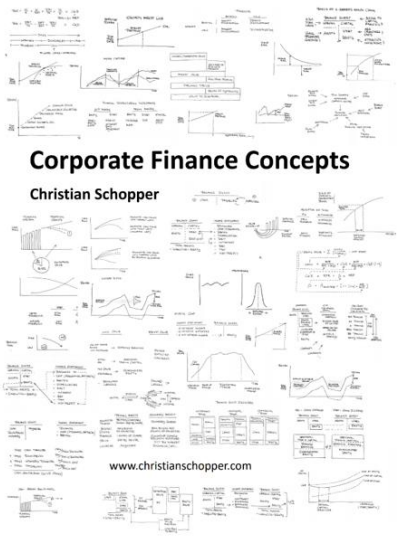
Duration Management

2015

For more concepts click on:



Principles in Bond Behaviour

Bond Sensitivities

- Imagine the interest rate is 10% across all maturities
  - A **one-year pure discount bond** pays $110 at maturity
  - A **five-year pure discount bond** pays $161.05 at maturity
  - Both of these bonds are worth $100, as given by the following:

- **Which** pure discount bond **will change more when interest rates move**?

- The percentage price changes in long-term pure discount bonds are greater than the percentage price changes in short-term pure discount bonds

Interest rate (%)	One-year pure discount bond	Five-year pure discount bond
8	$€101.85 = \frac{€110}{1.08}$	$€109.61 = \frac{€161.05}{(1.08)^5}$
10	$€100.00 = \frac{€110}{1.10}$	$€100.00 = \frac{€161.05}{(1.10)^5}$
12	$€98.21 = \frac{€110}{1.12}$	$€91.38 = \frac{€161.05}{(1.12)^5}$

Bond Sensitivities (cont´d)

Interest rate	Value
Five-year, 10% coupon bond	
8%	$€107.99 = \frac{€10}{1.08} + \frac{€10}{(1.08)^2} + \frac{€10}{(1.08)^3} + \frac{€10}{(1.08)^4} + \frac{€110}{(1.08)^5}$
10%	$€100.00 = \frac{€10}{1.10} + \frac{€10}{(1.10)^2} + \frac{€10}{(1.10)^3} + \frac{€10}{(1.10)^4} + \frac{€110}{(1.10)^5}$
12%	$€92.79 = \frac{€10}{1.12} + \frac{€10}{(1.12)^2} + \frac{€10}{(1.12)^3} + \frac{€10}{(1.12)^4} + \frac{€110}{(1.12)^5}$
Five-year, 1% coupon bond	
8%	$€72.05 = \frac{€1}{1.08} + \frac{€1}{(1.08)^2} + \frac{€1}{(1.08)^3} + \frac{€1}{(1.08)^4} + \frac{€101}{(1.08)^5}$
10%	$€65.88 = \frac{€1}{1.10} + \frac{€1}{(1.10)^2} + \frac{€1}{(1.10)^3} + \frac{€1}{(1.10)^4} + \frac{€101}{(1.10)^5}$
12%	$€60.35 = \frac{€1}{1.12} + \frac{€1}{(1.12)^2} + \frac{€1}{(1.12)^3} + \frac{€1}{(1.12)^4} + \frac{€101}{(1.12)^5}$

	10% Coupon bond	1% Coupon bond
Interest rate changes from 10% to 8%:	$7.99\% = \frac{€107.99}{€100} - 1$	$9.37\% = \frac{€72.05}{€65.88} - 1$
Interest rate changes from 10% to 12%:	$-7.21\% = \frac{€92.79}{€100} - 1$	$-8.39\% = \frac{€60.35}{€65.88} - 1$

Duration

Five-year, 10% coupon bond

Year	Payment (€)	Present value of payment (€)	Relative value = Present value of Payment / Value of bond
1	10	9.091	9.091/100 = 0.09091
2	10	8.264	0.08264
3	10	7.513	0.07513
4	10	6.830	0.06830
5	110	68.302	0.68302
		100.00	1.0

$$4.1699 \text{ years} = 1 \text{ year} \times 0.09091 + 2 \text{ years} \times 0.08264 + 3 \text{ years} \times 0.07513 + 4 \text{ years} \times 0.06830 + 5 \text{ years} \times 0.68302$$

- **The percentage price changes of a bond with high duration are greater than the percentage price changes of a bond with low duration**

Interest Rate Risk Management by Banks

Types of Interest Rate Risks for Banks

- **Interest Rate Risk**
  - The **potential loss from unexpected changes** in interest rates …
  - … which can significantly **alter a bank's profitability and market value of equity**

- Frequently assets and liabilities do not reprice at the same time, the result is a change in net interest income
  - The change in the value of assets and the change in the value of liabilities will also differ…
  - … causing a change in the value of stockholder's equity

- The ALCO's primary responsibility is interest rate risk management
  - It coordinates the bank's strategies to achieve the optimal risk/reward trade-off

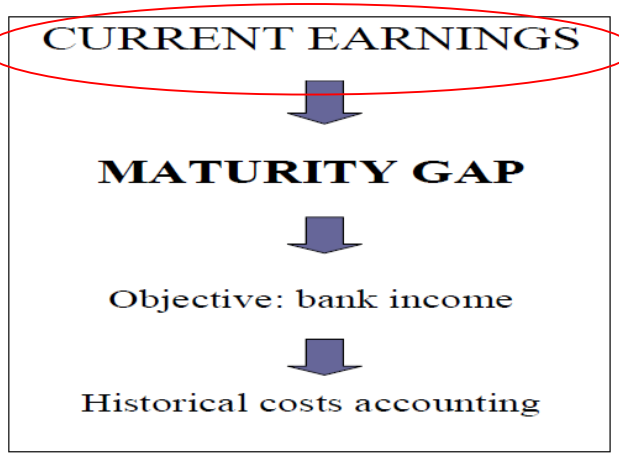
- **Spread Risk** (or: Reinvestment Rate Risk)
  - Changes in interest rates will change the **bank's cost of funds** …
  - … as well as the return on their invested assets
  - They may change by different amounts

