CHAPTER 6

ASSET-LIABILITY MANAGEMENT: DETERMINING AND MEASURING INTEREST RATES AND CONTROLLING INTEREST-SENSITIVE AND DURATION GAPS

Goals of This Chapter: The purpose of this chapter is to explore the options bankers have today for dealing with risk – especially the risk of loss due to changing interest rates – and to see how a bank’s management can coordinate the management of its assets with the management of its liabilities in order to achieve the institution’s goals.

Key Topic In This Chapter

- Asset, Liability, and Funds Management
- Market Rates and Interest Rate Risk
- The Goals of Interest Rate Hedging
- Interest Sensitive Gap Management
- Duration Gap Management
- Limitations of Hedging Techniques

Chapter Outline

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   B. Liability Management Strategy
   C. Funds Management Strategy
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B. Change in the Bank’s Net Worth

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VIII. Summary of the Chapter

Concept Checks

6-1. What do the following terms mean: Asset management? Liability management? Funds management?

Asset management refers to a banking strategy where management has control over the allocation of bank assets but believes the bank's sources of funds (principally deposits) are outside its control. Liability management is a strategy of control over bank liabilities by varying interest rates offered on borrowed funds. Funds management combines both asset and liability management approaches into a balanced liquidity management strategy.

6-2. What factors have motivated banks and many of their competitors to develop funds management techniques in recent years?

The necessity to find new sources of funds in the 1970s and the risk management problems encountered with troubled loans and volatile interest rates in the 1970s and 1980s led to the concept of planning and control over both sides of a bank's balance sheet -- the essence of funds management.

6-3. What forces cause interest rates to change? What kinds of risk do bankers and other financial firms face when interest rates change?

Interest rates are determined, not by individual banks, but by the collective borrowing and lending decisions of thousands of participants in the money and capital markets. They are also impacted by changing perceptions of risk by participants in the money and capital markets, especially the risk of borrower default, liquidity risk, price risk, reinvestment risk, inflation risk, term or maturity risk, marketability risk, and call risk.
Bankers can lose income or value no matter which way interest rates go. Rising interest rates can lead to losses on bank security instruments and on fixed-rate loans as the market values of these instruments fall. Falling interest rates will usually result in capital gains on fixed-rate securities and loans but a bank will lose income if it has more rate-sensitive assets than liabilities. Rising interest rates will also cause a loss to bank income if a bank has more rate-sensitive liabilities than rate-sensitive assets.

6-4. What makes it so difficult to correctly forecast interest rate changes?

Interest rates cannot be set by an individual bank or even by a group of banks; they are determined by thousands of investors trading in the credit markets. Moreover, each market rate of interest has multiple components--the risk-free interest rate plus various risk premia. A change in any of these rate components can cause interest rates to change. To consistently forecast market interest rates correctly would require bankers to correctly anticipate changes in the risk-free interest rate and in all rate components. Another important factor is the timing of the changes. To be able to take full advantage of their predictions, they also need to know when the changes will take place.

6-5. What is the yield curve and why is it important for bankers to know about its shape or slope?

The yield curve is a graphical description of the distribution of market interest rates by maturity of financial instrument. The slope of the yield curve determines the spread between long-term and short-term interest rates. In banking most of the long-term rates apply to loans and securities (i.e., bank assets) and most of the short-term interest rates are attached to bank deposits and money market borrowings. Thus, the shape or slope of the yield curve has a profound influence on a bank's net interest margin or spread between asset revenues and liability costs.

6-6. What is it that a bank or other lending institutions wishes to protect from adverse movements in interest rates?

A bank wishes to protect both the value of bank assets and liabilities and the revenues and costs generated by both assets and liabilities from adverse movements in interest rates.

6-7. What is the goal of hedging?

The goal of hedging in banking is to freeze the spread between asset returns and liability costs and to offset declining values on certain assets by profitable transactions so that a target rate of return is assured.

6-8. First National Bank of Bannerville has posted the following financial statement entries:

<table>
<thead>
<tr>
<th>Description</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interest revenues</td>
<td>$63 million</td>
</tr>
<tr>
<td>Interest costs</td>
<td>$42 million</td>
</tr>
<tr>
<td>Total earning assets</td>
<td>$700 million</td>
</tr>
</tbody>
</table>
The bank's net interest margin must be:

\[
\text{Net Interest Margin} = \frac{\text{$63$ mill. - $42$ mill.}}{\text{+$700$ mill.}} = 0.03 \text{ or } 3 \text{ percent}
\]

If interest revenues and interest costs double while earning assets grow by 50 percent, the net interest margin will change as follows:

\[
\frac{(\text{$63$ mill. - $42$ mill.}) \times 2}{\text{+$700$ mill.} \times (1.50)} = 0.04 \text{ or } 4 \text{ percent}
\]

Clearly the net interest margin increases—in this case by one third.

