

NPTEL ONLINE CERTIFICATION COURSES

Management of Fixed Income Securities

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Lecture 16: The Term Structure of Interest Rates-IV

CONCEPTS COVERED

- **Government Surplus and yield**

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KEYWORDS

- Crowding out Effect
- Open market operation
- Expansionary monetary policy
- Contractionary monetary policy

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Factors Affecting Yield curve shifts

- Assumption: Two-sector (Government and corporate) and two-segment (short-term (ST) and long-term (LT)) world
  - Government Purchase of Long-Term Securities from a Surplus
  - Expansionary Open Market Operation with the Purchase of Short-term Treasury Bills
  - Contractionary Open Market Operation with the Sale of Short-term Treasury Bills

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Government Surplus and Yield

- When the government has a surplus and uses it to buy long-term Government securities there is a decrease in the supply of long-term government securities.
- The decrease in supply would push the price of the long-term government securities up, resulting in a lower long-term govt. bond yield
- In the corporate bond market, the lower rates on long-term government securities would lead to an increase in the demand for long-term corporate securities, which, in turn, would lead to an excess demand in that market.
- As bondholders try to buy long-term corporate bonds, the prices on such bonds would increase, causing the yields on long-term corporate bonds to fall until a new equilibrium is reached.

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Government Surplus and Yield Cont…

Government Securities Market

Government buys L-T Bonds ⇒ L-T Bond prices increase and yields decrease : Tendency for Govt. bond YC to become negatively sloped.

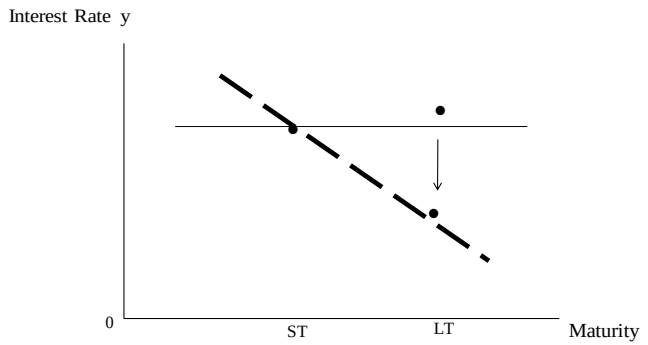
Corporate Market

Substitution effect: As L-T Govt. bond yields decrease, the demand for L-T corporate securities increases ⇒ L-T Corporate bond prices increase and their yields decrease: Tendency for Corporate YC to become negatively sloped.

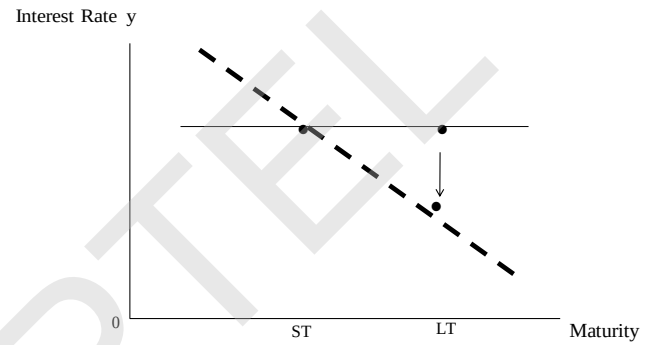
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Diagrammatic Representation

Government Bond Yield Curve



Corporate Bond Yield Curve



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Government Surplus and Yield Cont…

- The purchase of the long-term government securities decreases both long-term government and long-term corporate rates.
- Since the long-term market is assumed to be independent of short-term rates, the total adjustment to the government's purchase of long-term securities would occur through the decrease in long-term corporate and government bond rates.
- If corporate and government bond yield curves were initially flat, the government's action would cause the yield curves to become negatively sloped.

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Monetary Policy and Yield

- If the central bank were engaged in an expansionary open market operation (OMO) in which it were buying short-term government securities, there would be a tendency for the yield curve to become positively sloped

- If the central bank were buying long-term securities, there will be a tendency for the yield curve to be become negatively sloped.

- On the other hand, in a contractionary OMO, there would be a tendency for the government bond yield curve to become negatively sloped if the central bank were to sell some of its holdings of short-term bills and positively sloped if it were to sell some of its long-term security holdings.

- Open market operations also change the yield curve for corporate securities through a substitution effect.

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Expansionary Open Market Operation and Yield

Treasury Bills Market:

Central Bank buys S-T T-bills $\Rightarrow$ T-bill prices increase and yields decrease: Tendency for Treasury Bills YC to become positively sloped.

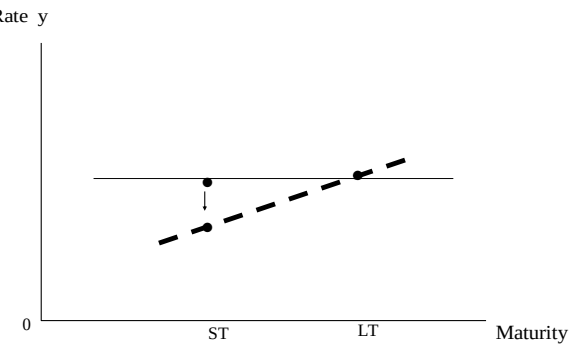
Corporate Market:

Substitution effect: As yields on S-T Treasury securities decrease, the demand for S-T corporate securities increases $\Rightarrow$ prices of S-T corporate increase and their yields decrease: Tendency for Corporate YC to become positively sloped.

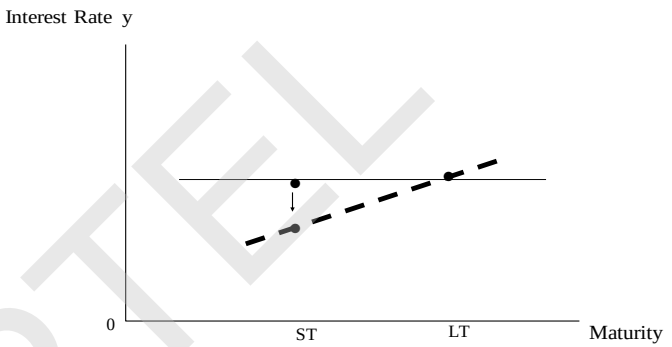
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Diagrammatic Representation

Government Bond Yield Curve



Corporate Bond Yield Curve



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Expansionary Open Market Operation and Yield

- Since the long-term market is assumed to be independent of short-term rates, the total adjustment to the Central bank's purchase of short-term securities to the public would be in the short-term corporate and Treasury bills markets with no impact on the long-term markets.

- If both the Treasury and corporate yield curves were initially flat, then the expansionary OMO would result in new positively sloped yield curves.

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Contractionary Open Market Operation and Yield

Treasury Bills Market:

Central Bank sells S-T Treasury Bills $\Rightarrow$ T-bill prices decrease and yields increase: Tendency for Treasury YC to become negatively sloped.

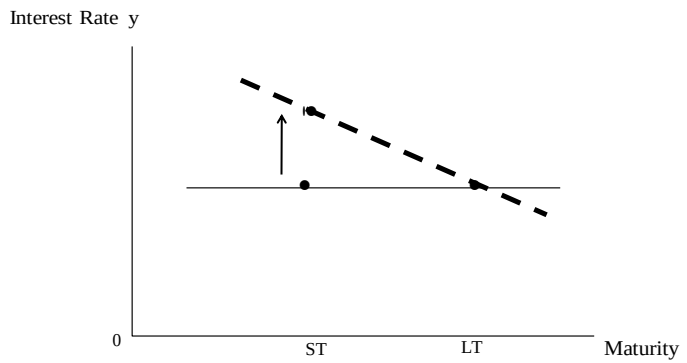
Corporate Market:

Substitution effect: As yields on S-T Treasury securities increase, the demand for S-T corporate securities decreases $\Rightarrow$ prices of S-T corporate decrease and their yields increase: Tendency for Corporate YC to become negatively sloped.

