Economics of Banking and Finance Markets
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Lecture - 10
Team structure of interest rate

Welcome; in this session let us discuss 3 theories associated with Term structure of interest rates here.

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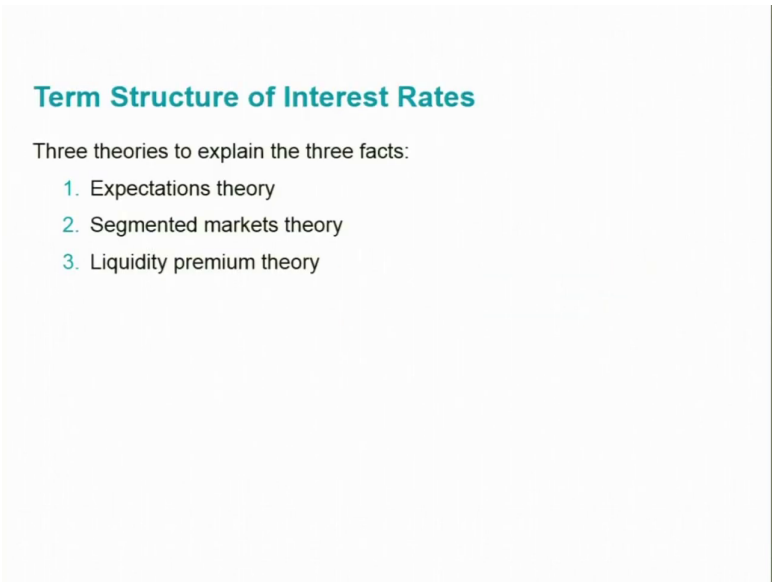

One is expectation theory, 2nd one is segmented markets theory and the 3rd one is liquidity premium theory.

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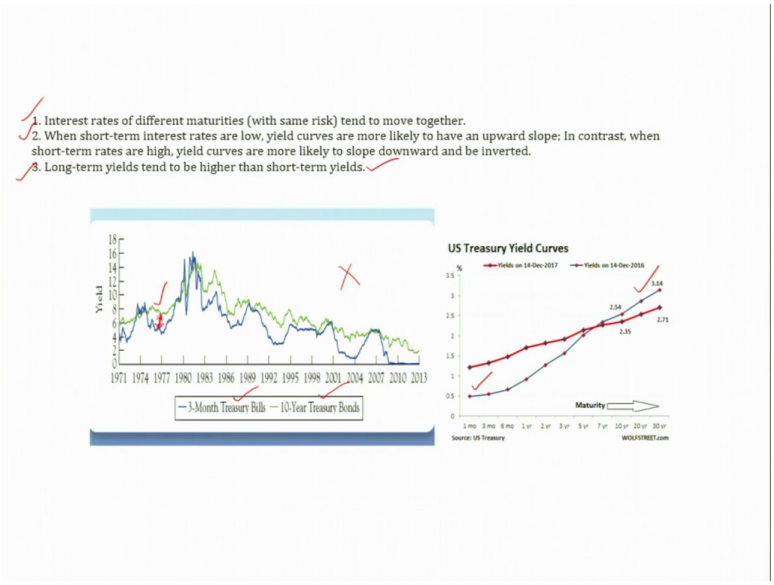

As we have discussed in the previous class, a theory of term structure of interest rate must explain, these three facts.

One is that the interest rates of different maturities tend to move together. Look at, for example, the first figure here; on the left-hand side. You can see that one is a 3-month treasury bill, and other one is 10-year treasury bonds. Do not get confused here, this is not a yield curve. This one is not a yield curve, here we are plotting interest rate that the of two different instrument that is short-term and long-term over time.

From this, we can see here is that the blue colour line denotes, that plots, the treasury bill interest rates. this is the term difference, we can interpret it as a yield curve, means if you want to measure from this point to this point.

Otherwise, this is that we have plotted over time. One of the inferences from here that there is a difference, that yield curve that measured by the yield curve the difference here. But another thing that, over time it moves together. Interest rates of different maturities; with the same risk, that the short-term and long-term tend to move together. You can see that the green line this one is, for 10-year treasury bonds.

Both moves together. When we discuss the 3 theories, at least one of them should be able to explain why it moves together. And the second one, we already seen here that in both the

right-hand side yield curve, in general, the yield curve tend to be higher upward sloping. Here, the short-term interest rate as compared to the long-term yields are lower.

We also we need to see the second condition that when short-term interest rates are low, yield curves are more likely to have an upward slope. In contrast, when short-term rates are high, yield curves are more likely to slope downward or to be inverted.

Let us see whether these three theories that we are going to discuss, whether they can explain these three facts.

