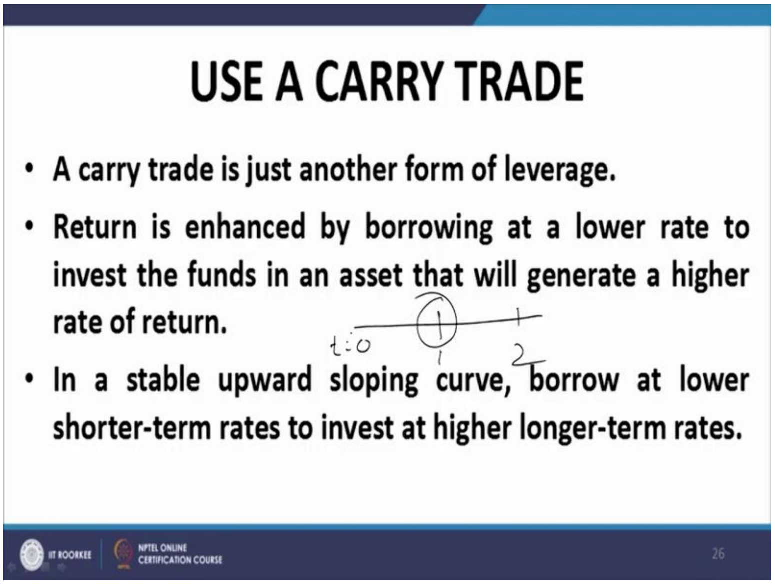
**Quantitative Investment Management**
**Professor J P Singh**
**Department of Management Studies**
**Indian Institute of Technology, Roorkee**
**Lecture 30**
**Fixed Income Portfolio Strategies - 2**

(Refer Slide Time: 00:36)




Let us continue from where we left off. The next strategy that I am going to talk about is using of this carry trade. A carry trade is just another form of leverage. Return is enhanced by borrowing at a lower rate and investing the funds in an asset that will generate a higher rate of return. Now the important point, let me cover the next point before I continue with it.

In a stable upward sloping will curve, borrow at lower short term rates to invest at higher long term rates. But there is a catch in this strategy, you see. That is what I want to highlight. Otherwise, this strategy in itself seems pretty elementary that you borrow funds at a cheaper rate and invest it at a higher rate, but had it been so simple, everybody in the world would have done the same thing.

The point is that there is an element of involvement of risk here, an enhancement of risk when you are investing in a sta, in a bond or in an instrument in giving you, or likely to give you a higher expected return. I emphasize strongly as I have been emphasizing throughout this course that we do the analysis on a two dimensional framework, the risk and the expected return.

The marketable securities have this property due to the interplay of millions of market players that the risk and return are compatible. Return, higher the risk in a particular investment, greater would be the expected return and vice versa. That plays or that rule applies equally well when we talk about carry trade. Let me illustrate what I am trying to say.

Let us say I borrow money at t equal to 0 for 1 year and I invest some money at a, in a 2 year bond right. Let me repeat. At t equal to 0, I borrow, say, 1,000 rupees, and, for 1 year, and I invest it in a 2 year bond. Now, at t equal to 1, there are two situations that are possible. Number 1, I liquidate my bond investment and I repay of the borrowing so that if there is a profit, if there is a capital gain, very good.

The other option is that at t equal to 1, I again borrow or I roll over that borrowing for another 1 year and hold the bond until the maturity. Let me repeat the problem. The problem is at t equal to 0, I borrow a certain amount of money, say, 1,000 rupees and invest in a 2 year bond. Now, at t equal to 1, because my borrowing is for 1 year, I have, one, I have to take one of the two situations.

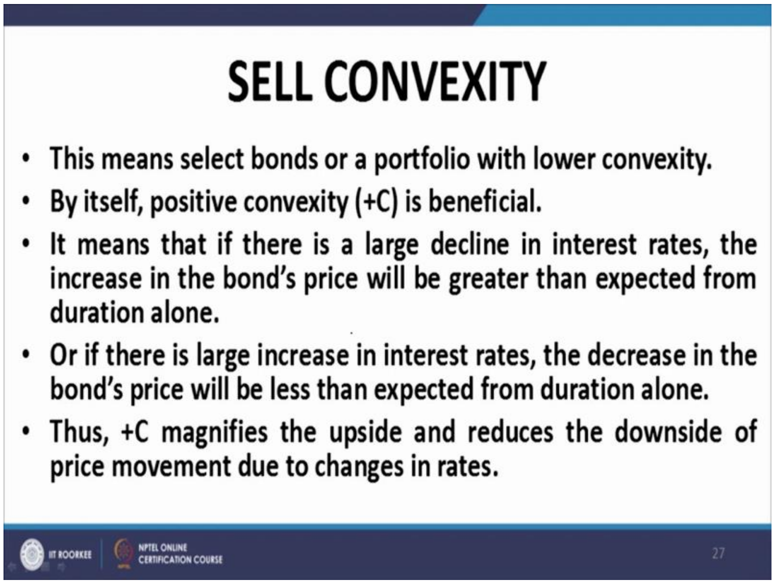
One is I repay of the borrowing by selling the investment in the market, two-year bond at t equal to 1 year, or I roll over the borrowing for another 1 year and hold the investment up to its maturity. Now, the point here is, the catch here is that when at t equal to 1, I do, I, I take up either of these two courses, either of these two approaches, I am exposed to risk, additional risk.

If I try to liquidate the 2 year bond at t equal to 1, year it would depend on the actual interest rates prevailing in the market at t equal to 1 year, not the projected rates that I had at t equal to 0, but it would depend on the actual interest rates that would prevail in the market at t equal to 1 year. I repeat, they may be different from the rates that were projected by me at t equal to 0 when I undertook the strategy.

So that is the additional risk. Interest rates are stochastic processes and they, their perfect prediction is obviously not possible. The second thing is, if I adopt the second strategy, the rate at which I am going to get the rollover, the rate at which this invest, this borrowing of 1 year is going to be rolled over from 1 year to 2 years would again depend on the market rates that prevail, unless of course I take a forward contract, which is not the issue here, which is not being considered here.

So in the absence of a forward contract, the rate at which my borrowing is going to be rolled over from 1 year to 2 year would again be a random variable, would again depend on market circumstances that prevail at t equal to 1 year. So when you are taking of this kind of trade, you are also being exposed to additional risk and the higher return that you anticipate is the consequence of this incremental risk that you are taking. So the principle of risk return tradeoff is not violated here.

(Refer Slide Time: 04:52)




Sell convexity. This is a very interesting strategy. I have been emphasizing it again and again that the convexity correction is positive. The convexity correction is positive. That means what? That means if there is a parallel shift upwards or downwards in the interest rates, in the market interest rates, the correction due to convexity is always positive, it always leads to an increase in price.

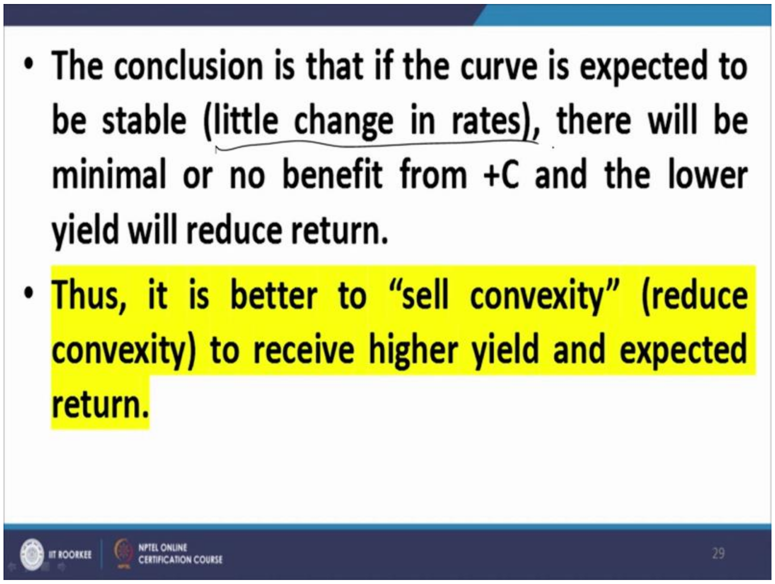
And that means what? That means the convexity, if you, if you, because the convexity is always to the benefit of the older, order, or always yields to an increase in price, that means what? That means the convexity is command, going to command a price in the market. So if you are able to sell convexity, you would obviously make some profits out of it. How you do it? Let us just go through this.

This means select bonds or a portfolio with lower convexity. Lower the convexity, the cheaper would be your investment, lesser would be your investment because higher the convexity, higher is the benefit from an interest rate change, and therefore higher would be the price or value of that investment. By itself, positive convexity is beneficial. That is what I mentioned just now.

