Level III

Liability-Driven and Index-Based Strategies

2020 Exam

Contents and Introduction

2 Liability-Driven Investing

ALM considers both assets and liabilities in the portfolio decision making process

- Asset-Driven Liabilities (ADL)
- Liability-Driven Investing (LDI)

Liability Type	Amount of Cash Outlay	Timing of Cash Outlay	Example
I	Known	Known	Traditional fixed income bonds
II	Known	Uncertain	Callable and putable bonds
III	Uncertain	Known	Floating rate notes
IV	Uncertain	Uncertain	Defined benefit plan obligations

Example 1: Classification of Liabilities

Modern Mortgage, a savings bank, decides to establish an ALCO to improve risk management and coordination of its loan and deposit rate-setting processes. Modern's primary assets are long-term, fixed-rate, monthly payment, fully amortizing residential mortgage loans. The mortgage loans are prime quality and have loan-to-value ratios that average 80%. The loans are pre-payable at par value by the homeowners at no fee. Modern also holds a portfolio of non-callable, fixed-income government bonds (considered free of default risk) of varying maturities to manage its liquidity needs. The primary liabilities are demand and time deposits that are fully guaranteed by a government deposit insurance fund. The demand deposits are redeemable by check or debit card. The time deposits have fixed rates and maturities ranging from 90 days to three years and are redeemable before maturity at a small fee. The banking-sector regulator in the country in which Modern operates has introduced a new capital requirement for savings banks. In accordance with the requirement, contingent convertible long-term bonds are issued by the savings bank and sold to institutional investors. The key feature is that if defaults on the mortgage loans reach a certain level or the savings bank's capital ratio drops below a certain level, as determined by the regulator, the bonds convert to equity at a specified price per share.

As a first step, the ALCO needs to identify the types of assets and liabilities that comprise its balance sheet using the classification scheme in Exhibit 1. Type I has certain amounts and dates for its cash flows; Type II has known amounts but uncertain dates; Type III has specified dates but unknown amounts; and Type IV has uncertain amounts and dates.

Specify and explain the classification scheme for the following:

1. Residential mortgage loans
2. Government bonds
3. Demand and time deposits
4. Contingent convertible bonds

3 Interest Rate Immunization—Managing the Interest Rate Risk of a Single Liability

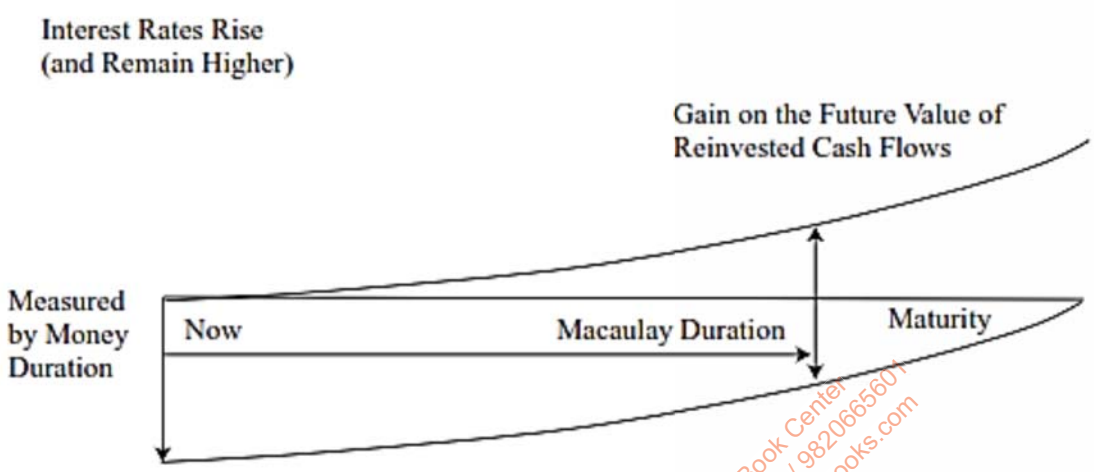
Immunization is the process of structuring and managing a fixed-income bond portfolio to minimize the variance in the realized rate of return over a known time horizon

Basic immunization strategy: zero-coupon bond which matures on the same day as the liability

If zero-coupon bond not available then create a bond portfolio

- Market value ≥ present value of liability
- Macaulay duration = liability's due date
- Minimize portfolio convexity

Rebalance portfolio as duration of bonds changes



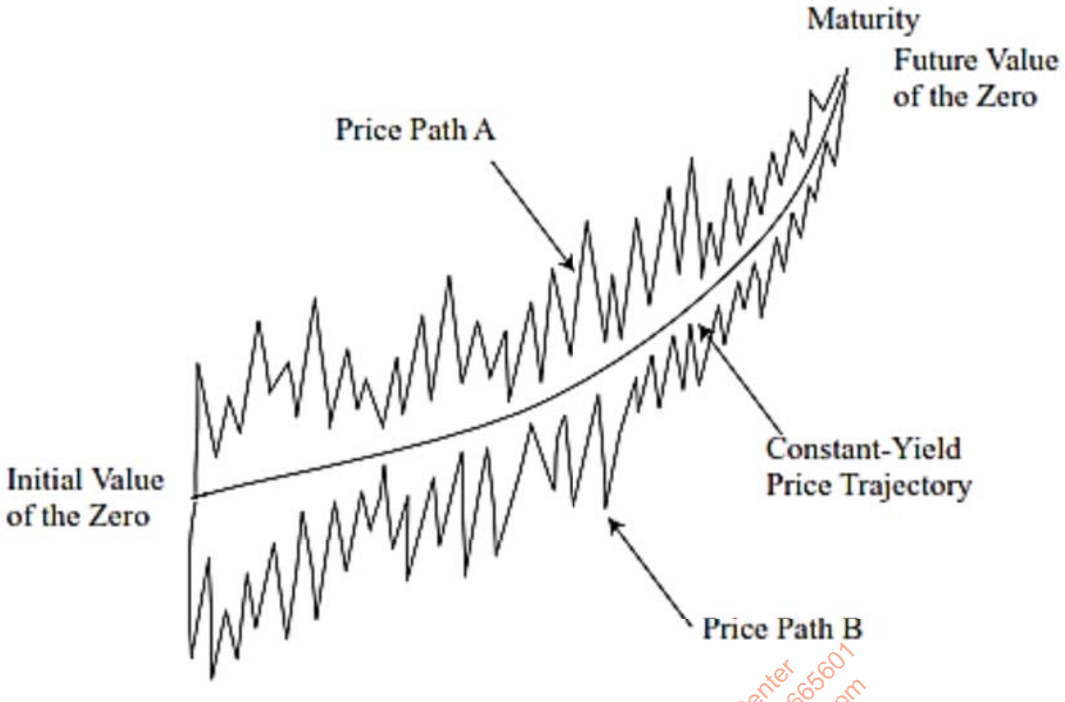
Zero-Replication

Liability: payment of EUR 250 million at the end of 6 years.

