

FN452: Asset management and portfolio analysis

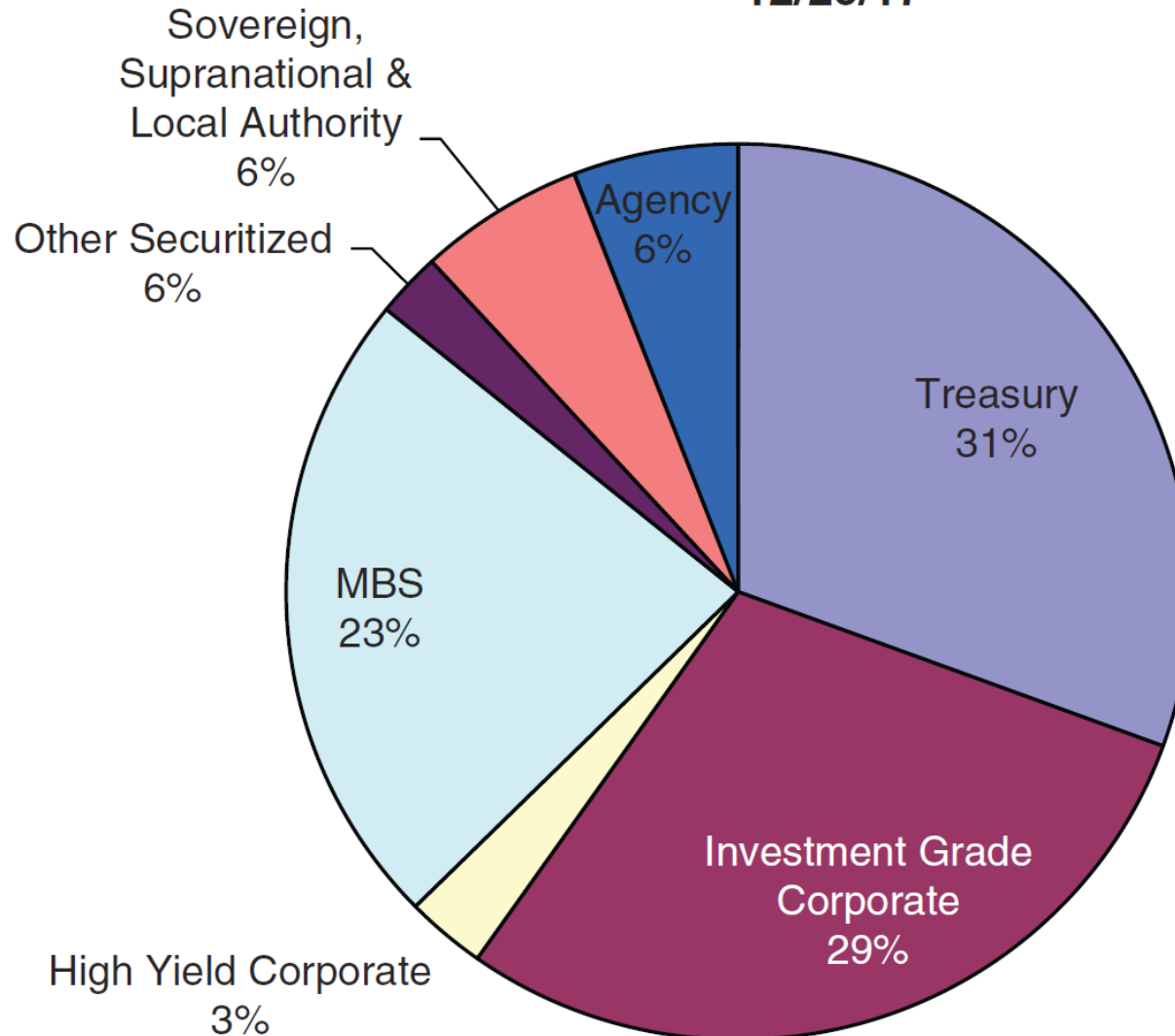
Bond portfolio management

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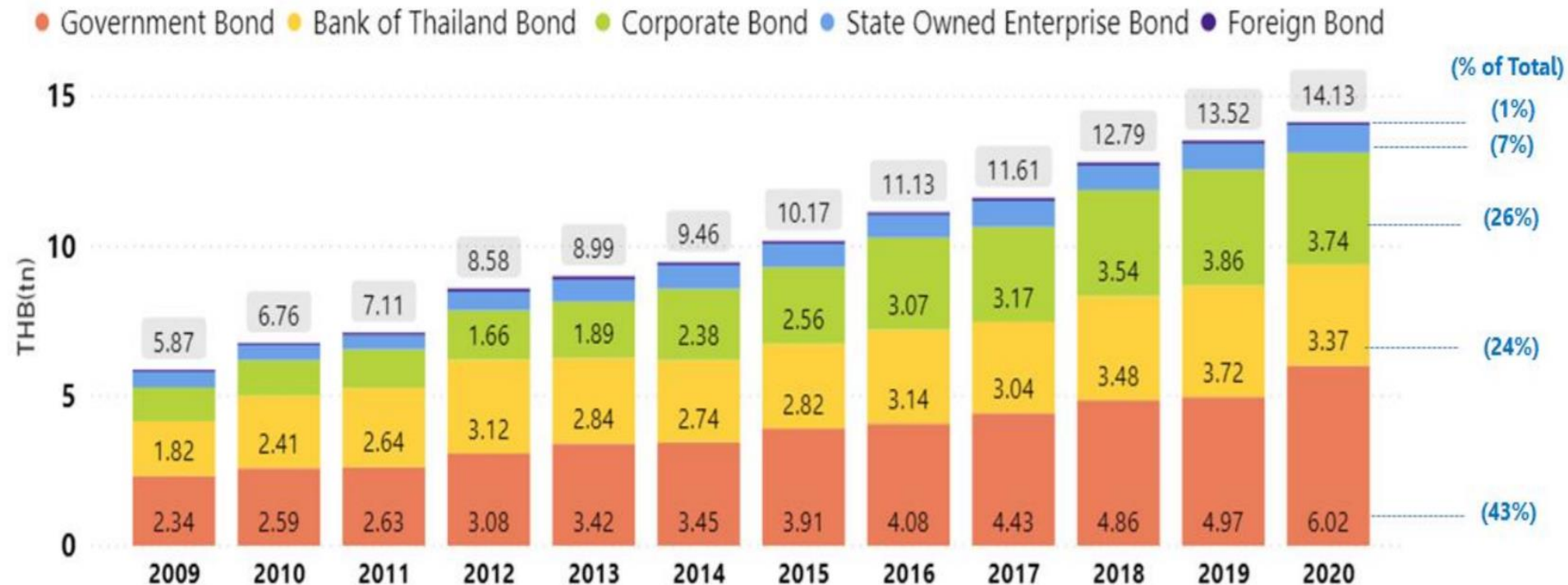
The US bond market

**Bloomberg Barclays Universal Index
12/29/17**



Thai bond market

Figure 1: Outstanding Value of Thai Bond Market



Bond fundamentals

- Bond characteristics – features, types of issuers, provisions
- Bond yield curves
- Bond valuation – relationship between value and yield
- Bond risks – duration, convexity, credit

$$\frac{\Delta P}{P} = -D^* \Delta y + \frac{1}{2} \times \text{Convexity} \times (\Delta y)^2$$

$$D = \frac{\sum_{t=1}^T \frac{t \times CF_t}{(1+y)^t} + \frac{T \times Par}{(1+y)^T}}{P}, D^* = \frac{D}{(1+y)}$$

$$\text{Convexity} = \frac{1}{(1+y)^2} \left[\sum_{t=1}^T \frac{(t^2 + t) \times CF_t}{(1+y)^t} + \frac{(T^2 + T) \times Par}{(1+y)^T} \right] / P$$

Calculation of duration of two bonds

Interest rate:	10%				
	Time until Payment (Years)	Payment	Payment Discounted at 10%	Weight*	Column (B) x Column (E)
A. 8% coupon bond	1	80	72.727	0.0765	0.0765
	2	80	66.116	0.0696	0.1392
	3	1080	<u>811.420</u>	<u>0.8539</u>	<u>2.5617</u>
Sum:			950.263	1.0000	2.7774
B. Zero-coupon bond	1	0	0.000	0.0000	0.0000
	2	0	0.000	0.0000	0.0000
	3	1000	<u>751.315</u>	<u>1.0000</u>	<u>3.0000</u>
Sum:			751.315	1.0000	3.0000

