Financial Markets and Institutions

Commercial Banks Risk Management

Mishkin & Eakins 7th ed. Chapter 17 & 23

Basics of banking

- Recall: How do banks make their profits?
- Main profits of banks come from their activities as intermediaries (Deposits / loans)
  - Profits come from the differences: cost of deposits / borrowings vs. income from loans / trading activities
  - Through these activities, banks transform the characteristics of the assets (liquidity, risk, size, return)
  - RISK!

Common risks faced by banks

1. Credit risk: Risk that promised cash flows from loans and securities may not be paid in full
2. Market risks: Risks incurred from A&L's in bank's trading book due to changes in:
   - Interest rates
   - Exchange rates
   - Prices (equity, commodities, etc)
3. Interest rate risk: Risk incurred when maturities of assets and liabilities are mismatched
4. Liquidity risk: The risk that a sudden surge in liability withdrawals may require banks to liquidate assets in a very short period of time and at less than fair market prices

How to manage risks

Credit risk

Market risk

Interest rate risk

Liquidity risk

Risks to be measured and actively managed

Risks to be controlled and minimized

A&L M

Liquidity M

Capital Adequacy

Constraints

Managing Interest-Rate Risk

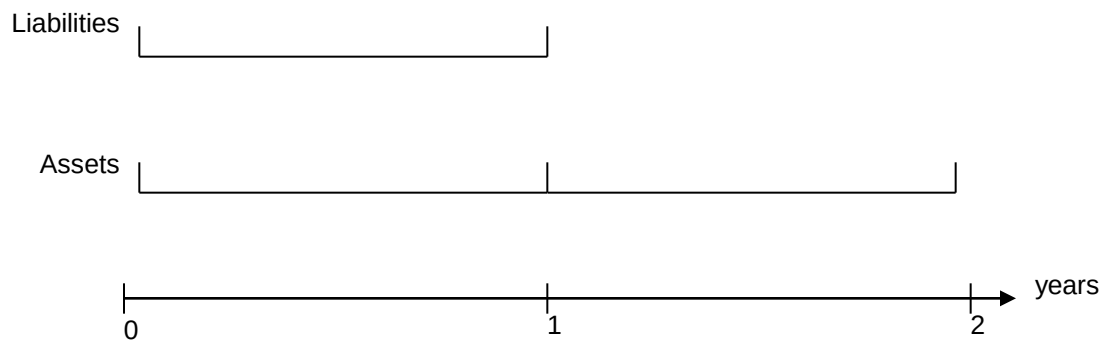
- Financial institutions, banks in particular, specialize in earning a higher rate of return on their assets relative to the interest paid on their liabilities.

- **Interest Rate Risk**: risk that a bank's net income or net worth will be negatively affected by a change in the market interest rate.

- As interest rate volatility increased in the last 20 years, interest-rate risk exposure has become a concern for financial institutions.

A&L M: Interest rate risk: Example 1

- Liabilities: $100 million, maturity: one year, cost: 9%
- Assets: $100 million, maturity: 2 years, return: 10%



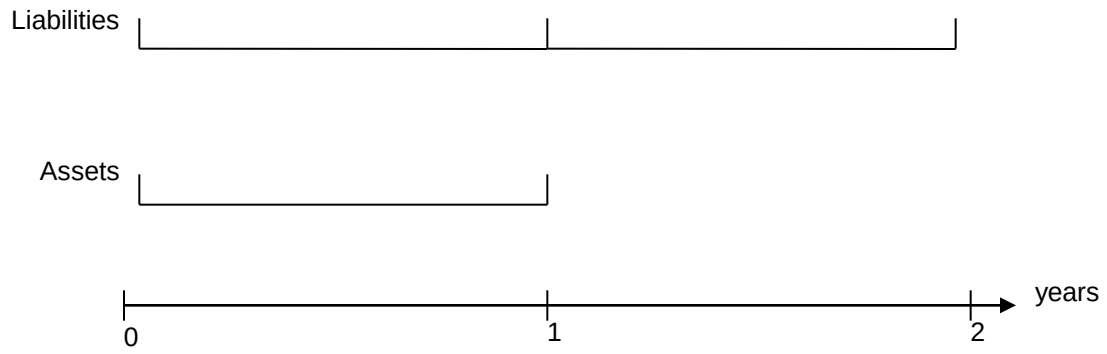
- Bank is “short funded”
- First year profit: 1%, i.e. $1 million

