Fixed Income Investment

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Lecture 4

Bond Investment Strategies
Passive Strategies

- Indexing
- Cash-Flow Matching
- Classical Immunization

Bond Investment Strategies

Types of Bonds Strategies:

- Active Strategies
- Passive Strategies
- Hybrid Strategies

Active Strategies

Strategies that involve taking active bond positions with the primary objective of obtaining an abnormal return.

Active strategies are typically speculative.

Types:

- Interest Rate Anticipation Strategies
- Credit Strategies
- Fundamental Valuation Strategies

Passive Strategies

Strategies in which no change in the position is necessary once the bonds are selected.

Types

- Indexing
- Cash-Flow Matching
- Classical Immunization

Hybrid Strategies

Strategies that have both active and passive features.

Types

- Immunization with Rebalancing
- Contingent Immunization

Passive Strategies

The objectives of passive management strategies can include:

- A simple buy-and-hold approach of investing in bonds with specific maturities, coupons, and quality ratings with the intent of holding the bonds to maturity
- Forming portfolios with returns that mirror the returns on a bond index
- Constructing portfolios that ensure there are sufficient funds to meet future liabilities.

We shall analyze the following passive strategies:

- Bond Indexing
- Cash-Flow Matching
- Classical Immunization

Bond Indexing

Construct a bond portfolio whose returns over time replicate the returns of a bond index.

Indexing is a passive strategy, often used by investment fund managers who believe that actively managed bond strategies do not outperform bond market indices.

Cash Flow Matching

A cash flow matching strategy involves constructing a bond portfolio with cash flows that match the outlays of the liabilities.

Cash flow matching is also referred to as a dedicated portfolio strategy

Method:

One method that can be used for cash flow matching is to start with the final liability for time T and work backwards.

Period T

For the last period, one would select a bond with a principal (F_T) and coupon (C_T) that matches the amount of that final liability (L_T):

$$L_T = F_T + C_T$$
$$L_T = F_T(1 + C^{RO})$$
$$where: C^{R0} = C_T / F_T$$

To meet this liability one could buy:

$L_T/(1+C^{R0})$

of par value of bonds maturing in T periods

Period T-1

To match the liability in period T-1.

Select bonds with a principal of F_{T-1} and coupon C_{T-1} (or coupon rate of $C^{R1} = C_{T-1}/ F_{T-1}$) that is equal to the projected liability in period T-1 (L_{T-1}) less the coupon amount of C_T from the T-period bonds selected:

$$L_{T-1} - C_T = F_{T-1} + C_{T-1}$$

$$L_{T-1} - C_T = F_{T-1}(1 + C^{R1})$$

To meet this liability, one could buy

$(L_{T-1}-C_T)/(1+ C^{R1})$

of par value of bonds maturing in T-1 periods

Period T-2

To match the liability in period T-2.

Select bonds with a principal of F_{T-2} and coupon C_{T-2} (or coupon rate of $C^{R2} = C_{T-2}/ F_{T-2}$) that is equal to the projected liability in period T-2 (L_{T-2}) less the coupon amounts of C_T and C_{T-1} from the T-period and T-1-period bonds selected

$$L_{T-2} - C_T - C_{T-1} = F_{T-2} + C_{T+2}$$

$$L_{T-2} - C_T - C_{T-1} = F_{T-2}(1 + C^{R2})$$

To meet this liability, one could buy
$(L_{T-2} - C_T - C_{T-1})/(1+ C^{R2})$
of par value of bonds maturing in T-2 periods.

Example

Cash-flow matching

Table below shows the matching of liabilities of \$4M, \$3M, and \$1M in years 3, 2, and 1 with 3-year, 2-year, and 1-year bonds each paying 5% annual coupons and selling at par.

Year	1	2	3
Liability	\$1M	\$3M	\$4M

Bonds	Coupon Rate	Par	Yield	Market Value	Liability	Year
3-Year	5%	100	5%	100	$4M	3
2-year	5%	100	5%	100	$3M	2
1-year	5%	100	5%	100	$1M	1

Cash-Flow Matching Strategy

The $4M liability at the end of year 3 is matched by buying $3,809,524 worth of three-year bonds:

$$\frac{\$4,000,0000}{1.05} = \$3,809,524$$

The $3M liability at the end of year 2 is matched by buying $2,675,737 of 2-year bonds:

$$\frac{(\$3,000,000 - 5\% \times \$3,809,524)}{1.05} = \$2,675,237$$

The $1M at the end of year 1 is matched by buying $643,559 of 1-year bonds:

$$\frac{(\$1{,}000{,}000 - (5\% \times 3{,}809{,}524) - 5\% \times 2{,}675{,}737}{1.05} = \$643{,}559$$

1	2	3	4	5	6
Year	Total Bond Values	Coupon Income	Maturing Principal	Liability	Ending Balance (3) + (4) – (5)
1	$7,128,820	$356,441	$643,559	$1,000,000	0
2	$6,485,261	$324,263	$2,675,737	$3,000,000	0
3	$3,809,524	$190,476	$3,809,524	$4,000,000	0

With cash-flow matching the basic goal is to construct a portfolio that will provide a stream of payments from coupons, sinking funds, and maturing principals that will match the liability payments.