- **Price Risk**
  - Changes in interest rates may change the **market values** of the bank's assets …
  - … and liabilities by different amounts

Maturity and Duration Hedging

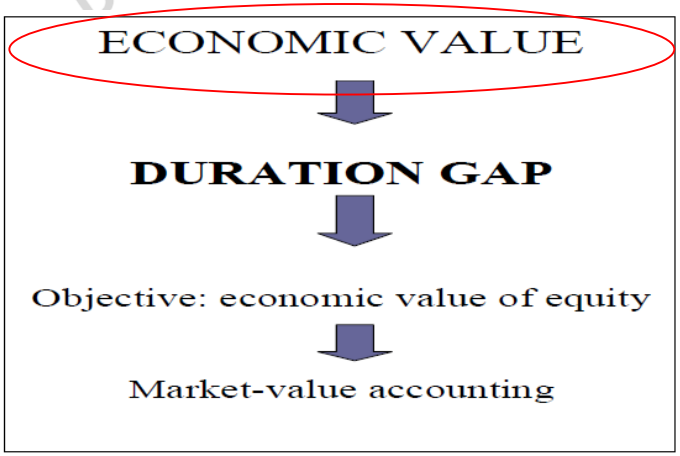
Spread Risk (or: Reinvestment Rate Risk)

- Impact on **bank's cost of funds**



Price Risk

- Impact on **bank´s market values**



Maturity / Funding GAP and Interest Rate Risk

- **Maturity GAP is also known as Funding GAP**

Potential variability in a bank's net interest income and market value of equity due to changes in the level of market interest rates

Example: $10,000 car loan

	BANK - Funding Gap	Assets	Yield			Liabilities	Cost
	4yr Car Loan	10000	8,0%		1yr Cert of Deposit	10000	4,5%
1st yr	4yr Car Loan	10000	8,0%		1yr Cert of Deposit	10000	4,5%
2nd yr	4yr Car Loan	10000	8,0%		?	10000	?

Funding or Maturity GAP for **Static GAP Analysis**

- GAP = Rate Sensitive Assets - Rate Sensitive Liabilities
- RSA = Amount of assets which will **mature or re-price in a give period of time**

Example indicates Negative Gap

- GAP(1y) = $0 - $10,000 = - $10,000

Interest locked in

Refunding unclear

What Determines Rate Sensitivity?

An asset or liability is considered **rate sensitive**, if during the time interval:

- It **matures**
- It represents and interim, or partial, principal **payment**
- It can be **repriced**
  - The interest rate applied to the outstanding principal **changes contractually** during the interval
  - The outstanding principal can be repriced when **some base** rate of index changes and management expects the base rate / index **to change** during the interval

Maturity / Funding GAP and Interest Rate Risk (cont´d)

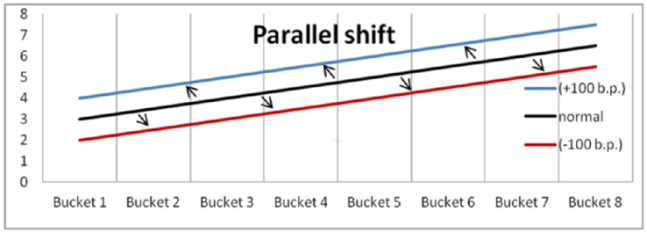
Maturity GAP focuses on **managing Net Interest Income in the short run**

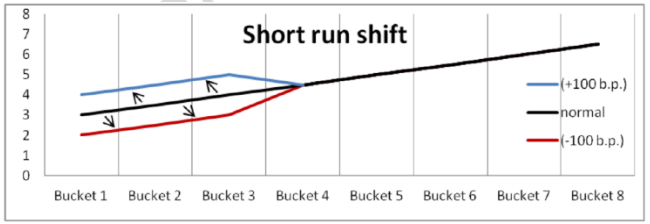
- Group assets and liabilities into **time "buckets**" according to when they mature or are expected to re-price
- Calculate GAP for each time bucket

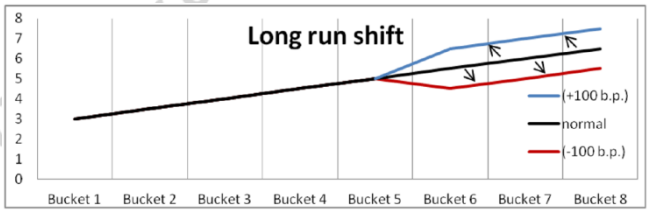
  → Funding GAP(t) = RSA(t) – RSL(t) (t = time bucket; e.g., 0-3 months)

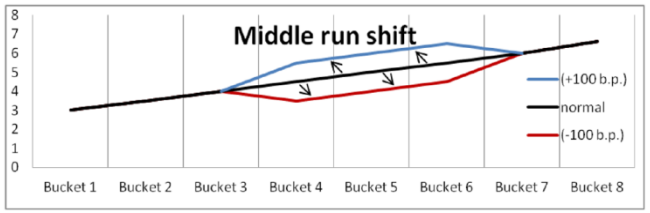
- **Impact on Net Interest Income driven by the Maturity GAP and change in interest rates**
  - … easy to assess in case of a parallel yield curve shift
- Scenarios to be assessed:
  - Changes in the slope of the yield curve or the relationship between asset yields and liability cost of funds
  - Changes in the volume of assets and liabilities
  - Change in the composition of assets and liabilities

Examples for Yield Curve Shifts









Balance Sheet for a Hypothetical Bank

BANK - BASE CASE	Assets	Yield			Liabilities	Cost
Rate Sensitive	500	8,0%			600	4,0%
Fixed-Rate	350	11,0%			220	6,0%
Non-Earning	150				100	
				Equity	80	
Total Assets	**1000**			**Total Liabs &Equity**	**1000**	
Earning Assets	850			Interest Baring Liabs	820	
Net Interest Income	41,3					
Net Interest Margin	4,86%					
GAP	-100					