A&L M: Interest rate risk: Example 1 (cont)

- Second year profits are uncertain
- If interest rates for liabilities stay at 9%, bank still profits $1 million
- If interests rise to 11%, bank would lose $1 M on the second year
- If interest rates rise above 11%, bank stands to take losses over the two-year period
- Refinancing risk: Risk that cost of rolling over / reborrowing funds is higher than returns for assets
  - Longer-term assets than liabilities

A&L M: Interest rate risk: Example 2

- Liabilities: $100 million, maturity: 2 years, cost: 9%
- Assets: $100 million, maturity: 1 year, return: 10%



- Bank is “long funded”
- Reinvestment risk

A&L M: Interest rate risk: Example 2 (cont)

- If returns on assets falls to 8%, bank would lose $1 M in the second year
- If returns on assets decrease below 8%, bank stands to take losses over the two-year period
- Examples: Banks borrowing at fixed-rate deposits and investing in floating-rate loans

Managing Interest-Rate Risk

- To see how financial institutions can measure and manage interest-rate risk exposure, we will examine the balance sheet for First National Bank (next slide).
- We will develop two tools, (1) Income Gap Analysis and (2) Duration Gap Analysis, to assist the financial manager in this effort.

A&L M: Interest rate risk

- Step 1: Measure exposure to interest rate risk
  - Determine amount of A&Ls that are rate sensitive (income gap, also called repricing / funding gap)
  - Determine the average maturity of A&Ls (duration gap)
- Step 2: Analyze what will happen if interest rates change
- Step 3: Immunize the portfolio
  - Increase / decrease amount of assets that are rate sensitive
  - Increase / decrease average maturity of assets to immunize portfolio

A&LM, interest rate risk: Income gap

- $GAP = RSA - RSL$
- RSA = all the assets that mature or are repriced within the gapping period (maturity bucket)
- RSL = all the liabilities that mature or are repriced within the gapping period (maturity bucket)
- Effect on bank income: $\Delta I = GAP \cdot \Delta i$
- ΔI: change in bank income
- Δi: change in interest rates
- In expected terms: $E[\Delta I] = GAP \cdot E[\Delta i]$

Example

First National Bank

Assets		Liabilities	
Reserves and cash items	$5 million	Checkable deposits	$15 million
Securities		Money market deposit	
Less than 1 year	$5 million	accounts	$5 million
1 to 2 years	$5 million	Savings deposits	$15 million
Greater than 2 years	$10 million	CDs	
Residential mortgages		Variable-rate	$10 million
Variable-rate	$10 million	Less than 1 year	$15 million
Fixed-rate (30-year)	$10 million	1 to 2 years	$5 million
Commercial loans		Greater than 2 years	$5 million
Less than 1 year	$15 million	Fed funds	$5 million
1 to 2 years	$10 million	Borrowings	
Greater than 2 years	$25 million	Less than 1 year	$10 million
Physical capital	$5 million	1 to 2 years	$5 million
		Greater than 2 years	$5 million
		Bank capital	$5 million
Total	$100 million	Total	$100 million

Risk Management Association home page
http://www.rmahq.org

Income Gap Analysis:
Determining Rate Sensitive Items for First National Bank with a maturity bucket of one year

Assets

- assets with maturity less than one year
- variable-rate mortgages
- short-term commercial loans
- portion of fixed-rate mortgages (say 20%)

Liabilities

- money market deposits
- variable-rate CDs
- short-term CDs
- federal funds
- short-term borrowings
- portion of checkable deposits (10%)
- portion of savings (20%)