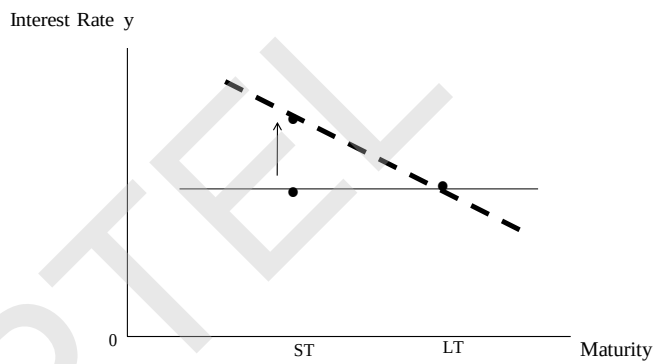
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Diagrammatic Representation

Government Bond yield Curve



Corporate Bond Yield Curve



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Contractionary Open Market Operation and Yield

- Since the long-term market is assumed to be independent of short-term rates, the total adjustment to the Central bank's sale of short-term securities to the public would be in the short-term corporate and Treasury markets with no impact on the long-term markets.

- If both the Treasury and corporate yield curves were initially flat, then the contractionary OMO would result in new negatively sloped yield curves.

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CONCLUSIONS

- The purchase of the long-term Treasury securities decreases both long-term government and long-term corporate rates.
- Open market operation changes the yield curve of government as well as corporate bond markets.
- If both the Treasury and corporate yield curves were initially flat, then the expansionary OMO would result in new positively sloped yield curves.
- If both the Treasury and corporate yield curves were initially flat, then the contractionary OMO would result in new negatively sloped yield curves.

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- Johnson, R.S. (2010), Bond Valuation, Selection, and Management, Second Edition, John Wiley & Sons, Inc., Hoboken, New Jersy.
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Lecture 17: The Term Structure of Interest Rates-V

CONCEPTS COVERED

- **Preferred Habitat Theory**

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KEYWORDS

- **Short-term yield**
- **Long-term yield**

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Preferred Habitat Theory

- Preferred Habitat Theory assumes that investors and borrowers are willing to give up their desired maturity segment and assume market risk if rates are attractive.

- PHT asserts that investors and borrowers or issuers will be induced to forego their perfect hedges and shift out of their preferred maturity segments when supply and demand conditions in different maturity markets do not match.

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Preferred Habitat Theory Cont…

- PHT is a necessary extension of the MST
- If an economy is poorly hedged (e.g., more investors want short-term investments and more borrowers want to borrow long term), then the market will not be in equilibrium.
- In such cases, short-term and long-term rates will change and the markets will clear as investors and borrowers give up their hedge.

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Illustration

- Consider a situation in which, on the demand side, investors in corporate securities prefer short-term to long-term instruments
- On the supply side, corporations have a greater need to finance long-term assets than short-term, and therefore prefer to issue more long-term bonds than short-term.
- Combined, these relative preferences would cause an excess demand for short-term bonds and an excess supply for long-term claims and an equilibrium adjustment would have to occur.

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Illustration Cont…

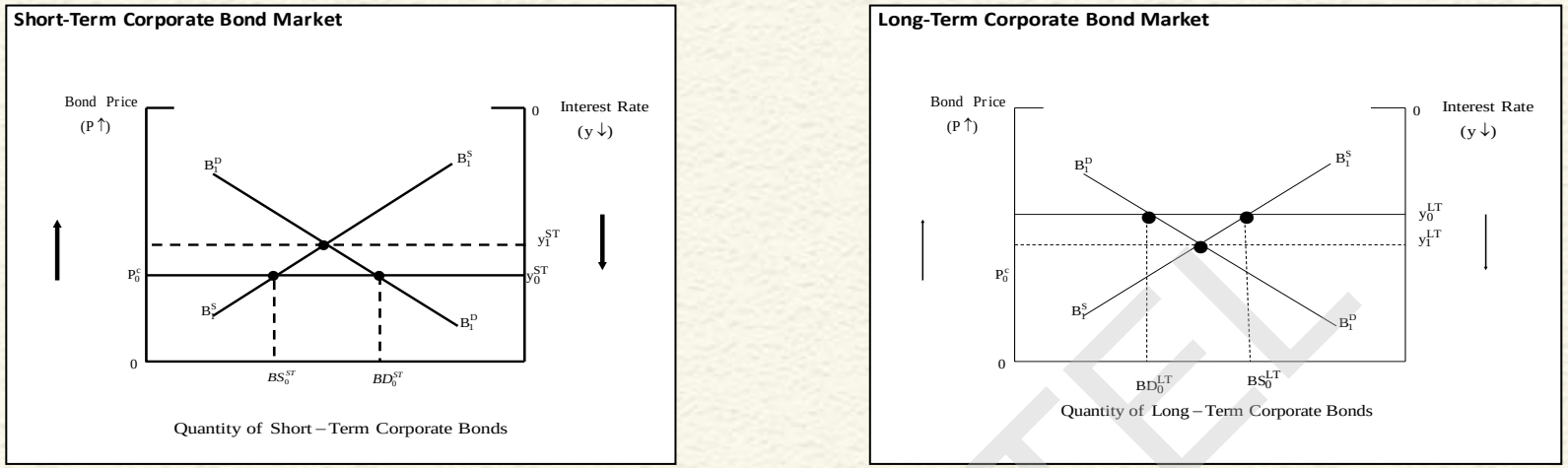
- In the long-term market, the excess supply would force issuers to lower their bond prices, thus increasing bond yields and inducing some investors to change their short-term investment demands.

- In the short-term market, the excess demand would cause bond prices to increase and rates to fall, inducing some corporations to finance their long-term assets by selling short-term claims.

- Ultimately, equilibriums in both markets would be reached with long-term rates higher than short-term rates, a premium necessary to compensate investors and borrowers/issuers for the market risk they have assumed.

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Illustration of Equilibrium Adjustment



The figure shows a short-term and long-term market for corporate bonds, where the bond demand in each segment is assumed to depend directly on its own segment's rate and the rate in the other segment, and where bond supply in each segment is assumed to depend inversely on its own rate and on the rate in the other segment.

The positions of the bond demand and supply graphs in the figure show an excess demand for short-term bonds and an excess supply of long-term bonds at a particular yield y^{ST}_0 and y^{LT}_0.

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Explanations

- The excess supply in the long-term market would force issuers to lower their bond prices, increasing long-term bond yields, and the excess demand in the short-term market would cause short-term bond prices to increase and their yields to fall.

- As long-term bond yields increase and short-term yields decrease, some investors would change their short-term investment demands or preference, increasing their demand for higher yielding long-term bonds (movement down the long-term bond demand curve) and decreasing their demand for lower yielding short-term bonds (movement up the short-term demand curve).

Explanations cont…

- On the supply side, the decrease in short-term rates and the increase in long-term rates would induce some corporations to finance their long-term assets by selling short-term claims.