A dedicated portfolio strategy is subject to some minor market risk given that some cash flows may need to be reinvested forward.

It also can be subject to default risk if lower quality bonds are purchased

The biggest risk with cash-flow matching strategies is that the bonds selected to match forecasted liabilities may be called, forcing the investment manager to purchase new bonds yielding lower rates

Classical Immunization

Immunization is a strategy of minimizing market risk by selecting a bond or bond portfolio with a duration equal to the horizon date

For liability management cases, the liability payment date is the liability's duration, D_L

Immunization can be described as a duration-matching strategy of equating the duration of the bond or asset to the duration of the liability.

When a bond's duration is equal to the liability's duration, the direct interest-on-interest effect and the inverse price effect exactly offset each other

As a result, the rate from the investment (ARR) or the value of the investment at the horizon or liability date does not change because of an interest rate change

Example 1

A fund has a single liability of $1,352 due in 3.5 years, D_L = 3.5 years, and current investment funds of $968.30.

The current yield curve is flat at 10%.

Immunization Strategy

Buy bond with Macaulay's duration of 3.5 years.

Buy 4-year, 9% annual coupon at YTM of 10% for P_0 = $968.30.
This Bond has D = 3.5.

This bond has both a duration of 3.5 years and is worth $968.50, given a yield curve at 10%.

If the fund buys this bond, then any parallel shift in the yield curve in the very near future would have price and interest rate effects that exactly offset each other.

As a result, the cash flow or ending wealth at year 3.5, referred to as the accumulation value or target value, would be exactly $1,352.

DURATION-MATCHING

Ending Values at 3.5 Years Given Different Interest Rates for 4- Year, 9% Annual Coupon Bond with Duration of 3.5

Time (yr)	9%	10%	11%
1	$ 90(1.09)$^{2.5}$ = $ 111.64	$ 90(1.10)$^{2.5}$ = $ 114.21	$ 90(1.11)$^{2.5}$ = $ 116.83
2	90(1.09)$^{1.5}$ = $ 102.42	90(1.10)$^{1.5}$ = $ 103.83	90(1.11)$^{1.5}$ = $ 105.25
3	90(1.09)$^{.5}$ = $ 93.96	90(1.10)$^{.5}$ = $ 94.39	90(1.11)$^{.5}$ = $ 94.82
3.5	1090/(1.09)$^{.5}$ = $1044.03	1090/(1.10)$^{.5}$ = $1039.27	1090/(1.11)$^{.5}$ = $ 1034.58
Target Value	$1352	$1352	$1352

Note: In addition to matching duration, immunization also requires that the initial investment or current market value of the assets purchased to be equal to or greater than the present value of the liability using the current YTM as a discount factor.

In this example, the present value of the $1,352 liability is $968.50 (= $1,352/$(1.10)^{3.5}$), which equals the current value of the bond and implies a 10% rate of return.

Duration-matching strategy works by having offsetting price and reinvestment effects.

In contrast, a maturity-matching strategy where a bond is selected with a maturity equal to the horizon date has no price effect and therefore no way to offset the reinvestment effect.

This can be seen in the next exhibit where unlike the duration-matched bond, a 10% annual coupon bond with a maturity of 3.5 years has different ending values given different interest rates.

MATURITY-MATCHING

Ending Values at 3.5 Years Given Different Interest Rates for 10% Annual Coupon Bond with Maturity of 3.5 Years

Time (yr)	9%	10%	11%
1	$ $100(1.09)^{2.5}$ = $124.04	$ $100(1.10)^{2.5}$ = $126.91	$ $100(1.11)^{2.5}$ = $129.81
2	$100(1.09)^{1.5}$ = $113.80	$100(1.10)^{1.5}$ = $115.37	$100(1.11)^{1.5}$ = $116.95
3	$100(1.09)^{.5}$ = $104.40	$100(1.10)^{.5}$ = $ 104.88	$100(1.11)^{.5}$ = $ 105.36
3.5	1050 = $1050	1050 = $1050	1050 = $1050
	$1392	$1397	$1402

Immunization and Rebalancing

Reasons for the presence of market risk with classical immunization

1. The shifts in yield curves were not parallel
2. Immunization only works when the duration of assets and liabilities are match at all times.

To achieve immunization, the duration of the bond must be equal to the remaining time in the horizon period.