It means that if there is a large decline in interest rates, the increase in the bonds price will be greater than expected from duration alone. So if there is a decline in interest rates, the price increases but the convexity correction is an add-on to the price that would have been worked out on the basis of using duration alone. And if there is a large increase in interest rate, the price decline worked out on, on the basis of duration alone, would be reduced by the convexity correction.

The convexity correction would operate opposite to the decline in prices, it would reduce the decline in prices, that is worked out on the basis of duration alone. Thus, plus C magnifies the upside and reduces the downside of price movement due to changes in rates.

(Refer Slide Time: 06:51)




The changes in rates have to be rather large. This is this is an issue of magnitudes, rather. So notwithstanding the fact that the convexity correction is always positive, the important thing that we need to keep in mind is that the impact of this convexity correction is minimal, and in order that it be significant, the interest rate changes have to be quite large because convexity is a second order correction in the Taylor series, as you know.

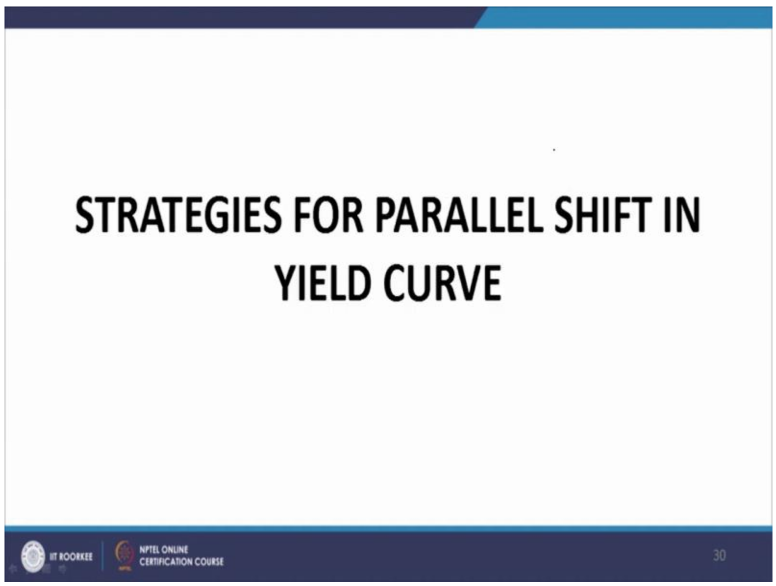
That means plus C has little impact on changes in price unless the rate change is significant. Of course, there is rarely any free lunch. Bonds or portfolios with higher plus C normally have lowest yield. So that is the catch. That means what? That means if you are not expecting a significant increase in or decrease in interest rates, it would be better to take up or better to constitute a bond portfolio with lower convexity because the convexity correction is not going to be material.

On the other hand, by opting for bond portfolio with higher convexity, you may be required or you may be actually sacrificing expected yield to significant action. So it is again a tradeoff. Higher convexity means lesser yield, higher convexity means greater positive convexity correction. Similarly, lower convexity means lower correction in the, in the price, but relatively higher yield in the portfolio itself.

So that is the trade-off. Higher convexity means higher price correction, positive price correction but lower market yield. Conversely, lower capacity means, lower convexity means lower price correction, and relatively higher yields in the bond portfolio. So again, we have a trade-off here.

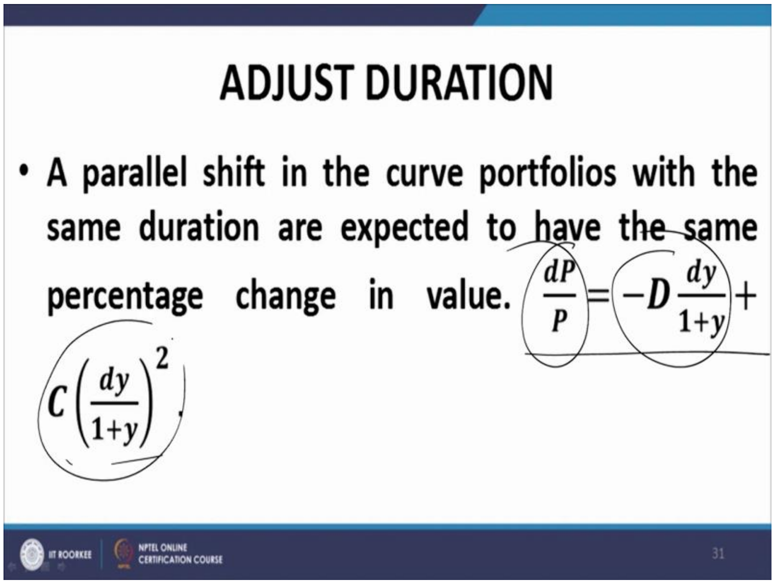
The conclusion is that if the curve is expected to be stable, little change in interest rates, their, the convexity correction shall be having a minimal effect, and therefore it is better that you, you sacrifice convexity, you have low convexity in your portfolio and make use of bonds which have low convexity but higher market yields.

(Refer Slide Time: 09:12)



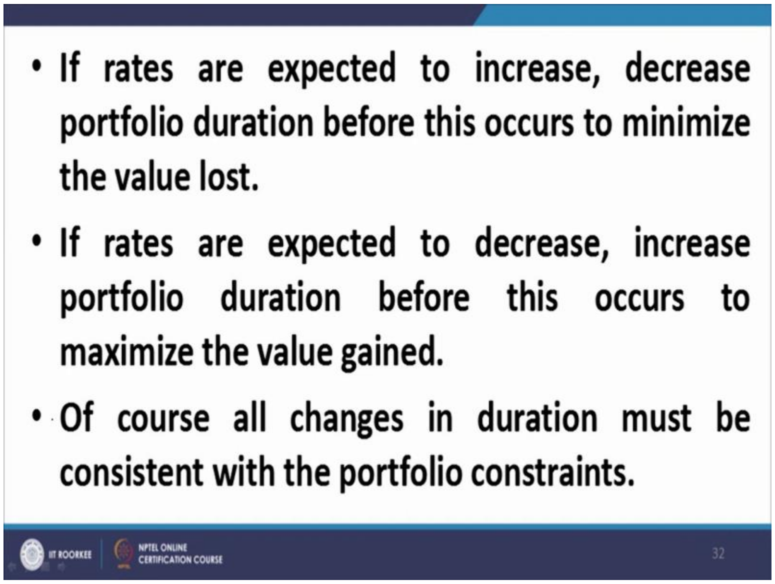

Strategies for parallel shift in the yield curve. So far we have talked about strategies that involve a stable yield curve. Let us talk about parallel shift yield curves.

(Refer Slide Time: 09:21)




This is the formula that we know, we all know, we are very familiar with, that is the duration convexity model for the percentage price change as the, and this is the duration, correction and this is the convexity correction.

(Refer Slide Time: 09:36)

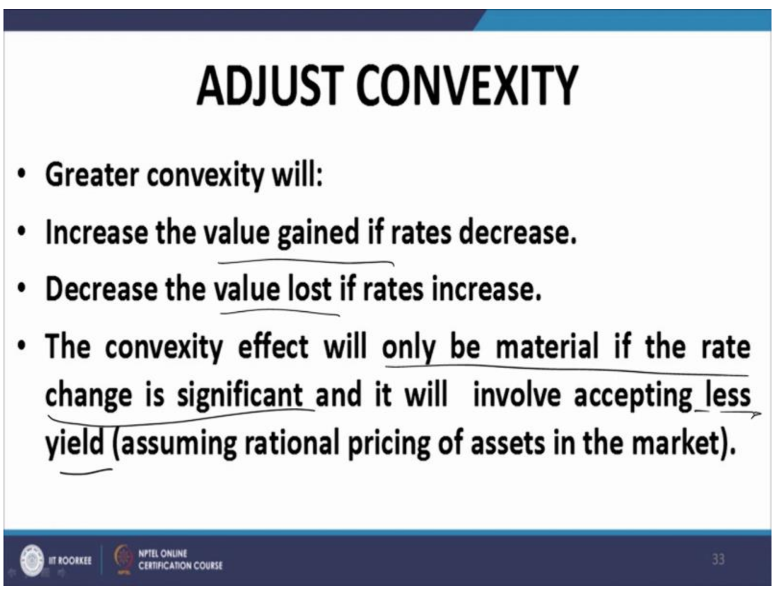



If rates are expected to increase, decrease portfolio duration before this occurs to minimize the value lost. If rates are going to increase, naturally, there would be a decline in the, in the value of your portfolio. If you reduce the duration, naturally the decline would be less because the change in bond prices or the percentage change in bond prices is proportional to duration.

If you ignore the curvature of the curve, if you ignore convexity, then we can say that the percentage change in price is proportional to the duration. So higher, if the, there is an increase in interest rates, higher the increase in interest rates, greater would be the fall in the prices of the bonds corresponding to a higher duration. Longer the duration, greater is the fall in the prices of the bond, shorter the duration, lesser is the impact of a price, of an interest rate change on that bond portfolio.