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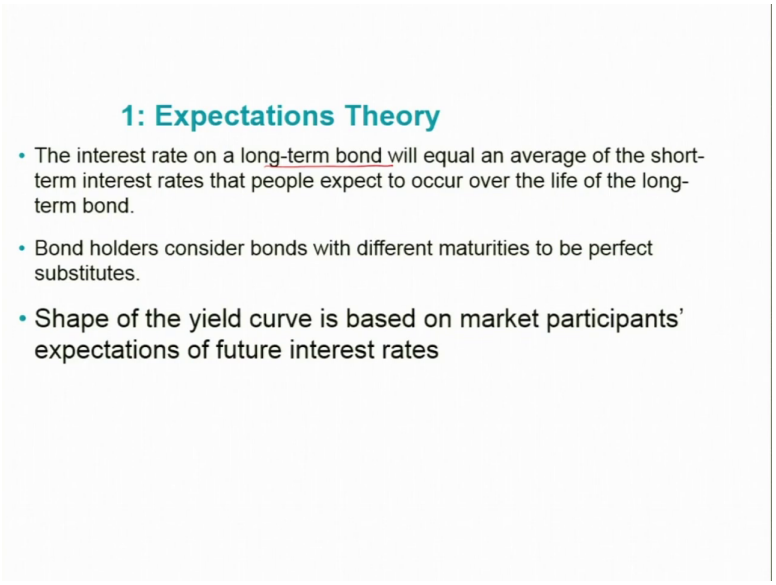

The first theory is called the expectation theory.

The expectation theory states that the interest rate on a long-term bond will equal an average of the short-term interest rate that people expect to occur over the life of the long-term bonds. Here bond holders consider a bond with different maturities to be perfect substitute.

In other words, they do not have any preference between short-term and long term; that means, they are indifferent between maturities or terms of bonds. In this case, the shape of the yield curve is based on market participants, expectation of future interest rates, how future interest rates will be.

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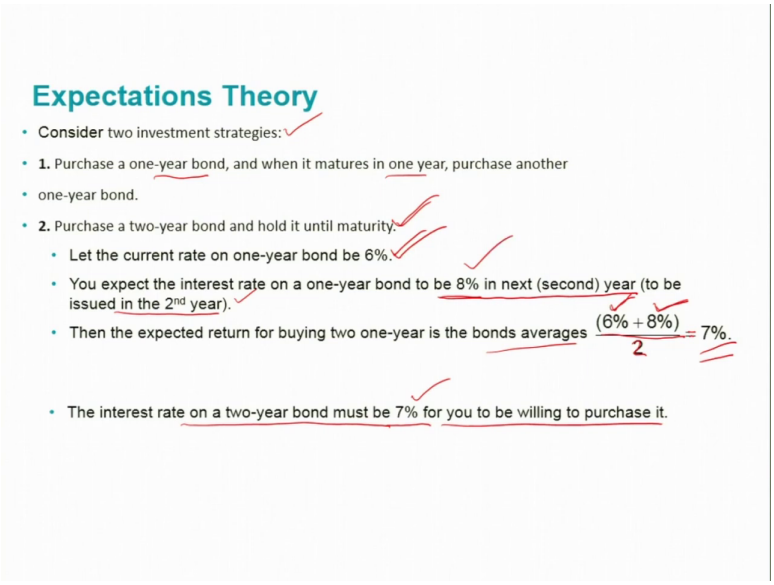

Let us explain this one by considering two investment strategies; purchasing a one-year bond and when it matures in one year, purchase another one-year bond. So, in this case there is no preference between one-year bond and two-year bond. That means, they are indifferent and here the strategy is that purchase one-year bond and when it matures in one year, purchase another one-year bond.

And another strategy is purchasing a two-year bond and hold it until its maturity. To explain this one, what the expectation theory states that the investor does not prefer one-year bond and two-year bond. And in this case the expectation theory say that based on the expectations, there will be a difference between short-term and long-term interest rate (that is, between the one year and 2-year term bonds), and the current rate of interest will be is going to be the average of both.

Let the current rate of rate of interest rate on a one-year bond is 6 percentage, and you expect the interest rate on a one-year bond to be 8 percentage in the second year. That means, the first year is going to be 6 percentage and you expect that the one-year bond in the second year (to be issued in the second year) is going to be 8 percentage.

Then the expected return for buying a two one-year is the bonds average interest rate; the average 6 percentage plus 8 percentage, is equal to 7 percentage. Just to state in another words if the one-year bond in this year is going to be 6 percentage and you are going to expect that the rate of interest for the one-year bond in the second year is going to be 8

percentage. So, when you buy a single bond of two-year bond today, the rate of interest that you expect is the average of your first-year interest rate and your expectation about one-year bond in the second year, which is going to be 7 percentage.

In this example, you can see that interest rate on two-year bond must be 7 percentage. You are willing to accept a rate of interest for a two-year bond if its 7 percentage. This is the essence of expectation theory.