Perfect hedge: six-year zero-coupon bond with a face value that matches the EUR 250 million liability

Structure and manage a portfolio of coupon-bearing bonds that replicates the period-to-period performance of the zero-coupon bond

- Portfolio's initial market value must match or exceed PV of zero-coupon bond
- Immunization achieved if any ensuing change in the cash flow yield on the bond portfolio is equal to the change in the yield to maturity on the zero-coupon bond
- Continuously match portfolio Macaulay duration with Macaulay duration of zero-coupon bond



Impact of Yield Curve Movements

Immunization achieved if change in cash flow yield is the same as that on a zero-coupon bond being replicated

- Parallel Shifts
- Bear Steepener
- Bear Flattener
- Bull Steepener
- Bull Flattener

Structural risk: immunization not achieved for some non-parallel shifts and twists

- Reduce risk by minimizing dispersion of cash flows
- Minimize convexity statistic
- Concentrate cash flows around horizon date

$$\text{Convexity} = \frac{\text{Macaulay duration}^2 + \text{Macaulay duration} + \text{Dispersion}}{(1 + \text{Cash flow yield})^2}$$

Immunization of a Single Liability

An entity has a single liability of EUR 250 million due 15 February 2023. The current date is 15 February 2017, so the investment horizon is six years. The asset manager for the entity seeks to build a three-bond portfolio to earn a rate of return sufficient to pay off the obligation.

	2.5-Year Bond	7-Year Bond	10-Year Bond
Coupon rate	1.50%	3.25%	5.00%
Maturity date	15 August 2019	15 February 2024	15 February 2027
Price	100.25	99.75	100.50
Yield to maturity	1.3979%	3.2903%	4.9360%
Par value	47,000,000	97,300,000	55,600,000
Market value	47,117,500	97,056,750	55,878,000
Macaulay duration	2.463	6.316	7.995
Convexity	7.253	44.257	73.747
Allocation	23.55%	48.52%	27.93%

Time	Date	Cash Flow	PV of Cash Flow	Weight	Time × Weight	Dispersion	Convexity
0	15-Feb-17	–200,052,250					
1	15-Aug-17	3,323,625	3,262,282	0.0163	0.0163	1.9735	0.0326
2	15-Feb-18	3,323,625	3,202,071	0.0160	0.0320	1.6009	0.0960
3	15-Aug-18	3,323,625	3,142,971	0.0157	0.0471	1.2728	0.1885
4	15-Feb-19	3,323,625	3,084,962	0.0154	0.0617	0.9871	0.3084
5	15-Aug-19	50,323,625	45,847,871	0.2292	1.1459	11.2324	6.8754
6	15-Feb-20	2,971,125	2,656,915	0.0133	0.0797	0.4782	0.5578
7	15-Aug-20	2,971,125	2,607,877	0.0130	0.0913	0.3260	0.7300
8	15-Feb-21	2,971,125	2,559,744	0.0128	0.1024	0.2048	0.9213
9	15-Aug-21	2,971,125	2,512,500	0.0126	0.1130	0.1131	1.1303
10	15-Feb-22	2,971,125	2,466,127	0.0123	0.1233	0.0493	1.3560
11	15-Aug-22	2,971,125	2,420,610	0.0121	0.1331	0.0121	1.5972
12	15-Feb-23	2,971,125	2,375,934	0.0119	0.1425	0.0000	1.8527
13	15-Aug-23	2,971,125	2,332,082	0.0117	0.1515	0.0116	2.1216
14	15-Feb-24	100,271,125	77,251,729	0.3862	5.4062	1.5434	81.0931
15	15-Aug-24	1,390,000	1,051,130	0.0053	0.0788	0.0473	1.2610
16	15-Feb-25	1,390,000	1,031,730	0.0052	0.0825	0.0825	1.4028
17	15-Aug-25	1,390,000	1,012,688	0.0051	0.0861	0.1265	1.5490
18	15-Feb-26	1,390,000	993,997	0.0050	0.0894	0.1788	1.6993
19	15-Aug-26	1,390,000	975,651	0.0049	0.0927	0.2389	1.8533
20	15-Feb-27	56,990,000	39,263,380	0.1963	3.9253	12.5585	82.4316
			200,052,250	1.0000	12.0008	33.0378	189.0580

Example 2: Selecting and Immunization Portfolio

An institutional client asks a fixed-income investment adviser to recommend a portfolio to immunize a single 10-year liability. It is understood that the chosen portfolio will need to be rebalanced over time to maintain its target duration. The adviser proposes two portfolios of coupon-bearing government bonds because zero-coupon bonds are not available. The portfolios have the same market value. The institutional client's objective is to minimize the variance in the realized rate of return over the 10-year horizon. The two portfolios have the following risk and return statistics:

	Portfolio A	Portfolio B
Cash flow yield	7.64%	7.65%
Macaulay duration	9.98	10.01
Convexity	107.88	129.43

These statistics are based on aggregating the interest and principal cash flows for the bonds that constitute the portfolios; they are not market value weighted averages of the yields, durations, and convexities of the individual bonds. The cash flow yield is stated on a semi-annual bond basis, meaning an annual percentage rate having a periodicity of two; the Macaulay durations and convexities are annualized.

Indicate the portfolio that the investment adviser should recommend, and explain the reasoning.