So if rates are expected to increase, decrease the duration, lower the duration, lower will be the price fall due to an increase in rates. Conversely, if rates are expected to decrease, increase portfolio duration. Larger the portfolio duration, larger would be the positive impact of increase in prices due to a decline in interest rates. Of course, all changes in duration must be consistent with the portfolio constraints.

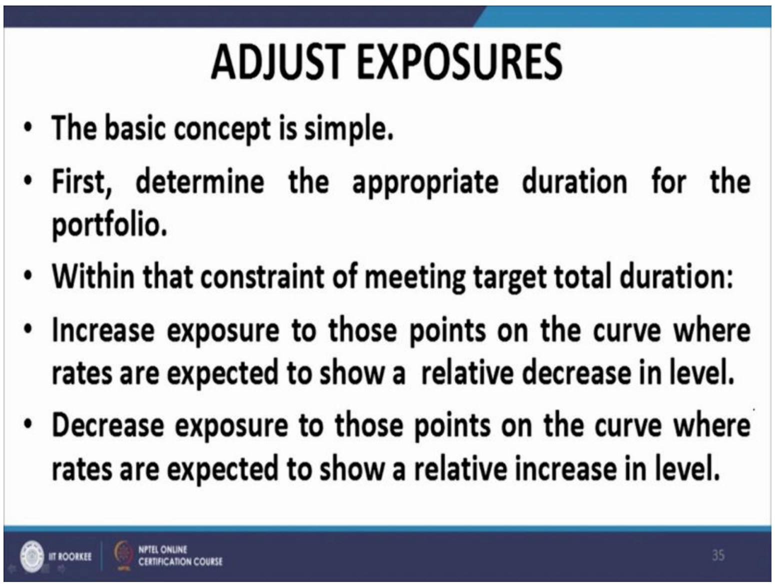
(Refer Slide Time: 10:59)




Adjust convexity, that is another strategy. Greater convexity will increase the value gained. I have just talked about convexity in a lot of detail. Let us quickly recap through this. Greater convexity means what? Increase the value gained if rates decrease, and decrease the value lost if rates increase. So the price correction is always positive. It leads to an increase in price or the percentage price.

The convexity effect will only be material, that is the catch, the convexity correction will only be material if the rate change is significant, because it is a second order correction. And it will involve accepting less yield assuming the traditional pricing of assets in the market. If you have two bonds A and B, both with the same cardinals except for convexity, bond A has lower convexity, bond B as higher convexity, then clearly bond B will command a relative premium compared to bond A if they have the same other cardinals.

(Refer Slide Time: 12:05)

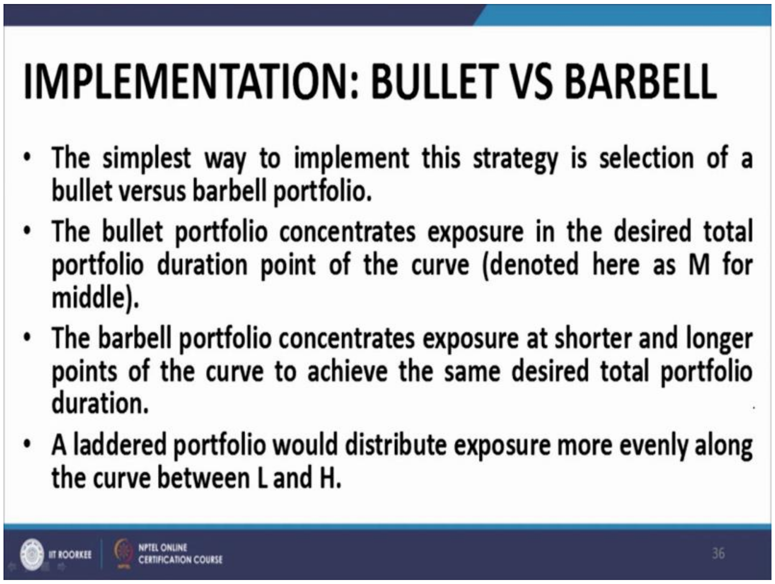



Strategies for non parallel shift in the yield curve. The basic concept is simple. What is the basic concept? Determine the appropriate duration for the portfolio. Within that constraint of meeting target duration, increase exposure to those points on the curve where rates are expected to show a relative decrease in level. Because what will happen if the rate, if your expectation turns out to be, to be correct?

The rates will decrease at these points on the curve, and corresponding to these points on the curve, the, because the lower rates would be yield, used in computing the prices, the prices will increase. And if the portfolio value is concentrated around these points at which the rates are expected to decrease, and the rates actually decrease, there would be significant value gain.

Increase exposure to those points on the curve where rates are expected to show a relative decrease. Decrease exposure to those points on the curve where rates are expected to show a relative increase.

(Refer Slide Time: 13:05)

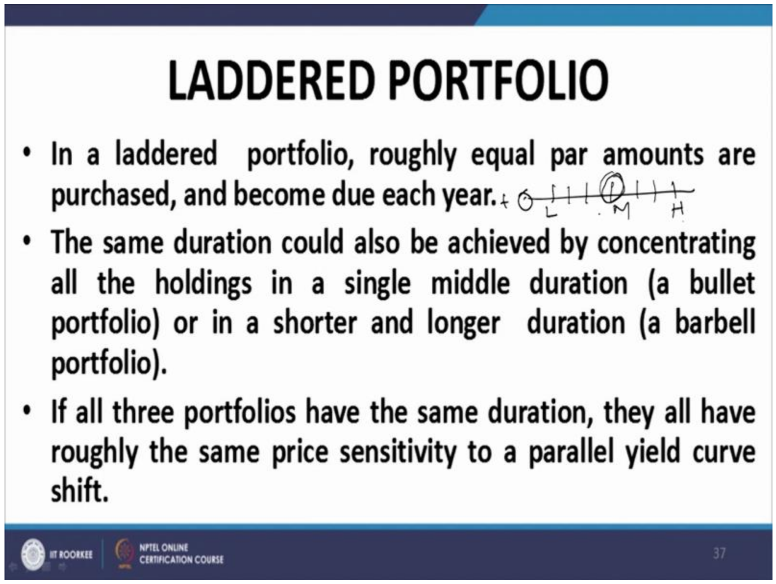



Implementation: Bullet versus Barbell. The simplest way to implement this strategy is selection of a bullet versus a barbell portfolio. The bullet portfolio concentrates exposure. Now, this is important. The bullet portfolio concentrates exposure in the desired total portfolio duration point of the curve, denoted here as M for middle.

The barbell portfolio concentrates exposure at shorter and longer points on the curve to achieve the same desired duration, but, a laddered portfolio, I will come back to it in this, in a few minutes. A laddered portfolio would distribute exposure more evenly along the curve between L and H.

So let me repeat. A bullet portfolio completely concentrates the exposure at the point of its duration, assuming that it is a zero coupon bond. A barbell portfolio distributes the exposure between two points such that the bullet portfolio remains in the middle and the barbell consists of zero coupon bonds. And a laddered portfolio is somewhere in between where we have portfolios of maturities at different time intervals over the, over the time interval between L and H.

(Refer Slide Time: 14:22)




So let me quickly read out the features of the laddered portfolio before we move forward. In a laddered portfolio, roughly equal par amounts are purchased and become due each year, each year. In a laddered portfolio, roughly equal par amounts are purchased and become due each year.

The same duration could also be achieved by concentrating all the holdings in a single middle duration, that is a bullet portfolio or in a shorter and longer duration, that is the barbell portfolio. So let me just illustrate it briefly. Let us say, this is, this is t equal to 0, let us say this is the point t equal to 0. And let us say this is L, let us say this is L, let us say this is H and let us say this is M.

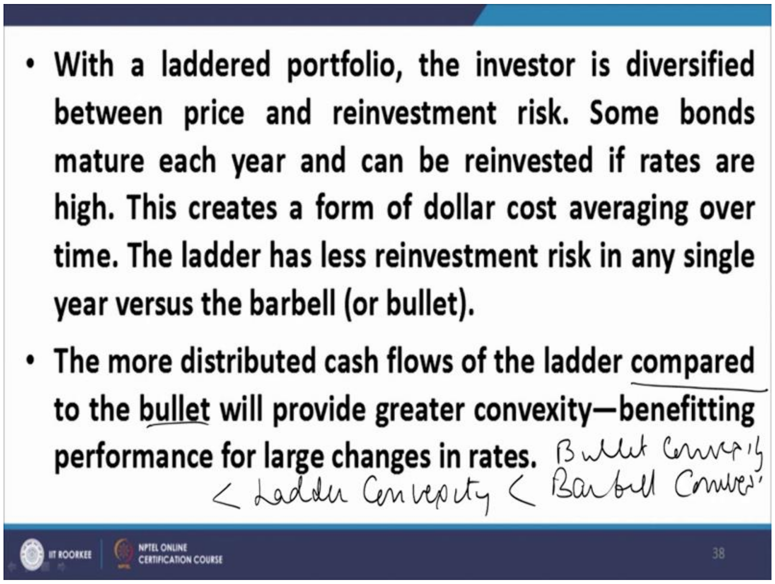
Now, a bullet portfolio will have a maturity of M and it will be zero coupon bonds, so its duration will also be M. A barbell portfolio will have a combination of L and H in such a way that the duration of the portfolio comprising of an L and H is exactly equal to M. The combination of the durations of L and H, the barbell duration works out to exactly M. And however, of course, this barbell will have a higher convexity than M, as we have seen earlier.