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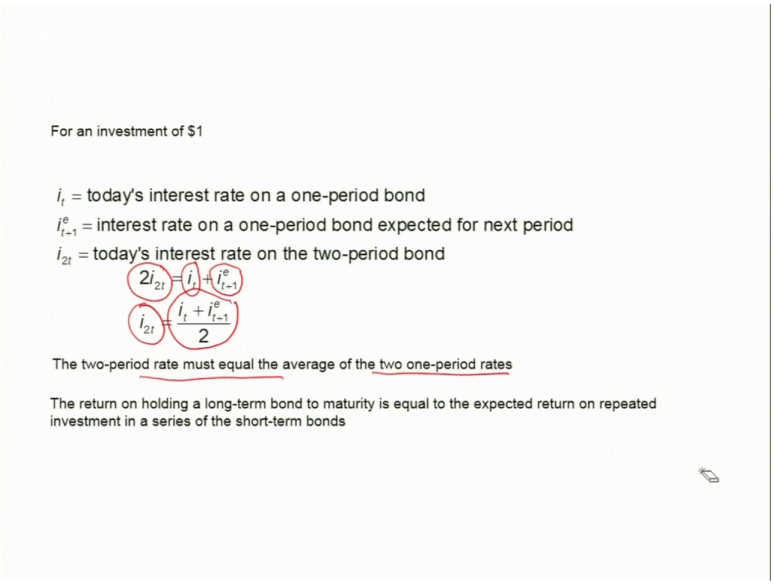

In this case for an investment of dollar 1, you are willing to accept interest rate for a two-year bond today is going to be the average of the current interest rate for a one-year bond plus your expectation about the one-year bond in the second year.

That is, the current rate of interest for two-year bond today is going to be the average of this one. A two-period rate must equal the average of the two one-period rates. So, the return on holding a long-term bond to maturity is equal to the expected return on repeated investment in a series of the short-term bonds. In this case, you can see that if the interest rate in the second year, for the one-year bond in the second year is higher than the short term.

Thus, when you plot you can see that you will be getting an upward slopping yield curve.

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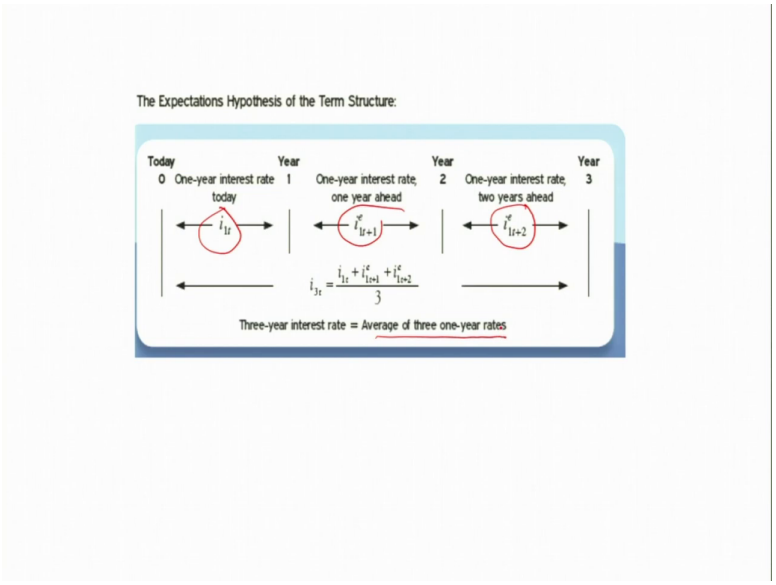

Summarizing this one, suppose if you want to expand this one to a three-year case. Yu can see that this is one-year interest rate, that is the year 1, year 2, is going to be the expectation, this is going to be this one. So, you can see that the interest rate for a three-year bond is going to be the average of these three one-year rates.

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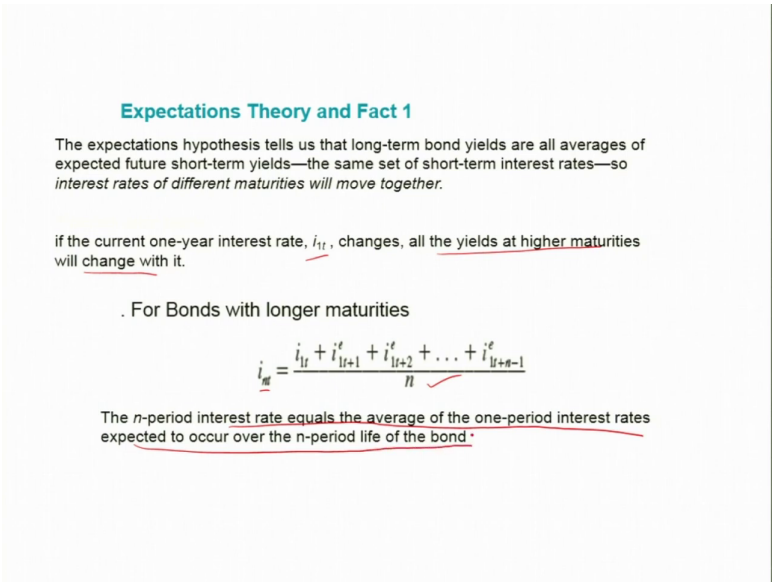

About the expectation theory and fact 1: the expectation hypothesis tells us that long-term bonds yields are the averages of expected future short-term yields, means the average of the

same set of short-term interest rates. So, interest rates of different maturities will move together.

