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CERTIFICATION COURSE

QUANTITATIVE INVESTMENT MANAGEMENT

LECTURE 27

The Barbell Strategy - 2

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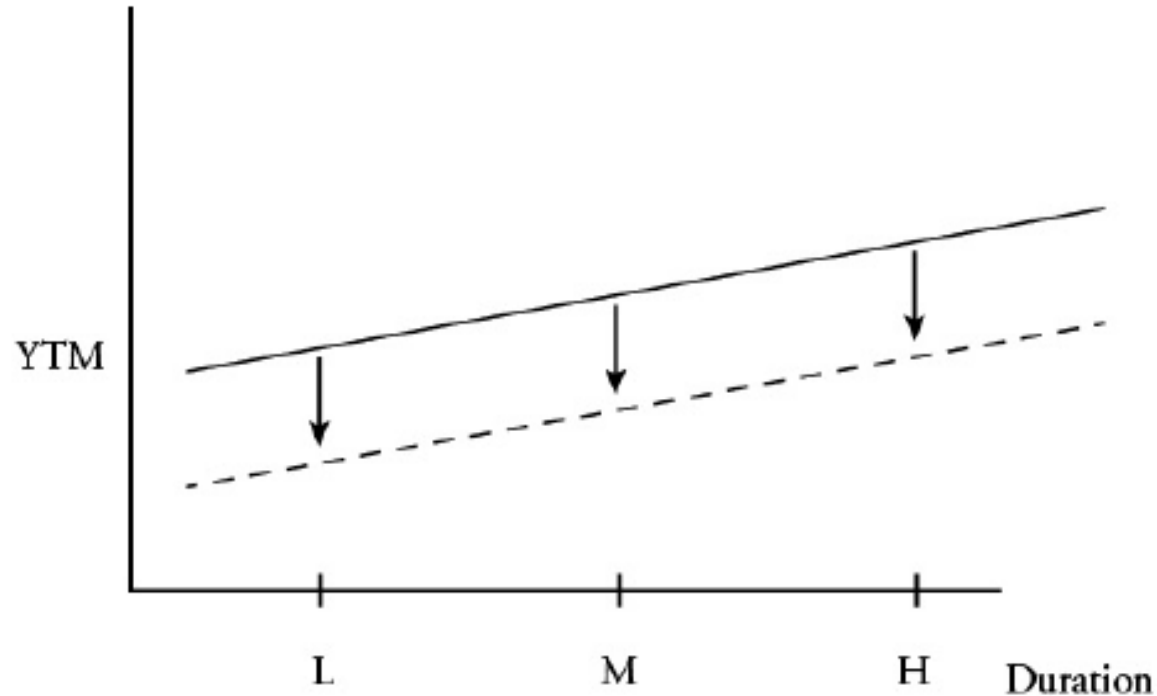
PARALLEL DECREASE IN YIELDS

- For a large parallel decrease in the curve, the immediate increase in barbell value will exceed the increase in the PVL due to the greater convexity effect (WHICH IS ALWAYS POSITIVE IRRESPECTIVE OF THE DIRECTION OF SHIFT).
- With the parallel decrease, the new portfolio IRR will decrease by basically the same amount as the decrease in discount rate for the PVL.

- In other words, the future rate of increase in assets and liabilities are still the same, but starting from a new PVA that is relatively higher than the new PVL, the FVA will exceed the FVL.



PARALLEL DECREASE IN YIELDS



EXAMPLE

- Consider the barbell strategy consisting of two bonds L & H with equal money weights (INR 1,044) of 1 year and 9 year ZCBs both with YTM's of 15% p.a. for immunizing a ZCB liability M of INR 4,200 due at $t=5$ years valued at INR 2000 at $t=0$. Assume that there is a instantaneous parallel downward shift of the yield curve by 2%. Evaluate the performance of the strategy.

SOLUTION

- Initial value of liability = 2000
- IRR (YTM) of liability: $\left(\frac{4200}{2000}\right)^{0.2} - 1 = 16\%$
- Initial investment in barbell: $\frac{4200}{1.15^5} = 2088$
- Redemption value of L bond at 15% YTM at one year = $1,044 \times 1.15 = 1200.60$
- Redemption value of H bond at 15% YTM at nine years = $1,044 \times 1.15^9 = 3672.66$

- After decline in interest rates by 2%
- $P_L^1 = \frac{1200.60}{1.13} = 1062.48$
- $P_H^1 = \frac{3672.66}{1.13^9} = 1222.57$
- $P_{BARBELL}^1 = P_L^1 + P_H^1 = 2285.05$
- $P_M^1 = \frac{4200}{1.14^5} = 2181.35$
- Clearly $P_{BARBELL}^1 > P_M^1$

- In this problem, the initial IRR of the barbell is 15% & the liability is 16% and the shift is 2% downwards uniformly. Hence, value of barbell & liability at $t=5$ years:
- Value of liability = $2181.35 \times 1.14^5 = 4200.00$
- Value of barbell = $2285.05 \times 1.13^5 = 4210.06$

STRUCTURAL RISK

- Fortunately, most interest rate changes can be described as roughly parallel, and by building the portfolio with an asset dispersion (hence, convexity) that exceeds the single liability, the portfolio may outperform the liability.
- Nevertheless, (Duration + Convexity) matching (without exact cash flow matching) immunization strategy does have structural risk that arises due to non-parallel shifts in yield curve.