Income gap: Example for 1-yr gap

Assets (million €)		Liabilities (million €)	
Reserves	5	Checkable deposits	15
Securities		Money market dep. Acc.	5
Less than 1 year	5	Savings deposits	15
1 to 2 years	5	CDs	
Greater than 2 yrs	10	Variable rate	10
Residential mortgages		Less than 1 yr	15
Variable rate	10	1 to 2 yrs	5
Fixed rate (30-yr)	10	Greater than 2 yrs	5
Commercial loans		Fed funds	5
Less than 1 yr	15	Borrowings	
1 to 2 yrs	10	Less than 1 yr	10
Greater than 2 yrs	25	1 to 2 yrs	5
Physical capital	5	Greater than 2 yrs	5
		Bank capital	5

Income Gap Analysis: Determining Rate Sensitive Items for First National Bank

Rate-Sensitive Assets = \$5m + \$ 10m + \$15m + 20% × \$20m

RSA = **\$32m**

Rate-Sensitive Liabilities = \$5m + \$25m + \$5m+ \$10m + 10% × \$15m
+ 20% × \$15m

RSL = **\$49.5m**

if $i \uparrow$ 5% [read "i +0.05" not "i*(1+5%)"] $\Rightarrow$

ΔAsset Income	= +5% × **\$32.0m**	= +\$ 1.6m
ΔLiability Costs	= +5% × **\$49.5m**	= +\$ 2.5m
ΔIncome	= \$1.6m – \$ 2.5	= –\$0.9m

Income Gap Analysis

If *RSL* > *RSA*, *i* ↑ results in *Net Income Margin* (*NIM*) ↓, *Income* ↓

$$GAP = RSA - RSL$$
$$= \$32.0\text{m} - \$49.5\text{m} = -\$17.5\text{m}$$

Suppose interest changes of 5%. Change in income is:

$$\Delta Income = GAP \times \Delta i$$
$$= -\$17.5\text{m} \times 5\% = -\$0.9\text{m}$$

This is essentially a short-term focus on interest-rate risk exposure. A longer-term focus uses **duration gap analysis.**

A&L M: Disadvantages of income gap

- The model considers only one interest rate change
- Assumption of a uniform change of asset and liabilities rates
- All assets and liabilities maturing within the maturity bucket are treated equally
- Assumption of a uniform change of all interest rates (parallel shift of the yield curve within each bucket)
- The model does not take into account the impact of interest rate changes on market values
  - present value of all assets and liabilities changes with changes in interest rates

Duration Gap Analysis

- Duration Gap Analysis: measures the sensitivity of a bank's **net worth** to changes in interest rate.
- Requires determining the **duration** for assets and liabilities, items whose market value will change as interest rates change.

What is duration?

- Duration measures the sensitivity of the price of a security to a 100 bps change in interest rate (expressed in % points)

$$DUR = \frac{\sum_{t=1}^{n} t \frac{CP_t}{(1+i)^t}}{\sum_{t=1}^{n} \frac{CP_t}{(1+i)^t}}$$

CP_t = cash payment at time t

i = interest rate

n = years to maturity of the security

- Property: The duration of a portfolio is the weighted average of the duration of each individual security

What is duration?

The basic equation for determining the change in market value for assets or liabilities is:

$$\% \text{ Change in Value} = -\text{DUR} \times [\Delta i / (1 + i)]$$

or

$$\text{Change in Value} = -\text{DUR} \times [\Delta i / (1 + i)] \times \text{Original Value}$$

Duration of First National Bank's Assets and Liabilities

TABLE 24.1 Duration of the First National Bank's Assets and Liabilities

	Amount ($ millions)	Duration (years)	Weighted Duration (years)
Assets			
Reserves and cash items	5	0.0	0.00
Securities			
Less than 1 year	5	0.4	0.02
1 to 2 years	5	1.6	0.08
Greater than 2 years	10	7.0	0.70
Residential mortgages			
Variable-rate	10	0.5	0.05
Fixed-rate (30-year)	10	6.0	0.60
Commercial loans			
Less than 1 year	15	0.7	0.11
1 to 2 years	10	1.4	0.14
Greater than 2 years	25	4.0	1.00
Physical capital	5	0.0	0.00
Average duration			2.70
Liabilities			
Checkable deposits	15	2.0	0.32
Money market deposit accounts	5	0.1	0.01
Savings deposits	15	1.0	0.16
CDs			
Variable-rate	10	0.5	0.05
Less than 1 year	15	0.2	0.03
1 to 2 years	5	1.2	0.06
Greater than 2 years	5	2.7	0.14
Fed funds	5	0.0	0.00
Borrowings			
Less than 1 year	10	0.3	0.03
1 to 2 years	5	1.3	0.07
Greater than 2 years	5	3.1	0.16
Average duration			1.03

