Overview

1. Interest rate risk
2. The repricing model; strengths and weaknesses
3. The maturity model

1. Interest rate risk

- The risk incurred by a bank when the maturities of its assets and liabilities are mismatched.
- Occurs when the value of a bank’s assets and liabilities have different sensitivities to market interest rates. Assets with longer durations have more sensitivity to market interest rates.
- Interest rate risk occurs because the prices and reinvestment income characteristics of long-term assets react to changes in market interest rates differently from the prices and interest expense characteristics of short-term liabilities.

2. Refinancing risk

- Refinancing risk is the uncertainty of the cost of a new source of funds that are being used to finance a long-term fixed-rate asset. This risk occurs when a bank is holding assets with maturities greater than the maturities of its liabilities.
- If a bank has a 10-year fixed-rate loan funded by a 2-year time deposit, it faces a risk of borrowing new deposits, or refinancing, at a higher rate in two years. Thus, interest rate increases would reduce net interest income.
- The bank would benefit if the rates fall as the cost of renewing the deposits would decrease, while the earning rate on the assets would not change. In this case, net interest income would increase.

3. Reinvestment risk

- Reinvestment risk is the uncertainty of the earning rate on the redeployment of assets that have matured. This risk occurs when a bank holds assets with maturities that are less than the maturities of its liabilities.
- If a bank has a 2-year loan funded by a 10-year fixed-rate time deposit, the bank faces the risk that it might be forced to lend or reinvest the money at lower rates after two years, perhaps even below the deposit rates.
- If the bank receives periodic cash flows (coupon payments from a bond or monthly payments on a loan), these periodic cash flows will also be reinvested at the new interest rates.
- Besides the effect on the income statement, this reinvestment risk may cause the realized yields on the assets to differ from the a priori expected yields.

4. There are two broad management approaches that are used to measure interest rate risk – known as ‘gap’ and ‘duration’ analysis.

The impact of unanticipated changes in interest rates:

- on profitability
  - Net Interest Income (NII) = Interest Income – Interest Expense
  - interest rate risk of NII is measured by the repricing model
- on market value of equity
  - market value of equity = market value of assets – market value of debt
  - interest rate risk of equity MV is measured by the maturity (duration) model
2. The repricing model: strengths and weaknesses

- **The repricing gap** is a measure of the difference between the value of assets that will reprice and the value of liabilities that will reprice within a specific time period, where reprice means the potential to receive a new interest rate.

- **Rate sensitivity** represents the time interval where repricing can occur. The model focuses on the potential changes in the net interest income variable. In effect, if interest rates change, interest income and interest expense will change as the various assets and liabilities are repriced, that is, receive new interest rates.

- **The maturity bucket** is the time window over which the dollar amounts of assets and liabilities are measured. The length of the repricing period determines which of the securities in a portfolio are rate-sensitive. The longer the repricing period, the more securities either mature or need to be repriced, and, therefore, the more the interest rate exposure.

- An **excessively short** repricing period omits consideration of the interest rate risk exposure of assets and liabilities that are repriced in the period immediately following the end of the repricing period, i.e., it understates the rate sensitivity of the balance sheet.

- An **excessively long** repricing period includes many securities that are repriced at different times within the repricing period, thereby overstating the rate sensitivity of the balance sheet.

### Interest–sensitive assets and liabilities

- short-term securities issued by the government and private borrowers
- short-term loans made by the bank to customers
- variable-rate loans made by the bank to borrowing customers
- borrowings from money markets
- short-term savings accounts
- money-market deposits
- variable-rate deposits

**Rate Sensitive Assets (Liabilities)** RSA (RSL) are repriced within a period of time called a maturity bucket

- Repricing occurs whenever either maturity or a roll date is reached
- The roll date is the reset date specified in floating rate instruments that determines the new market benchmark rate used to set cash flows (e.g., coupon payments)

We set the following 6 maturity buckets:

- 1 day
- 1day–3 months
- 3–6 months
- 6–12 months
- 1–5 yrs
- > 5 yrs

#### The repricing model

- Repricing Gap (GAP) = RSA – RSL
- ∆R = interest rate shock
- ∆NII = GAP × ∆R for each maturity bucket i
- Cumulative Gap (CGAP) = Σ GAP
- ∆NII = CGAP × ∆R, where ∆R is the average interest rate change on RSA and RSL
- Gap Ratio = CGAP/Assets