4 Interest Rate Immunization—Managing the Interest Rate Risk of Multiple Liabilities

1. Cash Flow Matching
2. Duration Matching
3. Derivatives Overlay
4. Contingent Immunization

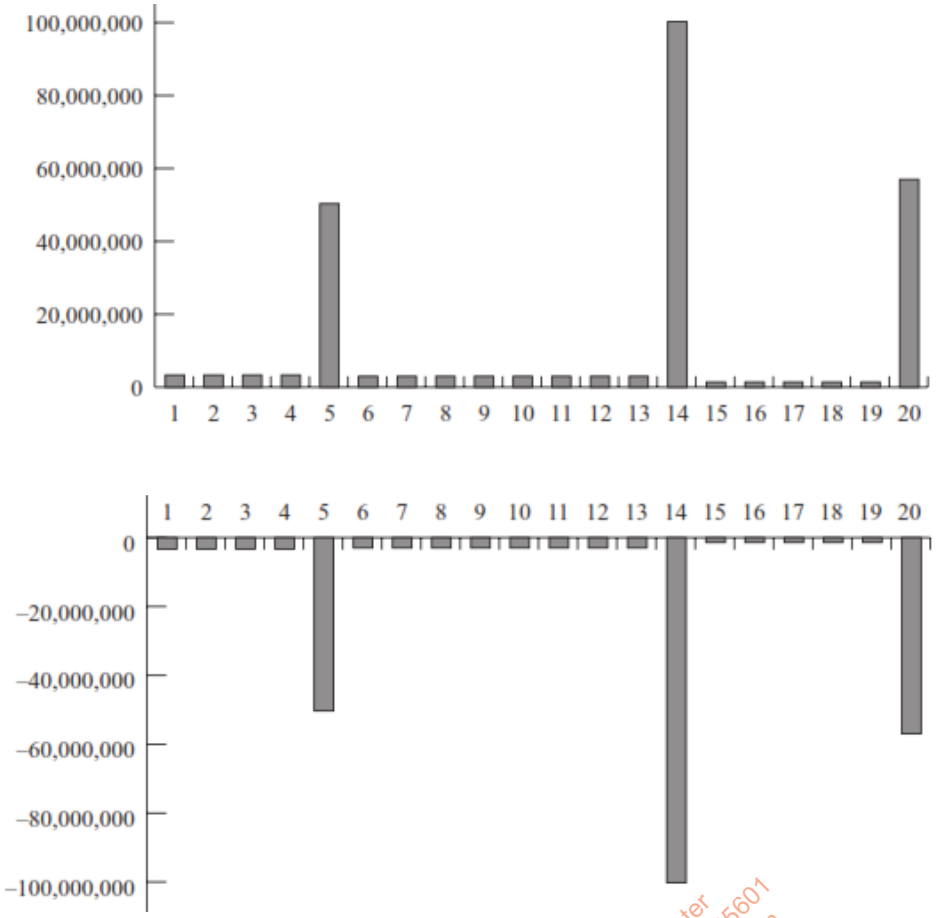
4.1 Cash Flow Matching

Build dedicated portfolio of zero-coupon or fixed-income bonds to ensure that there are sufficient cash inflows to pay the scheduled cash outflows.

Accounting defeasance: both assets and liabilities are removed from the balance sheet.

Sufficient funds must be available on or before each liability payment date to meet the obligation.

If portfolio is made up of traditional bonds, dealing with an annuity-like liability is problematic.



Example 3: Cash Flow Matching

Alfred Simonsson is assistant treasurer at a Swedish lumber company. The company has sold a large tract of land and now has sufficient cash holdings to retire some of its debt liabilities. The company's accounting department assures Mr. Simonsson that its external auditors will approve of a defeasement strategy if Swedish government bonds are purchased to match the interest and principal payments on the liabilities. Following is the schedule of payments due on the debt as of June 2017 that the company plans to defease:

June 2018	SEK 3,710,000
June 2019	SEK 6,620,000
June 2020	SEK 4,410,000
June 2021	SEK 5,250,000

The following Swedish government bonds are available. Interest on the bonds is paid annually in May of each year.

Coupon Rate	Maturity Date
2.75%	May 2018
3.50%	May 2019
4.75%	May 2020
5.50%	May 2021

How much in par value for each government bond will Mr. Simonsson need to buy to defease the debt liabilities, assuming that the minimum denomination in each security is SEK 10,000?

4.2 Duration Matching

Strategies for retiring debt liabilities		
Bond tender offer	**Cash flow matching**	**Duration matching**
Buy back debt liability in open market. The issue: typically bonds are illiquid and will have to be bought back at a premium.	If cash flow matching is through high-quality government bonds → accounting defeasement. The issue: government bonds are relatively expensive.	Lowest cost strategy. Liabilities are 'effectively' removed.

Conditions to immunize multiple liabilities:

1. Market value of assets ≥ market value of liabilities
2. Match money duration: asset basis point value = liability basis point value
3. Dispersion of cash flow and convexity of assets greater than those of liabilities

Basis point value = Money duration x 1 bp

Money duration = Modified duration x market value

Modified duration = Macaulay duration / (1 + cash flow yield per period)

Hedging Multiple Liabilities

Liabilities:

Total market value = 200,052,250

Cash flow yield = 0.037608

Macaulay duration = 6.0004

BPV = 117,824

Convexity = 45.54

	2.5-Year Bond	7-Year Bond	10-Year Bond
Coupon rate	1.50%	3.25%	5.00%
Maturity date	15 August 2019	15 February 2024	15 February 2027
Price	100.25	99.75	100.50
Yield to maturity	1.3979%	3.2903%	4.9360%
Par value	47,000,000	97,300,000	55,600,000
Market value	47,117,500	97,056,750	55,878,000

Assets:

Total market value = 202,224,094

Cash flow yield = 0.035822

BPV = 117,824

Convexity = 48.68

	1.5-Year Bond	6-Year Bond	11.5-Year Bond
Coupon rate	1.00%	2.875%	4.50%
Maturity date	15 August 2018	15 February 2023	15 August 2028
Price	99.875	99.75	100.25
Yield to maturity	1.0842%	2.9207%	4.4720%
Par value	41,825,000	100,000,000	60,550,000
Market value	41,772,719	99,750,000	60,701,375

Upward Parallel Shift	Immunizing Assets	Debt Liabilities	Difference
Δ Market value	–2,842,408	–2,858,681	16,273
Δ Cash flow yield	0.2437%	0.2449%	–0.0012%
Δ Portfolio BPV	–2,370	–2,207	–163
Downward Parallel Shift	Immunizing Assets	Debt Liabilities	Difference
Δ Market value	2,900,910	2,913,414	–12,504
Δ Cash flow yield	–0.2437%	–0.2449%	0.0012%
Δ Portfolio BPV	2,429	2,256	173
Steepening Twist	Immunizing Assets	Debt Liabilities	Difference
Δ Market value	–1,178,071	–835,156	–342,915
Δ Cash flow yield	0.1004%	0.0711%	0.0293%
Δ Portfolio BPV	–984	–645	–339
Flattening Twist	Immunizing Assets	Debt Liabilities	Difference
Δ Market value	1,215,285	850,957	364,328
Δ Cash flow yield	–0.1027%	–0.0720%	–0.0307%
Δ Portfolio BPV	1,016	658	358

Example 4

A Japanese corporation recently sold one of its lines of business and would like to use the cash to retire the debt liabilities that financed those assets. Summary statistics for the multiple debt liabilities, which range in maturity from three to seven years, are market value, JPY 110.4 billion; portfolio modified duration, 5.84; portfolio convexity, 46.08; and BPV, JPY 64.47 million.

An investment bank working with the corporation offers three alternatives to accomplish the objective:

1. **Bond tender offer.** The corporation would buy back the debt liabilities on the open market, paying a premium above the market price. The corporation currently has a single-A rating and hopes for an upgrade once its balance sheet is improved by retiring the debt. The investment bank anticipates that the tender offer would have to be at a price commensurate with a triple-A rating to entice the bondholders to sell. The bonds are widely held by domestic and international institutional investors.

2. **Cash flow matching.** The corporation buys a portfolio of government bonds that matches, as closely as possible, the coupon interest and principal redemptions on the debt liabilities. The investment bank is highly confident that the corporation's external auditors will agree to accounting defeasement because the purchased bonds are government securities. That agreement will allow the corporation to remove both the defeasing asset portfolio and the liabilities from the balance sheet.