*Weight = Present value of each payment (column D) divided by bond price

Calculation of duration of two bonds

Interest rate:	0.1				
	Time until Payment (Years)	Payment	Payment Discounted at 10%	Weight	Column (B) times Column (E)
A. 8% coupon bond	1	80	=C6/(1+\$B\$1)^B6	=D6/D\$9	=E6*B6
	2	80	=C7/(1+\$B\$1)^B7	=D7/D\$9	=E7*B7
	3	1080	=C8/(1+\$B\$1)^B8	=D8/D\$9	=E8*B8
Sum:			=SUM(D6:D8)	=D9/D\$9	=SUM(F6:F8)
B. Zero-coupon	1	0	=C11/(1+\$B\$1)^B11	=D11/D\$14	=E11*B11
	2	0	=C12/(1+\$B\$1)^B12	=D12/D\$14	=E12*B12
	3	1000	=C13/(1+\$B\$1)^B13	=D13/D\$14	=E13*B13
Sum:			=SUM(D11:D13)	=D14/D\$14	=SUM(F11:F13)

Calculation of duration

- A bond with maturity of 30 years has a coupon rate of 8% (paid annually) and a YTM of 9%. Its price is 897.26 Baht, and its (Macaulay's) duration is 11.37 years. What will happen to the bond price if the bond's YTM increases to 9.1%?

Calculation of duration

- Go back to the previous table and change the YTM from 10% to 10.1%
 - The new 8% bond price is \$947.868 (difference of -2.395)
 - And the new zero-coupon bond price is \$749.269 (difference of -2.046)
- If we use the estimate formula, we get

$$\Delta P = -\frac{D \times \Delta y}{(1 + y)} P = -\frac{2.7774 \times (0.001)}{(1.10)} \times 950.263 = -2.399$$

which is very close to the real difference

Bond portfolio management

- Two important bond investment styles: **credit quality** and **interest rate sensitivity**
- Bloomberg Barclays US Aggregate Total Return Index typically consists of 70-80% government, agency, or AAA-rated bonds

High-grade		AGG index	
Low-grade			
	Short-term		Long-term

Bond portfolio management

Total return mandate – to match or beat the return on a standard benchmark

- Passive management strategies
- Active management strategies

Structured mandate – to customize the portfolio to the specific characteristics of liabilities

- Cash matching or dedicated portfolios
- Immunization

Passive management

Buy-and-hold strategy

- Finding securities with the desired levels of **credit quality**, **coupon rate**, **term to maturity** or **duration**, and other provisions such as call feature
- Many bond investors intend to hold bond to maturity, but still look for opportunities to trade if desirable occasion arise
- Bond investors need to **periodically reinvest** the funds from a matured issue
- A manager with an **intermediate-term** investment focus could hold bonds maturing between **one to nine years**

Passive management

Indexing strategy

- Full replication and stratified sampling
- Stratified sampling creates a bond portfolio that matches the important characteristics of the underlying index such as credit quality, maturity/duration, or average yield

Passive management



Vanguard Total Bond Market Index Fund Admiral Shares (VBTLX)

Also available as an [ETF](#) (starting at the price of one share).

Overview

Price & Performance

Portfolio & Management

Fees & Minimums

Distributions

News & Reviews

Product summary

This fund is designed to provide broad exposure to U.S. investment-grade bonds. Reflecting this goal, the fund invests in U.S. Treasuries and mortgage-backed securities of all maturities (short-, intermediate-, and long-term issues). As with other bond funds, one of the risks of the fund is that increases in interest rates may cause the price of the bonds in the portfolio to decrease—pricing the fund's net asset value (NAV) lower. Because the fund invests in several segments and maturities of the fixed income market, investors may consider the fund their core bond holding.

[View prospectus and reports](#)

Fund facts

Asset class	Intermediate-Term Bond
Category	Intermediate-Term Bond
Expense ratio as of 04/29/2021	0.05%
Minimum investment	\$3,000
	Available as an ETF (starting at the price of one share).
Fund number	0584
CUSIP	921937603
Fund advisor	Vanguard Fixed Income Group

Source: <https://investor.vanguard.com/mutual-funds/profile/vbtlx>

Price and yield

Price as of 04/30/2021	\$11.23
Change	\$0.01 ↑ 0.09% ↑
30 day SEC yield as of 04/28/2021	1.32% A

Risk potential



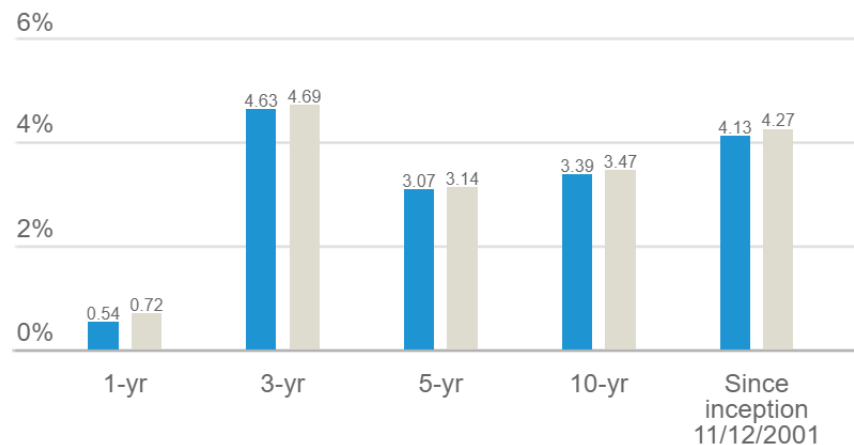
How the potential for risk affects your investment