Factors Affecting Net Income

Scenario Building

- 1% increase in the level of all short-term rates
- 1% decrease in spread between assets yields and interest cost
  - RSA increase to 8.5%
  - RSL increase to 5.5%
- Proportionate doubling in size
- Increase in RSA's and decrease in RSL's
  - RSA = 540, fixed rate = 310
  - RSL = 560, fixed rate = 260

BANK - BASE CASE	Assets	Yield			Liabilities	Cost
Rate Sensitive	500	8,0%			600	4,0%
Fixed-Rate	350	11,0%			220	6,0%
Non-Earning	150				100	
				Equity	80	
Total Assets	**1000**			**Total Liabs &Equity**	**1000**	
Earning Assets	850			Interest Baring Liabs	820	
Net Interest Income	41,3					
Net Interest Margin	4,86%					
GAP	-100					

1% Increase in Short-Term Rates

- **Change in NII = (GAP) * (change in interest rate)**
- **The larger the GAP, the greater the change in NII**
- **This applies only in the case of a parallel shift in the yield curve, which is rare**
- **If rates do not change by the same amount, then the GAP may change by more or less**
- **With a negative GAP, more liabilities than assets reprice higher; hence NII and NIM fall**

BANK - 1% incr. s/t	Assets	Yield			Liabilities	Cost
Rate Sensitive	500	9,0%			600	5,0%
Fixed-Rate	350	11,0%			220	6,0%
Non-Earning	150				100	
				Equity	80	
Total Assets	**1000**			**Total Liabs &Equity**	**1000**	
Earning Assets	850			Interest Baring Liabs	820	
Net Interest Income	40,3					
Net Interest Margin	4,74%					
GAP	-100					

BANK - BASE CASE	Assets	Yield			Liabilities	Cost
Rate Sensitive	500	8,0%			600	4,0%
Fixed-Rate	350	11,0%			220	6,0%
Non-Earning	150				100	
				Equity	80	
Total Assets	**1000**			**Total Liabs &Equity**	**1000**	
Earning Assets	850			Interest Baring Liabs	820	
Net Interest Income	41,3					
Net Interest Margin	4,86%					
GAP	-100					

1% Decrease in Spread / Non-Parallel Shift in the Yield Curve

- ***NII and NIM fall (rise) with a decrease (increase) in the spread***
- **If liabilities are short-term and assets are long-term, the spread will:**
  - **<u>widen</u> as the yield curve increases in slope**
  - **<u>narrow</u> when the yield curve decreases in slope and/or inverts**

BANK - 1% decr. Sprea	Assets	Yield			Liabilities	Cost
Rate Sensitive	500	8,5%			600	5,5%
Fixed-Rate	350	11,0%			220	6,0%
Non-Earning	150				100	
				Equity	80	
Total Assets	**1000**			**Total Liabs &Equity**	**1000**	
Earning Assets	850			Interest Baring Liabs	820	
Net Interest Income	34,8					
Net Interest Margin	4,09%					
GAP	-100					

BANK - BASE CASE	Assets	Yield			Liabilities	Cost
Rate Sensitive	500	8,0%			600	4,0%
Fixed-Rate	350	11,0%			220	6,0%
Non-Earning	150				100	
				Equity	80	
Total Assets	**1000**			**Total Liabs &Equity**	**1000**	
Earning Assets	850			Interest Baring Liabs	820	
Net Interest Income	41,3					
Net Interest Margin	4,86%					
GAP	-100					

Proportionate Doubling in Size

- **Net interest income varies directly with changes in the volume of earning assets and interest-bearing liabilities, regardless of the level of interest rates**

BANK - Prop Doubling	Assets	Yield			Liabilities	Cost
Rate Sensitive	1000	8,0%			1200	4,0%
Fixed-Rate	700	11,0%			440	6,0%
Non-Earning	300				200	
				Equity	160	
Total Assets	**2000**			**Total Liabs &Equity**	**2000**	
Earning Assets	1700			Interest Baring Liabs	1640	
Net Interest Income	82,6					
Net Interest Margin	4,86%					
GAP	-200					

BANK - BASE CASE	Assets	Yield			Liabilities	Cost
Rate Sensitive	500	8,0%			600	4,0%
Fixed-Rate	350	11,0%			220	6,0%
Non-Earning	150				100	
				Equity	80	
Total Assets	**1000**			**Total Liabs &Equity**	**1000**	
Earning Assets	850			Interest Baring Liabs	820	
Net Interest Income	41,3					
Net Interest Margin	4,86%					
GAP	-100					

Increase in RSAs and Decrease in RSLs

- **Although the bank's GAP (and hence risk) is lower, NII is also lower.**
- **To reduce risk, a bank with a negative GAP would try to increase RSAs (variable rate loans or shorter maturities on loans and investments) and decrease RSLs (issue relatively more longer-term CDs and fewer fed funds purchased)**
- **Changes in portfolio composition also raise or lower interest income and expense based on the type of change**

BANK - Chg RSA / RSL	Assets	Yield			Liabilities	Cost
Rate Sensitive	540	8,0%			560	4,0%
Fixed-Rate	310	11,0%			260	6,0%
Non-Earning	150				100	
				Equity	80	
Total Assets	**1000**			**Total Liabs &Equity**	**1000**	
Earning Assets	850			Interest Baring Liabs	820	
Net Interest Income	39,3					
Net Interest Margin	4,62%					
GAP	-20					

BANK - BASE CASE	Assets	Yield			Liabilities	Cost
Rate Sensitive	500	8,0%			600	4,0%
Fixed-Rate	350	11,0%			220	6,0%
Non-Earning	150				100	
				Equity	80	
Total Assets	**1000**			**Total Liabs &Equity**	**1000**	
Earning Assets	850			Interest Baring Liabs	820	
Net Interest Income	41,3					
Net Interest Margin	4,86%					
GAP	-100					