3. **Duration matching.** The corporation buys a portfolio of high-quality corporate bonds that matches the duration of the debt liabilities. Interest rate derivative contracts will be used to keep the duration on its target as time passes and yields change. The investment bank thinks it is very unlikely that the external auditors will allow this strategy to qualify for accounting defeasement. The corporation can explain to investors and the rating agencies in the management section of its annual report, however, that it is aiming to "effectively defease" the debt. To carry out this strategy, the investment bank suggests three different portfolios of investment-grade corporate bonds that range in maturity from 2 years to 10 years. Each portfolio has a market value of about JPY 115 billion, which is considered sufficient to pay off the liabilities.

	Portfolio A	Portfolio B	Portfolio C
Modified duration	5.60	5.61	5.85
Convexity	42.89	50.11	46.09
BPV (in millions)	JPY 64.50	JPY 64.51	JPY 67.28

4.3 Derivatives Overlay

Derivatives overlay strategy: derivatives such as interest rate futures contracts are used to immunize single or multiple liabilities.

Futures contracts are a cost effective method to rebalance portfolio to maintain target duration as yield curve changes.

Asset manager might hold a portfolio of short-term bonds and then use a derivatives overlay strategy to plug the duration gap.

Asset portfolio BPV + (N_f × Futures BPV) = Liability portfolio BPV

$$N_f = \frac{\text{Liability portfolio BPV} - \text{Asset portfolio BPV}}{\text{Futures BPV}}$$

$$\text{Futures BPV} \approx \frac{\text{BPV}_{\text{CTD}}}{\text{CF}_{\text{CTD}}}$$

Example 5: Duration Overlay

A Frankfurt-based asset manager uses the Long Bund contract traded at the Intercontinental Exchange (ICE) futures exchange to manage the gaps that arise from “duration drift” in a portfolio of German government bonds that are used to immunize a portfolio of corporate debt liabilities. This futures contract has a notional principal of EUR 100,000 and a 6% coupon rate. The German government bonds that are eligible for delivery have maturities between 8.5 years and 10.5 years.

Currently, the corporate debt liabilities have a market value of EUR 330,224,185, a modified duration of 7.23, and a BPV of EUR 238,752. The asset portfolio has a market value of EUR 332,216,004, a modified duration of 7.42, and a BPV of EUR 246,504. The duration drift has arisen because of a widening spread between corporate and government bond yields as interest rates in general have come down. The lower yields on government bonds have increased the modified durations relative to corporates.

Based on the deliverable bond, the asset manager estimates that the BPV for each futures contract is EUR 65.11.

1. Does the asset manager go long (buy) or go short (sell) the futures contract?
2. How many contracts does the manager buy or sell to close the duration gap?

4.4 Contingent Immunization

- Contingent immunization can be used when portfolio asset value > present value of liabilities
  - Hedge liabilities using passive strategy
  - Actively manage surplus
  - Revert to passive-only strategy if surplus falls below a designated threshold

- Surplus can be invested in any asset category
  - Liquidity is important

- Futures contracts be used as part of a contingent immunization strategy
  - Over-hedge if yields are expected to decline
  - Under-hedge if yields are expected to increase

Example 6: Contingent Immunization & Derivatives Overlay

An asset manager is asked to build and manage a portfolio of fixed-income bonds to retire multiple corporate debt liabilities. The debt liabilities have a market value of GBP 50,652,108, a modified duration of 7.15, and a BPV of GBP 36,216.

The asset manager buys a portfolio of British government bonds having a market value of GBP 64,271,055, a modified duration of 3.75, and a BPV of GBP 24,102. The initial surplus of GBP 13,618,947 and the negative duration gap of GBP 12,114 are intentional. The surplus allows the manager to pursue a contingent immunization strategy to retire the debt at, hopefully, a lower cost than a more conservative duration matching approach. The duration gap requires the manager to buy, or go long, interest rate futures contracts to close the gap. The manager can choose to over-hedge or under-hedge, however, depending on market circumstances.

The futures contract that the manager buys is based on 10-year gilts having a par value of GBP 100,000. It is estimated to have a BPV of GBP 98.2533 per contract. Currently, the asset manager has purchased, or gone long, 160 contracts.

Which statement *best* describes the asset manager's hedging strategy and the held view on future 10-year gilt interest rates? The asset manager is:

A. over-hedging because the rate view is that 10-year yields will be rising.

B. over-hedging because the rate view is that 10-year yields will be falling.

C. under-hedging because the rate view is that 10-year yields will be rising.

D. under-hedging because the rate view is that 10-year yields will be falling.

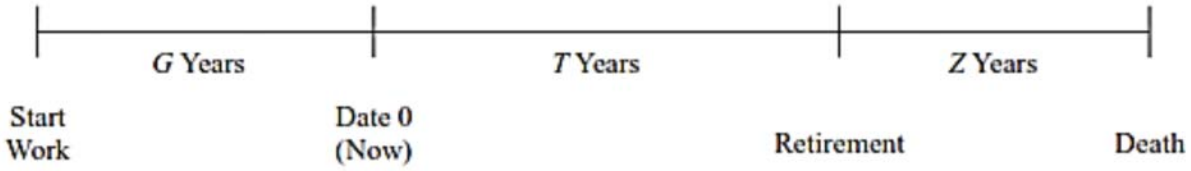
5 Liability-Driven Investing—An Example of a Defined Benefit Pension Plan

Liability Type	Amount of Cash Outlay	Timing of Cash Outlay	Example
I	Known	Known	Traditional fixed income bonds
II	Known	Uncertain	Callable and putable bonds
III	Uncertain	Known	Floating rate notes
IV	Uncertain	Uncertain	Defined benefit plan obligations

Macaulay and modified duration do **not** apply.

Use **effective duration**.

Exhibit 14 Time Line Assumptions for the Representative Employee



$$\text{Effective duration} = \frac{(PV_-) - (PV_+)}{2 \times \Delta\text{Curve} \times (PV_0)}$$

Two measures of retirement obligations:

- ABO is based on current wages
- PBO is based on projected future wages

Duration Gaps and Hedging

- ABO and PBO amounts and effective duration measures can be different
  - ABO represents a legal liability; use if plan is likely to be covered to a DC plan
  - If DB plan is likely to be maintained then use PBO

- Pension plan portfolios might have bonds, equities and alternative investments; a decrease in interest rates can significantly increase the asset-liability mismatch.