6-9. Can you explain the concept of gap management?

Gap management involves determining the maturity distribution and the repricing schedule for a bank's assets and liabilities. When more assets are subject to repricing or will reach maturity in a given period than liabilities or vice versa, the bank has a GAP and is exposed to loss from adverse interest-rate movements based on the gap's size.

6-10 When is a bank or other financial intermediary asset sensitive? Liability sensitive?

A financial institution is asset sensitive when it has more interest-rate sensitive assets maturing or subject to repricing during a specific time period than rate-sensitive liabilities. A liability sensitive position, in contrast, would find the financial institution having more interest-rate sensitive deposits and other liabilities than rate-sensitive assets for a particular planning period.

6-11. Commerce National Bank reports interest-sensitive assets of $870 million and interest-sensitive liabilities of $625 million during the coming month. Is the bank asset sensitive or liability sensitive? What is likely to happen to the bank’s net interest margin if interest rates rise? If they fall?

Because interest-sensitive assets are larger than liabilities by $245 million the bank is asset sensitive.

If interest rates rise, the bank's net interest margin should rise as asset revenues increase by more than the resulting increase in liability costs. On the other hand, if interest rates fall, the bank's net interest margin will fall as asset revenues decline faster than liability costs.

6-12. Peoples’ Savings Bank has a cumulative gap for the coming year of + $135 million and interest rates are expected to fall by two and a half percentage points. Can you calculate the expected change in net interest income that this thrift institution might experience? What change will occur in net interest income if interest rates rise by one and a quarter percentage points?

\[
\text{Expected Change in } = 135 \text{ million } \times (-0.025) = -3.38 \text{ million}
\]
Net Interest Income

What change will occur in net interest income if interest rates rise by one and a quarter percentage points?

\[
\text{Expected Change in Net Interest Income} = 135 \text{ million} \times (+0.0125) = +1.69 \text{ million}
\]

6-13 How do you measure the dollar interest-sensitive gap? The relative interest-sensitive gap? What is the interest-sensitivity ratio?

The dollar interest-sensitive gap is measured by taking the repriceable (interest-sensitive) assets minus the repriceable (interest-sensitive) liabilities over some set planning period. Common planning periods include 3 months, 6 months and 1 year. The relative interest-sensitive gap is the dollar interest-sensitive gap divided by some measure of bank size (often total assets). The interest-sensitivity ratio is just the ratio of interest-sensitive assets to interest sensitive liabilities. Regardless of which measure you use, the results should be consistent. If you find a positive (negative) gap for dollar interest-sensitive gap, you should also find a positive (negative) relative interest-sensitive gap and an interest sensitivity ratio greater (less) than one.

6-14 Suppose Carroll Bank and Trust reports interest-sensitive assets of $570 million and interest-sensitive liabilities of $685 million. What is the bank’s dollar interest-sensitive gap? Its relative interest-sensitive gap and interest-sensitivity ratio?

\[
\begin{align*}
\text{Dollar Interest-Sensitive Gap} &= \text{Interest-Sensitive Assets} - \text{Interest Sensitive Liabilities} \\
&= 570 - 685 = -115
\end{align*}
\]

\[
\begin{align*}
\text{Relative Gap} &= \frac{\text{IS Gap}}{\text{Bank Size}} = \frac{-115}{570} = -0.2018 \text{ or -20.18 percent}
\end{align*}
\]

\[
\begin{align*}
\text{Interest-Sensitivity Ratio} &= \frac{\text{Interest-Sensitive Assets}}{\text{Interest-Sensitive Liabilities}} = \frac{570}{685} = .8321
\end{align*}
\]

6-15 Explain the concept of weighted interest-sensitive gap. How can this concept aid management in measuring a financial institution’s real interest-sensitive gap risk exposure?