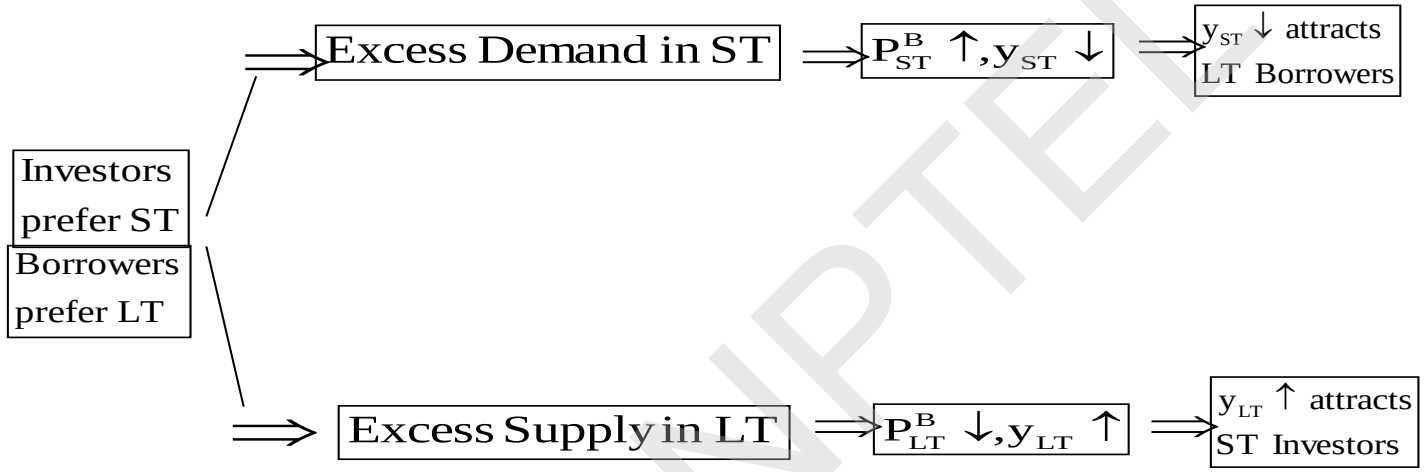
- This would lead to a substitution in which corporations would increase their sale of the lower yielding short-term bonds (movement up the short-term bond supply curve), and decrease their sale on the higher yielding long-term bonds (movement down the long-term supply curve).

- Ultimately, equilibriums in both markets would be reached with long-term rates higher than short-term rates.

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Summary

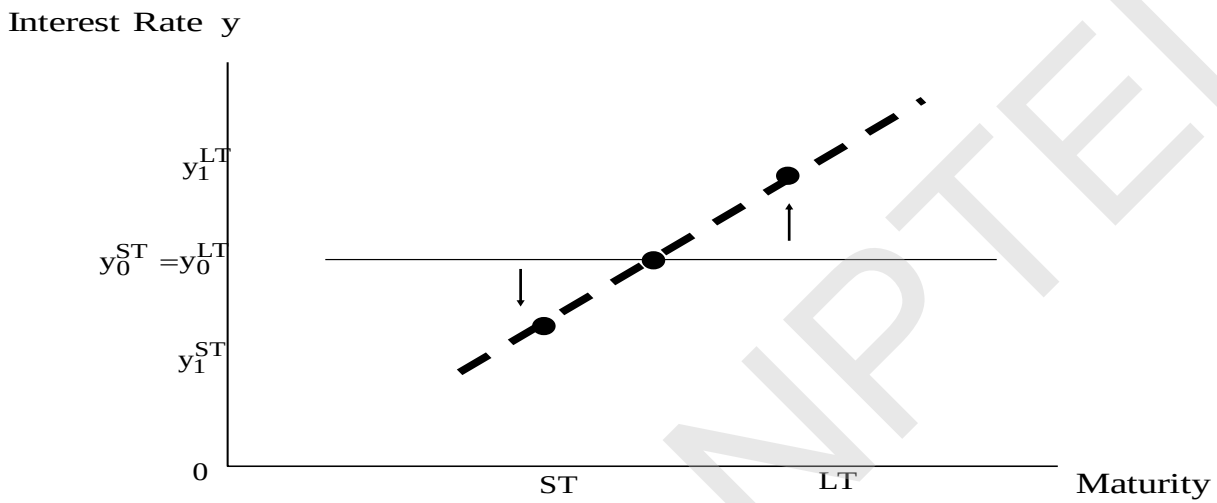
Poorly Hedged Situation: Investors prefer ST investments; corporate issuers/borrowers, prefer to borrow LT (sell LT corporate bonds):



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Bond Yield Curve

Corporate Bond Yield Curve



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Practical Scenarios

- PHT suggests that yield curves are positively sloped if investors prefer short-term to long-term investments and issuers prefer to issue long term bonds. That happens as longer maturity bonds tend to be more sensitive to interest rate changes and issuers have more long-term financing needs

- In the reverse situation the yield curve tends to be negatively sloped.

- Differential preferences make the economy poorly hedged

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CONCLUSIONS

- According to preferred habitat theory investors and borrowers or issuers will be induced to forego their perfect hedges and shift out of their preferred maturity segments when supply and demand conditions in different maturity markets do not match

- Long-term rates are higher than short-term rates as a premium necessary to compensate investors and borrowers/issuers for the market risk they've assumed

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REFERENCES

- Johnson, R.S. (2010), Bond Valuation, Selection, and Management, Second Edition, John Wiley & Sons, Inc., Hoboken, New Jersy.

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Lecture 18: The Term Structure of Interest Rates-VI

CONCEPTS COVERED

- **Pure Expectations Theory**

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KEYWORDS

- Implied forward rate
- Locking in strategy
- Bond investor expectations

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Pure Expectations Theory (PET)

- Explains the impact of investors' and borrowers' expectations on the term structure of interest rates

- PET posits that the yield curve is governed by the condition that the implied forward rate is equal to the expected sport rate.

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Implied Forward Rate

- ***Implied Forward Rate*** is the future rate that is implied by today's interest rate structure and it is attainable by a *locking-in strategy*
- Suppose the current YTM on a 2-year zero coupon bond is 9% and the current YTM on a 1-year zero coupon bond is 10%. Using the geometric mean, the implied forward rate on a 1-year bond, one year from now would be 8% (assume annual compounding).

$$YTM_2 = \left[(1+YTM_1)(1+f_{11})\right]^{1/2} - 1$$

$$f_{11} = \frac{(1+YTM_2)^2}{(1+YTM_1)} - 1$$

$$f_{11} = \frac{(1.09)^2}{(1.10)} - 1 = 0.08$$

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Locking in Strategy

- Execute a short sale by borrowing the one-year bond and selling it at its market price of Rs. 909.09 = Rs. 1,000/1.10 (or borrow Rs. 909.09 at 10%).
- With two-year bonds trading at Rs. 841.68 = Rs. $1,000/(1.09)^2$, buy Rs. 909.09/Rs. 841.68 = 1.08 issues of the two year bond.
- One year later, cover the short sale by paying the holder of the one-year bond his principal of Rs. 1,000 (or repay loan).
- Two years later receive the principal on the maturing two-year bond issues of (1.08)(Rs. 1,000) = Rs. 1080.

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Locking in Strategy Cont…

- With this locking-in strategy the investor does not make a cash investment until the end of the first year when he covers the short sale; in the present, the investor simply initiates the strategy.

- Thus, the investment of Rs. 1000 is made at the end of the first year. In turn, the return on the investment is the principal payment of Rs. 1080 on the 1.08 holdings of the two-year bonds that comes one year after the investment (short sale coverage) is made.

- The rate of return on this one-year investment is 8% ((Rs.1,080-Rs.1,000)/Rs. 1,000).