Then we can have a situation where we have portfolios having maturities that L, L plus 1, L plus 2, up to M, and then M plus 1, M plus 2 up to, up to H. Assuming that these maturities are evenly spaced between L and H, then this is called a laddered portfolio, and again this will have a duration equal to M, all. And its convexity will lie between that of M, which has the lowest and the barbell which has the highest.

So bullet, barbell and laddered portfolio, all will have the same duration, but bullet will have the least convexity, barbell will have the highest convexity, and laddered portfolio will have a convexity in between. So that same duration could also be achieved by concentrating all the holdings in a single middle duration, bullet duration, or a shorter and longer duration, barbell duration, a barber portfolio, rather.

If all the three portfolios of the same duration, they all have roughly the same price sensitivity to a parallel yield curve shift. At least for small shifts, they will have same sensitivity. Of course, when the shift is significant, the convexity impact or the convexity effect would come into play. But that is only if the parallel shift is significant.

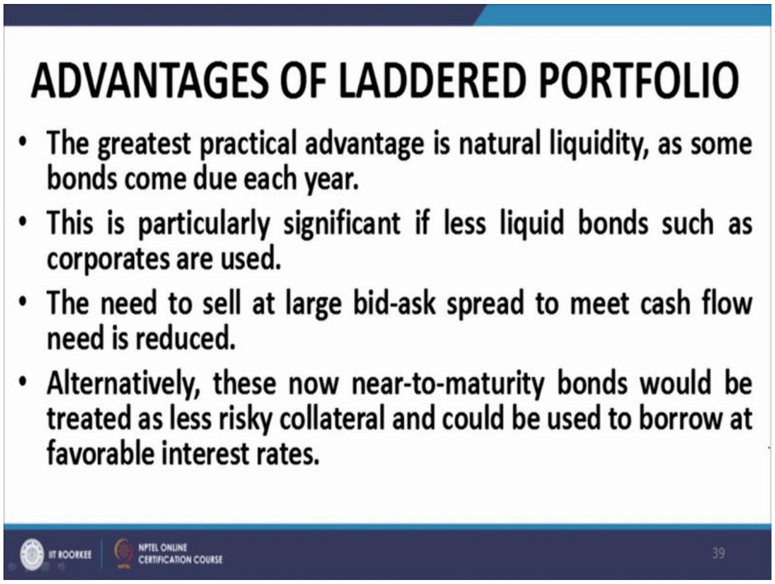
(Refer Slide Time: 17:17)




With a laddered portfolio, the investor is diversified between price and reinvestment risk. Some bonds mature each year and can be reinvested if rates are high. This creates a form of dollar cost averaging over time. The ladder has less reinvestment risk in any single year versus the barbell, because the entire reinvestment of the barbell is going to take place at t equal to L.

When the portfolio, when the lower maturity matures, you will have to invest it or reinvest the proceeds of that portfolio for the period from t equal to L to t equal to M when the bullet liability is to be repaid. The more distributed cash flows of the ladder compared to the bullet, compared to the bullet, please note that, not compared to the barbell, will provide greater convexity benefiting performance for large changes in rates. So bullet convexity is less than ladder convexity is less than barbell convexity.

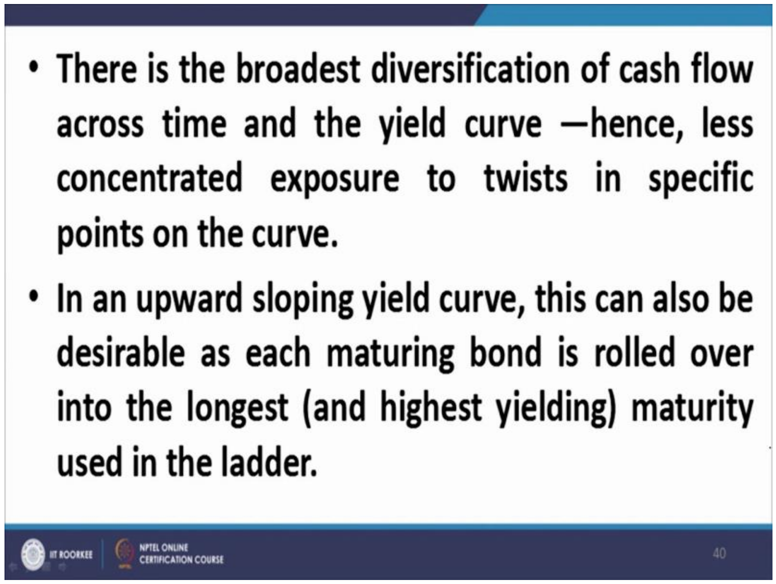
(Refer Slide Time: 18:41)




Advantages of laddered portfolio. The greatest practical advantage is natural liquidity. As some bonds come due each year, this is particularly significant if less liquid bonds such as corporates are used. The need to sell at large bid-ask spread to meet cash flow need is reduced.

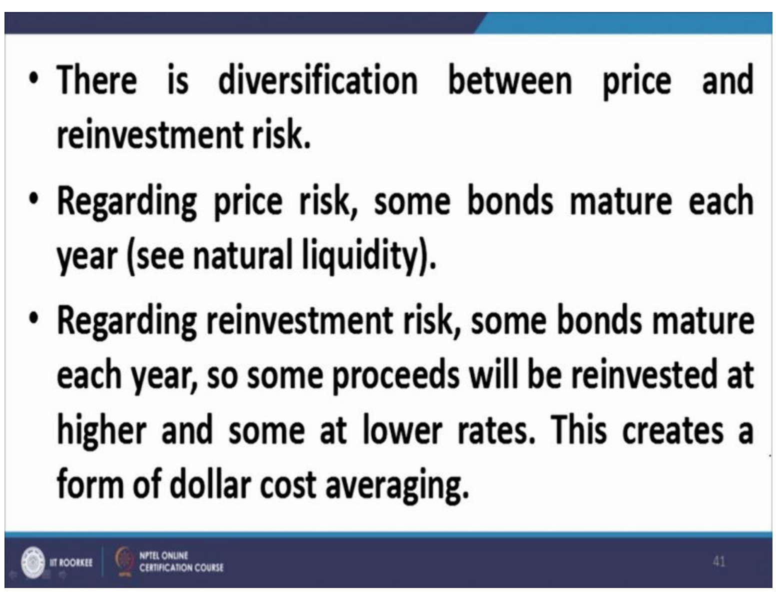
Alternatively, these now near-to-maturity bonds would be treated as less risky collateral and could be used to borrow at favorable interest rates. So even if you are not able to liquidate the bond in the market because the maturities were very close, you may be able to get loan against these collaterals at favorable terms.

(Refer Slide Time: 19:26)



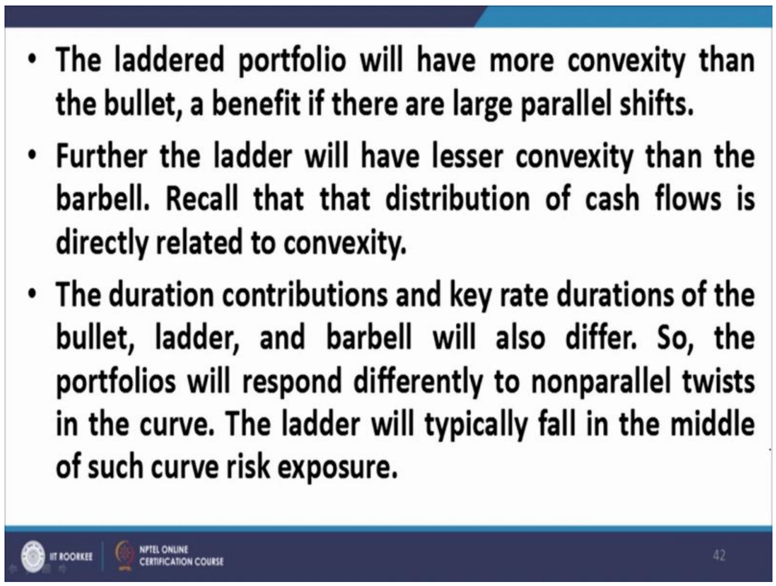

There is the broadest diversification of cash flow across time and the yield curve. Hence, less concentrated exposure to twist in specific points of the curve. In an upward sloping yield curve, this can also be desirable at each material, as each maturing bond is rolled over into the longest and highest yielding maturity used in the ladder. And that is provided, of course, that the yield curve structure is unchanged, the yield curve spectrum or the spectrum of spot rates is unchanged over the period of your, period of relevance.