Summary of Maturity GAP and the Change in NII

- If there is a **parallel shift** in the yield curve: $\Delta NII_{exp} = GAP \times \Delta i_{exp}$
- … a parallel shift in the yield curve is rare, though
  - If rates do not change by the same amount and at the same time, then net interest income may change by more or less

GAP Summary				
GAP	**Change in Interest Income**		**Change in Interest Expense**	**Change in Net Interest Income**
Positive	Increase	>	Increase	Increase
Positive	Decrease	>	Decrease	Decrease
Negative	Increase	<	Increase	Decrease
Negative	Decrease	<	Decrease	Increase
Zero	Increase	=	Increase	None
Zero	Decrease	=	Decrease	None

Interest Rate Sensitivity Reports

GAP values are reported a periodic and cumulative basis for each time interval

- Periodic GAP
  - Is the **GAP for each time bucket** and measures the timing of potential income effects from interest rate changes
- Cumulative GAP
  - It is the **sum of periodic GAPs** and measures aggregate interest rate risk over the entire period
  - Cumulative GAP is important since it directly measures a bank's net interest sensitivity throughout the time interval

	1-7 Days	8-30 Days	31-90 Days	91-180 Days	181-365 Days	Over 1 year	Not Rate Sensitive	Total
Assets								
U.S. Treas & ag		0,7	3,6	1,2	0,3	3,7		9,5
MM Inv			1,2	1,8				3,0
Municipals			0,7	1,0	2,2	7,6		11,5
FF & Repo's	5,0							5,0
Comm loans	1,0	13,8	2,9	4,7	4,6	15,5		42,5
Install loans	0,3	0,5	1,6	1,3	1,9	8,2		13,8
Cash							9,0	9,0
Other assets							5,7	5,7
Total Assets	6,3	15,0	10,0	10,0	9,0	35,0	14,7	100,0
Liabilities and Equity								
MMDA		5,0	12,3					17,3
Super NOW	2,2							2,2
CD's < 100,000	0,9	2,0	5,1	6,9	1,8	2,9		19,6
CD's > 100,000	1,9	4,0	12,9	7,9	1,2			27,9
FF purchased								-
NOW				9,6				9,6
Savings						1,9		1,9
DD							13,5	13,5
Other liabilities							1,0	1,0
Equity							7,0	7,0
Total Liab & Eq.	5,0	11,0	30,3	24,4	3,0	4,8	21,5	100,0
Periodic GAP	1,3	4,0	-20,3	-14,4	6,0	30,2		
Cumulative GAP	1,3	5,3	-15,0	-29,4	-23,4	6,8		

Assessment of the Static GAP Analysis

- **Positive GAP**
  - **…indicates a bank has more rate sensitive assets than liabilities, and that net interest income will generally rise (fall) when interest rates rise (fall)**
- **Negative GAP**
  - **…indicates a bank has more rate sensitive liabilities than rate sensitive assets, and that net interest income will generally fall (rise) when interest rates rise (fall)**

Static GAP Analysis considers the impact of changing rates on the bank's net interest income

- Advantages
  - Easy to understand
  - Works well with small changes in interest rates
- Disadvantages
  - Ex-post measurement errors
  - Ignores the time value of money
  - Ignores the cumulative impact of interest rate changes
  - Typically considers demand deposits to be non-rate sensitive
  - Ignores embedded options in the bank's assets and liabilities

Measuring Interest Rate Risk with the GAP Ratio

GAP Ratio = RSAs / RSLs

- GAP ratio > 1 indicates positive GAP
- GAP ratio < 1 indicates negative GAP

Is there an Optimal GAP?

- **No**, there is not …
- Generally, the farther a bank's GAP is from zero, the greater is the bank's risk …
- Must evaluate overall risk and return profile and objectives to determine an optimal GAP

- **Neither the GAP** …
- … **nor GAP ratio** …
- … provide direct information on the potential variability in earnings when rates change

- Example:
  - Bank A & B **both** with $500m TAs
  - Bank A: $3m RSAs , $2 m RSLs
    GAP = $1 m
    GAP ratio = 1.5
  - Bank B: $300m RSAs, $200m RSLs
    GAP = $100 m
    GAP ratio = 1.5
  - Clearly, the **second bank assumes greater interest rate risk** …
  - … because its net interest income will change more when interest rates change

Maturity GAP and Net Interest Margin

- Many banks will specify a target GAP to earning asset ratio in the ALCO policy statements

$$\frac{\text{Target Gap}}{\text{Earning assets}} = \frac{(\text{Allowable \% Change in NIM})(\text{Expected NIM})}{\text{Expected \% change in interest rates}}$$

- Example:
  - Bank with $50m earning assets
  - Expects to generate a 5% NIM
  - Management will risk changes in NIM equal to +/- 20% during the year
  - Hence, NIM should fluctuate between 4% and 6%

  - Management expects interest rates to vary up to +/- 4% during the upcoming year
  - Therefore: Bank's ratio of its 1-year cumulative GAP (absolute value) to earning assets should not exceed 25%

    Target GAP / Earning Assets

    = (.20)(0.05) / 0.04 = 0.25

  - Management's willingness to allow only a +/- 20% variation in NIM sets limits on the GAP, …
  - … which would be allowed to vary from +$12.5m to -$12.5m, based on $50m in earning assets

- **Speculating on the GAP?**
- **Managers may attempt to adjust the interest rate risk exposure in anticipation of changes in interest rates**
- **This is speculative because it assumes that management can forecast rates better than the market**
- **Difficult to vary the GAP and win as this requires consistently accurate interest rate forecasts**
- **Also, a bank has limited flexibility in adjusting its GAP; e.g., loan and deposit terms**
- **There is no adjustment for the timing of cash flows or dynamics of the changing GAP position**