If the current one-year interest rate is going to be i_{1t}, we can also calculate for bond with long-term maturities for n number of years is going to be this rate; that means, n number of periods. So, divide it with the n number of maturity period. So, the n period interest rate equals the average of the one-period interest rates expected to occur over the n period of life n period life of the bond.

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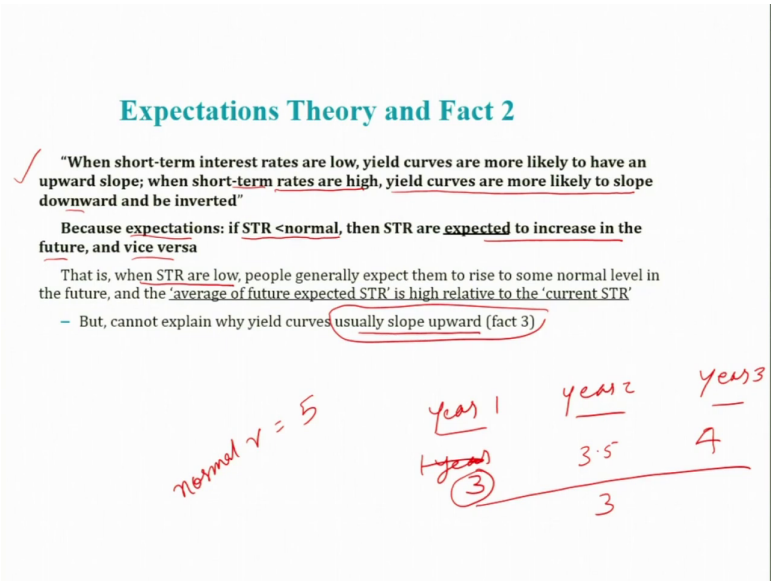

About expectation theory and fact 2: we have seen that when the short-term interest rate is low, yields curve are more likely to have an upward slope. Simply, when the short-term interest rates are low yield curves are more likely to have an upward slope. Moreover, in contrast when short-term rates are high the yield curves are more likely to slope downward and be inverted.

Let us bring the expectation theory into this context and explain why, for example, when the short-term interest rates are low, why long-term interest rates are going to be high. When short-term interest rates are low, yield curves are more likely to have an upward slope, why? All this because of expectations about the future.

If short-term interest rates are low, it is below the normal. Let us bring the concept of the normal interest rates here: when we say that the short-term interest rates are below the

normal, you can see that the short-term interest rates are expected to increase in the future. So that means, the all the one-year bond when you take, for one-year 1-year, year 2, year 3, like that.

Assume that the normal interest rate (normal r) is for example 5 percentage.

Also assume that the current rate of interest is 3 percentage, we know that this is below the normal. What we expect in the second year that the interest rate is going to increase. The expectation will be that it is going to be, 3.5 percentage in the 2-year, or going to be 4 percentage in year 3, and is going to be 4.5 in year 4 and is going to be 5 percentage year 5.

Here, the expectation plays a role; if the short-term rate of interest is less than the normal, then the short-term rates for the second year, the years ahead, second year, third year, fourth year, fourth year, fifth year etcetera is expected to increase.

In contrast, when the short-term rates are above the normal, the rate of interest is going to decline in the future. Suppose the short-term rates are high, then you can see that in the future short-term rate of interest is going to decline. In that case, the average you will be getting, the average of the future short-term interest rates is going to be less than the current short-term interest rates.

However, one of the issues with this theory is that it cannot explain why yield curves are usually upward slope, why most time it becomes upward sloping. When the short-term interest rates are low then we can say that the yield curves are more likely to have an upward slope.

Similarly, when the short-term rates are high; that is higher than the normal interest rates, then we can say that the yield curves are more likely to slope downward and be inverted, this is fact number 2. But it cannot explain why usually the yield curves are slope upward that is, it cannot explain a fact number 3.

