

Chapter 23

Risk Management in Financial Institutions

■ Answers to End-of-Chapter Questions

1. Adverse selection in loan markets requires that lenders screen out the bad credit risks from the good ones so loans are profitable to them. To accomplish effective screening, lenders must collect reliable information from prospective borrowers. Effective screening and information collection together form an important principle of credit risk management. Financial institutions perform background checks on each customer especially on how they obtain their source of income via the Anti-Money Laundering Act (AMLA). Through the AMLA, they can identify any high risk activities which are also illegal that can be detrimental in the long run to the financial institution. There is also software which can detect and identify high risk individuals which is linked to the police.
2. When banks lend to each other they expose their own banks to a lot of high risk transactions. For example, during the global financial crisis of 2007-2009 Bank A which is of high financial standing and the strongest and biggest among other banks in the country lends funds to Bank B which has subprime assets in its portfolio, and during recession, Bank B won't be able to pay back Bank A which results in Bank A being exposed to subprime assets as well. Thus, after the crisis, banks have become more cautious about their lending practices and are less willing to take uncalculated risks.
3. Uncertain. In some cases, raising rates may generate more income and thus increase profits. However, the higher interest rates do increase adverse selection in which the risk-prone borrowers are more likely to seek out the loans. Thus the rate of default might go up and bank profits could suffer.
4. To reduce adverse selection, a banker needs to screen out bad credit risks by learning as much as possible about potential borrowers. Similarly, to minimize moral hazard, the banker must continually monitor borrowers to see that they are complying with restrictive loan covenants. Hence it pays for the banker to be nosy.
5. Compensating balances can act as collateral. They also help establish long-term customer relationships, which make it easier for the bank to collect information about prospective borrowers, thus reducing the adverse selection problem. Compensating balances help the bank monitor the activities of a borrowing firm, so that it can prevent the firm from taking on too much risk, thereby not acting in the interest of the bank.

6. Risk must be diversified at the financial institutions level, and the most difficult is to manage risks within the financial institution itself. Risks cannot be eliminated especially if it is dealing with market risk and as a financial institution, it cannot transfer its risk to customers. Financial institutions also invest their money in other financial institutions or businesses worldwide and they need to diversify accordingly amongst high risk, medium risk and low risk financial instruments in order to reap high returns for their customers. Should the institutions take high risk for the customers then the customer has to pay a high fee for that in line with high risk-high return trade off.

■ Quantitative Problems

1. A bank issues a \$100,000 variable-rate, 30-year mortgage with a nominal annual rate of 4.5%. If the required rate drops to 4.0% after the first six months, what is the impact on the interest income for the first 12 months?

Solution: At 4.5%, the required payment is calculated as:

$$PV = 100,000, I = 4.5/12, N = 360, FV = 0$$

Compute *PMT*. $PMT = 506.685$

If rate remain at 4.5%, the mortgage balance after 12 months is:

$$PMT = 506.685, N = 348, I = 4.5/12, FV = 0$$

Compute *PV*. $PV = 98,386.71$, or \$1,613.29 of the payments went toward principal.

The total payments = $\$506.685 \times 12 = \$6,080.22$.

Interest income for the year is $\$6,080.22 - \$1,613.29 = \$4,466.93$

If rates drop to 4% for the last 6 months of the year:

First, calculate the interest for the first six months:

$$PMT = 506.685, N = 354, I = 4.5/12, FV = 0$$

Compute *PV*. $PV = 99,202.38$, or \$797.62 of the payments went toward principal.

The total payments = $506.685 \times 6 = \$3,040.11$.

Interest income for the year is $\$3,040.11 - \$797.62 = \$2,242.49$ of interest income.

Next, calculate the interest for the last six months:

At 4.0%, the required payment is calculated as:

$$PV = 99,202.38, I = 4.0/12, N = 354, FV = 0$$

Compute *PMT*. $PMT = 477.772$

$$PMT = 477.772, N = 348, I = 4.0/12, FV = 0$$

Compute *PV*. $PV = 98,312.41$, or \$889.97 of the payments went toward principal.