- Duration gaps can be addressed using derivative contracts

- Hedging ratio

- Strategic hedging

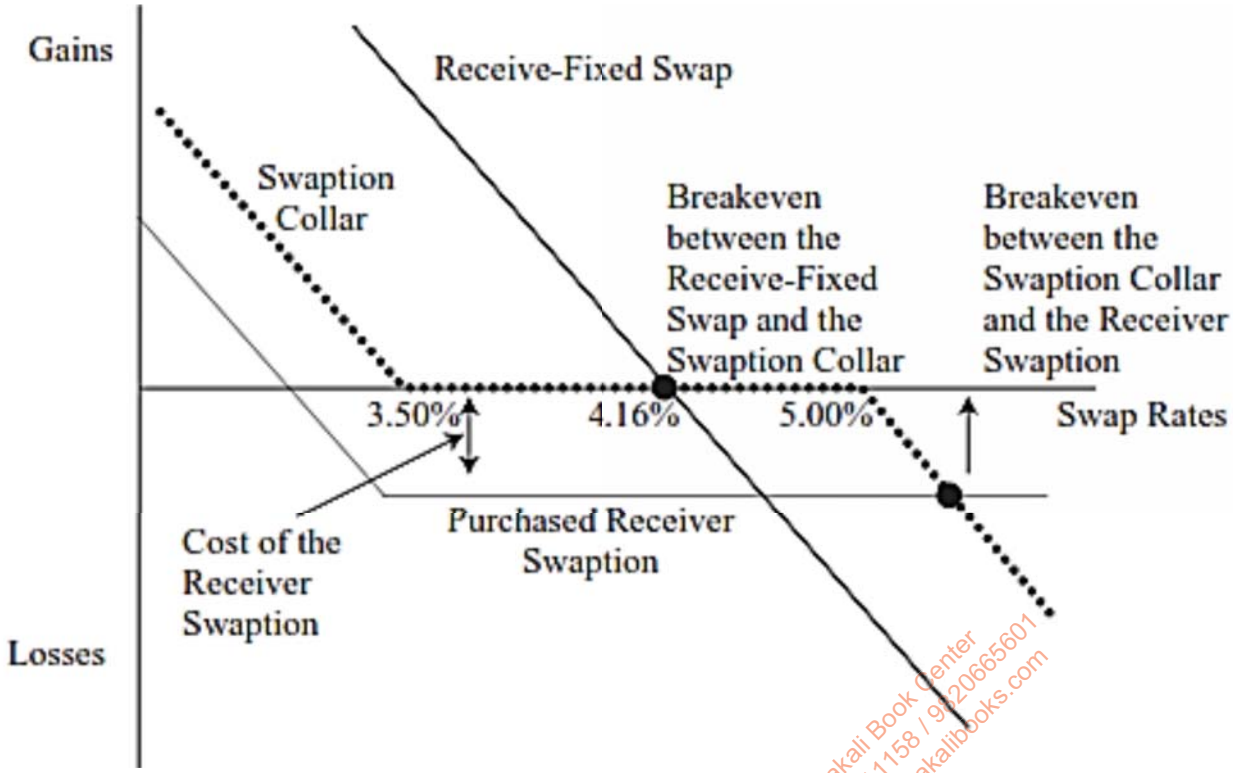
Swaps and Swaptions

- Interest rate swap

$$\text{Asset BPV} + \left[\text{NP} \times \frac{\text{Swap BPV}}{100}\right] = \text{Liability BPV}$$

- Receiver swaption

- Swaption collar



Example 6: Swaps and Swaptions (1/2)

A corporation is concerned about the defined benefit pension plan that it sponsors for its unionized employees. Because of recent declines in corporate bond yields and weak performance in its equity investments, the plan finds itself to be only about 80% funded. That fact is raising concerns with its employees as well as with the rating agencies. Currently, the present value of the corporation's retirement obligations is estimated by the plan's actuarial advisers to be about USD 1.321 billion using the PBO measure of liabilities. The corporation has no plans to close the defined benefit plan but is concerned about having to report the funding status in its financial statements. The market value of its asset portfolio is USD 1.032 billion—the plan is underfunded by USD 289 million.

The pension fund's asset allocation is rather aggressive: 70% equity, 10% alternative assets, and 20% fixed income. The fund manager hopes that a recovering equity market will reverse the deficit and ultimately return the plan to a fully funded position. Still, the manager is concerned about tightening corporate spreads as the economy improves. That scenario could lead to lower discount rates that are used to calculate the present value of the liabilities and offset any gains in the stock market.

The pension plan has hired a qualified professional asset manager (QPAM) to offer advice on derivatives overlay strategies and to execute the contracts with a commercial bank. The QPAM suggests that the pension plan consider the use of interest rate derivatives to partially close the duration gap between its assets and liabilities. The actuarial advisers to the plan estimate that the effective duration of the liabilities is 9.2, so that the BPV is USD 1.215 million. The corporate sponsor requires that the manager assume an effective duration of zero on equity and alternative assets. The fixed-income portfolio consists mostly of long-term bonds, including significant holdings of zero-coupon government securities. Its effective duration is estimated to be 25.6. Taken together, the asset BPV is USD 528,384. The negative money duration gap is substantial.

Example 6: Swaps and Swaptions (2/2)

The QPAM has negotiated three interest rate derivatives with the commercial bank. The first is a 30-year, 3.80% receive-fixed swap referencing three-month Libor. The swap's effective duration is +17.51 and its BPV is 0.1751 per USD 100 of notional principal. The second is a receiver swaption having a strike rate of 3.60%. The plan pays a premium of 145 bps upfront to buy the right to enter a 30-year swap as the fixed-rate receiver. The expiration date is set to match the date when the pension plan next reports its funding status. The third is a swaption collar, the combination of buying the 3.60% receiver swaption and writing a 4.25% payer swaption. The premiums on the two swaptions offset, so this is a "zero-cost" collar.

After some discussions with the rates desk at the commercial bank and a conversation with the bank's strategy group, the plan manager instructs the QPAM to select the 3.80% receive-fixed interest rate swap. Moreover, the manager chooses a hedging ratio of 75%.

1. Calculate the notional principal on the interest rate swap to achieve the 75% hedging ratio.

2. Indicate the plan manager's likely view on future 30-year swap fixed rates given the decision to choose the swap rather than the purchased receiver swaption or the swaption collar.

6 Risks in Liability-Driven Investing

Asset BPV x Δ Asset yields + Hedge BPV x Δ Hedge yields ≈ Liability BPV x Δ Liability yields

Model risks arise because assumptions in models and approximations turn out to be inaccurate

- Effective duration for equity
- Portfolio duration as a weighted average
- Estimation of ABO and PBO
- Estimation of futures contract BPV

Yield curve twists

Spread risk

Credit risk and collateral exhaustion risk

Asset liquidity

Example 8: Risks Associated with LDI Strategies (1/2)

A derivatives consultant, a former head of interest rate swaps trading at a major London bank, is asked by a Spanish corporation to devise an overlay strategy to “effectively defease” a large debt liability. That means that there are dedicated assets to retire the debt even if both assets and the liability remain on the balance sheet. The corporation currently has enough euro-denominated cash assets to retire the bonds, but its bank advises that acquiring the securities via a tender offer at this time will be prohibitively expensive.