(Refer Slide Time: 19:59)



There is diversification between price and reinvestment risk. Regarding prices, some bonds mature each year. Regarding reinvestment rates, some bonds mature each year. So some proceeds will be reinvested at higher and some at lower rates. This creates a form of dollar cost averaging.

(Refer Slide Time: 20:17)




The ladder portfolio will have more convexity than the bullet, benefit if there are large parallel shifts. Further, the ladder will have lesser convexity than the barbell. Recall that the distribution of cash flows is directly related to convexity. So because the distribution of the ladder is higher, the convexity, the, because the distribution of the ladder is higher, compared to the bullet, it has a higher convexity than the bullet.

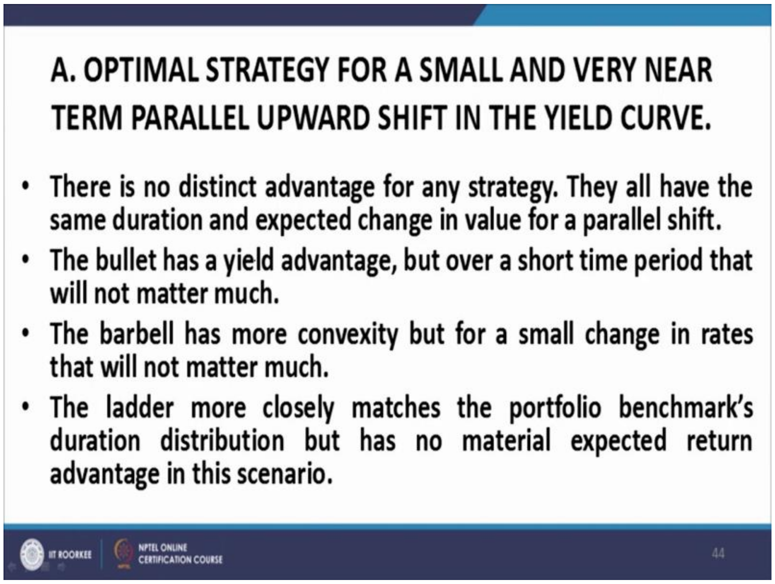
But because the dispersion of the barbell is higher than the, than the ladder, the convexity of the barbell is higher than the ladder. The duration contributions and key rate durations of the bullet, ladder and barbell will also differ. So, the portfolios will respond differently to nonparallel shifts in the curve. The ladder will typically fall in the middle of such curve risk exposure.

And this is an important point that because the, although the durations constituted for the bullet, the ladder and the barbell are identical, they are constituted by different combinations of assets. So when there is a change in the shape of the spot yield curve, they would respond differently, notwithstanding the fact that they have the same duration.

Same duration would yield in same or approximately same percentage price changes, provided the shift in the yield curve is parallel, is parallel, I repeat, is parallel. If the shift is not parallel, then the fact that durations are equal would not imply that the percentage price change is the same in each case because the equality of durations does not mean that they are created by the same asset.

In the case of the barbell, they are created by two assets L and H, and in the case of the ladder they are created by a number of assets across the entire spectrum from L to H. However, in the bullet, they are created by only one asset. This differential in the construct, constitution of equal duration portfolios will manifest itself as different price changes due to shaping risk, due to a change in the shape or structure of the spot yield curve.

(Refer Slide Time: 22:46)

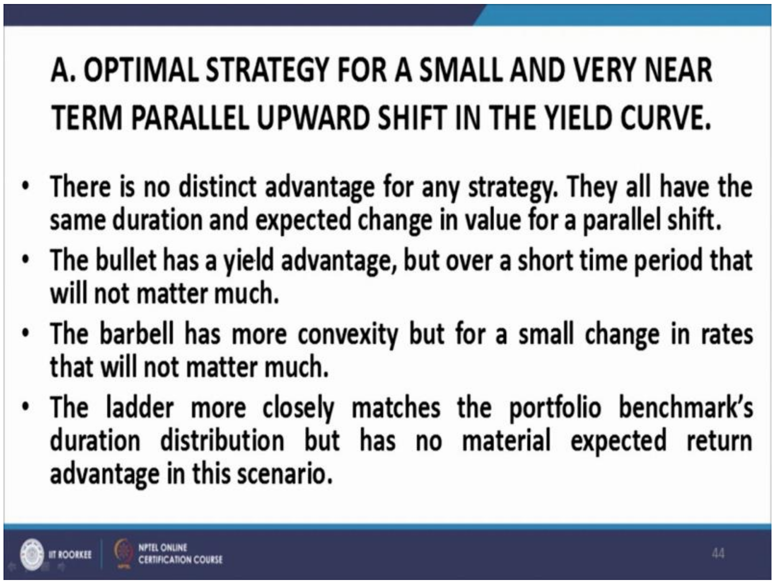



Example: selection of the curve strategy. Consider a portfolio with a benchmark that is laddered and has a duration of 10. The manager is considering three possible strategies. Bullet: 100 percent in securities with a duration of 10. The yield and convexity are 4.51 percent and 16.4 percent. You can see, as you see very soon, the return is highest and the convexity is lowest for the bullet portfolio. The return, expected return and convexity operate in different directions.

Barbell: 50 percent in securities with a duration of 2 and 50 percent in securities with a duration of 18, the, for portfolio duration of 10. The yield and convexity are 4.3 percent and 24.7 percent. Compare it with 4.51 percent for the bullet, you have in the case of the barbell, 4.30 percent.

And then we have the ladder. Match the benchmark which has an equal distribution of 1 to 19 direction bonds for portfolio duration of 10. The yield and convexity is 4.39 percent, higher than the barbell, lower than the bullet, and the convexity is 20.1, which is again, higher than the bullet, which is 16.4 and lower than the barbell, which is 24.7.

(Refer Slide Time: 24:17)

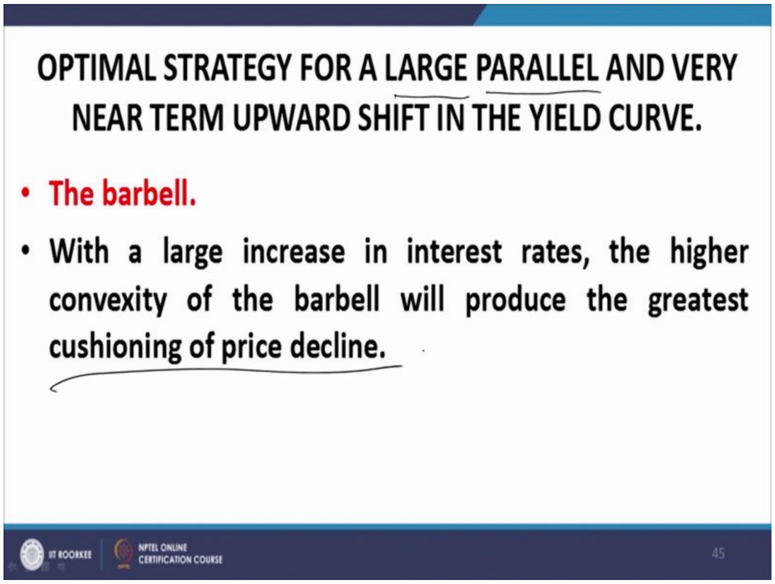



Now, let us see the various optimal strategies. Optimal strategy for a small and a very near-term parallel upward shift in the yield curve. What happens in this case? In this case, there is no significant advantage for each strategy. They all have the same duration and therefore the duration effect will be pretty much the same in the case of the bullet, the barbell or the ladder and the expected change in value for a parallel shift will be almost the same.

Because the change is small, the convexity effect would be minimal, and as a result of it, the advantage of the barbell will be very small. The bullet has a yield advantage, no doubt about that, but the barbell will have a small plus due to the highest convexity because convexity is positive.

And it has a higher convexity, so it will contribute to a slightly higher return due to the convexity effect. But that is neutralized by the higher yield of the bullet. And the ladder comes somewhere in between, and it closely matches the portfolios benchmark duration distribution but has no material expected return advantage in this scenario.

