you go for a dollar gap analysis. Dollar gap analysis never considers the time value of the cash flows. So, here whenever we

are going for a duration gap analysis the time value consideration is always considered always taken into account.

So, if the time values are considered in that particular context then it can give you a better measure in comparison to the dollar gap analysis and if you remember again for the dollar gap analysis also the dollar gap always calculated on the basis of a particular maturity buckets.

So, choosing the maturity bucket was difficult because there is huge gap in terms of the maturity bucket with respect to the assets and liabilities with what we called the temporal gap always we observe in the commercial banking system.

So, because of that sometimes we face the problem that what is adequate maturity should be considered to construct that particular bucket or how basically we can make a balance between the assets and liabilities with the different maturities but duration analysis basically is free from that so it avoid the problem of choosing the appropriate time buckets while calculating the interest rate sensitivity towards the assets and liabilities.

They are additive in nature so individual matching is unwarranted and not required individual matching in the sense what we mean that, individual item wise assets and liability matching is not considered, it is not required to be considered.

So, in aggregate we have to find out what is the duration of assets and duration of the liabilities accordingly we can decide that whether this particular company has a positive or negative gap. So, depending upon the interest rate scenario we can predict that how this particular interest rate is going to affect the value of this particular company.

It also provide a greater flexibility for adjustment of assets and liabilities because it does not affect the whenever individual we are matching so then it creates the problem but whenever in aggregate we are matching it then there is lot of chance in terms of inclusion and exclusion of the assets in the balance sheet to manage your interest rate risk to make your duration gap is equal to 0 if you are really going to immunize that particular interest rate risk in the market.

Then another most important thing is the dollar gap analysis mostly concentrated on the value of the net interest margin but whenever we talk about the duration gap analysis it mostly considers the net worth or the shareholders interest is taken into consideration and as you

know that the shareholders value maximization is one of the soul objective of the banks or any other organization, so that particular thing also is taken care whenever the duration gap analysis is considered.

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The slide is titled "Weaknesses of DGAP and EVE Sensitivity Analysis". It features a list of four bullet points: "• Difficult to measure duration accurately", "• Incorrect measure of discount rate", "• Requirement of constant rebalancing", and "• Difficult to measure duration for assets that do not earn or pay interest". The slide has a blue and white color scheme with decorative icons of gears, a tree, and a molecular structure. A video inset in the bottom right corner shows a man in a white shirt speaking. The NPTEL logo is visible in the bottom left corner.

There are many weakness also if you talk about the weakness of the duration gap it is difficult to measure duration accurately because of the complexity or dynamics of the maturity period of the different assets and liabilities.

Incorrect measure of discount rate sometime whenever you go for calculating the duration we are using a discount rate but that at particular discount rate may not be appropriate discount rate we should be used for calculation of that price of this particular asset which can be used to calculate the duration of that particular asset so the incorrect measure of discount rate is another issue.

Then requirement of constant rebalancing so that means whenever you are calculating the durations very periodical bases duration has to be calculated and accordingly the assets and liabilities structure has to be changed. So, because it depends upon the interest rate in the market because ones interest rate changes then the value of all those kind of assets will change or value of liability will be changed accordingly your duration will also be changed.

So, in that particular context we have to keep in the mind that the constant monitoring constantly balancing is happening with respect to those assets and liabilities what the commercial banks have. And another thing is difficult to measure for durations for assets that do not earn or pay any interest.

There are certain kind of assets what the banks have for those assets we cannot measure the duration because those assets basically neither they earn any kind of interest or nor they pay any kind of interest for any kind of operations within that particular system. So, for that only this interest rate is not available for that and there is no such interest rate exist for that then the valuation of that particular share relatively difficult. So, ones that particular valuation is difficult than the calculation of duration also for those kind of assets is difficult.

So, these are some of the limitations but in a true sense if you observe the duration gap and dollar gap has their own significance in the commercial banking sector and commercial banking management where the most widely used methods to minimize this interest rate risk in the market.

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**CONCLUSION**

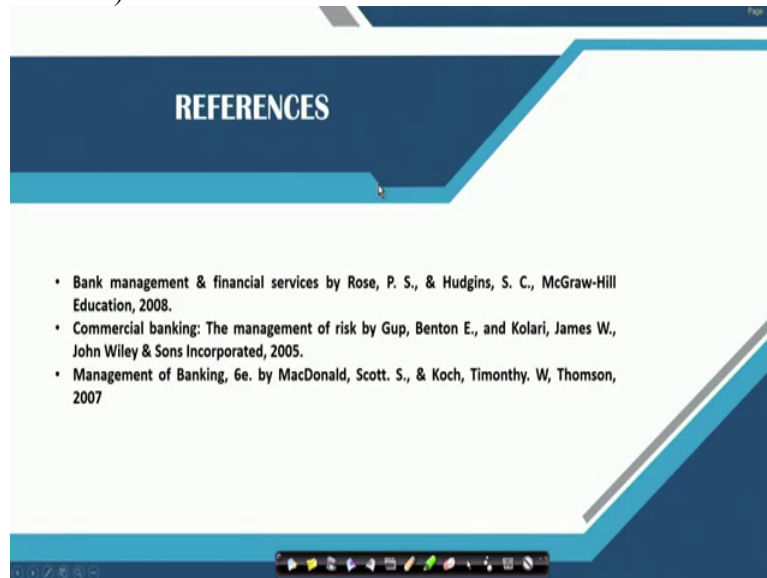
- In the process of immunization the duration gap should be equal to zero
- Bank should operate with average asset duration slightly below its average liability duration
- When book value of interest income is the target, in the process of immunization, duration of bank's equity equal to length of time horizon that the bank wishes to use in hedging net interest income
- Sensitivity analysis of economic value of equity is conducting what if analysis of all the factors that affect EVE across a wide range of interest rate environments

What basically we have discussed that in the process of immunization the dollar gap should be equal to 0. The bank always should operate to make your dollar gap 0 the bank should operate with the average asset duration which is slightly below its average liability duration.

When the book value of interest income is the target apart from the economic value of equity in the process of immunization that duration of banks equity should be equal to the length of the time horizon what the bank wishes to use in the hedging rate interest income, and the sensitivity analysis of economic value of equity is nothing but a what if analysis of all the factors which can affect the economic value of equity across a wide range of interest rate environments.

And accordingly we have to prepare ourselves that how we can manage the interest rate risks in the market whenever there is a fluctuations of the rates in the system.

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So these are the references what you can go through for the detailed analysis. Thank you.