- Hence, by using a locking-in strategy, an 8% rate of return on a one-year investment to be made one year in the future is attained

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Impact of Market Expectations on Current Interest rate Structure

Assumptions:

1. Consider a market consisting of only two bonds: a risk-free *one- year zero-coupon bond* and a risk-free *two-year zero-coupon bond*, both with principals of Rs. 100.
2. Assume that supply and demand conditions are such that both the one-year and two-year bonds are trading at an 8% YTM.
3. Suppose that the market expects the yield curve to shift up to 10% next year, but, as yet, has not factored that expectation into its current investment decisions.
4. Assume the market is risk-neutral, such that investors do not require a risk premium for investing in risky securities (i.e., they will accept an expected rate on a risky investment that is equal to the risk-free rate).
5. Investors with one-year and two-year horizon periods are willing to consider alternative segments (or bond demand is a function of expected rates).
6. Issuers have a strong maturity segmentation preference and are not willing to assume interest rate risk

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Impact of Market Expectations on Current Interest rate Structure Cont…

Consider investors with horizon period = 2 years

Alternatives:

Buy 2-year bond at 8%

Buy a series of 1-year bonds: 1-year bond today at 8% and 1-year bond one year later at $E(r_{11}) = 10\%$. The expected return from the series would be :

$$YTM_{2:Series} = \left[(1.08)(1.10)\right]^{1/2} - 1 = 0.09$$

In a risk-neutral world, investors with horizon period of 2 years would prefer the series of 1-year bonds over the 2-year bond.

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Impact of Market Expectations on Current Interest rate Structure Cont…

Consider investors with horizon period = 1 year

Alternatives:

Buy 1-year bond at 8%.

Buy a 2-year bonds at 8% for $P_2 = 100/(1.08)^2 = 85.734$, then sell it one year later at an expected price of $E(P_{11}) = 100/(1.10) = 90.91$. The expected rate of return would be:

$$E(r_{11}) = \frac{90.91 - 85.734}{85.734} = 0.06$$

- In a risk-neutral world, investors with horizon period = 1 year would prefer the 1-year bond over the 2-year bond.

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Impact of Market Expectations on Current Interest rate Structure Cont…

- In a risk-neutral market with an expectation of higher rates next year, both investors with one-year horizon dates and investors with two-year horizon dates would purchase one-year instead of two-year bonds

- If many investors do this, an increase in the demand for one-year bonds and a decrease in the demand for two-year bonds would occur until the average annual rate on the two-year bond is equal to the equivalent annual rate from the series of one-year investments (or where the one-year bond's rate is equal to the rate expected on the two-year bond held one year).

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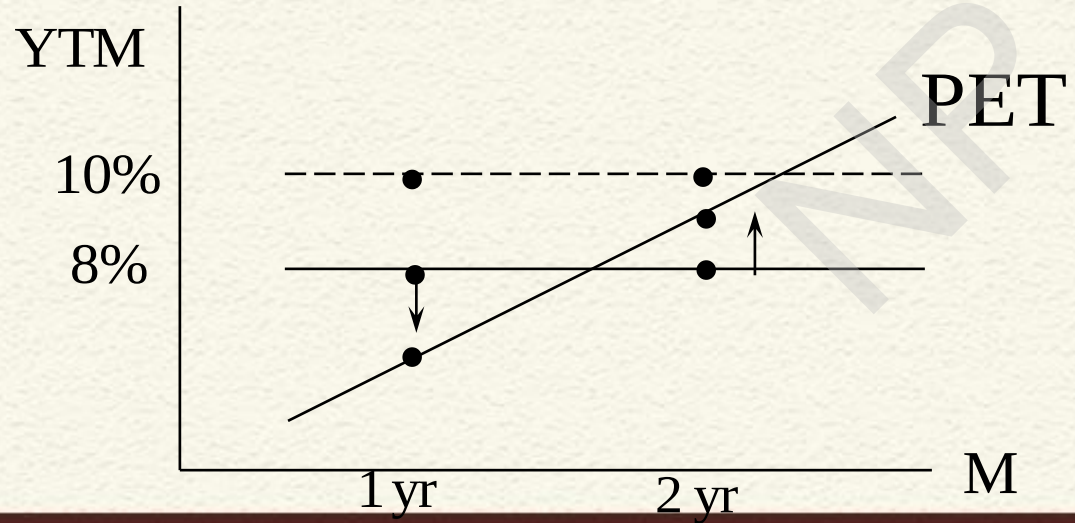
Impact of Market Expectations on Current Interest rate Structure Cont…

Investors with HD of 2 years and those with HD of 1 year would prefer one-year bonds over two- year bonds.

Market Response:

$B_2^D \downarrow \Rightarrow P_2^B \downarrow \Rightarrow y_2 \uparrow$

$B_1^D \uparrow \Rightarrow P_1^B \uparrow \Rightarrow y_1 \downarrow$



YC becomes Positively Sloped

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Possible Equilibrium Scenarios

One scenario would be for the adjustment to take place solely in two-year market.

In the example, if the price on a two-year bond fell such that it traded at a YTM of 9% and the rate on a one-year bond stayed at 8%, then investors with two-year horizon dates would be indifferent between a two-year bond yielding a certain 9% and a series of one-year bonds yielding 10% and 8%, for an expected rate of 9%.

Investors with one-year horizon dates would likewise be indifferent between a one-year bond yielding 8% and a two-year bond purchased at 9% and sold one year later at 10%, for an expected one-year rate of 8%.

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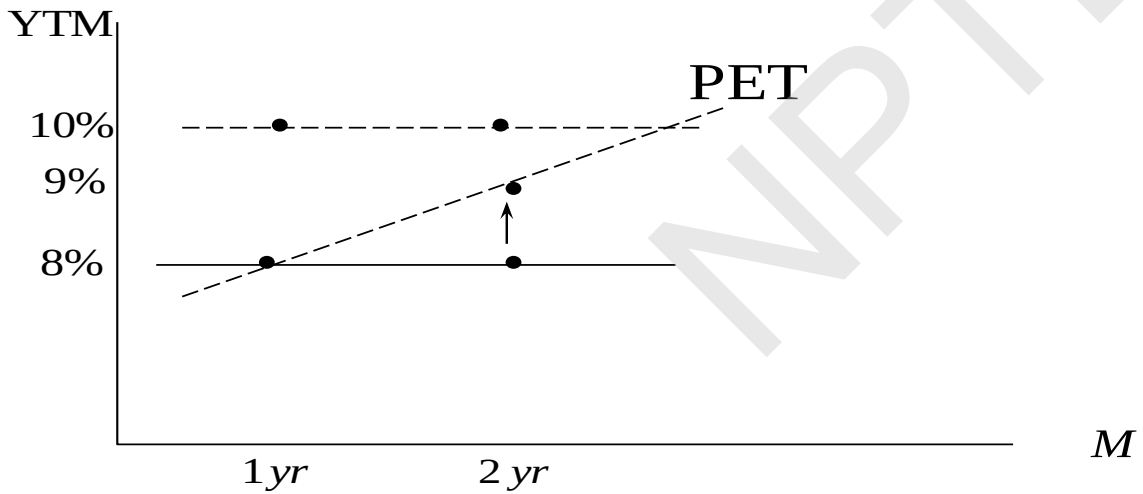
Possible Equilibrium Scenarios Cont…

If the market response to the expectation is only in terms of a change in the two-year bond, then then equilibrium yield on the two-year will be 9%.

$B_2^D \downarrow \Rightarrow P_2^B \downarrow \Rightarrow YTM_2 \uparrow$

$YTM_2 \uparrow$ until $YTM_2 = YTM_{2:series} = 9\%$

When $YTM_2 = 9\%$, $YTM_1 = 8\%$, then $f_{11} = E(R_{11}) = 10\%$.