Weighted interest-sensitive gap is based on the idea that not all interest rates change at the same speed. Some are more sensitive than others. Interest rates on bank assets may change more slowly than interest rates on liabilities and both of these may change at a different speed than those interest rates determined in the open market. In, the weighted interest-sensitive gap methodology all interest-sensitive assets and liabilities are given a weight based on their speed (sensitivity) relative to some market interest rate. Fed Funds loans, for example, have an interest rate which is determined in the market and which would have a weight of 1. All other loans, investments and deposits would have a weight based on their speed relative to the Fed Funds
rate. To determine the interest-sensitive gap, the dollar amount of each type of asset or liability would be multiplied by its weight and added to the rest of the interest-sensitive assets or liabilities. Once the weighted total of the assets and liabilities is determined, a weighted interest-sensitive gap can be determined by subtracting the interest-sensitive liabilities from the interest-sensitive assets. This weighted interest-sensitive gap should be more accurate than the unweighted interest-sensitive gap. The interest-sensitive gap may change from negative to positive or vice versa and may change significantly the interest rate strategy pursued by the bank.

6-16. What is *duration*?

Duration is a value-weighted measure of the maturity of a security or other income-generating asset that takes into consideration the amount and timing of all cash flows expected from the asset.

6-17. How is a financial institution’s duration gap determined?

A bank's duration gap is determined by taking the difference between the duration of a bank's assets and the duration of its liabilities. The duration of the bank’s assets can be determined by taking a weighted average of the duration of all of the assets in the bank’s portfolio. The weight is the dollar amount of a particular type of asset out of the total dollar amount of the assets of the bank. The duration of the liabilities can be determined in a similar manner.

6-18. What are the advantages of using duration as an asset-liability management tool as opposed to interest-sensitive gap analysis?

Interest-sensitive gap only looks at the impact of changes in interest rates on the bank’s net income. It does not take into account the effect of interest rate changes on the market value of the bank’s equity capital position. In addition, duration provides a single number which tells the bank their overall exposure to interest rate risk.

6-19. How can you tell you are fully hedged using duration gap analysis?

You are fully hedged when the dollar weighted duration of the assets portfolio of the bank equals the dollar weighted duration of the liability portfolio. This means that the bank has a zero duration gap position when it is fully hedged. Of course, because the bank usually has more assets than liabilities the duration of the liabilities needs to be adjusted by the ratio of total liabilities to total assets to be entirely correct.

6-20. What are the principal limitations of duration gap analysis? Can you think of some ways of reducing the impact of these limitations?

There are several limitations with duration gap analysis. It is often difficult to find assets and liabilities of the same duration to fit into the bank’s portfolio. In addition, some accounts such as deposits and others don’t have well defined patterns of cash flows which makes it difficult to calculate duration for these accounts. Duration is also affected by prepayments by customers as well as default. Finally, duration analysis works best when interest rate changes are small and
short and long term interest rates change by the same amount. If this is not true, duration analysis is not as accurate.

6-21. Suppose that a thrift institution has an average asset duration of 2.5 years and an average liability duration of 3.0 years. If the bank holds total assets of $560 million and total liabilities of $467 million, does it have a significant duration gap? If interest rates rise, what will happen to the value of the bank's net worth?

\[
\text{Duration Gap} = D_A - D_L \times \frac{\text{Liabilities}}{\text{Assets}} = 2.5 \text{ yrs.} - 3.0 \text{ yrs.} \times \frac{\$467 \text{ million}}{\$560 \text{ million}}
\]

\[
= 2.5 \text{ years} - 2.5018 \text{ years}
\]

\[
= -0.018 \text{ years}
\]

This bank has a very slight negative duration gap; so small in fact that we could consider it insignificant. If interest rates rise, the bank's liabilities will fall slightly more in value than its assets, resulting in a small increase in net worth.

6-22. Stilwater Bank and Trust Company has an average asset duration of 3.25 years and an average liability duration of 1.75 years. Its liabilities amount to $485 million, while its assets total $512 million. Suppose that interest rates were 7 percent and then rise to 8 percent. What will happen to the value of the Stilwater Bank's net worth as a result of a decline in interest rates?

First, we need an estimate of Stilwater's duration gap. This is:

\[
\text{Duration Gap} = 3.25 \text{ yrs.} - 1.75 \text{ yrs.} \times \frac{\$485 \text{ mill.}}{\$512 \text{ mill.}} = +1.5923 \text{ years}
\]

Then, the change in net worth if interest rates rise from 7 percent to 8 percent will be:

\[
\text{Change in NW} = \left[\frac{-3.25 \text{ yrs.}}{(1 + .07)} x \$512 \text{ mill.}} - \frac{-1.75 \text{ yrs.}}{(1 + .07)} x \$485 \text{ mill.}}\right]
\]

\[
= $7.62 \text{ million.}
\]