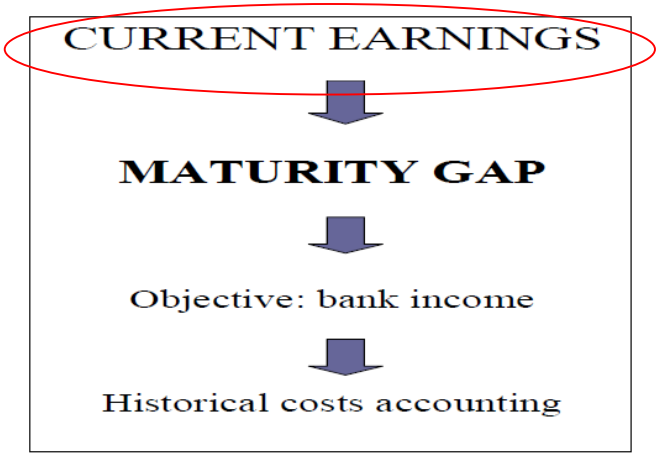
Adjust a Bank´s Effective Rate Sensitivity

Objective	Approaches
Reduce asset sensitivity	Buy longer-term securities. Lengthen the maturities of loans. Move from floating-rate loans to term loans.
Increase asset sensitivity	Buy short-term securities. Shorten loan maturities. Make more loans on a floating-rate basis.
Reduce liability sensitivity	Pay premiums to attract longer-term deposit instruments. Issue long-term subordinated debt.
Increase liability sensitivity	Pay premiums to attract short-term deposit instruments. Borrow more via non-core purchased liabilities.

Maturity and Duration Hedging

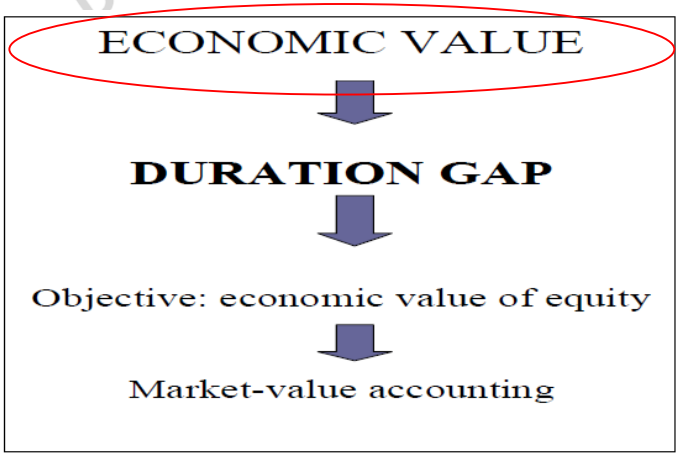
Spread Risk (or: Reinvestment Rate Risk)

- Impact on **bank's cost of funds**



Price Risk

- Impact on **bank´s market values**



From the Maturity GAP to the Duration GAP

- **A bank can protect either the Market Value of Equity or …**
- **… the Book Value of Net Interest Income, …**
- **… but not both**

If Asset Duration > Liability Duration and …

… if Interest Rates rise …

… Market Value of Equity will fall

Steps in Duration GAP Analysis

- Forecast interest rates
- Estimate the market values of bank assets, liabilities and stockholders' equity
- Estimate the weighted average duration of assets and the weighted average duration of liabilities
  - Incorporate the effects of both on- and off-balance sheet items
- Forecasts changes in the market value of stockholders' equity across different interest rate environments

Hypothetical Bank Balance Sheet

$$D = \frac{\frac{84\times 1}{(1.12)^1} + \frac{84\times 2}{(1.12)^2} + \frac{84\times 3}{(1.12)^3} + \frac{700\times 3}{(1.12)^3}}{700}$$

BANK - BASE CASE	Par Value	% Coupon	Years Mat	YTM	Mkt Value	Duration
ASSETS						
Cash	100,0				100,0	
Earning Assets						
3yr Commercial Loan	700,0	12,0%	3	12,0%	700,0	2,69
6yr T Bond	200,0	8,0%	6	8,0%	200,0	4,99
Total Earning Assets	900,0				900,0	
Non-Earning Assets	0,0				0,0	
Total Assets	1000,0				1000,0	2,88
LIABILITIES						
Interest Bearing Liabilities						
1yr Time Deposit	620,0	5,0%	1	5,0%	620,0	1,00
3yr Certificate of Deposit	300,0	7,0%	3	7,0%	300,0	2,81
Total Int Bear Liabilities	920,0				920,0	
Total Non Int Bear Liabs	0,0				0,0	
Total Liabilities	920,0				920,0	1,59
Equity	80,0				80,0	
Total Liabs & Equity	1000,0				1000,0	

Duration GAP and Economic Value of Equity

Weighted Average Duration of Assets

$$DA = \sum_{i}^{n} w_i Da_i$$

Weighting as of Market Values (wi)

Weighted Average Duration of Liab´s

$$DL = \sum_{j}^{m} z_j Dl_j$$

Weighting as of Market Values (zi)

- With MVAs and MVLs as the respective market values …
- … the Economic Value of Equity is defined as: $\Delta EVE = \Delta MVA - \Delta MVL$
- … and the Duration GAP: $DGAP = DA - (MVL/MVA)DL$
- … then this results in: $\Delta EVE = - DGAP \left[\frac{\Delta y}{(1+y)} \right] MVA$

y as the general level of interest rates

- **To protect the economic value of equity against any change when rates change, the bank would set the duration gap to zero**

DGAP = DA - u * DL

u = Tot Liabs / (Tot Liabs + Equity)

Calculation of the Duration GAP

Duration GAP

- DA = (700/1000)*2.69 + (200/1000)*4.99 = 2.88
- DL = (620/920)*1.00 + (300/920)*2.81 = 1.59
- **DGAP** = 2.88 - (920/1000)*1.59 = **1.42 years**

- The average duration of assets > duration of liabilities, …
- … hence in the case of interest rate fluctuations asset values change by more than liability values