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Possible Equilibrium Scenarios Cont…

- ***Another scenario*** would be for the adjustment to take place solely in one-year market.

- In this case, if the price on the one-year bond increased such that it traded at a YTM of 6%, and the rate on the two-year bond stayed at 8%, then investors with one-year horizon dates would be indifferent between a one-year bond yielding a certain 6% and a two-year bond (priced at Rs. 857.34 = Rs. $1,000/1.08^2$) that they would sell one year later at expected one-year yield of 10% to earn an expected rate of 6%.

- At one-year and two-year yields of 6% and 8%, respectively, investors with two-year horizon dates would be indifferent between a two-year bond yielding a certain 8% and a series of one-year bonds yielding 6% and 10%, for an expected rate of 8%.

- Thus in this adjustment scenario, the impact of the market's expectation of higher rates would be to push the shorter term one-year rates down to 6%

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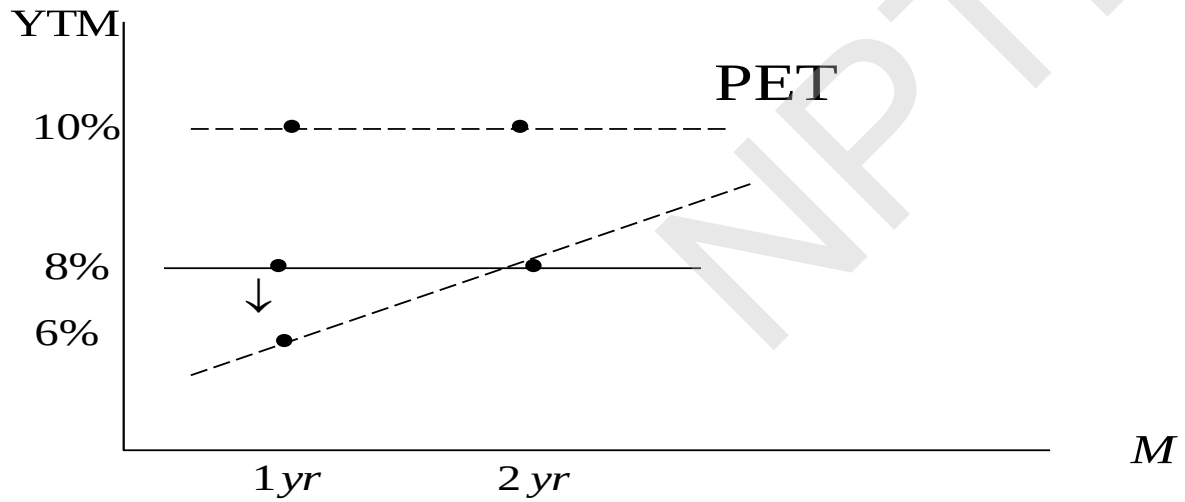
Possible Equilibrium Scenarios Cont…

If the market response to the expectation is only in terms of a change in the one-year bond, then then equilibrium yield on the one-year will be 6%.

$B_1^D \uparrow \Rightarrow P_1^B \uparrow \Rightarrow YTM_1 \downarrow$

$YTM_1 \downarrow$ until $YTM_1 = YTM_1(\text{holding } 2-\text{yr}, 1\text{yr}) = 6\%$

When $YTM_1 = 6\%$, $YTM_2 = 8\%$, then $f_{11} = E(R_{11}) = 10\%$.



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Possible Equilibrium Scenarios Cont…

- In this example, if the equilibrium YTM on the two-year bond is 9% and the equilibrium YTM on the one-year bond is 8%, then *the implied forward rate is 10%,* the same as the expected rate on a one-year bond, one year from now.

- Similarly, if the equilibrium YTM on the two-year bond is 8% and the equilibrium YTM on the one-year bond is 6%, then the *implied forward rate is also 10%,* the same as the expected rate on a one-year bond, one year from now.

- Thus, in equilibrium the yield curve will be governed by the condition that the implied forward rate is equal to the expected spot rate of 10%.

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Possible Equilibrium Scenarios Cont…

$$YTM_2 = [(1+YTM_1)(1+f_{11})]^{1/2} - 1$$

$$f_{11} = \frac{(1+YTM_2)^2}{(1+YTM_1)} - 1$$

$$f_{11} = \frac{(1.09)^2}{(1.08)} - 1 = 0.10$$

or

$$f_{11} = \frac{(1.08)^2}{(1.06)} - 1 = 0.10$$

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CONCLUSIONS

- Implied forward rate is the future rate that is implied by today's interest rate structure
- According to pure expectations theory the yield curve is governed by the condition that the implied forward rate is equal to the expected sport rate.

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Lecture 19: The Term Structure of Interest Rates-VII

CONCEPTS COVERED

- **Pure Expectations Theory**

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KEYWORDS

- Expectations
- Bond Issuer Response

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Expectations and Bond Issuers Response

- Let bond issuers and borrowers also consider expectation, and also like investors, they are risk neutral.

- Issuers/borrower consider expectations in their current financing decisions suggests that a bond issuer financing a two-year asset would consider issuing either:

  (i) A two-year bond at 8%

  or

  (ii) A series of one-year bonds: one-year today at 8% and a one-year bond one year later at 10% for an average rate of 9%.

The two-year borrower would therefore prefer to issue two-year bonds at 8%.

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Expectations and Bond Issuers Response Cont…

A bond issuer financing a one-year asset – *one-year borrower* – could issue either:

(i) A one-year bonds at 8%

or

(ii) A two-year bond at 8% (for example, borrowing 857.3388 = 1000/(1.08)2) and then buy the bond back in the market (or prepay) one year later when rates are at 10% and the price on bond is 909.09 (= 1000/1.10), paying a one-year borrowing rate of 6% (= (909.09 /857.3388) – 1).

A one-year borrower would therefore prefer to issue two-year bonds instead of one-year.

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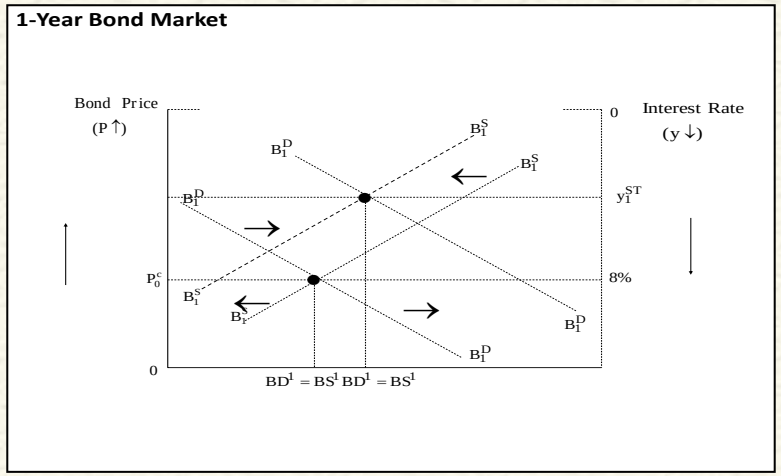
Expectations and Bond Issuers Response Cont…

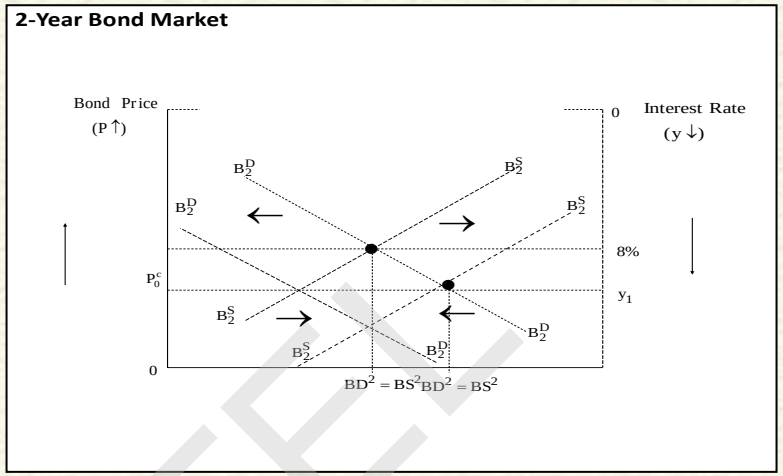
- In the ***two-year market***, the expectation of higher rates would cause the supply of two-year bonds to increase (rightward shift in the bond supply curve), lowering their price and increasing the two-year yield. This would, in turn, reinforce the demand impact where the demand and price for two-year bonds are decreasing, causing two-year yields to increase.