The 10-year fixed-rate bonds are callable at par value in three years. This is a one-time call option. If the issuer does not exercise the option, the bonds are then non-callable for the remaining time to maturity. The corporation’s CFO anticipates higher benchmark interest rates in the coming years. Therefore, the strategy of investing the available funds for three years and then calling the debt is questionable because the embedded call option might be “out of the money” when the call date arrives. Moreover, it is likely that the cost to buy the bonds on the open market at that time will still be prohibitive.

The corporation has considered a cash flow matching approach by buying a corporate bond having the same credit rating and a call structure (call date and call price) close to the corporation’s own debt liability. The bank working with the CFO has been unable to identify an acceptable bond, however. Instead, the bank suggests that the corporation buy a 10-year non-callable, fixed-rate corporate bond and use a swaption to mimic the characteristics of the embedded call option. The idea is to transform the callable bond (the liability) into a non-callable security synthetically using the swaption. Then the newly purchased non-callable bond “effectively” defeases the transformed “non-callable” debt liability.

Example 8: Risks Associated with LDI Strategies (2/2)

To confirm the bank's recommendation for the derivatives overlay, the CFO turns to the derivatives consultant, asking if the corporation should (1) buy a payer swaption, (2) buy a receiver swaption, (3) write a payer swaption, or (4) write a receiver swaption. The time frames for the swaptions correspond to the embedded call option. They are "3y7y" contracts, an option to enter a seven-year interest rate swap in three years. The CFO also asks the consultant about the risks to the recommended swaption position.

1. Indicate the swaption position that the derivatives consultant should recommend to the corporation.
2. Indicate the risks in using the derivatives overlay.

7 Bond Indexes and the Challenges of Matching a Fixed-Income Portfolio to an Index

- Investment strategy based on bond market index offers exposure to the fixed income universe
  - Diversification
  - Low administrative costs

- Investment success is measured based on how closely the chosen market portfolio mirrors returns of underling bond market index (tracking risk or tracking error)

- Fixed income markets are much larger and broader than equity markets

- Illiquidity of corporate bonds makes valuation challenging; matrix pricing uses available data on comparable securities to estimate fair value of illiquid bonds

Primary Indexing Risk Factors

Strategies: pure indexing, enhanced indexing strategy, active management

Primary Indexing Risk Factors

- Portfolio modified adjusted duration
- Key rate duration
- Percent in sector and quality
- Sector and quality spread duration contribution
- Sector/coupon/maturity cell weights
- Issuer exposure

Present value of distribution of cash flows methodology: approximate and match the yield curve risk of an index over discrete time periods

Goal of matching primary indexing risk factors is to minimize **tracking error**.

Example 9: Minimizing Tracking Error

Cindy Cheng, a Hong Kong–based portfolio manager, has established the All Asia Dragon Fund, a fixed-income fund designed to outperform the Markit iBoxx Asian Local Bond Index (ALBI). The ALBI tracks the total return performance of liquid bonds denominated in local currencies in China, Hong Kong, India, Indonesia, Korea, Malaysia, the Philippines, Singapore, Taiwan, and Thailand. The index includes both sovereign and non-government bond issues, with constituent selection criteria by country as well as country weights designed to balance the desire for liquidity and stability.

Individual bond weightings are based on market capitalization, and country weightings, reviewed annually, are designed to reflect the investability of developing Asian local currency bonds available to international investors. These weights are driven by local market size and market capitalization, secondary bond market liquidity, accessibility to foreign investors, and development of infrastructure that supports fixed-income investment and trading such as credit ratings, yield curves, and derivative products.

Given the large number of bonds in the index, Cheng uses a representative sample of the bonds to construct the fund. She chooses bonds so that the fund's duration, country weightings, and sector/quality percentage weights closely match the ALBI. Given the complexity of managing bond investments in these local markets, Cheng is targeting a 1.25% tracking error for the fund.

1. Interpret Cheng's tracking error target for the All Asia Dragon Fund

2. One of Cheng's largest institutional investors has encouraged her to reduce tracking error. Suggest steps Cheng could take to minimize this risk in the fund.

- Portfolio modified adjusted duration
- Key rate duration
- Percent in sector and quality
- Sector and quality spread duration contribution
- Sector/coupon/maturity cell weights
- Issuer exposure

Present value of distribution of cash flows methodology

1. The manager divides the cash flows for each non-callable security in the index into discrete semi-annual periods, aggregates them, and then adds the cash flows for callable securities in the index based on the probability of call for each given period.
2. The present value of aggregated cash flows for each semi-annual period is computed, with the total present value of all such aggregated cash flows equal to the index's present value. The percentage of the present value of each cash flow vertex is calculated.
3. The time period is then multiplied by the present value of each cash flow. Because each cash flow represents an effective zero-coupon payment in the corresponding period, the time period reflects the duration of each cash flow. For example, the third period's contribution to duration might be 1.5 years × 3.0%, or 0.045.
4. Finally, each period's contribution to duration is added to arrive at a total representing the bond index's duration. The portfolio being managed will be largely protected from deviations from the benchmark associated with yield curve changes by matching the percentage of the portfolio's present value that comes due at specific points in time with that of the index.

8 Alternative Methods for Establishing Passive Bond Market Exposure

- Full replication
- Enhanced indexing strategy (stratified sampling or cell approach)
  - Lower cost enhancements
  - Issue selection enhancements
  - Yield curve enhancements
  - Sector/quality enhancements
  - Call exposure enhancements

- Investment vehicles
  - Bond mutual funds
  - Exchange traded funds (ETFs)
  - Total return swaps (TRS)

Example 10: Passive Investing

Adelaide Super, a superannuation fund, offers a range of fixed interest (or fixed-income) investment choices to its members. Superannuation funds are Australian government-supported arrangements for Australian workers to save for retirement, which combine a government-mandated minimum percentage of wages contributed by employers with a voluntary employee contribution that offers tax benefits. Superannuation plans are similar to defined contribution plans common in the United States, Europe, and Asia.

Three of the bond fund choices Adelaide Super offers are as follows:

• Dundee Australian Fixed-Income Fund. The investment objective is to outperform the Bloomberg AusBond Composite Index in the medium to long term. The index includes investment-grade fixed-interest bonds with a minimum of one month to maturity issued in the Australian debt market under Australian law, including the government, semi-government, credit, and supranational/sovereign sectors. The index includes AUD-denominated bonds only. The investment strategy is to match index duration but add value through fundamental and model-driven return strategies.

• Newcastleton Australian Bond Fund. The fund aims to outperform the Bloomberg AusBond Composite Index over any three-year rolling period, before fees, expenses, and taxes, and uses multiple strategies such as duration, curve positioning, and credit and sector rotation rather than one strategy, allowing the fund to take advantage of opportunities across fixed-income markets under all market conditions.

