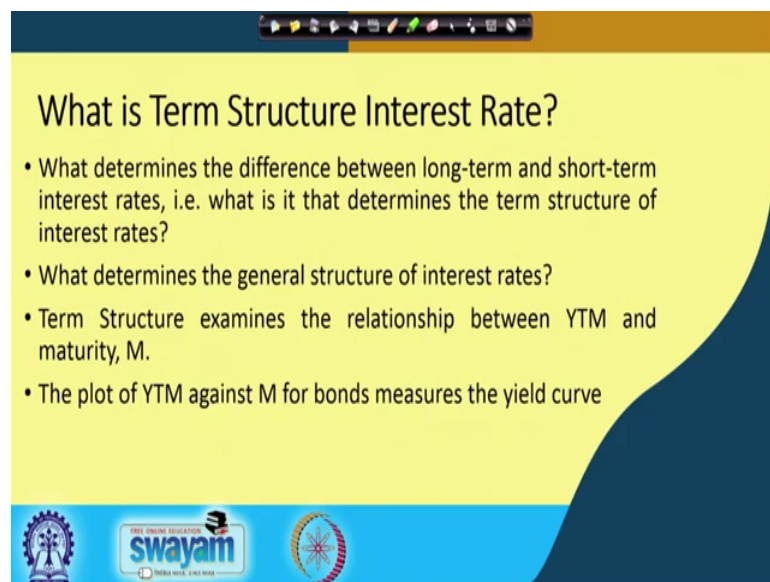


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**Lecture – 13**  
**Term Structure Theories of Interest Rate – I**

So, in the previous class we discussed about the different theories which try to determine the aggregate level of interest rate or level of interest rate in the economy. Then the other is so related to the interest rate is basically the Term Structure Theories of Interest Rate. So, before we analyze that what exactly the term structure theory of interest rate; let me explain you that why we want to study the concept of term structure theory.

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**What is Term Structure Interest Rate?**

- What determines the difference between long-term and short-term interest rates, i.e. what is it that determines the term structure of interest rates?
- What determines the general structure of interest rates?
- Term Structure examines the relationship between YTM and maturity,  $M$ .
- The plot of YTM against  $M$  for bonds measures the yield curve

The slide features a yellow background with a dark blue curved shape on the right side. At the bottom, there are logos for IIT Kharagpur, Swayam, and another circular logo.

That whenever you talk about the term structure interest rate theories or the concept of term structure interest rate; the term structure is basically nothing, but that why the interest rate in the long term bond or long term securities are different from the short term securities.

So, in general what kind of questions or what kind of issues the term structure theory is trying to answer or there are two questions what basically the address: one is what determines the difference between long term and short term interest rates, which means that what is that determines the term structure interest rates. And what determines the general structure of interest rates, to be precise if I give you this example that whenever

we are issuing particular bond that one bonds maturity period is 10 years another bonds maturity period is 5 years. You might have observed that the bond which maturity period is 10 years they provide more return than the bond whose maturity period is 5 years; why is it. So, why basically these yield or they or they returned from a long term bond is more than the return from a short term bond, that is the first question.

And what is the second question? The second question is that whenever even if with the same term to maturity, you will observe that may be one bonds maturity period is 10 years and another bond the same bond which maturity period is also 10 years, but the issues are different, may one bond is issued by one agency another bond is issued by another agency. So, you might have observe still even if the same maturity the interest rates or the return from these two different, these two different bonds are varying. Why it is varying? Why basically even if the same maturity the interest rate or the return from these two bonds differ? So, here basically there are lot of issues or lot of reasons behind that and all those reasons and all those concepts are explained through the different theories of term structure interest rate.

So, in a general sense if you in a layman perspective or in a very common perspective if you want to define what do you mean by the term structure interest rate or what do you mean by the term structure. The term structure basically examines the relationship between the yield to maturity and the maturity period. Just now I said that one 10 years bond, one 5 years bond. So, here your 10 years are 5 years are the maturity period and the return or the yield what you are getting from this, if you are holding the bond up to that maturity that is basically your YTM or the Yield To Maturity. So, the particular curve which shows the relationship between yield to maturity and this term, term to maturity that is basically called the yield curve.

So, the yield curve determination or how to derive the yield curve that basically we get through this term structure interest rate theories; that means, the term structure interest rate theories try to, theories basically try to help off to derive the yield curve of a particular bond. So, these are the major issues always we encounter whenever you talk about the term structure theories of interest rate.