- In the ***one-year market***, the expectation of higher rates would cause the supply of one-year bonds to decrease (leftward shift in the one-year bond supply curve), increasing their price and lowering the one-year yield. This would, in turn, reinforce the demand impact where the demand and price for one-year bonds are increasing, causing one-year yields to decrease.

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Illustration of Equilibrium Adjustment





In equilibrium, the increase in the supply of two-year bonds (rightward shift in the two-year bond supply curve) and the decrease in the supply for one-year bonds (leftward shift in the one-year bond supply curve), combined with the demand adjustments of one-year bond demand increasing (one-year bond demand curve shifting right) and two-year bond demand decreasing (two-year bond demand curve shifting left) will continue until the average annual rate on the two-year bond is equal to the equivalent annual rate from the series of one-year loans (or the one-year bond's rate is equal to the rate expected on the two-year bond held one year).

Yield Curve with Pure Expectations of Higher Interest Rates: Investors and Issuers Response

- Expectations of rates increasing from 8% to 10%.
- Investors with HD of 2 years and those with HD of 1 year would prefer one-year bonds over two- year bonds.
- 2-year borrowers would prefer to finance with 2-year bonds and 1-year borrower would prefer to finance with 2-year bonds.
- Market Response:

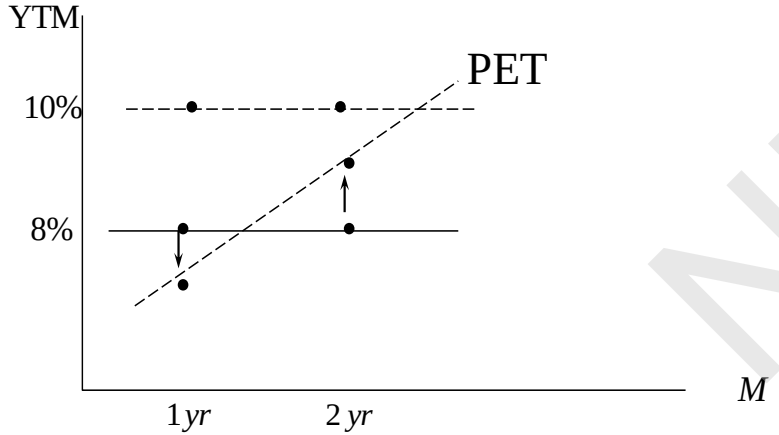
$B_2^D \downarrow \Rightarrow P_2^B \downarrow \Rightarrow YTM_2 \uparrow$

$B_2^S \uparrow \Rightarrow P_2^B \downarrow \Rightarrow YTM_2 \uparrow$

$B_1^D \uparrow \Rightarrow P_1^B \uparrow \Rightarrow YTM_1 \downarrow$

$B_1^S \downarrow \Rightarrow P_1^B \uparrow \Rightarrow YTM_1 \downarrow$

YC Becomes Positively Sloped



Similar to investors, the response of issuers/borrowers to the expectation of higher rates contributes to the steepening of the yield curves.

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Market Expectations of Lower Interest Rates

- Given a yield curve currently flat at 10% and a market expectation that it would shift down to 8% next year, an investor with a two-year horizon date would prefer the two-year bond at 10% to a series of one-year bonds yielding an expected rate of only 9% ($E(R) = [(1.10)(1.08)]^{1/2} - 1 = 0.09$).

- Similarly, an investor with a one-year horizon would also prefer buying a two-year bond that has an expected rate of return of 12% ($P_2 = 100/(1.10)^2 = 82.6446$, $E(P_{11}) = 100/1.08 = 92.5926$, $E(R) = [92.5926-82.6446]/82.6446 = 0.12$) to the one-year bond that yields only 10%.

- Both one-year and two-year investors would therefore prefer to buy two-year bonds instead of one-year.

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Market Expectations of Lower Interest Rates Cont…

- A two-year borrower would favor financing with a series of one-year bonds at 10% and 8% for an average of 9% ([(1.10)(1.08)]1/2 -1 = 0.09) to a two-year bond at 10%.

- Similarly, a one-year borrower would prefer current financing with one-year bonds at 10% to issuing a two-year bond at 10% (for example, borrowing 826.4463 = $1000/(1.10)^2$) and then buying the bond back in the market one year later when rates are at 8% and the price on bond is 925.9259 (= 1000/1.08), paying a one-year borrowing rate of 12% (= (925.9259/826.4436) – 1).

- Both one-year and two-year borrowers would therefore prefer to issue one-year bonds instead of two-year.

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Market Expectations of Lower Interest Rates Cont…

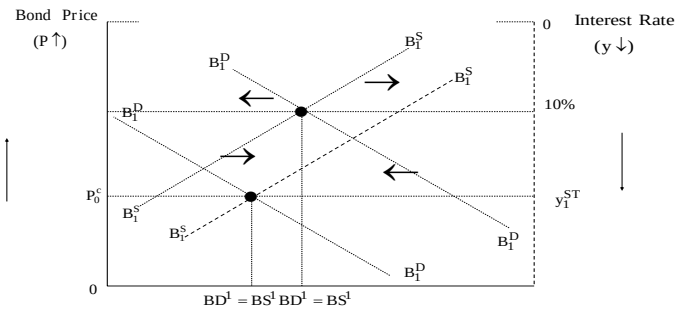
- In the market, the expectation of lower rates would cause the supply of two-year bonds to decrease (leftward shift in the bond supply curve), increasing their price and decreasing the two-year yield, and the supply of one-year bonds to increase (rightward shift in the one-year bond supply curve), decreasing their price and increasing the one-year yield.

- These adjustments along with the demand adjustments of one-year bond demand decreasing (one-year bond demand curve shifting left) and two-year bond demand increasing (two-year bond demand curve shifting right) would continue until the rate on the two-year bond equaled the average rate from the series of one-year investments, or until the rate on the one-year bond equaled the expected rate from holding a two-year bond one year (or when the implied forward rate is equal to expected spot rates) – the same equilibrium condition as bond investors.