Performance

Average annual returns

as of 03/31/2021

Show Quarter-end Month-end [View as a table](#)

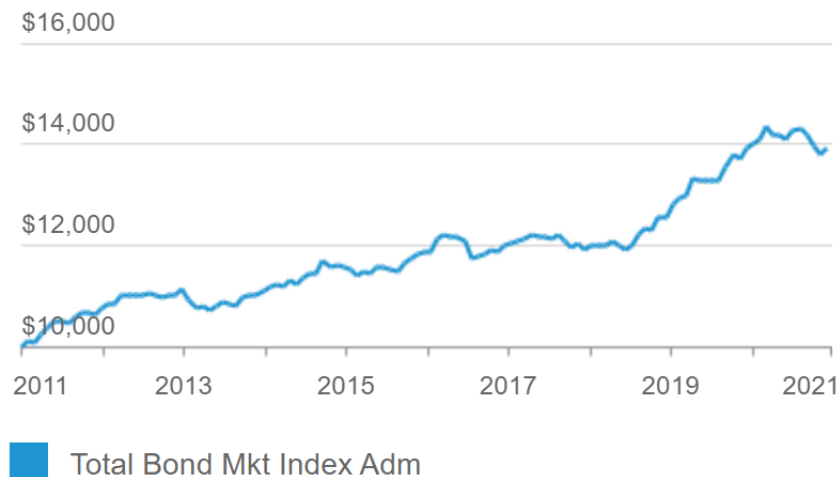


Total Bond Mkt Index Adm

Spliced BloomBarc USAgg Flt Adjlx* (Benchmark)

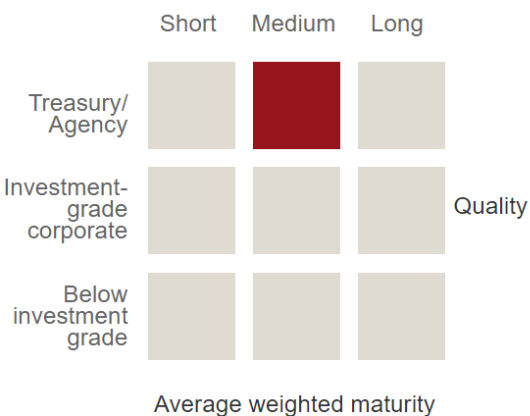
Hypothetical growth of \$10,000

as of 03/31/2021



Source: <https://investor.vanguard.com/mutual-funds/profile/vbtlx>

Bond style



Fixed income characteristics

as of 03/31/2021

	Total Bond Mkt Index Adm	BloomBarc US Agg Float Adj Index (Benchmark)
Number of bonds	10118	12161
<u>Yield to maturity</u>	1.6%	1.6%
Average coupon	2.8%	2.7%
<u>Average effective maturity</u>	8.5 years	8.5 years
<u>Average duration</u>	6.6 years	6.6 years
Short-term reserves	—	—
Fund total net assets	\$299.0 billion	—
Share class total net assets	\$116.7 billion	—

Source: <https://investor.vanguard.com/mutual-funds/profile/vbtlx>

Passive management



Distribution by issuer (% of fund)

as of 03/31/2021

	Total Bond Mkt Index Adm
Asset-Backed	0.4%
Commercial Mortgage-Backed	2.3%
Finance	8.7%
Foreign	4.0%
Government Mortgage-Backed	20.9%
Industrial	17.8%
Other	1.5%
Treasury/Agency	42.1%
Utilities	2.3%
Total	100.0%

Distribution by credit quality* (% of fund)

as of 03/31/2021

	Total Bond Mkt Index Adm
U.S. Government	63.5%
AAA	5.0%
AA	3.1%
A	12.2%
BBB	16.2%
Total	100.0%

Passive management



Distribution by effective maturity (% of fund)

as of 03/31/2021

	Total Bond Mkt Index Adm
Under 1 Year	1.2%
1 - 5 Years	47.9%
5 - 10 Years	30.3%
10 - 15 Years	1.9%
15 - 20 Years	4.2%
20 - 25 Years	5.4%
Over 25 Years	9.1%
Total	100.0%