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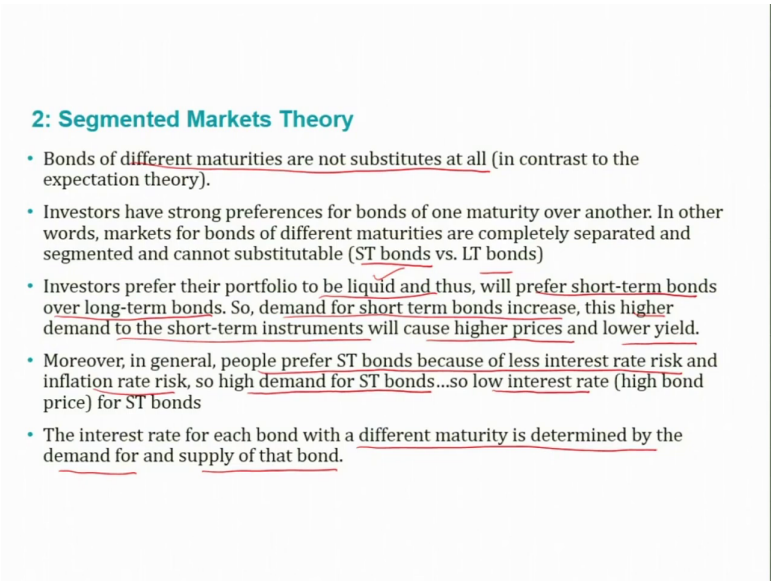

Let us now move to another theory called segmented markets theory. In this theorem, the main assumption is that bonds of different maturities are not substitute at all, which is in contrast to the expectation theory, where there are no preferences between bonds of one term as compared to another term.

But in this market segmentation theory, we say that bonds of different maturities are not substitute at all; investors have strong preferences for bonds of one maturity over another. In other words, market for bonds of different maturities is completely separated and segmented and cannot substitutable. That is, there is clear cut segmentation between short-term bonds and long-term bonds.

Here, investors prefer their portfolio to be liquid, and thus prefer short-term bonds over long-term bonds. There is a clear-cut preference for short-term bonds mainly because the short-term bonds are more liquid and there is less risk associated, interest rate risk and inflation risk are less with the short-term bonds as compared to long-term bonds. As a result, there is a clear preference for short-term bonds over long-term bonds.

When we translate this preference into demand for bonds, you know that, when there is a high demand for short-term bonds because of the liquidity condition, interest rate risk and liquidity considerations, it would lead to high price for the short-term bonds. That means, higher demand to short-term bond instrument will cause a higher price, and lower yield or lower rate of interest.

The interest rate for each bond with a different maturity is by the demand for and supply of that bond. So, in this case what we have seen that a short-term bond, it has high liquidity and less inflation risk and interest rate risk, as a result its price is going to be high and interest rate is going to be low.

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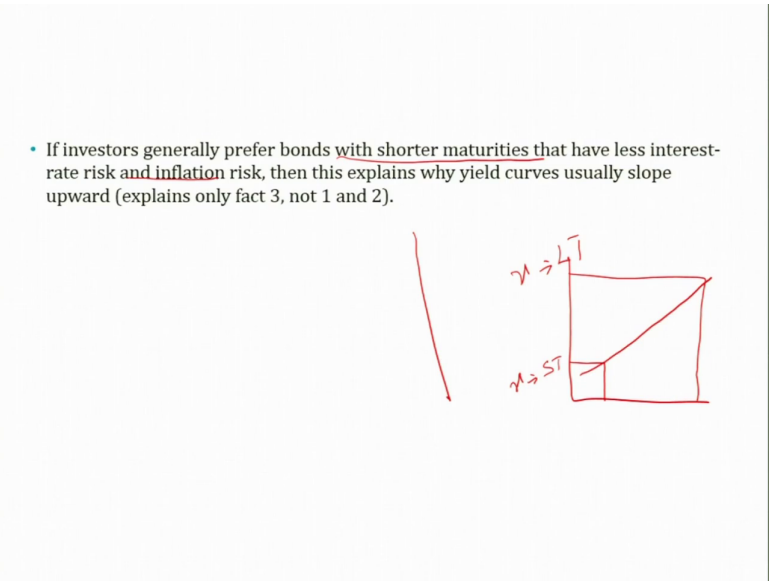

You can translate this one to easily to relate with the fact number 3. Because of the factors we mentioned here the demand for short-term bonds are high, which means market segmentation with a high demand for bonds with a short-term maturity as compared to long-term maturities.

The demand for short-term bonds increases, and thus, there will be low rate of interest for short-term bonds, and as a result, you can see that the yield curve will be upward sloping. That means, the short-term interest rate corresponding to short-term bonds will be less than long-term interest rates corresponding to long-term bonds.

Therefore, we can say that the yield curve almost always slopes upwards. It means that the segment market theory can explain why the yield curve slopes upwards. However, it cannot explain a fact number 1 and 2.