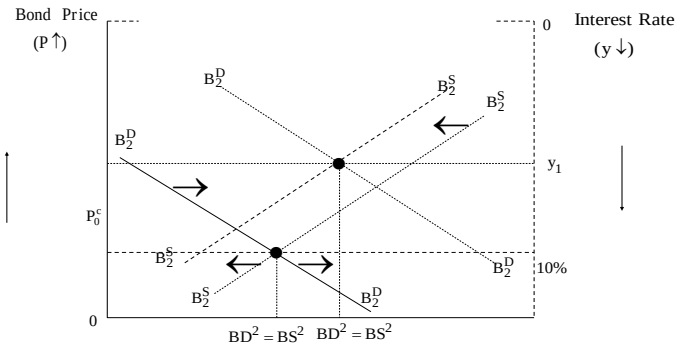
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Market Expectations of Lower Interest Rates Cont…

1-Year Bond Market



2-Year Bond Market

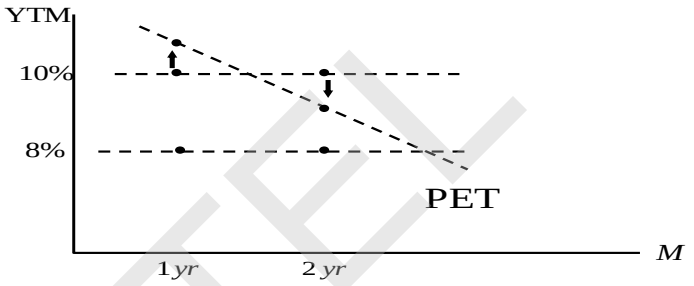


- Expectations of rates decreasing from 10% to 8%.
- Investors with HD of 2 years and those with HD of 1 year would prefer two-year bonds over one- year bonds.
- 2-year and 1-year borrowers would prefer to finance with 1-year bonds. Market Response:

$B_1^D \downarrow \Rightarrow P_1^B \downarrow \Rightarrow YTM_1 \uparrow$ $B_2^D \uparrow \Rightarrow P_2^B \uparrow \Rightarrow YTM_2 \downarrow$

$B_1^S \uparrow \Rightarrow P_1^B \downarrow \Rightarrow YTM_1 \uparrow$ $B_2^S \downarrow \Rightarrow P_2^B \uparrow \Rightarrow YTM_2 \downarrow$

YC Becomes Negatively Sloped



If the yield curve were currently flat at 10% and there was a market expectation that it would shift down to 8% next year, then the expectation of lower rates would cause the yield curve to become negatively sloped.

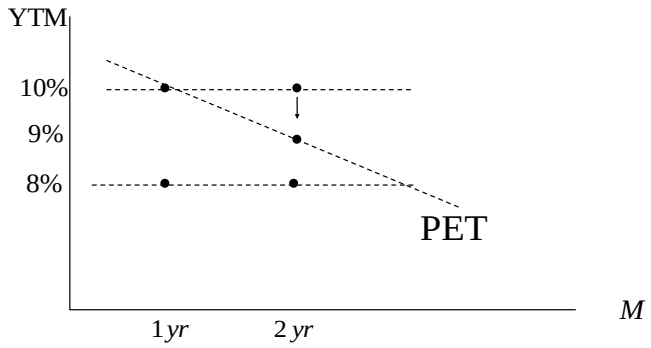
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Market Expectations of Lower Interest Rates Cont…

If the market response to the expectation is only in terms of a change in the two-year bond, then then equilibrium yield on the two-year will be 9%.

$B_2^D \uparrow \Rightarrow P_2^B \uparrow \Rightarrow YTM_2 \downarrow$
$YTM_2 \downarrow$ until $YTM_2 = YTM_{2series} = 9\%$

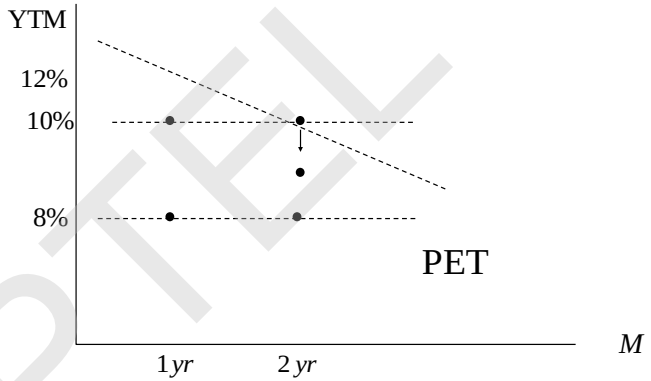
When $YTM_2 = 9\%$, $YTM_1 = 10\%$, then $f_{11} = E(R_{11}) = 8\%$.



If the market response to the expectation is only in terms of a change in the one-year bond, then then equilibrium yield on the one-year will be 12%.

$B_1^D \downarrow \Rightarrow P_2^B \downarrow \Rightarrow YTM_2 \uparrow$
$YTM_1 \uparrow$ until $YTM_1 = YTM(\text{holding } 2\text{yr}, 1\text{year}) = 12\%$

When $YTM_2 = 10\%$, $YTM_1 = 12\%$, then $f_{11} = E(R_{11}) = 8\%$



Whether the one-year and two-year yields are at 10% and 9% ,12% and 10%, or somewhere in between, the resulting yield curve will satisfy the condition that the implied forward rate is equal to the expected spot rate of 8%:

$$YTM_2 = [(1 + YTM_1)(1 + f_{11})]^{1/2} - 1$$

$$f_{11} = \frac{(1 + YTM_2)^2}{(1 + YTM_1)} - 1$$

$$f_{11} = \frac{(1.09)^2}{(1.10)} - 1 = .08$$

or

$$f_{11} = \frac{(1.10)^2}{(1.12)} - 1 = .08$$

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Market Expectations of No Change in Interest Rates

- Suppose the yield curve is currently positively sloped, with the rate on the one-year bond at 8% and the rate on the two-year bond at 9%. This time, though, suppose that the market expects no change in yields and that this expectation has not yet been reflected in the yield curve.

- In this scenario, investors with horizon dates of two years would prefer the two-year bond yielding 9% to a series of one-year bonds yielding 8% now and 8% expected at the end of one year (for a two-year equivalent of 8%).

- Similarly, investors with one-year horizon dates would also prefer the two-year bond held for one year in which the expected rate is 10%, compared to only 8% from the one-year bond.

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Market Expectations of No Change in Interest Rates

- Given the investors preference for two-year bonds, a market response would occur in which demand for the two-year bond would rise, in turn increasing its price and lowering its yield, and the demand and price for the one-year bond would decrease, increasing its yield.

- Thus, investors would flatten the positively-sloped yield curve, given the expectation of no change in the yield curve.

- Bond suppliers would also contribute to a flattening of the positively-sloped yield curve given the expectation of no change in the yield curve.

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CONCLUSIONS

- The response of issuers/borrowers to the expectation of higher rates contributes to the steepening of the yield curves.
- The expectation of lower rates would cause the yield curve to become negatively sloped.
- Investors would flatten the positively-sloped yield curve, given the expectation of no change in the yield curve

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- Johnson, R.S. (2010), Bond Valuation, Selection, and Management, Second Edition, John Wiley & Sons, Inc., Hoboken, New Jersy.

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NPTEL ONLINE CERTIFICATION COURSES

Management of Fixed Income Securities

Prof. Jitendra Mahakud
Department of Humanities and Social Sciences
Indian Institute of Technology Kharagpur

Lecture 20: The Term Structure of Interest Rates-VIII

CONCEPTS COVERED

- Features of Pure Expectations Theory
- Forecasting Future Spot Yield Curve
- Liquidity Premium Theory

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KEYWORDS

- Spot Yield Curve
- Expected Rate of Return
- Hedgeable Rate
- Risk Premium

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Features of Pure Expectations Theory

- In equilibrium the yield curve reflects current expectations about future rates.
- When the equilibrium yield curve was positively sloped, the market expected higher rates in the future.
- When the curve was negatively sloped, the market expected lower rates.
- If PET strictly holds then the expected future rates would be equal to the implied forward rates.
- Given a spot yield curve, one could use PET to estimate next period's spot yield curve by determining the implied forward rates

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Forecasting Future Spot Yield Curves (Example)

Maturity	Spot Rates	Expected Spot Rates One year from Present	Expected Spot Rates Two Years from Present
(1)	(2)	(3)	(4)
1	10.0%		
2	10.5%		
3	11.0%		
4	11.5%		
5	12.0%		

This Table shows spot rates on bonds with maturities ranging from one year to five years (Column-2). From these rates, expected spot rates (S_t) can generated for bonds one year from the present (Column-3) and two years from the present (Column-4). The expected spot rates shown are equal to their corresponding implied forward rates.