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**Shape of the Yield Curve**

- Yield curves can be **positively-sloped** with long-term rates being greater than shorter-term ones. Such yield curves are called **normal** or **upward sloping curves**. They are usually convex from below, with the YTM flattening out at higher maturities.
- Yield curves can also be **negatively-sloped**, with short-term rates greater than long-term ones. These curves are known as **inverted** or **downward sloping yield curves**. Like normal curves, these curves also tend to be convex, with the yields flattening out at the higher maturities.
- Yield curves can be relatively **flat**, with YTM being invariant to maturity.

The slide includes a hand-drawn graph on the right side showing three yield curves: an upward-sloping curve labeled 'normal yield curve', a downward-sloping curve labeled 'inverted yield curve', and a flat curve labeled 'flat yield curve'. The vertical axis is labeled 'YTM' and the horizontal axis is labeled 'M' for maturity. The slide also features the Swamyam logo and a presenter in the bottom right corner.

So, let us see that how that particular theory works; you see all already I have mentioned you or I have discussed with you that the term structure theories try to explain or try to measure the yield curve a particular of a particular bond. But then how what is the step, how the particular yield curve looks like, what is the shape of that yield curve. If you say in general sense always you might have known that the long the return from a long term bond is always more than they return from the short run bond. If they return from a long term bond is more than the return from the short term bond then always we can find.

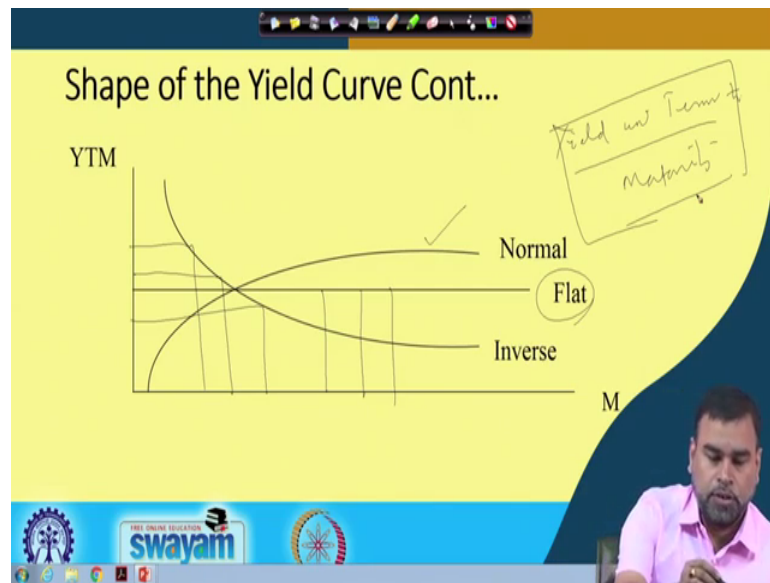
There is a positively sloped yield; that means, the yield curve can be positively sloped with long term rates being greater than the short term bonds that always we can find out and that kind of yield curve is basically known as the normal yield curve or the upward yield curve. So, how it basically exactly look like? If in one access we have the term to maturity another access we have the yield to maturity mostly the yield curve looks like this; that means, if you are if this is your yield to maturity and this is your maturity period; if maturity is a increasing then the yield is also increasing. So, this is basically a upward yield curve or positively sloped yield curve. So, this is basically also the normal yield curve, but in general sense always we know that the long term yield is always more than or the bonds are having longer maturity gives more yield than the bonds having shorter maturity.

And this is usually convex from below that particular diagram basically shows that and with the YTM flattening out in the higher maturity. So, if you go for higher maturity period you will find not much fluctuations in terms of the yield whenever you compare it with the shorter term maturity bonds. So, the yield curve also can be negatively sloped where the short term rates is greater than the long term rates. So, that is also there is also possibility that the short term rates can be lesser than the long term rates and when it is possible, whenever the this purchasing power of the consumer is very low or the inflation rate is quite high in the economic system. In that time investing in the short term is relatively more risky than investment investing in the long term. The reason is the inflation is already high there is the high probability that in the near future this inflation rate may go down.

So, because of that what happens that; obviously, the return or the yield from the short term bonds may be more than return or the yield from the long term bonds. So, this is what basically the yield curve or an inverted yield curve we can observe. In some of the countries whenever there is some kind of this kind of situation arises, you might have observed the shape of the yield curve looks basically inverted.

So, this is what basically we are talking about the inverted yield curve. So, here like normal yield curve these curves also tend to be convex with the yields flattening out at the higher maturity, the yield curve also can be relatively flat, the yield curve also can be relatively flat if the short term rate and long term rate both are different. So, that is specifically another way of understanding, way of looking this yield curve; that if the long term yield and short yield both are same then what you can say that the yield to maturity is invariant to the term to maturity. So, with the change in the term to maturity the return or yield also is not going to be changed.