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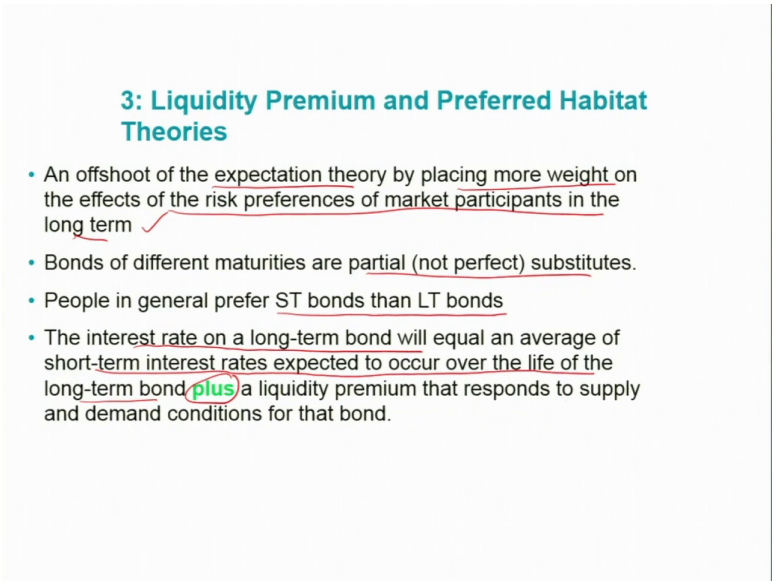

Another set of theorems is liquidity premium and preferred habitat theories. This is an offshoot of the expectation theory where we take the first part of the expectation theorem. We further place more weights on the effects of risk preference of market participants in the long term.

Here we assume that bonds of different maturities are partial substitutes. People in general prefer short-term bonds over the long-term bonds. However, they would like to alter their preference if they have been compensated for this preference. In general, they prefer short-term bonds over the long-term bonds, then what we see that if they get a premium for demanding long-term, they are willing to compromise the risk of liquidity associated with long-term bonds. They will compromise if they get a premium for demanding long-term bonds.

In this case, we can see that the interest rate on a long-term bond will be equal to an average of short-term interest rate expected to occur over the life of the long-term bonds, that is what we have seen in the expectation theory, plus a liquidity premium.

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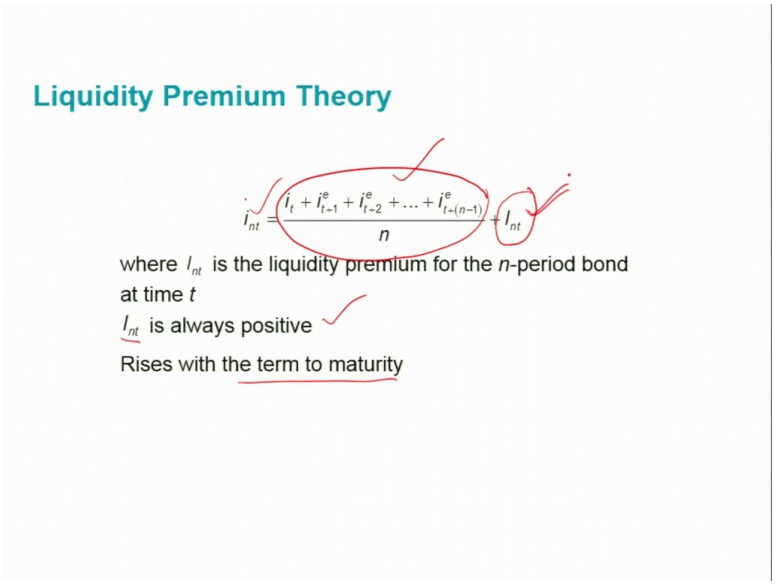

Look at the equation here, we can see that interest rate of a long-term bond, that is the interest rate of a long-term bonds for n-number of periods, is the average of so many short-term bonds that is happening over the period plus a liquidity premium. So, this 'l_{nt}' is going to be always positive; that means, rises with the term to maturity.

In another words, the first part is going to be the average rate of interest that the expectation theory predicts, and the second component is going to be the liquidity premium.

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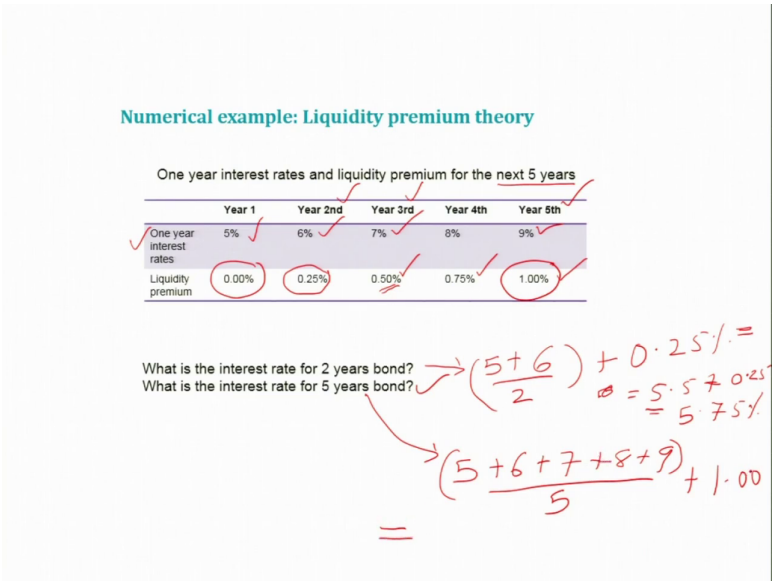