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Forecasting Future Spot Yield Curves (Example Cont…)

f_{12}

$$S_3 = [(1+S_1)(1+f_{11})(1+f_{12})]^{1/3} - 1$$

$$S_3 = [(1+S_2)^2(1+f_{12})]^{1/3} - 1$$

$$f_{12} = \frac{(1+S_3)^3}{(1+S_2)^2} - 1$$

$$f_{12} = \frac{(1.11)^3}{(1.105)^2} - 1 = 0.12$$

f_{32}

$$S_5 = [(1+S_1)(1+f_{11})(1+f_{12})(1+f_{13})(1+f_{14})]^{1/5} - 1$$

$$S_5 = [(1+S_2)^2(1+f_{32})^3]^{1/5} - 1$$

$$f_{32} = \left[\frac{(1+S_5)^5}{(1+S_2)^2}\right]^{1/3} - 1$$

$$f_{32} = \left[\frac{(1.12)^5}{(1.105)^2}\right]^{1/3} - 1 = 0.13$$

General Formula :

$$f_{Mt} = \left[\frac{(1+S_{M+t})^{M+t}}{(1+S_t)^t}\right]^{1/M} - 1$$

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Forecasting Future Spot Yield Curves (Example Cont…)

Maturity	Spot Rates	Expected Spot Rates One year from Present	Expected Spot Rates Two Years from Present
(1)	(2)	(3)	(4)
1	10.0%	f_{11} = 11.0%	f_{12} = 12.0%
2	10.5%	f_{21} = 11.5%	f_{22} = 12.5%
3	11.0%	f_{31} = 12.0%	f_{32} = 13.0%
4	11.5%	f_{41} = 12.5%	
5	12.0%		

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Using Forward Rates to Determine Expected Rates of Return

- According to PET, if the market is risk-neutral, then the implied forward rate is equal to the expected spot rate and the expected rate of return for holding any bond for one year is equal to the current spot rate on one-year bonds
- Example: What is the expected rate of return from purchasing a two-year zero-coupon bond at the spot rate of 10.5% and selling it one year later at an expected one-year spot rate equal to the implied forward rate of f_{11} = 11%? Face Value: Rs. 100

$$E(P_{11}) = \frac{100}{1.11} = 90.09$$

$$P_{20} = \frac{100}{(1.105)^2} = 81.8984$$

$$E(R) = \frac{90.09 - 81.8984}{81.8984} = 0.10$$

This is the same rate obtained from investing in a one-year bond.

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Using Forward Rates to Determine Expected Rates of Return Example Cont…

What is the expected rate of return from holding a three-year bond for one year, then selling it at the implied forward rate of f_{21} of 11.5%, Face value: Rs. 100

$$E(P_{21}) = \frac{100}{(1.115)^2} = 80.43596$$

$$P_{30} = \frac{100}{(1.11)^3} = 73.1191$$

$$E(R) = \frac{80.43596 - 73.1191}{73.1191} = 0.10$$

Any of the bonds with spot rates shown in the exhibit would have expected rates for one year of 10% if the implied forward rate were used as the estimated expected rate.

Similarly, any bond held for two years and sold at its forward rate would earn the two-year spot rate of 10.5%.

For example, a four-year bond purchased at the spot rate of 11.5% and expected to be sold two years later at f_{22} = 12.5%, would trade at an expected rate of 10.5% – the same as the current two-year spot.

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Hedgable Rates

- Analysts often refer to forward rates as **hedgable rates.**
- The most practical use of forward rates or expected spot yield curves generated from forward rates is that they provide **cut-off rates**, useful in evaluating investment decisions.
- For example, an investor with a one-year horizon date should only consider investing in the two-year bond in our example, if the investor expected one-year rates one year later to be less than f_{11} = 11%.
- Thus, forward rates serve as a good cut-off rate for evaluating investments.

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Determination of Long-term YTM

The long-term YTM expressed as an average (geometric average) of today's rate and implied forward rates, f_{MT}.

$$YTM_M = [(1+YTM_1)(1+f_{11})(1+f_{12})(1+f_{13})\cdots(1+f_{1,M-1})]^{1/M} - 1$$

Example: 3-year zero-coupon bond trading at Rs. 800, principal of Rs. 1000 at maturity, annual compounding . Find the YTM

One Method: $[1000/800]^{1/3} - 1 = 0.0772 = 7.72\%$

There are other ways in which an Rs. 800 investment can grow to equal Rs. 1,000 at the end of three years.

Example: If rates on current 1-year bonds are at $R_{Mt} = R_{10} = 10\%$, rates on 1-year bonds one year from now are expected to be at $R_{11} = 8\%$, and rates on 1-year bonds two years from now are expected to be at $R_{12} = 5.219\%$, then an Rs. 800 investment will grow over three years to equal Rs. 1,000.

$$800(1.10)(1.08)(1.05219) = 1000$$

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Determination of Long-term YTM

YTM of 7.72% can therefore be viewed as the geometric average of 10%, 8%, and 5.219%:

$$P_0^B(1+YTM_M)^M = F = P_0^B[(1+YTM_1)(1+R_{11})(1+R_{12})(1+R_{13})\cdots(1+R_{1,M-1})]$$

$$(1+YTM_M)^M = \frac{F}{P_0^B} = [(1+YTM_1)(1+R_{11})(1+R_{12})(1+R_{13})\cdots(1+R_{1,M-1})]$$

$$(1+YTM_3)^3 = (1.0772)^3 = \frac{1000}{800} = [(1.10)(1.08)(1.05219)]$$

$$YTM_M = [(1+YTM_1)(1+R_{11})(1+R_{12})(1+R_{13})\cdots(1+R_{1,M-1})]^{1/M} - 1$$

$$YTM_3 = [(1.10)(1.08)(1.05219)]^{1/3} - 1 = 0.0772$$

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Liquidity Preference Theory

- A limitation of PET is that it does not consider risk as it assumes a risk neutral world.
- Long-term bonds are more price sensitive to interest rate changes than short-term bonds. As a result, the prices of long-term securities tend to be more volatile and therefore more risky than short-term securities.
- The ***Liquidity Premium Theory*** (LPT), also referred to as the ***Risk Premium Theory*** (RPT), posits that there is a liquidity premium for long-term bonds over short-term bonds.
- LPT asserts that investors will hold longer maturity bonds if they offer higher yields than the expected future rate, with the risk premium increasing with the terms to maturity.
- This would suggest that the yield curve is governed by the condition that the expected spot rate is equal to the forward rate plus a liquidity premium (LP) equal to a maturity spread ($R_{LT} - R_{ST}$), with the premium increasing with maturity.

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CONCLUSIONS

- When the equilibrium yield curve was positively sloped, the market expected higher rates in the future.
- When the curve was negatively sloped, the market expected lower rates.
- If PET strictly holds then the expected future rates would be equal to the implied forward rates.
- The long-term YTM expressed as an average (geometric average) of today's rate and implied forward rates
- The Liquidity Premium Theory posits that there is a liquidity premium for long-term bonds over short-term bonds.

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