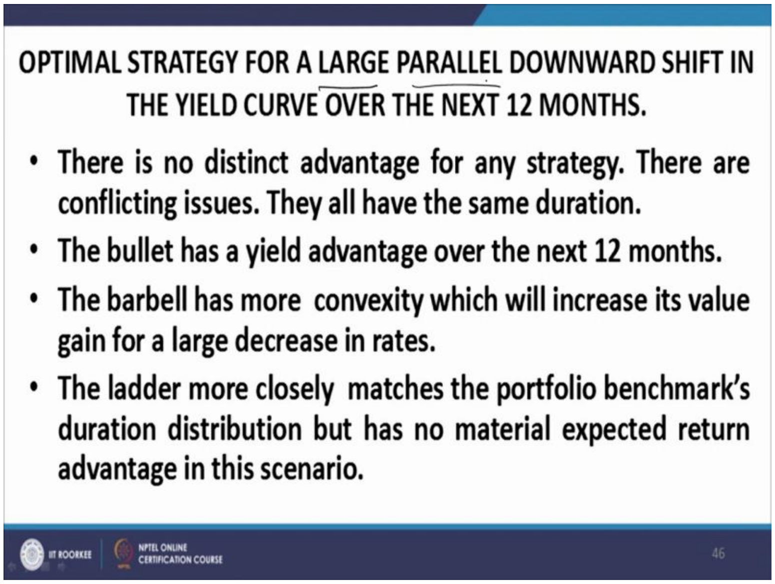
(Refer Slide Time: 25:35)




Optimal strategy in the case of a large parallel and very near-term upward shift in the yield curve. A parallel upward shift. Now, it is a large parallel upward shift. Large means, we have to look at the convexity. And because, if there is a large shift, and if the shift is parallel, convexity comes into play very significantly and the convexity correction becomes relevant.

And it is an upward shift so the interest rates increase, so the prices will decrease, and in this case the barbell will be the best strategy because it has the highest convexity. With a large increase in interest rates, the higher convexity of the barbell will produce the greatest cushioning of the price decline. That is what I mentioned.

(Refer Slide Time: 26:25)



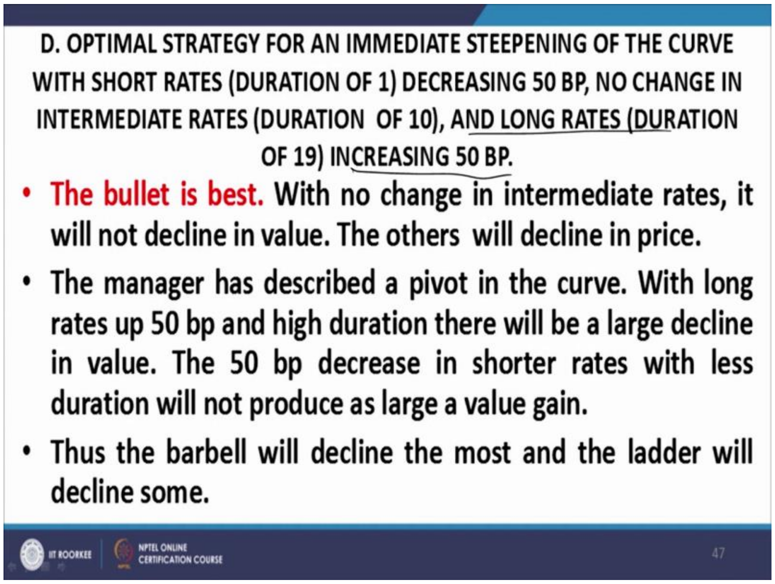

Optimal strategy for a large parallel downward shift in the yield curve over the next 12 months. Now, this is interesting. We are having a large, so convexity comes into play, parallel, so duration and convexity both will come into play, and the shift is over the next 12 months, that is another important.

There is no distinct advantage for any strategy. There are conflicting issues. They all have the same duration. So as far as duration is concerned, they are equivalent more or less. The bullet has the lowest convexity, but it has the highest yield advantage over the next 12 months.

The barbell has the highest convexity but it has the lowest yield advantage, and as a result of which although the convexity correction will operate in the positive direction, the, the yield, the intrinsic yield of the barbell portfolio is relatively lower. The ladder more closely matches the portfolio benchmark duration distribution, but has no material expected return advantage in the scenario.

So while the bullet has a yield advantage, it has lowest convexity. The barbell has the highest convexity, and it has a lowest yield. So these two relative extremes will tend to neutralize each other, since the, since the shift is over the next 12 months, and then yields, the consideration of yield is important.

(Refer Slide Time: 27:56)




So next is optimal strategy for an immediate steepening of the curve with short rates duration of 1 decreased 50 basis points, no change in the intermediate rates, duration of 10 and long rates of 19 increasing 50 basis points. Now, here, the barbell becomes the worst strategy and the bullet becomes the best strategy. Why is that? Let us try to…

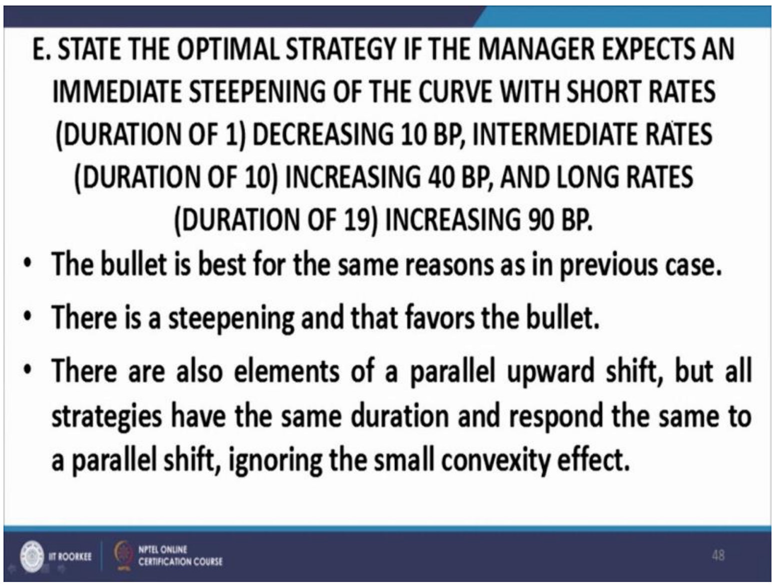
What they are saying is that the, the near-term rates are decreasing. Now, when the near term rates are decreasing the L component of the barbell will increase in price. But the L component of the barbells increase in price, will be small because it has a small duration. And the H, because the higher rates are increasing, you see, the long term rates are increasing. The long term rates are increasing.

And now because the long term rates are increasing, the H component of the barbell will decrease in price, and that decrease in price is going to be significant. Why? Because it has a long duration. Larger the duration, larger is the percentage change in price. So to that extent, the bullet will operate as the best and the barbell would operate as the worst. And the, the, the ladder would come somewhere in between. So that is what is the analysis.

With no change in the intermediate rates, it will not decline in value, the bullet will not decline in value. The others will decline in price. Why? Because the long term duration will have a greater price impact compared to the short term duration. And in the long term, the rates have increased.

And therefore, the prices will decline and they have a longer, longer duration. So the price decline is also more. The price increase on the shortened side is relatively less. And this will operate both for the bull, for the barbell, barbell to a larger extent, and ladder to a lesser extent.

(Refer Slide Time: 29:57)



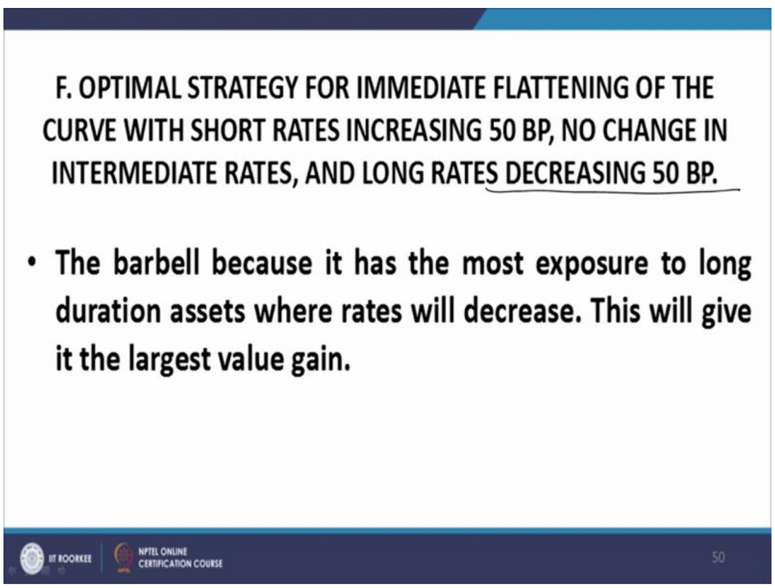

Then we have the optimal strategy if the manager expects an immediate steepening of the curve with short rates decreasing 10 percent, intermediate rates increasing 40 percent and long term rates increasing 90 percent. So in this case, the bullet is best for the same reasons as we saw in the previous example.

There is a steepening and that favors the bullet. There are also elements of parallel upward shift but all strategies of the same duration and respond the same to a parallel shift ignoring the small convexity effect.

(Refer Slide Time: 30:35)


And this is the diagram corresponding to this particular problem.