- Although the durations of A & L are matched, structural risk arises due to the fact that barbell duration is created with a different allocation of asset durations (L and H) versus the bullet liability duration (M only).
- That can lead to differing performance of the assets and liabilities as the yield curve makes non-parallel shifts.

IMPORTANT INFERENCES ON PARALLEL SHIFTS

- The parallel shift analysis Indicates that immunization can be described as *zero replication*.
- A single zero coupon bond can be used for a no-risk, perfect cash flow match.



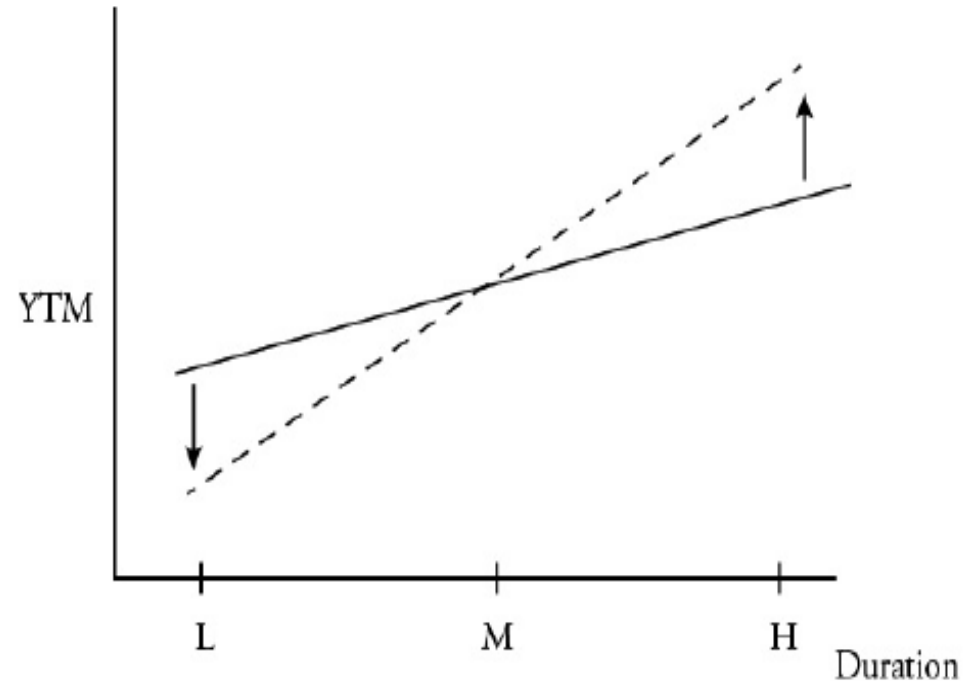
- The changes in barbell portfolio value will do better due to positive convexity than the changes in value of that replicating zero-coupon bond.
- The changes in barbell portfolio IRR will replicate the changes in yield of that replicating zero-coupon bond due to the shift being parallel.
- The parallel shift analysis does not imply that the strategy is always structurally risk free.
- Other kinds of yield curve reshaping may or may not cause the strategy to fail in meeting the future payout.

PARALLEL SHIFT ANALYSIS & ACTIVE MANAGEMENT

- The parallel shift analysis does not mean the strategy is buy and hold.
- The duration of coupon-bearing bonds (constituting the barbell) declines more slowly than maturity.
- The bullet liability duration will decline linearly with the approaching pay date.
- To maintain the immunization, the portfolio assets must be continually rebalanced to match barbell portfolio duration to liability duration as time or market conditions change; otherwise, the strategy is at risk.

YIELD CURVE STEEPENING

- Assume for this discussion that:
- Rates do not change for the M duration liability.
- But move in roughly opposite directions for the L and H duration assets.



- Assume that yield L decreases while yield H increase relative to yield M by an equal amount.
- The barbell portfolio market value will decrease because the decline in value of the longer duration bond will exceed the increase in the value of the shorter duration bond.
- PVL will be unchanged with no change in yield M.
- PVA is now below PVL.

- That, by itself, does not indicate the strategy will fail.
- If portfolio IRR increases sufficiently, the required FV might still be reached.
- Recall that portfolio IRR would tend to increase above a single point M YTM with a steeper curve.
- This indicates that a steepening curve may create structural risk.

EXAMPLE

- Consider the barbell strategy consisting of two bonds L & H with equal money weights (INR 1,000) of 1 year and 9 year ZCBs for immunizing a ZCB liability M of INR 4,022.71 at $t=5$ years. All the bonds are trading at a YTM of 15% p.a. Assume that there is a instantaneous steepening of the yield curve due to which we have $S_{01} = 12\%$, $S_{05} = 15\%$ & $S_{09} = 18\%$. Evaluate the performance of the strategy.

SOLUTION

- After the shift, we have:
- $P_L = \frac{1,000 \times 1.15}{1.12} = \frac{1,150}{1.12} = 1,026.79$
- $P_H = \frac{1,000 \times 1.15^9}{1.18^9} = \frac{3,517.88}{1.18^9} = 793.12$
- $P_{BARBELL} = P_L + P_H = 1819.92$
- $P_M = \frac{4022.71}{1.15^5} = 2000.00$
- Clearly $P_{BARBELL} < P_M$

- The new IRR of the barbell can be calculated by solving: $1819.92 = \frac{1,150}{(1+y)} + \frac{3,517.88}{(1+y)^9}$. We get $y=17.26\%$.
- Hence, value of barbell & liability at $t=5$ years:
- Value of liability = $2000.00 \times 1.15^5 = 4022.71$
- Value of barbell = $1819.92 \times 1.1726^5 = 4034.61$