Problems

6-1. A government bond is currently selling for $900 and pays $80 per year in interest for 5 years when it matures. If the redemption value of this bond is $1,000, what is its yield to maturity if purchased today for $900? The yield to maturity equation for this bond would be:

\[
$900 = \frac{\$80}{(1 + \text{YTM})^1} + \frac{\$80}{(1 + \text{YTM})^2} + \frac{\$80}{(1 + \text{YTM})^3} + \frac{\$80}{(1 + \text{YTM})^4} + \frac{\$80}{(1 + \text{YTM})^5} + \frac{\$1,000}{(1 + \text{YTM})^5}
\]
Using a financial calculator or Excel the YTM is determined to be 10.68%.

6-2. Suppose the government bond described in problem 1 above is held for three years and then the thrift institution acquiring the bond decides to sell it at a price of $950. Can you figure out the average annual yield the thrift institution will have earned for its 3-year investment in the bond?

In this instance the yield-to-maturity equation can be modified slightly to find the correct holding-period yield that the bank would earn. Specifically,

$$900 = \frac{80}{(1 + HPY)^1} + \frac{80}{(1 + HPY)^2} + \frac{80}{(1 + HPY)^3} + \frac{950}{(1 + HPY)^3}$$

Using a financial calculator or Excel the HPY is determined to be 10.56%.

6-3. U.S. Treasury bills are available for purchase this week at the following prices (based upon $100 par value) and with the indicated maturities:

a. $97.25, 182 days.

b. $96.50, 270 days.

c. $98.75, 91 days.

The discount rates and equivalent yields to maturity (bond-equivalent or coupon-equivalent yields) on each of these Treasury bills are:

<table>
<thead>
<tr>
<th>Discount Rates</th>
<th>Equivalent Yields to Maturity</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. (\frac{(100 - 97.25)}{100} \times \frac{360}{182}) = 5.44%</td>
<td>(\frac{(100 - 97.25)}{97.25} \times \frac{365}{182}) = 5.67%</td>
</tr>
<tr>
<td>b. (\frac{(100 - 96.50)}{100} \times \frac{360}{270}) = 4.67%</td>
<td>(\frac{(100 - 96.50)}{96.50} \times \frac{365}{270}) = 4.90%</td>
</tr>
<tr>
<td>c. (\frac{(100 - 98.75)}{100} \times \frac{360}{91}) = 4.95%</td>
<td>(\frac{(100 - 98.75)}{98.75} \times \frac{365}{91}) = 5.08%</td>
</tr>
</tbody>
</table>

6-4. The First State Bank of Ashfork reports a net interest margin of 3.25 percent in its most recent financial report with total interest revenues of $88 million and total interest costs of $72 million. What volume of earning assets must the bank hold?

The relevant formula is:

Net Interest Margin = .0325 = \(\frac{\$88 \text{ mil.} - \$72 \text{ mil.}}{\text{Earning Assets}}\)

Then Earning Assets = $492.31 million.
Suppose the bank's interest revenues rise by 8 percent and its interest costs and earning assets increase 10 percent. What will happen to Ash Fork's net interest margin?

Substituting in the correct formula we have:

\[
\text{New Net Interest Margin} = \frac{\$88 \text{ million} (1 + .08) - \$72 \text{ million}(1 + .10)}{\$492.3 \text{ million}(1 + .10)}
\]

\[
= \frac{\$95.04 \text{ million} - \$79.20 \text{ million}}{\$541.53 \text{ million}}
\]

\[= 0.0293 \text{ or 2.93 percent.}\]

6-5. If a bank's net interest margin, which was 2.85 percent, doubles and its total assets, which stood originally at $545 million, rise by 40 percent, what change will occur in the bank's net interest income?

The correct formula is:

\[.0285 \times 2 = \frac{\text{Net Interest Income}}{\$545 \text{ million} \times (1 + .4)}\]

or Net Interest Income = 0.057 * $763 million

\[= \$43.49 \text{ million.}\]

6-6. The cumulative interest-rate gap of Commonwealth Federal Savings and Loan doubles from an initial figure of -$35 million. If market interest rates fall by 25 percent from an initial level of 6 percent, what change will occur in this thrift’s net interest income?

The key formula here is:

\[
\text{Change in the Bank's Net Interest Income} = \text{Change in interest rates (in percentage points)} \times \text{cumulative gap}
\]

\[
= 0.06 \times .25 \times (-$35 \text{ mill.}) \times 2
\]

\[= 1.05\]

Thus, the bank's net interest income will rise by 5 percent.