The total payments = $\$477.772 \times 6 = \$2,866.63$.

Interest income for the year is $\$2,866.63 - \$889.97 = \$1,976.66$ of interest income.

Total interest income = $\$2,242.49 + \$1,976.66 = \$4,219.15$

Interest income has fallen by \$247.78, or 5.5%, below what it would have been had the interest rate not fallen.

2. A bank issues a \$150,000 fixed-rate, 35-year mortgage with a nominal annual rate of 5.5%. If the required rate drops to 5.0% immediately after the mortgage is issued, what is the impact on the value of the mortgage?

Solution:

At 5.5%, the required payment is calculated as:

$$PV = 150,000, I = 5.5/12, N = 420, FV = 0$$

Compute *PMT*. $PMT = 805.52$

In a 5.0% market, the value of the mortgage is:

$$PMT = 805.52, I = 5.0/12, N = 420, FV = 0$$

Compute *PV*. $PV = 159,608$.

The value of the mortgage has increased by \$9,608 or 6.405%.

3. Calculate the duration of a \$100,000 fixed-rate, 30-year mortgage with a nominal annual rate of 7.0%. What is the expected percentage change in value if the required rate drops to 6.5% immediately after the mortgage is issued?

Solution: The duration calculation should be completed using a spreadsheet. Although the technique is the same, there are 360 months to handle. Doing this, the duration can be calculated as 10.15 years.

$$\frac{\Delta P}{P} = -\text{Duration} \times \frac{\Delta i}{1+i} = -10.15 \times (-0.005/1.07) = 4.74\%$$

4. The value of a \$200,000 fixed-rate, 35-year mortgage falls to \$179,074 when interest rates move from 10% to 12%. What is the approximate duration of the mortgage?

Solution:

$$\frac{\Delta P}{P} = -\text{Duration} \times \frac{\Delta i}{1+i}, \text{ or } \text{Duration} = -\frac{1+i}{\Delta i} \times \frac{\Delta P}{P}$$

$$\text{Duration} = \frac{-1.1}{0.02} \times \frac{-20,926}{200,000} = 5.75 \text{ years}$$

5. Calculate the duration of a commercial loan. The face value of the loan is \$2,000,000. It requires simple interest yearly, with an APR of 8%. The loan is due in four years. The current market rate for such loans is 8%.

Solution: The annual interest is $0.08 \times \$2,000,000 = \$160,000$

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	160,000	160,000	160,000	2,160,000
2,000,000	148,148	137,174	127,013	1,587,664
3.577097	0.074074	0.137174	0.19052	3.175329

This loan has a duration of 3.57 years.

6. A bank's balance sheet contains interest-sensitive assets of \$560 million and interest-sensitive liabilities of \$930 million. Calculate the income gap.

Solution:

$$\text{GAP} = \$560 - \$930 = -\$370 \text{ million}$$

Another way to state this is the bank has a liability-sensitive gap of \$370 million.

7. Calculate the income gap for a financial institution with rate-sensitive assets of \$40 million and rate-sensitive liabilities of \$96 million. If interest rates rise from 8% to 9.6%, what is the expected change in income?

Solution:

$$\begin{aligned} \text{GAP} &= \text{RSA} - \text{RSL} \\ &= \$40 \text{ million} - \$96 \text{ million} \\ &= -\$56 \text{ million} \\ \Delta I &= -\text{GAP} \times \Delta i \\ &= -\$56 \text{ million} \times 0.016 \\ &= -\$896,000 \end{aligned}$$

8. Calculate the income gap given the following items:

- \$8 million in reserves
- \$25 million in variable-rate mortgages
- \$4 million in checkable deposits
- \$2 million in savings deposits
- \$6 million of 2-year CD's

Solution:

$$\begin{aligned} \text{GAP} &= \text{RSA} - \text{RSL} \\ \text{RSA} &= \$25 \text{ million} \\ \text{RSL} &= \$4 \text{ million} + \$2 \text{ million} = \$6 \text{ million} \\ \text{GAP} &= \$25 \text{ million} - \$6 \text{ million} \\ \text{GAP} &= \$19 \text{ million} \end{aligned}$$

9. The following financial statement is for the current year. From the past, you know that 10% of fixed-rate mortgages prepay each year. You also estimate that 10% of checkable deposits and 20% of savings accounts are rate sensitive.