• Paisley Fixed-Interest Fund. The fund aims to provide investment returns after fees in excess of the fund's benchmark, which is the Bloomberg AusBond Bank Bill Index and the Bloomberg AusBond Composite Index (equally weighted) by investing in a diversified portfolio of Australian income-producing assets. Paisley seeks to minimize transaction costs via a buy-and-hold strategy, as opposed to active management. The AusBond Bank Bill Index is based on the bank bill market, which is the short-term market (90 days or less) in which Australian banks borrow from and lend to one another via bank bills.

Rank the three fixed-income funds in order of risk profile, and suggest a typical employee for whom this might be a suitable investment.

9 Benchmark Selection

- A benchmark requires clear, transparent rules for security inclusion and weighting, investability, daily valuation and availability of past returns, and turnover
- Fixed income benchmarks are not as stable as equity benchmarks
  - Duration drifts downwards with time
  - Market dynamics and issuer preferences dictate issuer composition for broad-based indexes and maturity selection for narrower indexes
  - Value-weighted indexes assign a large share of index to borrowers with the largest amount of debt outstanding
- Investors should define underling duration preferences and risk/return profile before selecting a benchmark
  - Investors may combine sub-benchmark categories into an overall benchmark
- **Smart beta** involves the use of simple, transparent, rules-based strategies as a basis for investment decisions

Example 11: Benchmarks (1/2)

Given the significant rise in regional bond issuance following the 2008 financial crisis, Next Europe Asset Management Limited aims to grow its assets under management by attracting a variety of new local Eurozone investors to the broader set of alternatives available in the current fixed-income market. Several of the indexes that Next Europe offers as a basis for investment are as follows:

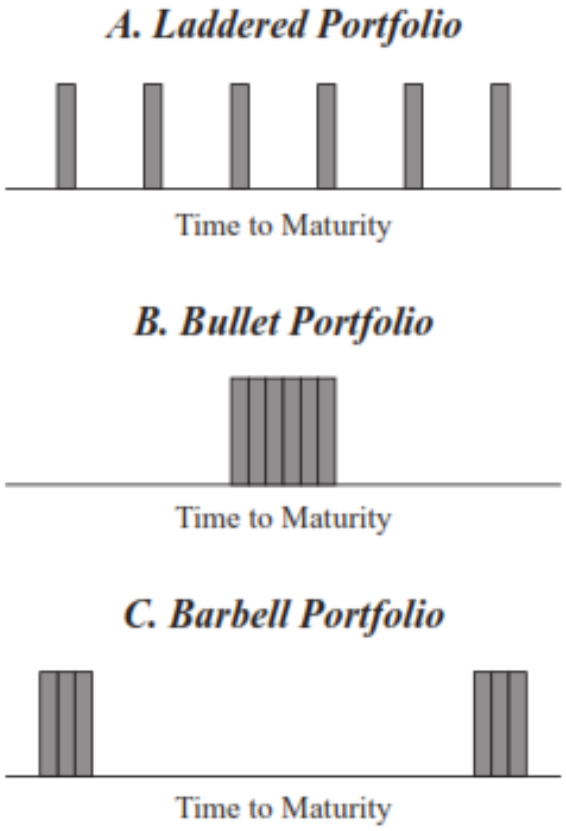
- **S&P Eurozone Sovereign Bond Index**. This index consists of fixed-rate, sovereign debt publicly issued by Eurozone national governments for their domestic markets with various maturities including 1 to 3 years, 3 to 5 years, 5 to 7 years, 7 to 10 years, and 10+ years. For example, the one- to three-year index had a weighted average maturity of 1.88 years and a modified duration of 1.82 as of 31 December 2015.
- **Bloomberg EUR Investment Grade European Corporate Bond Index (BERC).** The BERC index consists of local, EUR-based corporate debt issuance in Eurozone countries and had an effective duration of 5.39 as of January 2016.
- **Bloomberg EUR High Yield Corporate Bond Index (BEUH).** This index consists of sub-investment grade, EUR-denominated bonds issued by Eurozone-based corporations. It had an effective duration of 4.44 as of January 2016.
- **FTSE Pfandbrief Index.** The Pfandbrief, which represents the largest segment of the German private debt market, is a bond issued by German mortgage banks, collateralized by long-term assets such as real estate or public sector loans. These securities are also referred to as covered bonds, and are being used as a model for similar issuance in other European countries. The FTSE Pfandbrief indexes include jumbo Pfandbriefs from German issuers, as well as those of comparable structure and quality from other Eurozone countries. The sub-indexes offer a range of maturities including 1 to 3 years, 3 to 5 years, 5 to 7 years, 7 to 10 years and 10+ years.

Example 11: Benchmarks (1/2)

Which of the above indexes would be suitable for the following investor portfolios?

1. A highly risk-averse investor who is sensitive to fluctuations in portfolio value.
2. A new German private university that has established an endowment with a very long-term investment horizon.
3. A Danish life insurer relying on the fixed-income portfolio managed by Next Europe to meet both short-term claims as well as offset long-term obligations.

10 Laddered Bond Portfolios



- Laddered portfolios offer diversification over the yield curve
- Balance between reinvestment and price risk
- Attractive in stable, upward sloping yield curve environment
- Offer liquidity even if underlying bonds are not liquid
- High convexity

$$\text{Covexity} = \frac{\text{Macaulay duration}^2 + \text{Macaulay duration} + \text{Dispersion}}{(1 + \text{Cash flow yield})^2}$$

- Laddered portfolios can be created using fixed maturity corporate bond ETFs
- Decision to build a laddered portfolio should be evaluated against buying shares in a fixed-income mutual fund

Example 12: A Laddered Portfolio (1/2)

Zheng Zilong, CFA, is a Shanghai-based wealth adviser. A major client of his, the Wang family, holds most of its assets in residential property and equity investments. Mr. Zheng recommends that the Wang family also have a laddered portfolio of Chinese government bonds. He suggests the following portfolio, priced for settlement on 1 January 2017:

Coupon Rate	Payment Frequency	Maturity	Flat Price	Yield (s.a.)	Par Value	Market Value
3.22%	Annual	26-Mar-18	101.7493	1.758%	10 Million	10,422,826
3.14%	Annual	8-Sept-20	102.1336	2.508%	10 Million	10,312,292
3.05%	Annual	22-Oct-22	101.4045	2.764%	10 Million	10,199,779
2.99%	Semi-annual	15-Oct-25	101.4454	2.803%	10 Million	10,208,611
					40 Million	41,143,508

The yields to maturity on the first three bonds have been converted from a periodicity of one to two in order to report them on a consistent semi-annual bond basis, as indicated by "(s.a.)". The total market value of the portfolio is CNY 41,143,508. The cash flow yield for the portfolio is 2.661%, whereas the market value weighted average yield is 2.455%.