BANK - BASE CASE	Par Value	% Coupon	Years Mat	YTM	Mkt Value	Duration
ASSETS						
Cash	100,0				100,0	
Earning Assets						
3yr Commercial Loan	700,0	12,0%	3	12,0%	700,0	2,69
6yr T Bond	200,0	8,0%	6	8,0%	200,0	4,99
Total Earning Assets	900,0				900,0	
Non-Earning Assets	0,0				0,0	
Total Assets	1000,0				1000,0	2,88
LIABILITIES						
Interest Bearing Liabilities						
1yr Time Deposit	620,0	5,0%	1	5,0%	620,0	1,00
3yr Certificate of Deposit	300,0	7,0%	3	7,0%	300,0	2,81
Total Int Bear Liabilities	920,0				920,0	
Total Non Int Bear Liabs	0,0				0,0	
Total Liabilities	920,0				920,0	1,59
Equity	80,0				80,0	
Total Liabs & Equity	1000,0				1000,0	

1% Increase in All Rates

$$PV = \sum_{t=1}^{3} \frac{84}{1.13^t} + \frac{700}{1.13^3}$$

BANK - YIELD INCREASE	Par Value	% Coupon	Years Mat	YTM	Mkt Value	Duration
ASSETS						
Cash	100,0				100,0	
Earning Assets						
3yr Commercial Loan	700,0	12,0%	3	13,0%	683,5	2,69
6yr T Bond	200,0	8,0%	6	9,0%	191,0	4,97
Total Earning Assets	900,0				874,5	
Non-Earning Assets	0,0				0,0	
Total Assets	1000,0				974,5	2,86
LIABILITIES						
Interest Bearing Liabilities						
1yr Time Deposit	620,0	5,0%	1	6,0%	614,2	1,00
3yr Certificate of Deposit	300,0	7,0%	3	8,0%	292,3	2,81
Total Int Bear Liabilities	920,0				906,4	
Total Non Int Bear Liabs	0,0				0,0	
Total Liabilities	920,0				906,4	1,58
Equity	80,0				68,1	
Total Liabs & Equity	1000,0				974,5	

Calculation of Duration GAP and Economic Value of Equity

Duration GAP

- DA = (683/974)*2.68 + (191/974)*4.97 = 2.86
- DL = (614/906)*1.00 + (292/906)*2.80 = 1.58
- **DGAP** = 2.86 - (906/974)*1.58 = **1.36 years**

- The average duration of assets > duration of liabilities, …
- … hence in the case of interest rate fluctuations asset values change by more than liability values

BANK - YIELD INCREASE	Par Value	% Coupon	Years Mat	YTM	Mkt Value	Duration
ASSETS						
Cash	100,0				100,0	
Earning Assets						
3yr Commercial Loan	700,0	12,0%	3	13,0%	683,5	2,69
6yr T Bond	200,0	8,0%	6	9,0%	191,0	4,97
Total Earning Assets	900,0				874,5	
Non-Earning Assets	0,0				0,0	
Total Assets	1000,0				974,5	2,86
LIABILITIES						
Interest Bearing Liabilities						
1yr Time Deposit	620,0	5,0%	1	6,0%	614,2	1,00
3yr Certificate of Deposit	300,0	7,0%	3	8,0%	292,3	2,81
Total Int Bear Liabilities	920,0				906,4	
Total Non Int Bear Liabs	0,0				0,0	
Total Liabilities	920,0				906,4	1,58
Equity	80,0				68,1	
Total Liabs & Equity	1000,0				974,5	

$$\Delta EVE = -DGAP\left[\frac{\Delta y}{(1+y)}\right]MVA$$

$$\Delta EVE = -1.42\left[\frac{.01}{1.10}\right]\$1{,}000 = -\$12.91$$

Summary of Duration GAP

- **Positive DGAP**
  - **Indicates that assets are more price sensitive than liabilities, on average**
    - **Thus, when interest rates rise (fall), assets will fall proportionately more (less) in value than liabilities and EVE will fall (rise) accordingly**
- **Negative DGAP**
  - **Indicates that weighted liabilities are more price sensitive than weighted assets**
    - **Thus, when interest rates rise (fall), assets will fall proportionately less (more) in value that liabilities and the EVE will rise (fall)**

DGAP Summary						
DGAP	Change in Interest Rates	Assets		Liabilities		Equity
Positive	Increase	Decrease	>	Decrease	→	Decrease
Positive	Decrease	Increase	>	Increase	→	Increase
Negative	Increase	Decrease	<	Decrease	→	Increase
Negative	Decrease	Increase	<	Increase	→	Decrease
Zero	Increase	Decrease	=	Decrease	→	None
Zero	Decrease	Increase	=	Increase	→	None

Immunized Portfolio - What is the Minimum Risk Position?

Duration GAP

- DA = (700/1000)*2.69 + (200/1000)*4.99 = 2.88
- DL = (620/920)*1.00 + (300/920)*2.81 = 1.59
- **DGAP** = 2.88 - (920/1000)*1.59 = **1.42 years**

Task: Eliminate the risk of changes in the MVE, …

… so how much must DA or DL change?