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So, after this if you see that just now I have I have told that and this is the way this shape of the yield curve looks like this diagram I have shown you that is a normal yield curve and if it is inverse yield curve this is the way basically the inverse yield curve looks like you see here YTM term to maturity increases here YTM basically changes right. So, this is basically another type of yield curve then this is basically your flat yield curve which is the your yield is or yield to maturity is not changing even if the period is changing.

So, whatever period you are talking about the yield is not going to be changed. So, that is basically we call at the flat yield curve and the yield curve already I have mentioned you the yield curve. So, the relationship between your yield and term to maturity and term to maturity; so, this is what basically we talked about whenever we talk about the yield curve and this is convex from below that is already we have explained in the previous slide. So, then we have after getting these idea that what these yield curve look like and what are those different types of yield curve can be prevailed in the market then we can move in to the another argument on these that what are those factors we decide the step of the yield curve

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**Shape of the Yield Curve Cont...**

- The actual shape of the yield curve depends on:
  - The types of bonds under consideration (e.g., AAA bond versus B bond)
  - Economic conditions (e.g., economic growth or recession, tight monetary conditions, etc.)
  - The maturity preferences of investors and borrowers
  - Investors' and borrowers' expectations about future rates, inflation, and the state of economy.

*Handwritten notes:* Yield → low, High, Yield → low, High, Yield ↓, Long term, Short term, Yield ↓

**swayam**

So; obviously, the shape of the yield curve depends upon the types of the bonds you know there are different type of bonds available in the market, you have high rated bond like AAA or B rated all kind of bonds. So; obviously, the long term bonds give low return the yield from the long term bond.

The yield from the long term bond is low and yield from the low rated bond is high it is the high rated bond and it is the low rated bond. So, that is what because this is more risky and that is why to compensate the risk the issuer can provide more yield for the low rated bond to the investors and another one the economic conditions; obviously, monetary conditions monetary policy if; obviously, if the policy rates if the policy rates are very low then; obviously, the interest rate in the market also will be low. So, because of that we can expect that yield also be low because that time the money supply in the economy will be very high.

Now the policy rate will be low the interest rate will be low then there is this that will have the impact upon the yield in that particular point of time. So, in this context this yield may increase because the price also gets affected by that. So, the monetary policy means if the interest rate goes up the tight monetary policy means if the interest rate goes up, then the money supply basically goes down then it will have the impact on the investment on the different financial securities then; obviously, your yield also gets affected.

So, this is what basically these economic conditions including monetary policy also affect the shape of the yield curve in the economic system. Then the maturity preferences of investors and borrowers that we will discuss through the different theories that for example, some investors prefer only to invest in the long term bond on the basis of requirements, because if somebody wants money after 10 years and he can hence a specific amount of money they want to get out of these or specific amount of return they want to they want to get out of these. Then what they do? They prefer to invest in the long term bond instead of investing in the short term bond.

But there are certain investors or certain participants they always preferred through invest in the short term investment arising period is very short therefore, there is a preference. So, always we will find that under these economic conditions the investor basically is in interest rate for investing in the long term bond and short term bond that basically will decide that how the shape of the yield curve will look like. And also the investors and borrowers expectation about the future rates future interest rate inflation and the state of the economy. So, how this economy is going to behave in the future in terms of the different macroeconomic fundamentals that also affect the yields of that from that particular bond and accordingly the yield curve shape can be changed. So, this is what basically the common factors which can decide the shape of the yield curve.

But we can explain all those arguments through different theories when the basic question here is how the long term interest rates can be determined what is the what is the logic through different what kind of different theoretical arguments through which we can say this is the way the long term interest rate can be determined.

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## Term Structure Theories

- Pure Expectations Theory
- Liquidity Premium Theory
- Preferred Habitat Theory
- Market Segmentation Theory

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So, we have four theories which explain basically the term structure interest rate theories one is your pure expectations theory, you have the liquidity premium theory, you have the preferred habitat theory, then you have the market segmentation theory. These are the four different theories which explain the term structure interest rate theories in the system. So, one by one we will see that how this interest rate theory is trying to explain that how the long term interest rate is determined in the financial system.