$\left(\frac{5+6}{2}\right) + 0.25\% = 5.5 + 0.25 = 5.75\%$

$\frac{(5+6+7+8+9)}{5} + 1.00$

$=$

Let us loot at an example here to explain this concept. a one-year interest rates and liquidity premium for the next 5 year is presented in this table. What you can see here is that the one-year interest rate for year 1 is going to be 5 percentage and 6 percentage is going to be the interest rate for a one-year bond in the 2nd year. And 7 percentage is going to be the interest rate for a one-year bond in year 3rd, and 9 percentage is going to be the interest rate for a one-year bond in the 5th year.

This is expectation, this is the 5 percentage is the current interest rate and rest are expectations, how about the liquidity premium? we are talking year 1, we consider that this is the short-term.

We assume here that they do not need any premium because this is the short-term interest rate in year 1. But about year 2, where the liquidity concerns come up, you know, when the term increases the liquidity decreases.

So, less liquid, so you know, investors need a premium of 0.25 percentage if they want to demand a two-year bond. We assume here that, for the third year, as the liquidity declined, they need a premium; that means, 0.5 percentage, here 0.75 percentage for the 4th year, 1 percentage as the liquidity premium for the 5th year.

So, what is the interest rate for a two-year bond in this example? What do you need to do for the one-year you, do not need any liquidity premium; for the two-year bond, for a two-year bond what you look at the expectation theorem; that means, the interest rate for a two-year bond is 5 percentage plus 6 divided by 2, plus for the second-year liquidity premium of 0.25 percentage.

This is going to be the interest rate for a two-year bond; this is equal to 5.5 plus 0.25 is equal to 5.75 for a two-year bond. So, what is the interest rate for a 5-year bond? You can see that is going to be the average of all; in this case this is going to be the average, the average of 5, 6, 7, 8 plus 9, plus you need to take the liquidity premium, the 5th year liquidity premium is 1.

When you add this one you are going to get the interest rate for a 5-year bond, the average of this one plus the liquidity premium.

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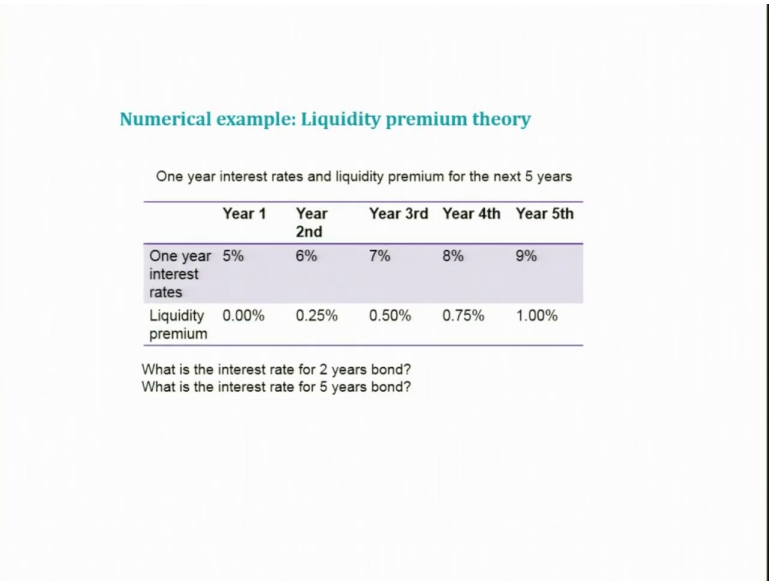

So, using this table we have calculated the liquidity premium and accordingly we calculated the interest rate for long-term bonds.

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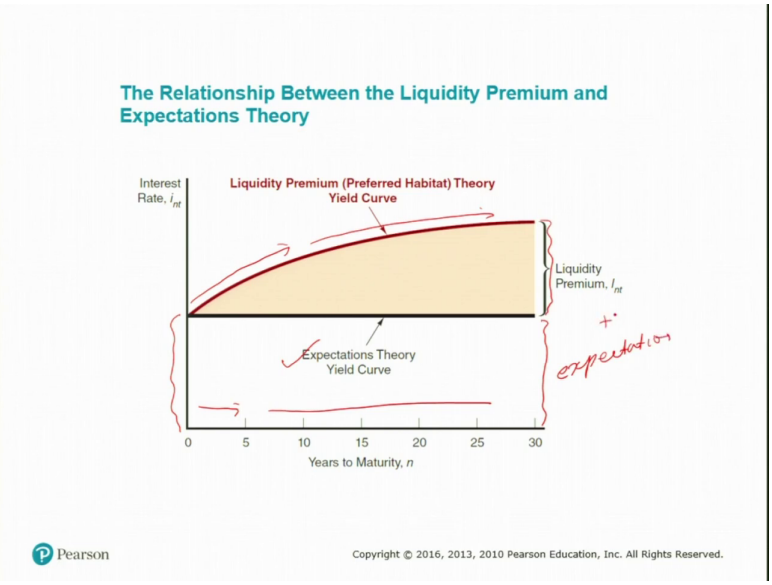

This can be also explained using this diagram. You can see that the first part this much the rate of interest in this segment is determined by the expectation theory.