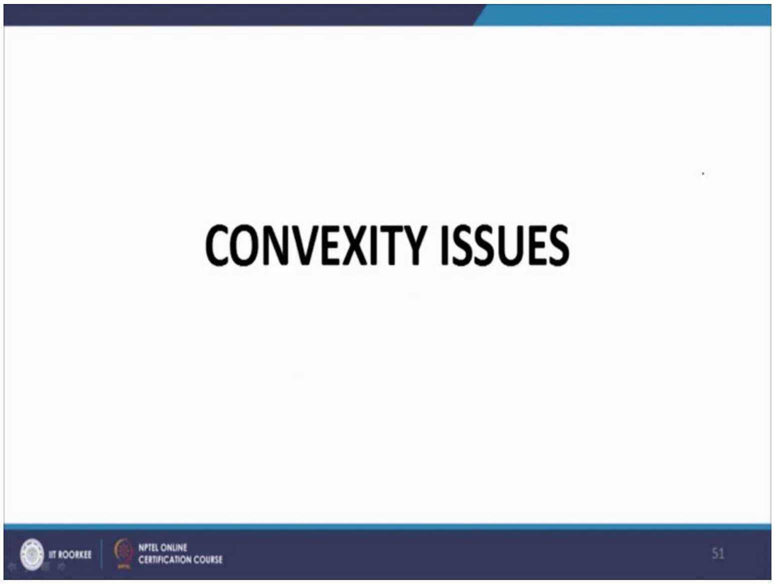
(Refer Slide Time: 30:37)




Then we come to optimal strategy for immediate flattening of the curve with short rates increasing 50 basis points. No change in intermediate rates and long rates increasing by, long rates decreasing, long rates decreasing by 50 basis, this means what? This means that the, the barbell will be the best. Why barbell will be the best? Because the long rates are decreasing, and barbell's duration is longer.

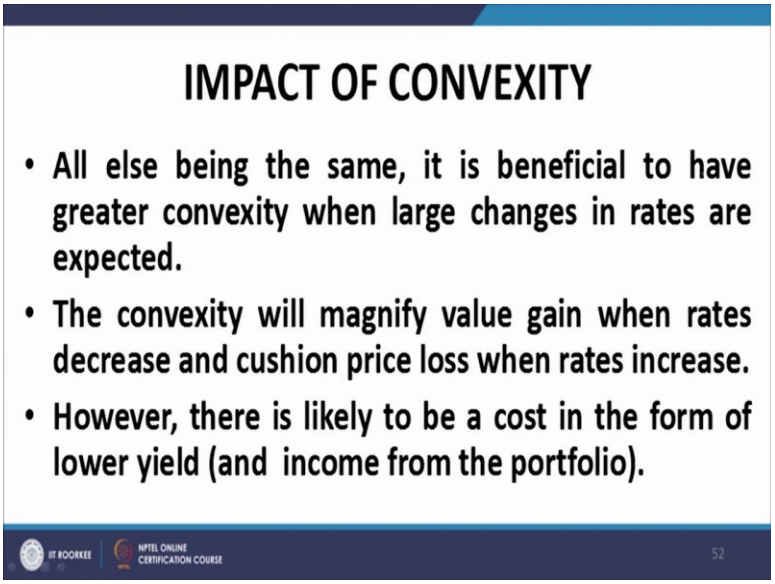
So the barbells or the H component of the barbell will increase in price to the maximum and the L component's decrease in price will be minimal because it has a smaller duration. So in this case, the barbell's price increase will be the best.

(Refer Slide Time: 31:18)




So we now talk briefly about convexity issues.

(Refer Slide Time: 31:21)



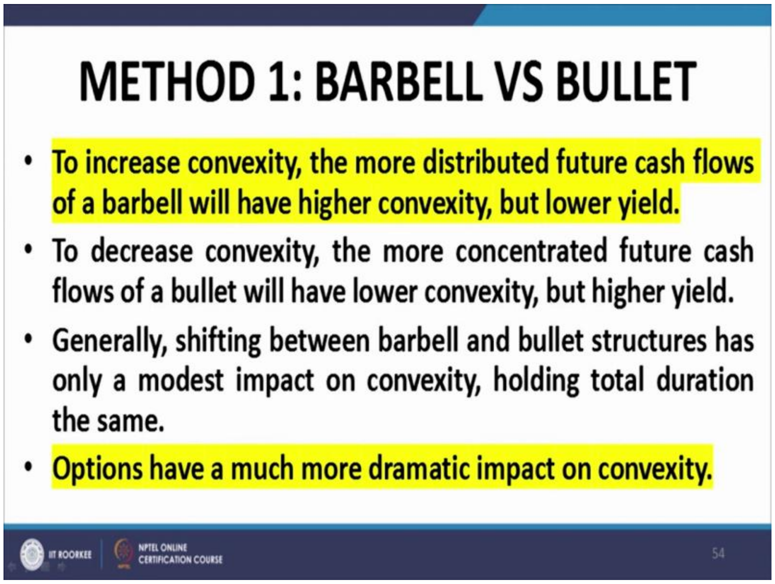

As far as the impact of convexity is concerned, let me quickly recap, because a lot of strategizing is based on the issue of convexity. So let me quickly recap in a sense whatever we have talked about in relation to convexity. It is the, it is the crux of whatever I have discussed in so far, the interest rate risk management is concerned.

All else being the same, it is beneficial to have greater convexity when large changes in rates are expected. The convexity will magnify value gain when rates decrease and cushion price loss when rates increase. However, there is likely to be a cost in the form of lower yield, and increase from the portfolio.

(Refer Slide Time: 32:01)

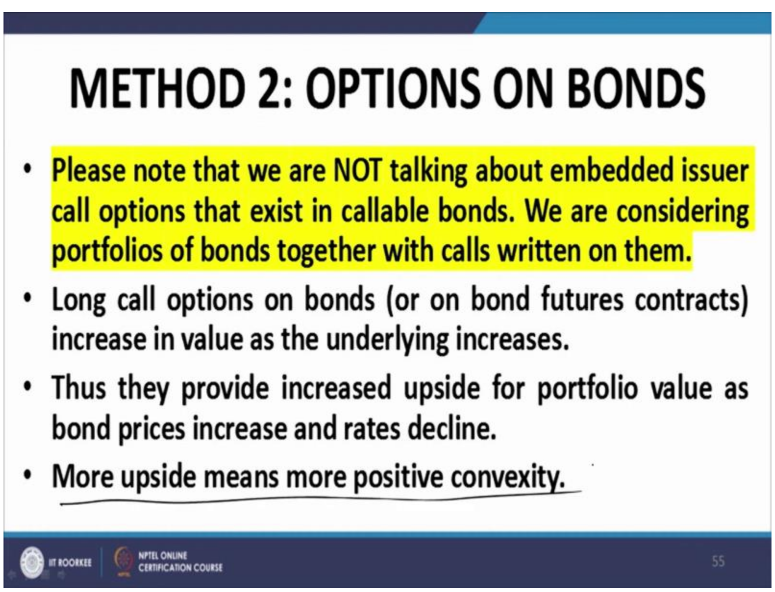

Increasing convexity.

(Refer Slide Time: 32:03)




Method 1: Barbell versus Bullet. We have discussed about it. So I will quickly read through the slide, nothing more. To increase convexity, the more distributed future cash flows of a barbell will have higher convexity, but lower yield compared to the bullet. To decrease convexity, the more concentrated future cash flows of a bullet will have lower convexity but higher yield. Generally, shifting between barbell and bullet structures have only a modest impact on convexity, holding total duration constant. Options have a much more dramatic effect on convexity. So let me talk about that.

(Refer Slide Time: 32:39)



Options on bonds. Please note that we are not talking about, we are not talking about embedded issuer call options that exist in callable bonds. We are considering portfolios of bonds together with calls written on them. So we are con, we are not considering embedded options which are a part of the bonds, we are not considering that.

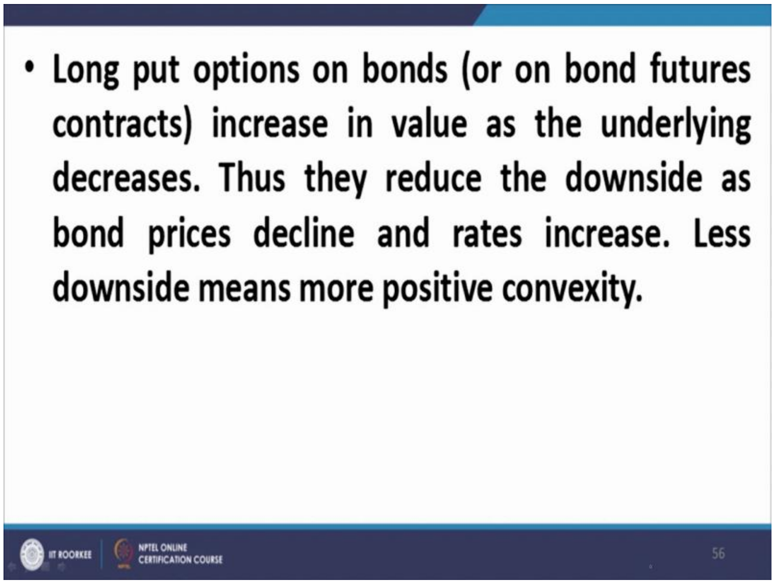
We are considering a portfolio of bonds, and in within that bonds, we have, we within that portfolio we also have call options written on the bonds which are a part of the portfolio. Now, long call options obviously, whatever the underlying asset may be, as the price of the underlying asset increases, the, the value of the long call also increases.