Duration Gap Analysis

- For each asset item, calculate its weighted duration =

  duration_of_item*(amount_of_asset_item/total_assets)

  Example: securities less than a year: 5*0.4/100=0.02
- Do this for all assets
- Add up all obtained values:

  Average duration of assets = 2.70

- Do the same with liabilities: note that total liabilities exclude capital. Here, $95million.

  Average duration of liabilities = 1.03

Duration Gap Analysis

Consider a change in rates from 10% to 15%.
Using the value from Table 1, we see:

Assets:

$$\Delta\text{Asset Value} = -2.7 \times .05/(1 + .10) \times \$100\text{m}$$
$$= -\$12.3\text{m}$$

Duration Gap Analysis

Liabilities:

$$\Delta\text{Liability Value} = -1.03 \times .05/(1 + .10) \times \$95\text{m}$$
$$= -\$4.5\text{m}$$

Net Worth:

$$\Delta NW = \Delta\text{Assets} - \Delta\text{Liabilities}$$

$$\Delta NW = -\$12.3\text{m} - (-\$4.5\text{m}) = -\$7.8\text{m}$$

Duration Gap Analysis

- For a rate change from 10% to 15%, the net worth of First National Bank will fall, changing by −$7.8m.
- Recall from the balance sheet that First National Bank has "Bank capital" totaling $5m. Following such a dramatic change in rate, the capital would fall to −$2.8m.

Duration Gap Analysis

We can reach the same conclusion using the general formulas:

$$DUR_{gap} = DUR_a - [L/A \times DUR_l]$$

$$\%\Delta NW = \Delta NW/A = -DUR_{gap} \times \Delta i/(1 + i)$$

Duration Gap Analysis

Applied to our example, we have:

$$
\begin{aligned}
DUR_{gap} &= DUR_a - [L/A \times DUR_l] \\
&= 2.7 - [(95/100) \times 1.03] \\
&= 1.72 \\
\%\Delta NW &= -DUR_{gap} \times \Delta i/(1 + i) \\
&= -1.72 \times .05/(1 + .10) \\
&= -.078, \text{ or } -7.8\%
\end{aligned}
$$

Duration Gap Analysis

- So far, we have focused on how to apply income gap analysis and duration gap analysis in a banking environment.
- The same analysis can be applied to other financial institutions. For example, let's look at a simple finance company which makes consumer loans. The balance sheet and duration worksheet for Friendly Finance Co. follows.

Duration Gap Analysis

Friendly Finance Company

Assets		Liabilities	
Cash and deposits	$3 million	Commercial paper	$40 million
Securities		Bank loans	
Less than 1 year	$5 million	Less than 1 year	$3 million
1 to 2 years	$1 million	1 to 2 years	$2 million
Greater than 2 years	$1 million	Greater than 2 years	$5 million
Consumer loans		Long-term bonds and	
Less than 1 year	$50 million	other long-term debt	$40 million
1 to 2 years	$20 million	Capital	$10 million
Greater than 2 years	$15 million		
Physical capital	$5 million		
Total	$100 million	Total	$100 million

TABLE 24.2 Duration of the Friendly Finance Company's Assets and Liabilities

	Amount ($ millions)	Duration (years)	Weighted Duration (years)
Assets			
Cash and deposits	3	0.0	0.00
Securities			
Less than 1 year	5	0.5	0.05
1 to 2 years	1	1.7	0.02
Greater than 2 years	1	9.0	0.09
Consumer loans			
Less than 1 year	50	0.5	0.25
1 to 2 years	20	1.5	0.30
Greater than 2 years	15	3.0	0.45
Physical capital	5	0.0	0.00
Average duration			1.16
Liabilities			
Commercial paper	40	0.2	0.09
Bank loans			
Less than 1 year	3	0.3	0.01
1 to 2 years	2	1.6	0.04
Greater than 2 years	5	3.5	0.19
Long-term bonds and other long-term debt	40	5.5	2.44
Average duration			2.77

Income Gap Analysis: Determining Rate Sensitive Items for Friendly Finance Co.