When the maturity period keeps on increasing, you can see that the liquidity premium also increases, it keeps on increasing like that, this component is the liquidity premium. You can

see that this component is the liquidity premium, and the bottom part is determined by expectation theory. This is the graphical representation of the liquidity premium theory.

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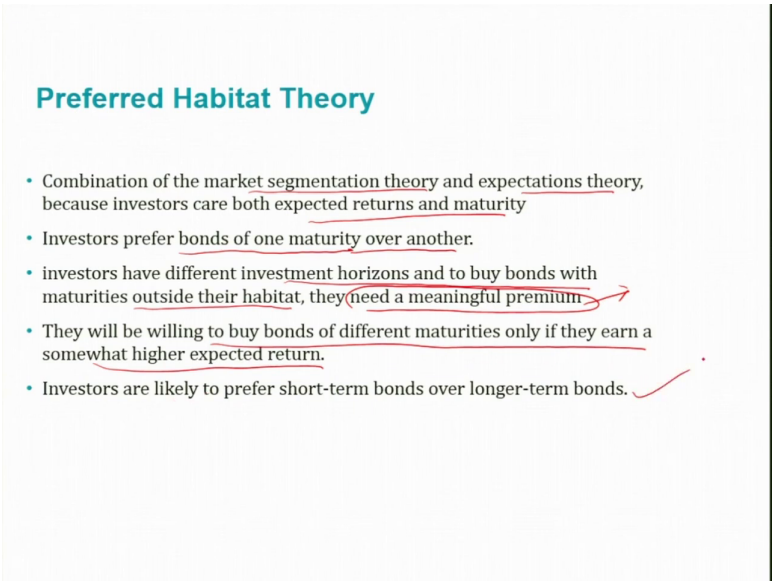

There is another version of this theory. This is called preferred habitat theory; this often goes with liquidity premium theory. This is a combination of marker segmentation theory and expectation theory because investors care about both expected returns and maturity.

According to this theorem, investors prefer bonds of one maturity to over another. In this case, investors have different investment horizon and willing to buy bonds with maturities outside their habitat, they need a meaningful premium. This is because when people/investors have a clear-cut preferred habitat.

To change this preference, they need a meaningful premium. That is, they will be willing to buy bonds of different maturities, only if they earn a somewhat higher expected return.

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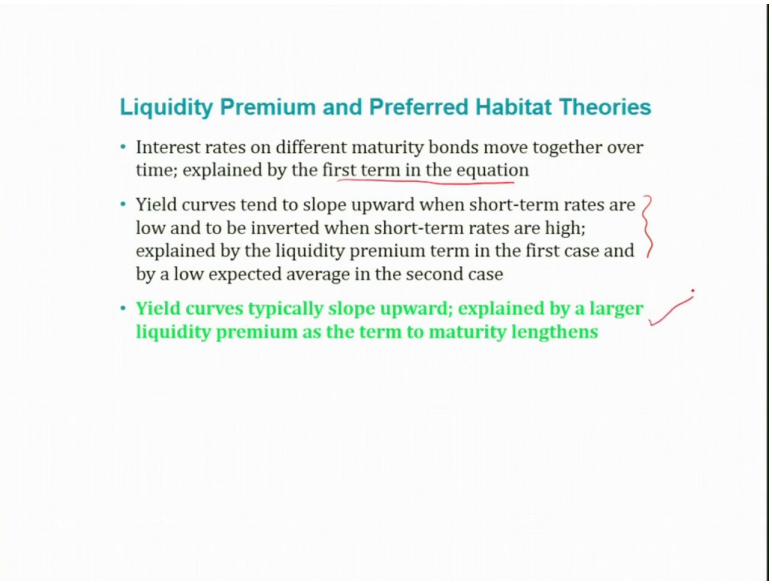

Liquidity premium and preferred habitat: interest rates on different maturity bonds move together over time and this is explained by the first term in the equation. Yield curves tend to slope upward; the second fact is also explained by this theorem. The last part, the yield curves typically slope upward, it is explained by a large liquidity premium of the term to maturity lengthens.

Thank you.

Key words: Term structure, interest rate, expectation theory, market segment theory, liquidity premium, preferred habitat, short-term, long-term