BANK - BASE CASE	Par Value	% Coupon	Years Mat	YTM	Mkt Value	Duration
ASSETS						
Cash	100,0				100,0	
Earning Assets						
3yr Commercial Loan	700,0	12,0%	3	12,0%	700,0	2,69
6yr T Bond	200,0	8,0%	6	8,0%	200,0	4,99
Total Earning Assets	900,0				900,0	
Non-Earning Assets	0,0				0,0	
Total Assets	1000,0				1000,0	2,88
LIABILITIES						
Interest Bearing Liabilities						
1yr Time Deposit	620,0	5,0%	1	5,0%	620,0	1,00
3yr Certificate of Deposit	300,0	7,0%	3	7,0%	300,0	2,81
Total Int Bear Liabilities	920,0				920,0	
Total Non Int Bear Liabs	0,0				0,0	
Total Liabilities	920,0				920,0	1,59
Equity	80,0				80,0	
Total Liabs & Equity	1000,0				1000,0	

Reduce DA:

Change DA = **- 1.42**

same as / eliminate Duration GAP

Increase DL:

Change DL = +1.42/u = **+ 1.54**

u = Tot Liabs / (Tot Liabs + Equity)

u = 920 / (920+80) = 0.92

Increase DL to: 1.54 + 1.58 = ca 3.11

Duration GAP = 2.88 – 0.92 (3.11) = ca 0

Immunized Portfolio

BANK - IMMUNIZED/BASE	Par Value	% Coupon	Years Mat	YTM	Mkt Value	Duration
ASSETS						
Cash	100,0				100,0	
Earning Assets						
3yr Commercial Loan	700,0	12,0%	3	12,0%	700,0	2,69
6yr T Bond	200,0	8,0%	6	8,0%	200,0	4,99
Total Earning Assets	900,0				900,0	
Non-Earning Assets	0,0				0,0	
Total Assets	1000,0				1000,0	2,88
LIABILITIES						
Interest Bearing Liabilities						
1yr Time Deposit	340,0	5,0%	1	5,0%	340,0	1,00
3yr Certificate of Deposit	300,0	7,0%	3	7,0%	300,0	2,81
6yr Zero Cert of Deposit	444,0	0,0%	6	8,0%	279,8	6,00
Total Int Bear Liabilities	1084,0				919,8	
Total Non Int Bear Liabs	0,0				0,0	
Total Liabilities	1084,0				919,8	3,11
Equity	80,0				80,2	
Total Liabs & Equity	n/m				1000,0	

Immunized Portfolio: 1% Increase in All Rates

- **EVE changed by only $0.5m with the immunized portfolio versus $12m when the portfolio was not immunized**

BANK - IMMUNIZED/YIELD INCR	Par Value	% Coupon	Years Mat	YTM	Mkt Value	Duration
ASSETS						
Cash	100,0				100,0	
Earning Assets						
3yr Commercial Loan	700,0	12,0%	3	13,0%	683,5	2,69
6yr T Bond	200,0	8,0%	6	9,0%	191,0	4,97
Total Earning Assets	900,0				874,5	
Non-Earning Assets	0,0				0,0	
Total Assets	1000,0				974,5	2,86
LIABILITIES						
Interest Bearing Liabilities						
1yr Time Deposit	340,0	5,0%	1	6,0%	336,8	1,00
3yr Certificate of Deposit	300,0	7,0%	3	8,0%	292,3	2,81
6yr Zero Cert of Deposit	444,0	0,0%	6	9,0%	264,7	6,00
Total Int Bear Liabilities	1084,0				893,8	
Total Non Int Bear Liabs	0,0				0,0	
Total Liabilities	1084,0				893,8	3,07
Equity	80,0				80,7	
Total Liabs & Equity	n/m				974,5	

Assessment of Duration GAP and EVE-Sensitivity Analysis

- Strengths
  - Duration analysis provides a comprehensive measure of interest rate risk
  - Duration measures are additive
    - This allows for the matching of total assets with total liabilities rather than the matching of individual accounts
  - Duration analysis takes a longer term view than static gap analysis

- Weaknesses
  - It is difficult to compute duration accurately
  - "Correct" duration analysis requires that each future cash flow be discounted by a distinct discount rate
  - A bank must continuously monitor and adjust the duration of its portfolio
  - It is difficult to estimate the duration on assets and liabilities that do not earn or pay interest
  - Duration measures are highly subjective

- It is difficult to actively vary Maturity GAP or Duration GAP and consistently win
  - Interest rates forecasts are frequently wrong
  - Even if rates change as predicted, banks have limited flexibility in vary GAP and DGAP and must often sacrifice yield to do so

Off Balance Sheet Structures

Off-Balance Sheet Activities

Derivatives

- Currency and interest rate swaps
- Over-the-counter options, futures, and forwards
- Other off-balance sheet activities
- U.S. banks and international expansion

Financial guarantees

- Standby letters of credit
- Bank loan commitments
- Note issuance facilities

- Financial Guarantee: The bank stands behind an obligation of a third party
  - A loan guarantee is a common example

Off-Balance Sheet Activities

- Market risk
  - Wild gyrations in interest rates in the 1980s
  - Turmoil in emerging markets in the 1990s
  - Periodic volatility in global financial markets

- Off-balance sheet activities to deal with market risk
  - Commitments based on a contingent claim -- an obligation by a bank to provide funds (lend funds or buy securities) if a contingency is realized
  - Two broad categories: financial guarantees and derivative instruments
  - Transforming deposit/lending institutions into risk management institutions
  - Tremendous growth of off-balance sheet activities of large banks

Financial Guarantees – Standby Letter of Credit

- Standby Letters of Credit (SLC)
  - SLCs obligate the **bank to pay the beneficiary if the account party defaults** on a financial obligation or performance contract
  - Equivalent to an OTC **put option written by the bank**
    - The firm can "put" the credit obligation back to the bank
  - **Financial SLCs**: Backup lines of credit on bonds, notes, and commercial paper serve as guarantee
  - **Performance SLCs**: Completion of construction contracts guaranteed
  - SLCs are considered loans
    - They may be collateralized
  - Need to diversify, limit credit risk, and increase capital to manage risks
  - Liquidity risk (or funding risk), capital risk, interest rate risk, and legal risk are inherent in these instruments
  - Material adverse change (MAC) clause
    - Enables bank to withdraw its commitment if the risk of the SLC changes substantially

Financial Guarantees – Bank Loan Commitments

- Bank Loan Commitments
  - **Promise by a bank** to a customer to **make a future loan** under certain conditions
  - Most commercial and industrial loans are made under some form of guarantee (informal or formal)

- *Line of credit* -- Informal commitment of a bank to lend funds to a client firm