Assets

- securities with a maturity less than one year
- consumer loans with a maturity less than one year

Liabilities

- commercial paper
- bank loans with a maturity less than one year

Income Gap Analysis

If $i \uparrow 5\%$

$$GAP = RSA - RSL = \$55 \text{ m} - \$43 \text{ m} = \$12 \text{ million}$$

$$\Delta Income = GAP \times \Delta i = \$12 \text{ m} \times 5\% = \$0.6 \text{ million}$$

Duration Gap Analysis

If $i \uparrow 5\%$

$$
\begin{aligned}
DUR_{gap} &= DUR_a - [L/A \times DUR_l] \\
&= 1.16 - [90/100 \times 2.77] \\
&= -1.33 \text{ years}
\end{aligned}
$$

$$
\begin{aligned}
\%\,\Delta NW &= -DUR_{gap} \text{ X } \Delta i\,/(1 + i) \\
&= -(-1.33) \times .05/(1 + .10) \\
&= .061, \text{ or } 6.1\%
\end{aligned}
$$

Managing Interest-Rate Risk

- Strategies for Managing Interest-Rate Risk
  - In example above, shorten duration of bank assets or lengthen duration of bank liabilities
  - To completely immunize net worth from interest-rate risk, set $DUR_{gap} = 0$

Reduce $DUR_a = 0.98 \Rightarrow DUR_{gap} = 0.98 - [(95/100) \times 1.03] = 0$

Raise $DUR_l = 2.80 \Rightarrow DUR_{gap} = 2.7 - [(95/100) \times 2.80] = 0$

Managing Credit Risk

- A major part of the business of financial institutions is making loans, and the major risk with loans is that the borrow will not repay.

- **Credit risk** is the risk that a borrower will not repay a loan according to the terms of the loan, either defaulting entirely or making late payments of interest or principal.

- Once again, the concepts of **adverse selection** and **moral hazard** will provide our framework to understand the principles financial managers must follow to minimize credit risk, yet make successful loans.

Managing Credit Risk

- Adverse selection is a problem in the market for loans because those with the highest credit risk have the biggest incentives to borrow from others.

- Moral hazard plays a role as well. Once a borrower has a loan, she has an incentive to engage in risky projects to produce the highest payoffs, especially if the project is financed mostly with debt.

Managing Credit Risk

- Solving Asymmetric Information Problems:

1. Screening and Monitoring:
   - Collect reliable information about prospective borrowers.
   - Specialize in lending: in regions or industries, gaining expertise in evaluating particular firms or individuals.
   - Require certain actions, or prohibiting others, and then periodically verifying that the borrower is complying with the terms of the loan contact.
   - Write protective covenants into loans contracts and actively manage them to ensure that borrowers are not taking risks at their expense.

Managing Credit Risk

2. **Long-term Customer Relationships**: past information contained in checking accounts, savings accounts, and previous loans provides valuable information to more easily determine creditworthiness.

3. **Loan Commitments**: arrangements where the bank agrees to provide a loan up to a fixed amount, whenever the firm requests the loan.

4. **Collateral:** Assets that must be surrendered if the terms of the loan are not met ("secured loans").

5. **Compensating Balances**: Reserves that a borrower must maintain in an account that act as collateral. Activity also provides private information about borrower.

Managing Credit Risk

6. Credit Rationing:

a. Lenders will refuse to lend to some borrowers, regardless of how much interest they are willing to pay

or

b. Lenders will only finance part of a project, requiring that the remaining part come from equity financing.

Mechanisms:

a. Adverse selection: riskier borrowers say they are willing to pay higher interests. The probability of repayment is thus very low.

b. Creates an incentive for borrowers to engage in less risky projects.