6-7. Given: Merchants State Bank has recorded the following financial data for the past three years (dollars in millions):

<table>
<thead>
<tr>
<th></th>
<th>Current Year</th>
<th>Previous Year</th>
<th>Two Years Ago</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interest revenues</td>
<td>$57</td>
<td>$56</td>
<td>$55</td>
</tr>
<tr>
<td>Interest expenses</td>
<td>49</td>
<td>42</td>
<td>34</td>
</tr>
<tr>
<td>Loans (Excluding nonperforming)</td>
<td>411</td>
<td>408</td>
<td>406</td>
</tr>
<tr>
<td>Investments</td>
<td>239</td>
<td>197</td>
<td>174</td>
</tr>
</tbody>
</table>
Solution:

Net interest margin (NIM) = Net Interest Income/Earning Assets, where
Net Interest Income = Net Interest Revenues - Net Interest Expenses
Earning Assets = Loans + Investments

NIM (Current) = ($57-49)/(411 + 239) = 8/650 = 0.0123 or 1.23%
NIM (previous) = ($56-42)/(408 + 197) = 14/605 = 0.0231 or 2.31%
NIM (Two years ago) = ($55-34)/(406 + 174) = 21/580 = 0.0362 or 3.62%

The net interest margin has been declining steadily and significantly. Probable causes include greater increases in interest expenses relative to interest income due to shifts in funding mix with greater dependence on borrowed funds (more expensive sources) relative to deposits (less expensive sources). Additionally, the mix in earning assets, with greater growth in lower yielding investment securities than in higher yielding loans, is another contributor to the steadily declining net interest margin.

Management needs to reevaluate its funding strategies and its loan and investment strategies. If slower loan growth is related to external forces -- for example, a weaker economy -- then less borrowing should be considered. If the slower loan growth is more internal, then more aggressive loan management would be appropriate.

6-8   The First National Bank of Wedora, California has the following interest-sensitive gaps:

<table>
<thead>
<tr>
<th></th>
<th>Coming Week</th>
<th>Next 30 Days</th>
<th>Next 31-90 Days</th>
<th>More Than 90 Days</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Interest -</strong></td>
<td>$144</td>
<td>$110</td>
<td>$164</td>
<td>$184</td>
</tr>
<tr>
<td><strong>Sensitive</strong></td>
<td>+29</td>
<td>+19</td>
<td>29</td>
<td>8</td>
</tr>
<tr>
<td><strong>Assets =</strong></td>
<td>$173</td>
<td>$129</td>
<td>$193</td>
<td>$192</td>
</tr>
<tr>
<td><strong>Interest -</strong></td>
<td>$232</td>
<td>$---</td>
<td>$---</td>
<td>$---</td>
</tr>
<tr>
<td><strong>Sensitive</strong></td>
<td>98</td>
<td>84</td>
<td>196</td>
<td>35</td>
</tr>
<tr>
<td><strong>Liabilities =</strong></td>
<td>36</td>
<td>6</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td><strong>GAP</strong></td>
<td>- $193</td>
<td>+ $39</td>
<td>- $3</td>
<td>+ $157</td>
</tr>
<tr>
<td><strong>Cumulative GAP</strong></td>
<td>- $193</td>
<td>- $154</td>
<td>- $157</td>
<td>$0</td>
</tr>
</tbody>
</table>

First National has a cumulative zero gap and therefore is not vulnerable to loss if interest rates rise. It does have a positive gap in two periods—the next 30 days and more than 90 days. During these particular periods a rise in interest rates would produce a short-run gain.
First National Bank of Barnett currently has the following interest-sensitive assets and liabilities on its balance sheet:

<table>
<thead>
<tr>
<th>Interest-Sensitive Assets</th>
<th>Interest-Sensitive Liabilities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Federal fund loans $65</td>
<td>Interest-bearing deposits $185</td>
</tr>
<tr>
<td>Security holdings $42</td>
<td>Money-market borrowings $78</td>
</tr>
<tr>
<td>Loans and leases $230</td>
<td></td>
</tr>
</tbody>
</table>

What is the bank’s current interest-sensitive gap? Suppose its Federal funds loans carry an interest-rate sensitivity weight of 1.0 while its investments have a rate-sensitivity weight of 1.15 and its loans and leases display a rate-sensitivity weight of 1.35. On the liability side First National’s rate-sensitivity weight is 0.79 for interest-bearing deposits and 0.98 for its money-market borrowings. Adjusted for these various interest-rate sensitivity weights, what is the bank’s weighted interest-sensitive gap? Suppose the Federal funds interest rate increases or decreases one percentage point. How will the bank’s net interest income be affected (a) given its current balance sheet make up and (b) reflecting its weighted balance sheet adjusted for the foregoing rate-sensitivity weights?