Quite naturally, because long call gives you a right to buy the asset, buy the underlying asset at a predetermined price. So if the price of the underlying asset goes above the excess price, the greater would be the profit by exercising the call and selling it in the market. So in a sense the payoff from the option at maturity is S capital T minus K, and higher the value of S T, higher the value of the payoff, and higher the value of the option.

So long call options on bonds or on bond future contracts increase in value as the value of the underlying increases. So long call value increases as value of the underlying increases. Thus, they provide increased upside for portfolio value as prices increase or rates decline. So that more upside means more convexity. So this is the bottom line.

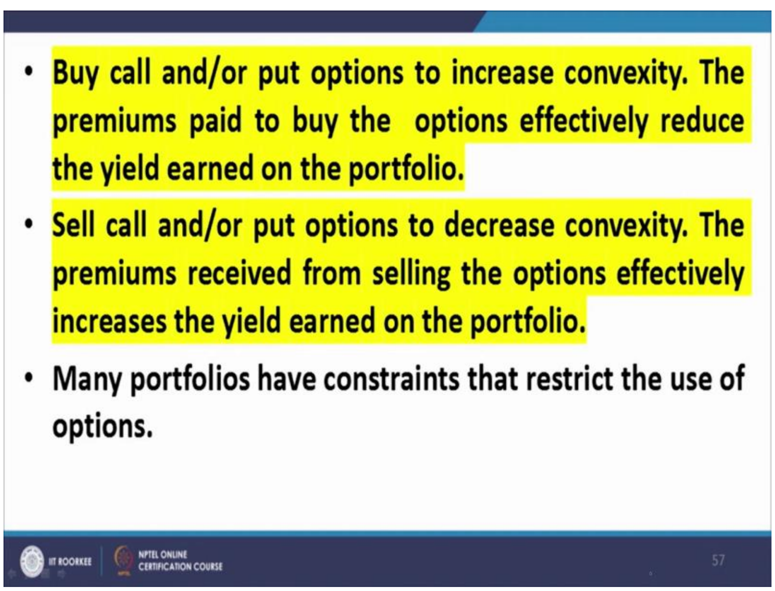
Because as the prices of the bonds increases, the value of the option increases, and the combined portfolio consists of the bonds as well as the options on those bonds. The call options on that bonds, the value of the bonds increase, value of the call options increases, and therefore the value of the portfolio increases, and therefore means higher value accretion, and therefore higher convexity.

(Refer Slide Time: 34:41)



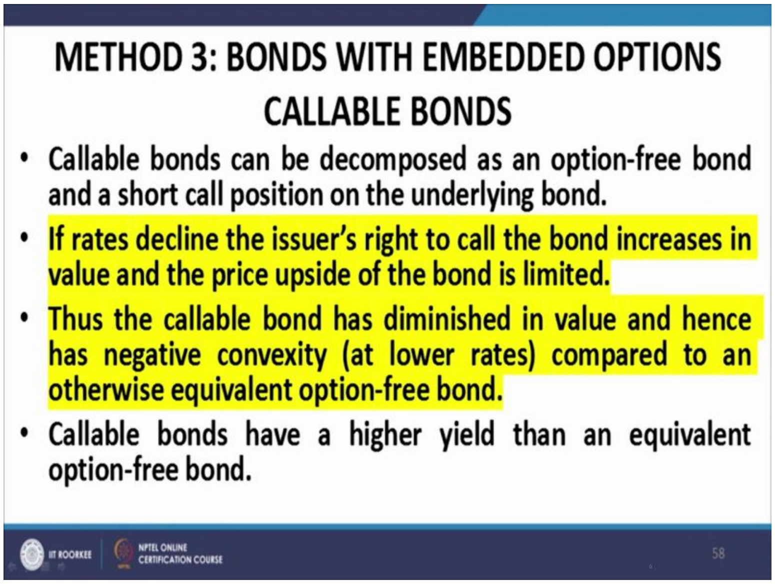

Long put options on bonds or on bond futures contracts increases in value as the underlying decreases. That is why, why? Because the put options give you a right to sell the underlying asset at a predetermined price. So lower the price, greater is the value of the put option. Thus they reduce the downside in the bond as bond prices decline or interest rise. And therefore they also mean positive convexity.

(Refer Slide Time: 35:09)




Thus, for increasing the convexity of a portfolio, buy call and/or put options to increase the convexity. The premiums paid to buy the options effectively reduce the yield earn on the portfolio. Sell call and, or put options to decrease convexity. The premiums received from selling the options effectively increase the yield earned on the portfolio. Many portfolios have constraints that restrict the use of options.

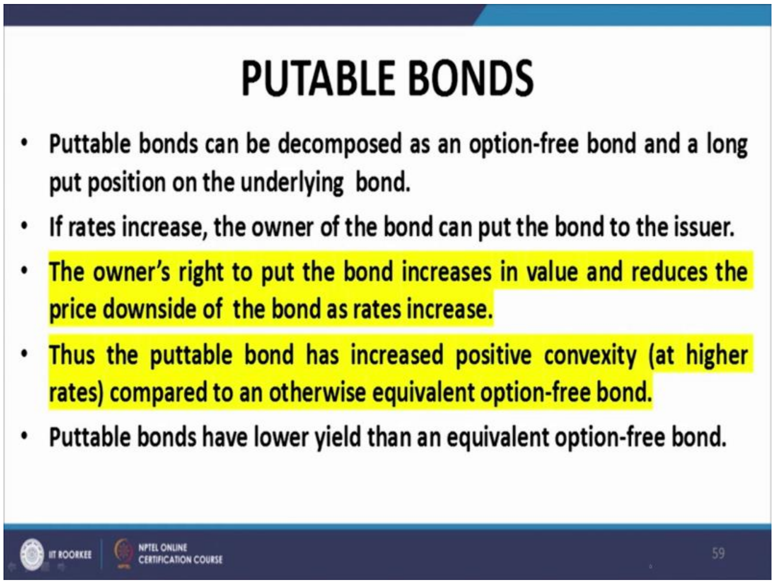
(Refer Slide Time: 35:36)




The third method is the case of bonds with embedded options. Callable bonds, rather, can be decomposed into an option-free bond, and a short call position. So if we had to decline the price increases but the price increase in the case of callable bonds is truncated because the issuer, as soon as the price goes above the exercise, will call back the bonds, and therefore the investors' right to a higher price corresponding to a decree, decrease in interest rates is curtailed, is truncated at the level of the excess price.

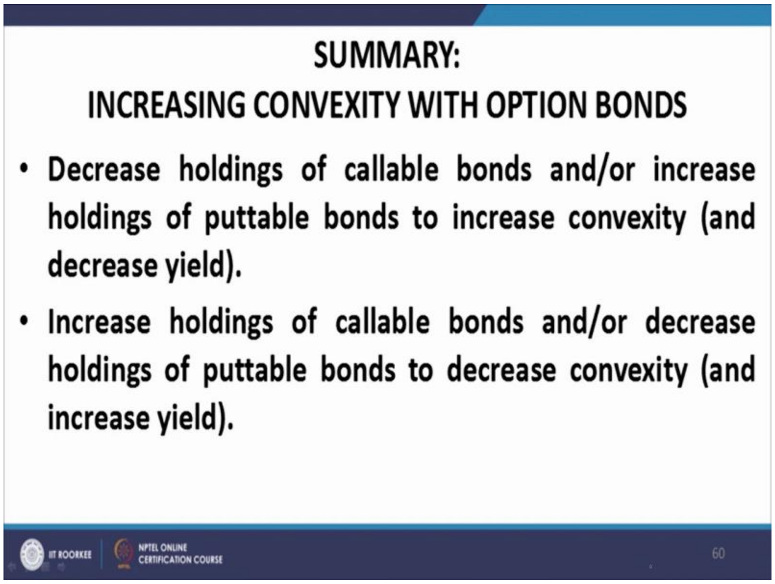
He will never get a price higher than the excess price notwithstanding whatever is the fall in the interest rates. Thus, the callable bond has diminished in value and, has negative convexity compared to the otherwise equivalent option-free bond, particularly in the region where the call, embedded call option is near the money. Call or callable bonds obviously have a higher yield than straight bonds because of the shortcut option, because the issuer retains a right. And because the issuer retains a right, he has to pay a price for that in terms of the increased yield to the investor.

(Refer Slide Time: 36:46)




So this is the story regarding putable bonds. Pretty much similar to what I have discussed about callable bonds.

(Refer Slide Time: 36:51)




And with this, I conclude the portion that is on depth securities. And from the next lecture, we will be starting a new topic. Thank you.