Historical volatility measures

as of 03/31/2021

Benchmark	R-squared**	Beta**
Spliced Bloomberg Barclays U.S. Aggregate Float Adjusted Index†	0.99	1.00
Bloomberg Barclays U.S. Aggregate Bond Index	0.99	1.00

Active management

- Interest rate anticipation – duration, yield curve shape
- Valuation analysis – security selection, credit risk
- Yield spread analysis – optionality, prepayment
- Global & tactical – sector allocation, country allocation, currency

Cash matching or dedicated portfolios

- Cash matching
 - Matching cash flows from fixed-income portfolio with those of obligation
- Dedicated portfolios
 - Multi-period cash flow matching
 - The manager selects bonds with total CFs that match a series of obligations → Once the CFs are matched, there is no need for rebalancing
 - However, sometimes, CF matching is impossible, e.g. hundred years of CFs are not sold in the market

Immunization

- **Immunization** - A strategy to shield net worth from interest rate movements
 - Widely used by pension funds, insurance companies, and banks
 - Immunize a portfolio by matching the interest rate exposure of assets and liabilities
 - Match the duration of the assets and liabilities
 - Price risk and reinvestment rate risk exactly cancel out
 - Result: Value of assets will track the value of liabilities whether rates rise or fall

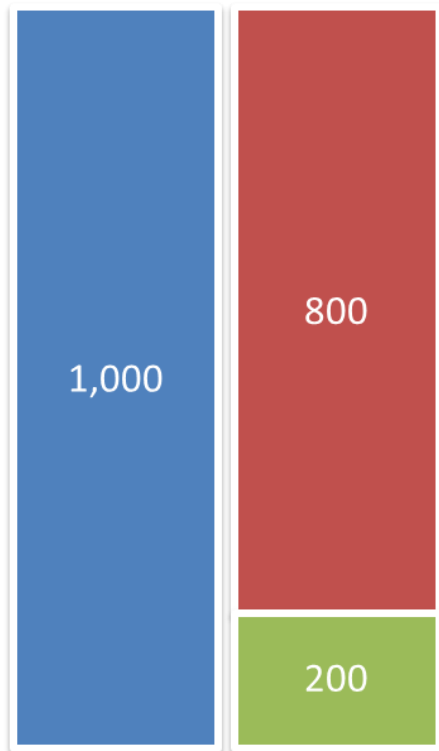
Immunization

Balance sheet of a life insurance company

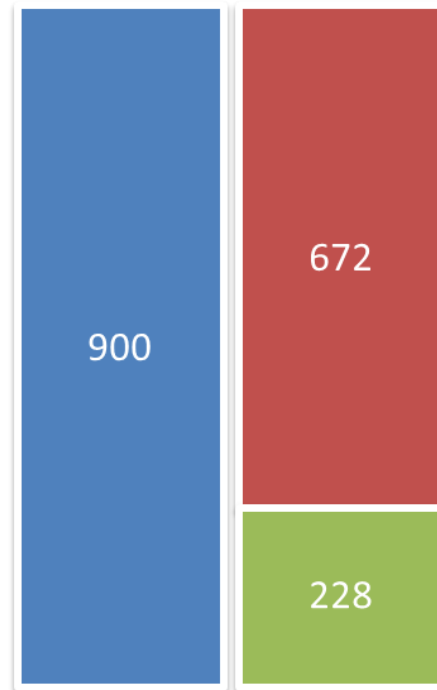
Assets	Liabilities
<ul style="list-style-type: none">▪ Cash▪ Loans▪ Fixed income investment<ul style="list-style-type: none">• Government bonds• Corporate bonds• Other bonds▪ Equity investment▪ Fixed assets▪ Others	<ul style="list-style-type: none">▪ Policyholders Reserve/ Technical Provision▪ Unit linked / Separate account liabilities <div data-bbox="1029 929 1821 1029">Shareholders' Equity</div> <ul style="list-style-type: none">▪ Paid-up share capital▪ Premium on share capital▪ Retained Earnings