Solution:

Dollar IS Gap = ISA - ISL = ($65 + $42 + $230) - ($185 + $78) = $337 - $263 = $74

Weighted IS Gap = [(1)($65) + (1.15)(42) + (1.35)(230)] - [(.79)($185) + (.98)($78)]
= $65 + $48.3 + $310.5 - $146.15 + $76.44
= $423.8 - $222.59
= $201.21

a.) Change in Bank’s Income = IS Gap * Change in interest rates
   = ($74) (.01) = $.74 million

Using the regular IS Gap; net income will change by plus or minus $740,000

b.) Change in Bank’s Income = Weighted IS Gap * Change in interest rates
   = ($201.21) (.01) = $2.012

Using the weighted IS Gap; net income will change by plus or minus $2,012,000

Hilltop Savings Association has interest-sensitive assets of $225 million and interest-sensitive liabilities of $168 million. What is the bank’s dollar interest-sensitive gap? What is Hilltop’s relative interest-sensitive gap? What is the value of its interest-sensitivity ratio? Is it asset sensitive or liability sensitive? Under what scenario for market interest rates will Hilltop experience a gain in net interest income? A loss in net interest income?

Dollar Interest-Sensitive Gap = ISA – ISL = $225 - $168 = $57
Relative Interest-Sensitive Gap = \( \frac{\text{ISA} - \text{ISL}}{\text{Bank Size}} = \frac{\$57}{\$225} = 0.2533 \)

Interest-Sensitivity Ratio = \( \frac{\text{ISA}}{\text{ISL}} = \frac{\$225}{\$168} = 1.3393 \)

This bank is asset sensitive. More assets will be repriced during this time period than liabilities. This means that if interest rates rise, the interest earned on assets will rise relative to the interest paid on liabilities and net interest margin will rise. However, if interest rates fall, interest earned on assets will fall more than interest paid on liabilities and net interest margin will fall.

6-11 Casio Merchants and Trust Bank, N.A., has a portfolio of loans and securities expected to generate cash inflows for the bank as follows:

<table>
<thead>
<tr>
<th>Expected Cash Receipts</th>
<th>Period in Which Receipts Are Expected</th>
</tr>
</thead>
<tbody>
<tr>
<td>$1,385,421</td>
<td>Current year</td>
</tr>
<tr>
<td>746,872</td>
<td>Two years from today</td>
</tr>
<tr>
<td>341,555</td>
<td>Three years from today</td>
</tr>
<tr>
<td>62,482</td>
<td>Four years from today</td>
</tr>
<tr>
<td>9,871</td>
<td>Five years from today</td>
</tr>
</tbody>
</table>

Deposits and money market borrowings are expected to require the following cash outflows:

<table>
<thead>
<tr>
<th>Expected Cash Payments</th>
<th>Period in Which Payments Will be Made</th>
</tr>
</thead>
<tbody>
<tr>
<td>$1,427,886</td>
<td>Current year</td>
</tr>
<tr>
<td>831,454</td>
<td>Two years from today</td>
</tr>
<tr>
<td>123,897</td>
<td>Three years from today</td>
</tr>
<tr>
<td>1,005</td>
<td>Four years from today</td>
</tr>
<tr>
<td>-----</td>
<td>Five years from today</td>
</tr>
</tbody>
</table>

If the discount rate applicable to the above cash flows is 8 percent, what is the duration of the bank's portfolio of earning assets and of its deposits and money market borrowings? What will happen to the bank's total returns, assuming all other factors are held constant, if interest rates rise? If interest rates fall? Given the size of the duration gap you have calculated, what type of hedging should the bank engage in? Please be specific about the hedging transactions that are needed and their expected effects.