The durations of assets and liabilities change with both time and yield changes:

1. The duration of a coupon bond declines more slowly than the terms to maturity. In the earlier example, the 4-year, 9% bond with a Macaulay duration of 3.5 years when rates were 10%, one year later would have duration of 2.77 years with no change in rates.

2. Duration changes with interest rate changes. Specifically, there is an inverse relation between interest rates and duration.

Thus, a bond and liability that currently have the same durations will not necessarily be equal as time passes and rates change.

Immunized positions require active management, called rebalancing, to ensure that the duration of the bond position is always equal to the remaining time to horizon.

Rebalancing Strategies when $D_B \neq D_L$

- Sell bond and buy new one
- Add a bond to change D_p
- Reinvest cash flows differently
- Use futures or options.

Bond Immunization: Focus Strategy

For a single liability, immunization can be achieved with a focus strategy or a barbell strategy.

In a focus strategy, a bond is selected with a duration that matches the duration of the liability or a bullet approach is applied where a portfolio of bonds are selected with all the bonds close to the desired duration.

Example
If the duration of the liability is 4 years, one could select a bond with a 4-year duration or form a portfolio of bonds with durations of 4 and 5 years.

Bond Immunization: Barbell Strategy

In a barbell strategy, the duration of the liability is matched with a bond portfolio with durations more at the extremes.

Example

For a duration liability of 4 years, an investor might invest half of his funds in a bond with a two-year duration and half in a bond with a six-year duration.

Note

The problem with the barbell strategy is that it may not immunize the position if the shift in the yield curve is not parallel.

Example 2

Life insurance company: sells a guaranteed investment contract (GIC). Life insurance company guarantees that a specified dollar amount will be paid to the policyholder at a specific future date.

Example: 5-year GIC that guarantees an interest rate of 7.5% per year on a bond-equivalent yield basis (or equivalent, 3.75% every six months for the next ten 6-month periods).Suppose that the payment made by the policyholder to purchase the GIC is $9,642,899.

The value that the life insurance company has guaranteed to the policyholder five years from now is $13,934,413.

When investing the $9,642,899, the target accumulated value for the life insurance company is $13,934,413 after five years, which is the same as a target yield of 7.5% on a bond-equivalent basis.

Total accumulated value and total return after five years form a 6-year 6.75% Bond selling to yield 7.5

New yield (%)	Coupon ($)	Reinvestment income ($)	Price of bond	Accumulated Value ($)	Total return (%)
11.00	3,375,000	970,432	9,607,657	13,953,089	7.53
10.50	3,375,000	919,903	9,652,592	13,947,495	7.52
10.00	3,375,000	870,039	9.697,846	13,942,885	7.51
9.50	3,375,000	820,831	9,743,423	13,939,253	7.51
9.00	3,375,000	772,271	9,789,325	13,936,596	7.50
8.50	3,375,000	724,350	9.835,556	13,934,906	7.50
8.00	3,375,000	677,061	9,882,119	13,934,180	7.50
7.50	3,375,000	630,395	9,929,017	13,934,413	7.50
7.00	3,375,000	584,345	9,976,254	13,935,599	7.50
6.50	3,375,000	538,902	10,023,832	13,937,734	7.50
6.00	3,375,000	494,059	10,071,755	13,940,814	7.51
5.50	3,375,000	449,808	10,120,027	13,944,835	7.52
5.00	3,375,000	406,141	10,168,650	13,949,791	7.52
4.50	3,375,000	363,051	10,217,628	13,955,679	7.53
4.00	3,375,000	320,531	10,266,965	13,962,495	7.54

Looking to the two last columns:

The accumulated value and the total return are never less than the target accumulated value and the target yield.

When the market yields rise, the change in the reinvestment income more than offsets the decline in price. When the market yield declines, the increase in price exceeds the decline in reinvestment income.

What characteristics of this bond assures that the target accumulated value will be realized regardless of how the market yield changes?

The duration of the liability is 4.82 (the duration of a zero coupon liability is equal to the number of years to maturity of the liability divided by 1 plus one-half the yield, 5 divided by 1+0.075/2)

The key should be that the bond duration has to be equal to the duration of the liability, in this case 4.82!!!!

To immunize a portfolio's target accumulated value (target yield) against a change in the market yield, the life insurance company must invest in a bond (or a bond portfolio) such that 1) the portfolio's duration is equal to the liability's duration, and 2) the initial present value of the cash flows from the bond (or bond portfolio) equals the present value of the future liability.

A bond with a duration shorter than the duration of the liability expose the portfolio to reinvestment risk.
A bond with a duration greater than the investment horizon exposes the portfolio to price risk.

Bond Immunization: Immunizing Multiple-Period Liabilities

For multiple-period liabilities, bond immunization strategies can be done by either:

1. Matching the duration of each liability with the appropriate bond or bullet bond portfolio

2. Constructing a portfolio with a duration equal to the weighted average of the durations of the liabilities (D^P_L)