Immunitization

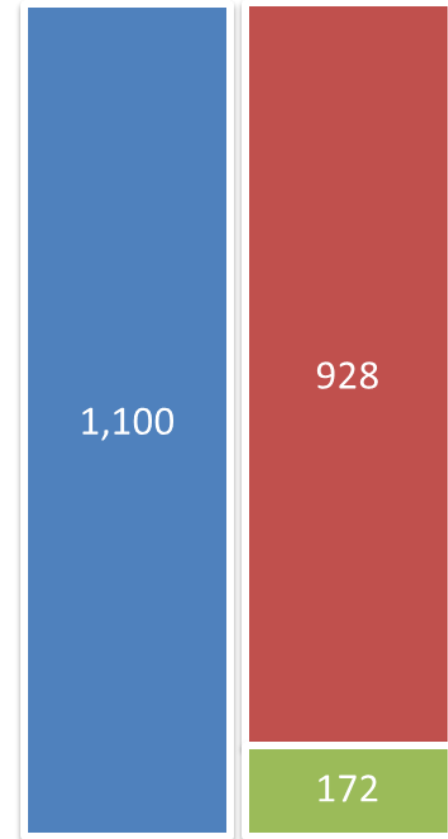
Asset Duration = 10
Liability Duration = 16



Base



Interest Rate Up



Interest Rate Down

Immunization

The situation:

- An insurance company issues a guaranteed investment contract to its customer for \$10,000
- This product has a 5-yr maturity and guaranteed interest rate of 8%; the company, therefore, promises to pay

$$\$10,000 \times (1.08)^5 = \$14,693.28 \text{ in 5 years}$$

- Suppose that the company funds its obligation with \$10,000 of 8% annual coupon bonds, selling at par value, with **6 years to maturity**

Immunization

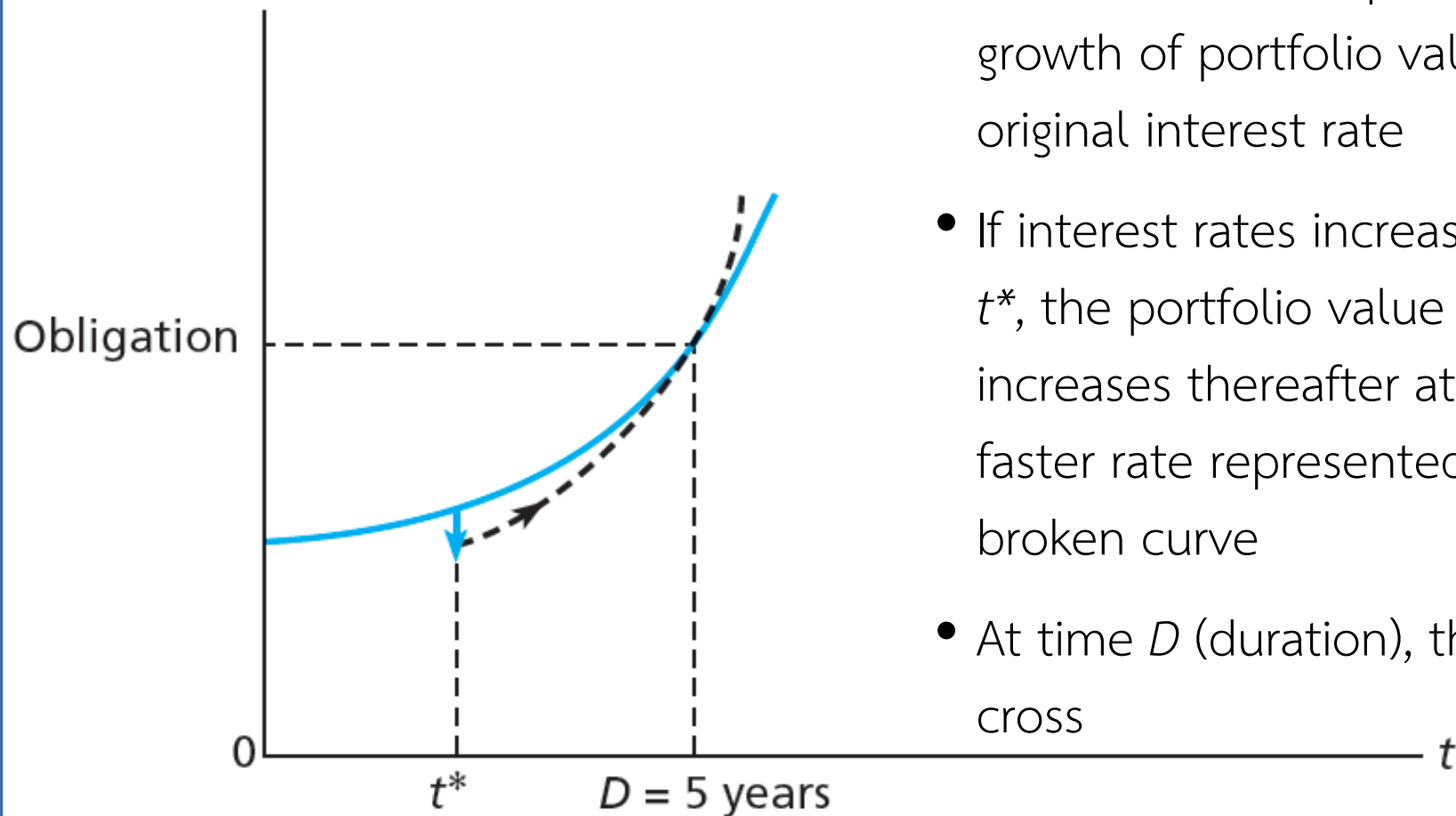
Terminal Value of Bond Portfolio after 5 Years