Solution:

Casio has asset duration of:

\[
\frac{\$1,385,421 \times 1 + \$746,872 \times 2 + \$341,555 \times 3 + \$62,482 \times 4 + \$9,871 \times 5}{(1 + 0.08)^1 \times (1 + 0.08)^2 \times (1 + 0.08)^3 \times (1 + 0.08)^4 \times (1 + 0.08)^5}
\]
\[ \text{DA} = \frac{1,385,421 + 746,872 + 341,555 + 62,482 + 9,871}{(1 + 0.08)^1 (1 + 0.08)^2 (1 + 0.08)^3 (1 + 0.08)^4 (1 + 0.08)^5} \]

= \$3,594,148 / \$2,246,912 = 1.5996 \text{ years} \\

Casio has a liability duration of:

\[ \text{DL} = \frac{1,427,886 \times 1 + 831,454 \times 2 + 123,897 \times 3 + 1,005 \times 4}{(1 + 0.08)^1 (1 + 0.08)^2 (1 + 0.08)^3 (1 + 0.08)^4} \]

= \$3,045,808 / \$2,134,047 = 1.4272 \text{ years} \\

Casio's Duration Gap = Asset Duration - Liability Duration = 1.5996 - 1.4272 = 0.1724 \text{ years}. \\

Because Casio's Asset Duration is greater than its Liability Duration, the bank has a positive duration gap, which means that the bank's total returns will decrease if interest rates rise because the value of the liabilities will decline by less than the value of the assets. On the other hand, if interest rates were to fall, this positive duration gap will result in the bank's total returns increasing. In this case, the value of the assets will rise by a greater amount than the value of the liabilities.

Given the magnitude of the duration gap, the management of Casio Merchants and Trust Bank needs to do a combination of things to close its duration gap between assets and liabilities. It probably needs to try to shorten asset duration, lengthen liability duration, and use financial futures or options to deal with whatever asset-liability gap exists at the moment. The bank may want to consider securitization or selling some of its assets, reinvesting the cash flows in maturities that will more closely match its liabilities' maturities. The bank may also consider negotiating some interest-rate swaps to change the cash flow patterns of its liabilities to more closely match its asset maturities.

6-12. Given the cash inflow and outflow figures in Problem 11 for Casio Merchants and Trust Bank, what would happen to the value of Casio's net worth as a result of this movement in interest rates? If interest rates drop from 8 percent to 7 percent, what happens to Casio's net worth in this case and by how much in dollars does it change?

From Problem #1 we find that Casio's average asset duration is 1.5996 years and average liability duration is 1.4272 years. If total assets are $125 million and total liabilities are $110 million, then Casio has a duration gap of:

\[ \text{Duration Gap} = 1.5996 - 1.4272 \times \frac{\$110 \text{ mill.}}{\$125 \text{ mill.}} \]

= 1.5996 - 1.2559
The change in Casio's net worth would be:

Change in Value of Net Worth = \[-DA \cdot \frac{\Delta r}{(1+r)} \cdot A\] - \[- DL \cdot \frac{\Delta r}{(1+r)} \cdot L\]

If interest rates fall from 8 percent to 7 percent,

\[
\text{Change in NW} = \left[ -1.5996 \times \frac{(-.01)}{(1+.08)} \times \$125 \right] - \left[ -1.4272 \times \frac{(-.01)}{(1+.08)} \times \$110 \text{ mill.} \right]
\]

\[
= +1.8514 - 1.4536
= +0.3978 \text{ million.}
\]

6-13. Leland Thrift Association reports an average asset duration of 4.5 years, an average liability duration of 3.25 years. The bank has total assets of $1.8 billion and liabilities totaling $1.5 billion. If interest rates rise from 7 percent to 9 percent, how will Leland's net worth change? What if interest rates fall from 7 to 5 percent?

The key formula is:

\[\text{Change in net worth} = \left\{-DA \cdot \frac{\Delta r}{(1+r)} \cdot A\right\} - \left\{- DL \cdot \frac{\Delta r}{(1+r)} \cdot L\right\}\]

For the change in interest rates from 7 to 9 percent, Leland's net worth will change to:

\[
\text{Change in Net Worth} = \left[ -4.5 \text{ years} \times \frac{(.02)}{(1+.07)} \times \$1800 \text{ mill.} \right] - \left[ -3.25 \text{ years} \times \frac{(.02)}{(1+.07)} \times \$1500 \text{ mill.} \right]
\]

\[
= -$151.40 \text{ million} + $91.12 \text{ million}
= -$60.28 \text{ million}
\]

On the other hand, if interest rates decline from 7 to 5 percent we have:

\[
\text{Change in Net Worth} = \left[ -4.5 \text{ yrs} \times \frac{(-.02)}{(1+.07)} \times \$1800 \text{ mill.} \right] - \left[ -3.25 \text{ yrs} \times \frac{(-.02)}{(1+.07)} \times \$1500 \text{ mill.} \right]
\]

\[
= +$151.40 \text{ mill.} - $91.12 \text{ mill.}
= +$60.28 \text{ million.}
\]
6-14. A bank holds a bond in its investment portfolio whose duration is 5.5 years. Its current market price is $950. While market interest rates are currently at 8 percent for comparable quality securities, an increase to 10 percent is expected in the coming weeks. What changes (in percentage terms) will the bond’s price experience if market interest rates change as anticipated?