- *Revolving line of credit* -- Formal agreement by a bank to lend funds on demand to a client firm under the terms of the contract
  - MAC clauses may be used to protect the bank from changing firm risk
  - Protect firms from availability and markup (or premium) risks of credit
  - Bank is exposed to interest rate risk

- *Funding risk* -- Risk that many borrowers will take down commitments at the same time and thereby strain bank liquidity
  - Also known as quantity risk
  - Most likely to occur during periods of tight credit
  - Some commitments are irrevocable (i.e., unconditional and binding)

Financial Guarantees – Note Issuance Facilities

- Note Issuance Facilities (NIF)
  - NIFs are medium-term (2-7 years) agreements in which a **bank guarantees the sale of a firm's short-term debt securities at or below pre-determined interest rates**
  - The bank will step in a timely fashion to buy the securities of the firm
    - Other terms for similar financial guarantees are *revolving underwriting facilities* (RUFs) and *standby note issuance facilities* (SNIFs)
    - Banks that use CDs might seek a *Roly-Poly CD facility*
    - Nonbank borrowers might issue short-term debt securities called *Euronotes* (denominated in dollars but sold outside of the U.S.)
  - Contingent risks to banks here as **underwriters** (i.e., arrangers if a single bank or tender panel if a group of banks) are credit risk and funding risk.

Example in Duration Hedging for a Bank

Duration Hedging

- If interest rates are likely to move quickly soon, management may be worried that their bank is vulnerable …

BANK OF AMSTERDAM
Market Value Balance Sheet

	Market value (€)	Duration
Assets		
Overnight money	35 million	0
Accounts receivable–backed loans	500 million	3 months
Inventory loans	275 million	6 months
Industrial loans	40 million	2 years
Mortgages	150 million	14.8 years
	1,000 million	
Liabilities and owners' equity		
Checking and savings accounts	400 million	0
Certificates of deposit	300 million	1 year
Long-term financing	200 million	10 years
Equity	100 million	
	1,000 million	

Duration Hedging (cont´d)

BANK OF AMSTERDAM
Market Value Balance Sheet

	Market value (€)	Duration
Assets		
Overnight money	35 million	0
Accounts receivable–backed loans	500 million	3 months
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	1,000 million	
Liabilities and owners' equity		
Checking and savings accounts	400 million	0
Certificates of deposit	300 million	1 year
Long-term financing	200 million	10 years
Equity	100 million	
	1,000 million	

Duration of assets:

$$2.56 \text{ years} = 0 \text{ years} \times \frac{€35 \text{ million}}{€1{,}000 \text{ million}} + \frac{1}{4}\text{year} \times \frac{€500 \text{ million}}{€1{,}000 \text{ million}} + \frac{1}{2}\text{year} \times \frac{€275 \text{ million}}{€1{,}000 \text{ million}} + 2 \text{ years} \times \frac{€40 \text{ million}}{€1{,}000 \text{ million}} + 14.8 \text{ years} \times \frac{€150 \text{ million}}{€1{,}000 \text{ million}}$$

Duration of liabilities:

$$2.56 = 0 \text{ years} \times \frac{€400 \text{ million}}{€900 \text{ million}} + 1 \text{ year} \times \frac{€300 \text{ million}}{€900 \text{ million}} + 10 \text{ years} \times \frac{€200 \text{ million}}{€900 \text{ million}}$$

- Argument: The firm is immune to interest rate risk …
- … **but**: Assets are larger than liabilities!
  - … in essence, equity cannot be ignored …

Duration Hedging (cont´d)

BANK OF AMSTERDAM
Market Value Balance Sheet

	Market value (€)	Duration
Assets		
Overnight money	35 million	0
Accounts receivable–backed loans	500 million	3 months
Inventory loans	275 million	6 months
Industrial loans	40 million	2 years
Mortgages	150 million	14.8 years
	1,000 million	
Liabilities and owners' equity		
Checking and savings accounts	400 million	0
Certificates of deposit	300 million	1 year
Long-term financing	200 million	10 years
Equity	100 million	
	1,000 million	

- Argument: Incorrect to simply match durations, because assets larger than liabilities
  - *Total* price change will be greater for assets than for liabilities, because there are more assets than liabilities in this bank

- The following relationship must hold if the bank is to be immunized – that is, immune to interest rate risk:

$$\text{Duration of assets} \times \text{Market value of assets} = \text{Duration of liabilities} \times \text{Market value of liabilities}$$

Increase the duration of the liabilities without changing the duration of the assets

$$\text{Duration of assets} \times \frac{\text{Market value of assets}}{\text{Market value of liabilities}} = 2.56 \text{ years} \times \frac{€1{,}000 \text{ million}}{€900 \text{ million}}$$
$$= 2.84 \text{ years}$$

$$2.56 \times €1 \text{ billion} = 2.84 \times €900 \text{ million}$$

Decrease the duration of the assets without changing the duration of the liabilities

$$\text{Duration of liabilities} \times \frac{\text{Market value of liabilities}}{\text{Market value of assets}} = 2.56 \text{ years} \times \frac{€900 \text{ million}}{€1{,}000 \text{ million}}$$
$$= 2.30 \text{ years}$$

$$2.30 \times €1 \text{ billion} = 2.56 \times €900 \text{ million}$$

Duration Hedging (cont´d)

Next steps:

- Increase the duration of the liabilities without changing the duration of the assets
- Decrease the duration of the assets without changing the duration of the liabilities

BANK OF AMSTERDAM
Market Value Balance Sheet

	Market value (€)	Duration
Assets		
Overnight money	35 million	0
Accounts receivable–backed loans	500 million	3 months
Inventory loans	275 million	6 months
Industrial loans	40 million	2 years
Mortgages	150 million	14.8 years
	1,000 million	
Liabilities and owners' equity		
Checking and savings accounts	400 million	0
Certificates of deposit	300 million	1 year
Long-term financing	200 million	10 years
Equity	100 million	
	1,000 million	

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