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## Pure Expectations Theory

- **Assumptions**
  - There is a perfect competition in financial markets.
  - The investors are rational, i.e., they wish to maximise the yield of their holding period.
  - Investors have a perfect foresight, and a large enough body of investors hold uniform expectations about the future level and changes of short-term interest rates and security prices.
  - There are no transactions costs.
  - Securities of different maturities are perfect substitutes for each other, i.e., they are homogeneous.
  - Holding period is the period of time for which the investor plans to hold or actually holds the security. It may be the same as the maturity period or it may differ from the latter. If it is longer than the maturity period, the investor must reinvest; if it is shorter, he must sell the security before the maturity period is over

swamyam



So, first of all if you see the pure expectations theory pure expectations theory is based upon certain assumptions and mostly the pure expectations theory is believing that there is a perfect competition in the available in the market; that means, there are more number of buyers and sellers exist investors are rational; that means, they want to maximize the yield in that holding period everybody is thinking rationally. Investors have a perfect foresight and large enough body of investors hold uniform expectations about the future changes in the different interest rate like short term interest rates and the prices of that particular security.

There is no transaction cost and obviously, the risk is neutral here in this particular context the risk is not available or risk is there everything can be predictable from the beginning that is why there is no uncertainty which is existing in the market. And the securities of the different maturities are perfect substitutes; that means what? If anybody there is no difference in terms of the investment arising period, anybody can invest in any type of bonds in terms of the maturity.

So, in the previous slide we were discuss we are explaining that some people prefer to invest in the long term bonds some people will be invested in the short term bond, but here whenever you are explaining the pure expectations theory we believe that there is no such kind of preferences or differences in terms of the short term and long term bonds. Everybody wants to invest in there is some kind of perfect substitutability between the short term and long term bonds which are available or existed in the financial system.

And holding period is the period of time for which the investor plans to hold or actually hold the security it may be same with the maturity or it may be differ from for maturity, but if it is longer than maturity period the investor must re invest in that particular bond or if it is shorter he must sell the security before the maturity is over. So; that means, hear what I here, am I where we are trying to explain let there is a bond whose maturity period is 10 years then the investor if go on up to 10 years the investor can sell the bond after 5 years after 5 years they can sell the bond or they can hold up the bond up to the maturity or if they are trying to hold that bond after this maturity then they have to again reinvested that bond they can extend that maturity period because maturity period is fixed from the beginning.

So, therefore, this is these are the different assumptions what this pure expectation theory takes. Then using these assumptions what this theory basically tries to explain?

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**Pure Expectations Theory Cont...**

- With the help of these assumptions, it is posited that today's long-term rate is the unbiased (arithmetic or geometric) average of the current short-term rate and the successive forward or expected one-period short-term rates during the period of long-term loan.
- It is represented as follows:
- $(1 + R_n^t) = [(1 + R_1^t)(1 + r_1^{t+1}) \dots (1 + r_1^{t+n-1})]^{1/N}$
- Where:
- $R_n$  = The actual long-term rate
- $N$  = Term to maturity
- $R_1$  = Current 1-year rate
- $r$  = Expected 1 year rate (forward rate)

Handwritten notes on the slide include:  $R_n \rightarrow$  long term rate,  $r = 3$ ,  $(1 + R_1)$ ,  $(1 + r_1^{t+1})$ ,  $(1 + r_1^{t+2})$ , and  $(1 + R_n)^N$ .

It explains that the today's long term rate is the unbiased average, the average can be arithmetic or geometric of the current short term rate and the successive forward rates or we can call it expected one period short term rates during the period of long term loan. So, for example, if you want to calculate the a long term rate where here in this case your  $R_n$  is equal to the long term rate, let  $n$  is equal to three. So, then what basically we trying to measure this if you are using this that  $1 + R_n t$  is equal to nothing but  $1 + R_1$ .

Here the  $R_1$  is basically the current spot rate and we have the forward implied forward rates that is  $1 + r_1 t$  plus  $1$  into  $1 + r_2 t$  plus  $2$ . So, on and then you can take the geometric mean of that to the power  $1$  by  $N$  that basically that basically will give you that what is the long term rate for that particular 3 years or 4 years. And here the one thing is this  $r$  which is basically your forward rate that we have to measure it and if you know this spot rate of today then forward rate of the next year, then the we can calculate the spot rate of two years bond or three years bond from today. So, in this context the it is nothing, but the long term rate is a arithmetic or geometric mean of the current spot rate.

And the future or the forward rates in that but, for that particular bond in the financial market in that particular point of time. So, then this is what basically we are talking

about the definition of the pure expectation theory then we can see that how this particular theory works.