Solution:

\[
\frac{\Delta P}{P} \approx -D_x \cdot \frac{\Delta i}{(1 + i)} = -5.5 \cdot \frac{.02}{(1.08)} = -.1019 \text{ or } -10.19 \text{ percent}
\]

This bond’s price will decrease by 10.19 percent or its price will decline to $853.

6-15. A bank’s dollar weighted asset duration is six years. Its total liabilities amount to $750 million, while its assets total $900 million. What is the dollar-weighted duration of the bank’s liability portfolio if the bank’s duration gap were zero?

Given the bank has a duration gap equal to zero:

\[
\text{Duration Gap} = D_A - D_L \cdot \frac{\text{Total Liabilities}}{\text{Total Assets}}
\]

\[
D_L = (D_A - \text{Duration Gap}) \cdot \frac{\text{Total Assets}}{\text{Total Liabilities}} = (6 - 0) \cdot \frac{\$900}{\$750} = 7.2 \text{ years}
\]
6-16. Commerce National Bank holds assets and liabilities whose average duration and dollar amount are shown as below:

<table>
<thead>
<tr>
<th>Asset and Liability Items</th>
<th>Avg. Duration</th>
<th>Dollar Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Investment-grade bonds</td>
<td>8.0 yrs.</td>
<td>$60 mill.</td>
</tr>
<tr>
<td>Commercial loans</td>
<td>3.6 yrs.</td>
<td>$320 mill.</td>
</tr>
<tr>
<td>Consumer loans</td>
<td>4.5 yrs.</td>
<td>$140 mill.</td>
</tr>
<tr>
<td>Deposits</td>
<td>1.1 yrs.</td>
<td>$490 mill.</td>
</tr>
<tr>
<td>Nondeposit borrowings</td>
<td>0.1 yrs</td>
<td>$20 mill.</td>
</tr>
</tbody>
</table>

What is the dollar-weighted duration of the bank’s asset portfolio and liability portfolio? What is the duration gap?

\[
D_A = 8.0 \text{ yrs.} \times \frac{\$60 \text{ mill.}}{\$520 \text{ mill.}} + 3.6 \text{ yrs.} \times \frac{\$320 \text{ mill.}}{\$520 \text{ mill.}} + 4.5 \text{ yrs.} \times \frac{\$140 \text{ mill.}}{\$520 \text{ mill.}} = 4.35 \text{ years}
\]

\[
D_L = 1.1 \text{ yrs.} \times \frac{\$490}{\$510} + 0.1 \text{ yrs.} \times \frac{\$20}{\$510} = 1.061 \text{ years}
\]

\[
\text{Duration Gap} = D_A - D_L \times \frac{\text{Total Liabilities}}{\text{Total Assets}} = 4.35 \text{ yrs.} - 1.061 \text{ yrs.} \times \frac{\$510}{\$520} = 3.31 \text{ years}
\]

6-17. A government bond currently carries a yield to maturity of 12 percent for a maturity of 5 years and a current market price of $940. The bond pays $100 in annual interest. If the bond has a par value of $1,000 its duration can be found from:

\[
D = \frac{\$100 \times 1 + \$100 \times 2 + \$100 \times 3 + \$100 \times 4 + \$1100 \times 5}{(1+0.12)^1 + (1+0.12)^2 + (1+0.12)^3 + (1+0.12)^4 + (1+0.12)^5} / \$940
\]

\[
= \frac{\$3837.31}{\$928} = 4.08 \text{ years}
\]

6-18. Dewey National Bank holds $15 million in government bonds having duration of 6 years. If interest rates suddenly rise from 6 percent to 7 percent, what percentage change should occur in the bonds’ market price?

The relevant formula is equation is: \((\Delta P/P) = -D \times [\Delta i/(1+i)]\).

We have: \((\Delta P/P) = -6 \text{ years} \times [+.01/(1 + 0.06)]\)

\[= -6 \text{ years} \times 0.009434\]
= -0.0566 or -5.66 percent.

The market price will decrease by 5.66% or the price will change to $14.151 million.