Example of repricing model

<table>
<thead>
<tr>
<th>Assets</th>
<th>$m</th>
<th>Liabilities and Net Worth</th>
<th>$m</th>
</tr>
</thead>
<tbody>
<tr>
<td>Short term consumer loans</td>
<td>50</td>
<td>Equity capital (fixed)</td>
<td>20</td>
</tr>
<tr>
<td>(1yr fixed rate)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Long term consumer loans</td>
<td>25</td>
<td>Demand deposits</td>
<td>40</td>
</tr>
<tr>
<td>(2yrs fixed rate)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3mo T-bills</td>
<td>30</td>
<td>Passbook savings</td>
<td>30</td>
</tr>
<tr>
<td>6mo T-bills</td>
<td>35</td>
<td>CDs (3mo)</td>
<td>40</td>
</tr>
<tr>
<td>3yr T-bills</td>
<td>70</td>
<td>Bankers acceptances (3mo)</td>
<td>20</td>
</tr>
<tr>
<td>Mortgages (10yrs, fixed rate)</td>
<td>20</td>
<td>Commercial papers (6mo)</td>
<td>60</td>
</tr>
<tr>
<td>Mortgages (30yrs, floating rate, 9mo adjust. period)</td>
<td>40</td>
<td>Time deposits (1yr)</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Time deposits (2yr)</td>
<td>40</td>
</tr>
<tr>
<td>TOTAL</td>
<td>270</td>
<td>TOTAL</td>
<td>270</td>
</tr>
</tbody>
</table>

Example of repricing model (cont.)

- 1 day GAP = 0 – 0 = 0 (DD and passbook excluded)
- (1day–3mo) GAP = 30 - (40+20) = -$30m
- (3mo–6mo) GAP = 35 – 60 = -$25m
- (6mo–12mo) GAP = (50+40) - 20 = $70m
- (1yr–5yr) GAP = (25+70) - 40 = $55m
- >5 yr GAP = 20 – (20+40+30) = -$70m

- 1yr CGAP = 0 –30–25+70 = $15m
- 1yr Gap Ratio = 15/270 = 5.6%
- 5yr CGAP = 0 –30–25+70+55 = $70m
- 5yr Gap Ratio = 70/270 = 25.9%
Assume a 1% increase in interest rates:
- 1 day $\Delta NII = 0 \times 0.01 = 0$
- (1day–3mo) $\Delta NII = -30m \times 0.01 = -300,000$
- (3mo–6mo) $\Delta NII = 25m \times 0.01 = 250,000$
- (6mo–12mo) $\Delta NII = 70m \times 0.01 = 700,000$
- (1yr–5yr) $\Delta NII = 70m \times 0.01 = 700,000$
- >5yr GAP = –70m × 0.01 = –700,000
- 1yr $\Delta NII = 15m \times 0.01 = 150,000$
- 5yr $\Delta NII = 70m \times 0.01 = 700,000$

Unequal shifts in interest rates
- $\Delta NII = (RSA \times \Delta R_{RSA}) - (RSL \times \Delta R_{RSL})$
- Even if GAP=0 (RSA=RSL), unequal shifts in interest rates can cause $\Delta NII$
- Must compare relative size of RSA and RSL (GAPs) to relative size of interest rate shocks:
  $\Delta R_{RSA} - \Delta R_{RSL} = \text{spread} = \text{Basis Risk}$
- The bank can restructure its assets and liabilities, on or off the balance sheet, to benefit from projected interest rate changes.
  - Positive gap: increase in rates increases NII
  - Negative gap: decrease in rates increases NII

Strengths of the repricing model
- Simplicity
- Low data input requirements
- Used by smaller banks to get an estimate of cash flow effects of interest rate shocks

Weaknesses of the repricing model
- Ignores market value effects
- Over-aggregation within maturity buckets
- Runoffs – even fixed rate instruments pay off principal and interest cash flows which must be reinvested at market rates. Must estimate cash flows received or paid out during the maturity bucket period. But assumes that runoffs are independent of the level of interest rates.
- Ignores cash flows from off-balance sheet items usually marked-to-market.

Maturity gap is the difference between the average maturity of assets and liabilities.
- If the maturity gap is zero, it is possible to immunize the portfolio, so that changes in interest rates will result in equal but offsetting changes in the value of assets and liabilities and net interest income.
- Thus, if interest rates increase (decrease), the fall (rise) in the value of the assets will be offset by a perfect fall (rise) in the value of the liabilities.
- The critical assumption is that the timing of the cash flows on the assets and liabilities must be the same.
- Large banks are able to reprice securities every day using their own internal models so reinvestment and repricing risks can be estimated for each day of the year.