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**Pure Expectations Theory Cont...**

The general formula for computing the j-period forward rate beginning at time t+n as of time t is:

$$r_{jt}^{t+n} = \sqrt[j]{\frac{(1 + R_{n+t}^t)^{n+j}}{(1 + R_n^t)^n}} - 1$$

Example: Suppose that the seven-year spot rate is 15% and six-year spot rate is 13%. The forward rate one-years from now implied by these spot rates can be calculated as follows:

$$\frac{(1 + R_7)^7}{(1 + R_6)^6} - 1$$

$$= \frac{(1 + 0.15)^7}{(1 + 0.13)^6} - 1 = \frac{(1.15)^7}{(1.13)^6} - 1 = 0.277 = 27.7\%$$

*Handwritten notes:*  
 Current spot rate  
 Forward rate  
 All are same if pure expectation theory

**swayam**

So, if you are trying to find out a this is your general formula for this pure expectations theory then here if one example for example, 7 year spot rate is 15 percent and 6 years spot rate is 13 percent. If you want to calculate the forward rate or implied forward rate from this then it is nothing, but 1 plus 0.15 to the power 7 divided by 1.1 1.3 to the power 6 minus 1 that is 27. 0.7 percent or if the 27.07 percent is available to you or 13 percent is available to you.

Then you can also calculate this 15 percent which is the spot rate for the 7 years maturity bonds. So, this is what basically the pure expectations theory is trying to explain. So, in overall what it tries to measure is tries to measure that if you have the current spot rate or short term spot rate one certain rate and you have the forward rates you have the forward rates then the long term rate can be calculated. And this long term rate is nothing, but it is just a arithmetic mean or the geometric mean of the these two rates current spot rate and the implied forward rates which are available in this particular system. So this is the way the long term rate can be calculated. So, this is what the expectation theory is trying to explain.

So, another thing here that if you observe that the expectation theory tries to incorporate trying to measure the expected spot rate from today, what is going to happen after 1

years, after 3 years, after 4 years and depending upon the implied forward rate and the spot rate the long term interest rate of that particular bond can be calculated.

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**Summary**

- The long-term rate will be higher than the short-term rate (i.e., the yield curve will be upward sloping) only if investors expect future short-term spot rates to be higher than the current short-term spot rate.
- Similarly, the long-term rate will be lower than the short-term rate (the yield curve will be downward sloping) when investors expect future short-term spot rates to fall below the current short-term spot rate.
- If no changes in future short-term spot rates are expected, the long and short rate will be equal to each other (the yield curve will be flat)
- the pure expectations theory views expectations about the future short-term interest rates as the only determinant of the term structures of interest rates

*improved yield curve*

*long term rate = current spot rate + average of forward rates*

So, here if you want to see that how basically this theory works and what is the, how basically this kind of conclusion we can draw. So, the long term rate would be higher than the short term rate if the yield curve will upward sloping if the investor expect future short terms spot rate could be higher be than the current short term spot rate.

So, if you see just now what we are trying to say, we are trying to say that here the question, this issue was your long term rate your long term rate is the arithmetic mean or the geometric mean of current spot rate and the forward rates right. So, here what we trying to say that if you after the measurement if the forward rates are basically are more than the current spot rate then; obviously, the long term rate the average of the these two rates will be a more in the long run. So, the long term rate; obviously, be more than the long term spot rate will be more than current short term spot rate if your expected short term forward rates will be more than or will be increasing or will need more than the current spot rates.

So, this is what basically we are talking about. So, in that particular point of time if your yield curve basically looks like this, but if the long term rate will be lower than the short term rate; that means, the yield curve will downward sloping.

That already we shown these, then what is happening? When it happens, when the investors expect the future short terms spot rate could be do be fall below the current short term spot rate. That means, the future spot rates what were expected spot rates what we are calculating expected spot rates and the forward rates what you are calculating, if this is basically which is calculated on the basis of the forward rates and the spot rate of today. If this one is basically declining or will be lesser than the current spot rate then what is happening the short term rate will be more than the long term rate. So, this is there then that particular point of time what we can observe we can observe that the yield curve basically downward sloping and in that point of time we call it this is a inverted yield curve; this is a inverted yield curve.

So, if no changes in future short term spot rates are expected then, the long term and short term rate be equal to each other and finally, the yield curve will be flat so this is what basically we can say the yield curve will be flat. So, in overall if you see that the pure expectations theory basically tries to explain about the future short term interest rates are the only determinants of the term structure interest rates. And there is no other factor we have to know only the current spot rate and the future short term interest rates or the forward rates. Then we can calculate the long term rate of a particular bond by using this two different variables is a simply the geometric or arithmetic mean of a those rates which are available in the system.

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The slide features a yellow background with a blue and orange header. At the bottom, there are three logos: a gear-like logo on the left, the 'swayam' logo in the center, and a circular logo on the right.

Please go through these particular references for this particular session.

Thank you.