Payment Number	Years Remaining until Obligation	Accumulated Value of Invested Payment
A. Rates remain at 8%		
1	4	$800 \times (1.08)^4 = 1,088.39$
2	3	$800 \times (1.08)^3 = 1,007.77$
3	2	$800 \times (1.08)^2 = 933.12$
4	1	$800 \times (1.08)^1 = 864.00$
5	0	$800 \times (1.08)^0 = 800.00$
Sale of bond	0	$10,800/1.08 = 10,000.00$
		14,693.28
B. Rates fall to 7%		
1	4	$800 \times (1.07)^4 = 1,048.64$
2	3	$800 \times (1.07)^3 = 980.03$
3	2	$800 \times (1.07)^2 = 915.92$
4	1	$800 \times (1.07)^1 = 856.00$
5	0	$800 \times (1.07)^0 = 800.00$
Sale of bond	0	$10,800/1.07 = 10,093.46$
		14,694.05
C. Rates increase to 9%		
1	4	$800 \times (1.09)^4 = 1,129.27$
2	3	$800 \times (1.09)^3 = 1,036.02$
3	2	$800 \times (1.09)^2 = 950.48$
4	1	$800 \times (1.09)^1 = 872.00$
5	0	$800 \times (1.09)^0 = 800.00$
Sale of bond	0	$10,800/1.09 = 9,908.26$
		14,696.02

- Fixed-income investors face 2 types of interest rate risk: **price risk** and **reinvestment rate risk**
- If the portfolio duration is chosen appropriately, these two effects will cancel out
- In our example, the **duration** of the 6-yr bond is **5 years**

Growth of Invested Funds

Accumulated value of invested funds



- The solid curve represents the growth of portfolio value at the original interest rate
- If interest rates increase at time t^* , the portfolio value falls but increases thereafter at the faster rate represented by the broken curve
- At time D (duration), the curves cross