3. The maturity model
- One extension is the maturity gap (MG):
  $$MG = W_A\text{RSA} - W_A\text{RSL}$$
  where:
  $W_A\text{RSA} = \text{weighted average rate–sensitive assets}$
  $W_A\text{RSL} = \text{weighted average rate–sensitive liabilities}$
- Explicitly incorporates market–value effects.
- For fixed-income assets and liabilities:
  - Rise (fall) in interest rates leads to fall (rise) in market price.
  - The longer the maturity, the greater the effect of interest rate changes on market price.
  - Fall in value of longer–term securities increases at diminishing rate for given increase in interest rates.

Goal is “immunization,” bank wants to be immune to changes in interest rates.
- If $M_A - M_L = 0$, is the bank immunized?
  - Extreme example: Suppose liabilities consist of 1-year zero coupon bond with face value $100. Assets consist of 1-year loan, which pays back $99.99 shortly after origination, and 1 cent at the end of the year.
  - Not immunized, although maturity gap equals zero.
  - Reason: Differences in market value sensitivity to changes in interest rates.
- If the relation between rate changes and price changes were both linear and equal on both sides of the balance sheet then:
  - Gap size determines the impact an interest rate change on net worth.
  - Setting $M_A - M_L = 0$ would protect the balance sheet for value changes due to interest rate fluctuations.
• The maturity model better reflects the economic reality or the true value of assets and liabilities if the bank portfolio was liquidated at today’s prices.
• If the maturity of a bank’s assets is greater than the maturity of its liabilities, an increase in interest rates will cause the value of the assets to fall more than the value of the liabilities because the assets mature later.
• The bigger the maturity gap, the more a bank’s net worth will suffer by an increase in interest rates.
• Another extension is the so-called ‘dynamic gap analysis’ approach, that involves forecasting interest rate changes and expected changes in the bank’s balance sheet for several periods in the future. Software models provide bank managers with simulation tools to inform them of the way in which gaps are expected to be structured at certain times in the future.

• The maturity model has two major shortcomings:
  (1) It does not account for the degree of leverage in the bank’s balance sheet, and
  (2) it ignores the timing of the cash flows from the bank’s assets and liabilities.
• As a result of these shortcomings, a strategy of matching asset and liability maturities moves the bank in the direction of hedging itself against interest rate risk, but it is easy to show that this strategy does not always eliminate all interest rate risk for a bank.

• If a bank risk manager is certain that interest rates were going to increase (fall) within the next six months, how should the bank manager adjust the bank’s maturity gap to take advantage of this anticipated increase?
• When rates rise, the value of the longer–lived assets will fall by more the shorter–lived liabilities.
• If the maturity gap is positive, the bank manager will want to shorten the maturity gap.
• If the repricing gap is negative, the manager will want to move it towards zero or positive.
• If rates are expected to decrease, the manager should reverse these strategies. Changing the maturity or repricing gaps on the balance sheet often involves changing the mix of assets and liabilities. Attempts to make these changes may involve changes in financial strategy for the bank which may not be easy to accomplish.

• Book value accounting reports assets and liabilities at the original issue values. Current market values may be different from book values because they reflect current market conditions, such as interest rates or prices. This is especially a problem if an asset or liability has to be liquidated immediately.
• For a bank, a major factor affecting asset and liability values is interest rate changes. If interest rates increase, the value of both loans (assets) and deposits and debt (liabilities) fall.
• If assets and liabilities are held until maturity, it does not affect the book valuation of the bank. However, if deposits or loans have to be refinanced, then market value accounting presents a better picture of the condition of the bank.
• The process by which changes in the economic value of assets and liabilities are accounted is called marking to market. The changes can be beneficial as well as detrimental to the total economic health of the bank.

• Book values represent historical costs of securities purchased, loans made, and liabilities sold. They do not reflect current values as determined by market values. Effective financial decision–making requires up–to–date information that incorporates current expectations about future events.
• Market values provide the best estimate of the present condition of a bank and serve as an effective signal to managers for future strategies.
• Book values are clearly measured and not subject to valuation errors, unlike market values. The paper gains and losses resulting from market value changes will never be realized if the bank holds the security until maturity.
• Thus, the changes in market value will not impact the bank’s profitability unless the security is sold prior to maturity.

• If bank balance sheets typically are accounted in book value terms, why be concerned about how interest rates affect the market values of assets and liabilities?
• The solvency of the balance sheet is an important variable to creditors of the bank. If the capital position of the bank decreases to near zero, creditors may not be willing to provide funding for the bank, and the bank may need assistance from the regulators, or may even fail.
• Thus any change in the market value of assets or liabilities that is caused by changes in the level of interest rate changes is of concern to regulators and customers.