Example 12: A Laddered Portfolio (2/2)

Most important for his presentation to the senior members of the Wang family is the schedule for the 30 cash flows:

1	26-Mar-17	322,000	16	8-Sep-20	10,314,000
2	15-Apr-17	149,500	17	15-Oct-20	149,500
3	8-Sep-17	314,000	18	22-Oct-20	305,000
4	15-Oct-17	149,500	19	15-Apr-21	149,500
5	22-Oct-17	305,000	20	15-Oct-21	149,500
6	26-Mar-18	10,322,000	21	22-Oct-21	305,000
7	15-Apr-18	149,500	22	15-Apr-22	149,500
8	8-Sep-18	314,000	23	15-Oct-22	149,500
9	15-Oct-18	149,500	24	22-Oct-22	10,305,000
10	22-Oct-18	305,000	25	15-Apr-23	149,500
11	15-Apr-19	149,500	26	15-Oct-23	149,500
12	8-Sep-19	314,000	27	15-Apr-24	149,500
13	15-Oct-19	149,500	28	15-Oct-24	149,500
14	22-Oct-19	305,000	29	15-Apr-25	149,500
15	15-Apr-20	149,500	30	15-Oct-25	10,149,500

Indicate the main points that Mr. Zheng should emphasize in this presentation about the laddered portfolio to senior members of the Wang family.

Summary 1/2

ALM considers both assets and liabilities in the portfolio decision-making process

- Asset-Driven Liabilities (ADL)
- Liability-Driven Investing (LDI)

Liability Type	Amount of Cash Outlay	Timing of Cash Outlay	Example
I	Known	Known	Traditional fixed income bonds
II	Known	Uncertain	Callable and putable bonds
III	Uncertain	Known	Floating-rate notes
IV	Uncertain	Uncertain	Defined benefit plan obligations

- Immunization is the process of structuring and managing a fixed-income bond portfolio to minimize the variance in the realized rate of return over a known time horizon.
- Basic immunization strategy: zero-coupon bond which matures on the same day as the liability.
- If a zero-coupon bond is not available, then create a portfolio of coupon-bearing bonds that replicates the period-to-period performance of the zero-coupon bond
- Immunization achieved if change in cash flow yield on the bond portfolio is equal to the change in the yield to maturity on the zero-coupon bond being replicated

Key characteristics:

- Market value ≥ present value of liability
- Macaulay duration = liability's due date
- Minimize portfolio convexity

- **Immunization achieved for parallel shifts and some non-parallel changes:** bear steepener and flattener and bull steepener and flattener.
- **Structural risk:** yield curve changes such that immunization is not achieved. This risk can be minimized by minimizing the convexity statistic.

Managing the Interest Rate Risk of Multiple Liabilities:

Cash flow matching: create portfolio of high-quality bonds to match the amount and timing of the liabilities.

- A motive for cash flow matching can be accounting defeasance, whereby both the assets and liabilities are removed from the balance sheet.

Duration matching

- Market value of assets ≥ market value of liabilities
- Match money duration: asset basis point value = liability basis point value
- Dispersion of cash flow and convexity of assets greater than those of liabilities

Derivatives overlay strategy: derivatives such as interest rate futures contracts are used to immunize single or multiple liabilities. The number of futures contracts needed to immunize is the liability BPV minus the asset BPV, divided by the futures BPV.

- If the result is a positive number, the entity buys, or goes long, futures contracts.
- If the result is a negative number, the entity sells, or goes short, futures contracts.
- The futures BPV can be approximated by the BPV for the cheapest-to- deliver security divided by the conversion factor for the cheapest-to-deliver security.

Contingent immunization: hedge liabilities and actively manage surplus.

- In principle, any asset classes can be used for the active investment.
- The entity can choose to over-hedge or under-hedge the number of futures contracts needed for passive immunization. That is, over-hedge if yields are expected to decline and under-hedge if yields are expected to increase.

Summary 2/2

- **The hedging ratio is the percentage of the gap that is closed with the derivatives. A hedging ratio of zero implies no hedging. A hedging ratio of 100% implies full immunization.**
- Strategic hedging is the active management of the hedging ratio.
- Duration gaps can be addressed using futures, swaps and swaptions.
- The choice among hedging with the receive-fixed swap, the purchased receiver swaption, and the swaption collar depends in part on the pension fund manager's view on future interest rates.
- If rates are expected to be low, the receive-fixed swap should be used.
- If rates are expected to go up, the swaption collar is preferred.
- If rates are anticipated to reach a certain threshold that depends on the option costs and the strike rates, the purchased receiver swaption can be used.

Asset BPV x Δ Asset yields + Hedge BPV x Δ Hedge yields ≈ Liability BPV x Δ Liability yields

Risks in Liability-Driven Investing include the following:

- **Model risks** arise because assumptions in models and approximations turn out to be inaccurate
  - Effective duration for equity
  - Portfolio duration as a weighted average
  - Estimation of ABO and PBO
  - Estimation of futures contract BPV
- **Yield curve twists**
- **Spread risk**
- **Credit risk and collateral exhaustion risk**
- **Asset liquidity**

- Investment strategy based on bond market index offers exposure to the fixed income universe. It offers the benefits of both diversification and low administrative costs.
- Investment success is measured based on how closely the chosen market portfolio mirrors the returns of an underling bond market index (tracking risk or tracking error).
- Illiquidity of corporate bonds makes valuation challenging; matrix pricing uses available data on comparable securities to estimate fair value of illiquid bonds
- Strategies include: pure indexing, enhanced indexing strategy, active management.
- Primary Indexing Risk Factors to be matched.
  a. Portfolio modified adjusted duration
  b. Key rate duration
  c. Percent in sector and quality
  d. Sector and quality spread duration contribution
  e. Sector/coupon/maturity cell weights
  f. Issuer exposure
- A benchmark requires clear, transparent rules for security inclusion and weighting, investability, daily valuation and availability of past returns, and turnover.

- **Fixed income benchmarks are not as stable as equity benchmarks owing to following reasons:**
  - Duration drifts downwards with time
  - Market dynamics and issuer preferences dictate issuer composition for broad-based indexes and maturity selection for narrower indexes
  - Value-weighted indexes assign a large share of index to borrowers with the largest amount of debt outstanding → leading to the "bums problem" (i.e. the bond index investors become overly exposed to leveraged firms).
- Investors should define underling duration preferences and risk/return profile before selecting a benchmark.
- Investors may combine sub-benchmark categories into an overall benchmark.
- **Smart beta** involves the use of simple, transparent, rules-based strategies as a basis for investment decisions
- Laddered portfolios offer diversification over the yield curve;
- laddered portfolios provide a balance between reinvestment and price risk;
- Laddered portfolios are attractive in stable, upward sloping yield curve environment;
- Laddered portfolios offer liquidity even if underlying bonds are not liquid;
- Laddered portfolios have high convexity;
- Laddered portfolios can be created using fixed maturity corporate bond ETFs;

Decision to build a laddered portfolio should be evaluated against buying shares in a fixed-income mutual fund.