Immunization

Market Value Balance Sheets

A. Interest rate = 8%

Assets		Liabilities	
Bonds	\$10,000	Obligation	\$10,000

B. Interest rate = 7%

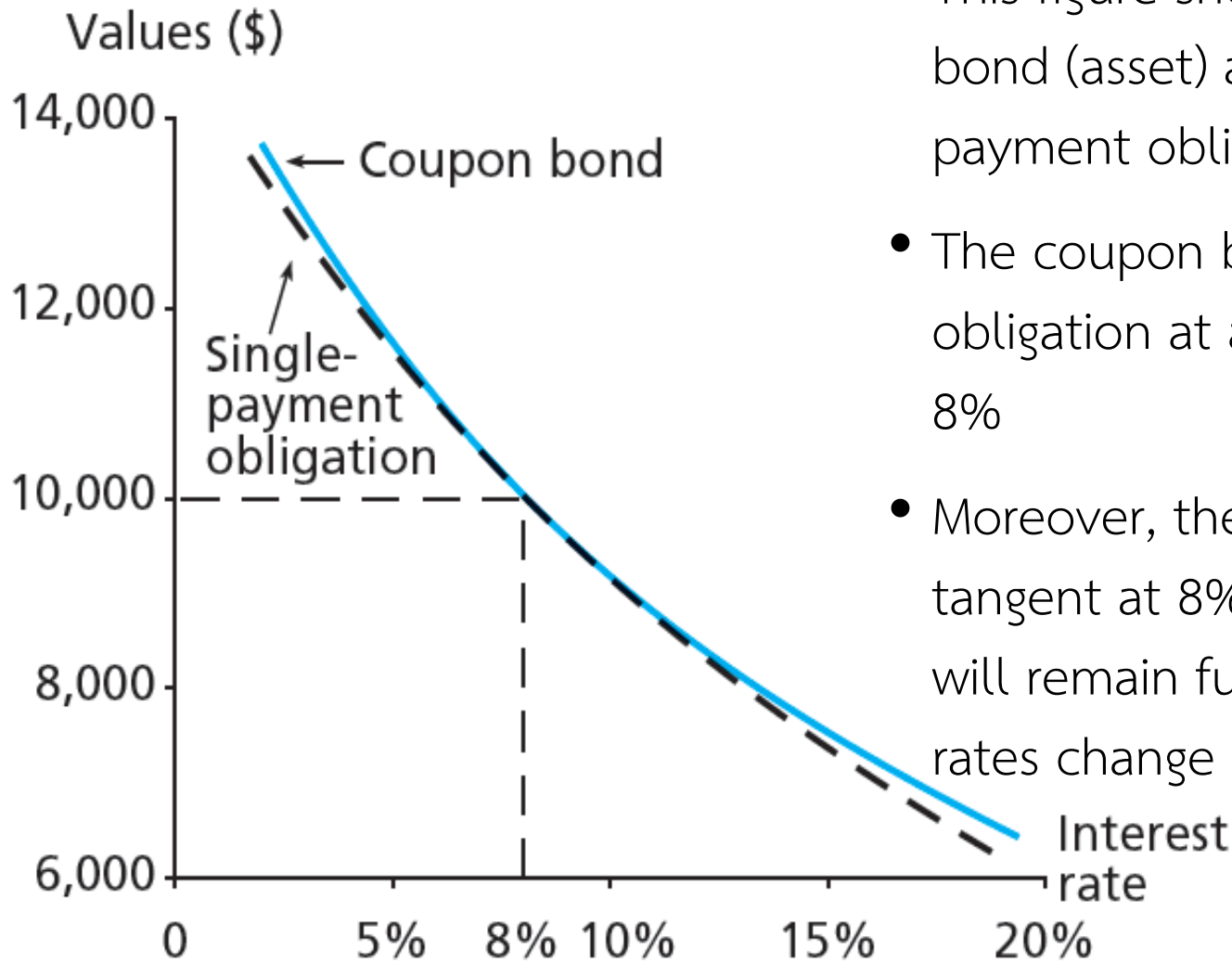
Assets		Liabilities	
Bonds	\$10,476.65	Obligation	\$10,476.11

C. Interest rate = 9%

Assets		Liabilities	
Bonds	\$9,551.41	Obligation	\$9,549.62

- Analyzed in terms of PV, assets equal liabilities even the interest rate fluctuates

Immunization



- This figure shows the PV of the bond (asset) and the single payment obligation (liability)
- The coupon bond fully funds the obligation at an interest rate of 8%
- Moreover, the PV curves are tangent at 8%, so the obligation will remain fully funded even if rates change by a small amount

Immunization – An example

The situation:

- An insurance company must make a payment of 19,487 Baht in 7 years. The market interest rate is 10%, so the PV of obligation is 10,000 Baht.
- The portfolio manager wishes to fund the obligation using 3-yr zero-coupon bonds and perpetuities paying annual coupons
- How can the manager immunize the obligation?

Immunization – An example

1. Calculate the duration of the liability = 7 years
2. Calculate the (Macaulay's) duration of the asset portfolio. The portfolio duration is the weighted average of duration of each component asset

$$\text{Asset duration} = w \times 3 \text{ years} + (1-w) \times 11 \text{ years}$$

3. Equate the asset duration to liability duration (7 years), we obtain

$$7 \text{ years} = w \times 3 \text{ years} + (1-w) \times 11 \text{ years}$$

we can solve that $w = 0.5$

4. This means that the manager must purchase 5,000 Baht of the zero-coupon bond and 5,000 Baht of the perpetuity. And the face value of the zero-coupon bond will be $5,000 \times 1.10^3 = 6,655$ Baht

Immunization – An example

The situation:

- Now suppose that 1 year has passed and the interest rate remains at 10%. The portfolio manager needs to reexamine her position
- Is the position still fully funded? Is it still immunized? If not, what actions are required?

Immunization – An example

- Now the PV of the obligation will grow to 11,000
- The zero-coupon bond value grows to 5,500 and the perpetuity has paid its 500 Baht of coupon and remains worth 5,000 Baht
- So, the obligation is **still fully funded**
- But the portfolio weight must be changed! The obligation's duration is now 6 years

$$6 \text{ years} = w \times 2 \text{ years} + (1-w) \times 11 \text{ years}$$

we can solve that $w = 5/9$

- This means that the manager must purchase $11,000 \times \frac{5}{9} = 6,111.11$ Baht of the zero-coupon bond and the rest in the perpetuity