Second National Bank			
Assets		Liabilities	
Reserves	\$ 1,500,000	Checkable Deposits	\$ 15,000,000
Securities		Money Market Deposits	\$ 5,500,000
< 1 Year	\$ 6,000,000	Savings Accounts	\$ 8,000,000
1 to 2 Years	\$ 8,000,000	CDs	
> 2 years	\$ 12,000,000	Variables-rate	\$ 15,000,000
Residential Mortgages		< 1 Year	\$ 22,000,000
Variables-rate	\$ 7,000,000	1 to 2 Years	\$ 5,000,000
Fixed-rate	\$ 13,000,000	> 2 years	\$ 2,500,000
Commercial Loans		Fed Funds	\$ 5,000,000
< 1 Year	\$ 1,500,000	Borrowings	
1 to 2 Years	\$ 18,500,000	< 1 Year	\$ 12,000,000
> 2 years	\$ 30,000,000	1 to 2 Years	\$ 3,000,000
Buildings, etc.	\$ 2,500,000	> 2 years	\$ 2,000,000
		Bank Capital	\$ 5,000,000
Total	\$100,000,000	Total	\$100,000,000

What is the current Income GAP for Second National Bank? What will happen to the bank's current net interest income if rates fall by 75 basis points?

Solution: $RSA = 6\text{ M} + 7\text{ M} + (0.10 \times 13\text{ M}) + 1.5\text{ M} = \15.8 million

$RSL = (0.10 \times 15\text{ M}) + 5.5\text{ M} + (0.20 \times 8\text{ M}) + 15\text{ M} + 22\text{ M} + 5\text{ M} + 12\text{ M} = \62.6 million

$GAP = \$15.8\text{ million} - \62.6 million

$GAP = -\$46.8\text{ million}$

$\Delta I = -46.8\text{ million} \times (-0.0075)$

$= +\$351,000$

10. Chicago Avenue Bank has the following assets:

Asset	Value	Duration (in years)
T-Bills	\$100,000,000	0.55
Consumer Loans	\$ 40,000,000	2.35
Commercial Loans	\$ 15,000,000	5.90

What is Chicago Avenue Bank's asset portfolio duration?

Solution: Total assets = \$155 M

Asset duration = $0.55 \times (100/155) + 2.35 \times (40/155) + 5.90 \times (15/155) = 1.53\text{ years}$

11. A bank added a bond to its retained portfolio. The bond has a duration of 12.3 years and cost \$1,109. Just after buying the bond, the bank discovered that market interest rates are expected to rise from 8% to 8.75%. What is the expected change in the bond's value?

Solution:

$$\frac{\Delta P}{P} = -\text{Duration} \times \frac{\Delta i}{1+i}$$

$$\Delta P = -12.3 \times \frac{0.0075}{1+0.08} \times \$1,109 = -\$94.73$$

12. Calculate the change in the market value of assets and liabilities when the average duration of assets is 3.60, the average duration of liabilities 0.88, and interest rates increase from 5% to 5.5%.

Solution: Assets:

$$\% \Delta A = -3.60 \times (0.005/1.05) = -1.71\%$$

Liabilities:

$$\% \Delta L = -0.88 \times (0.005/1.05) = -0.42\%$$

13. Springer County Bank has assets totaling \$180 million with a duration of 5 years, and liabilities totaling \$160 million with a duration of 2 years. If interest rates drop from 9% by 75 basis points, what is the change in the bank's capitalization ratio?

Solution: Prior to the rate change, the capitalization ratio = $20/180 = 11.11\%$

The duration gap = $5 - (160/180) \times 2 = 3.22$

Change in equity = $-3.22 \times (-0.0075/1.09) \times \$180 \text{ million} = \$3.988 \text{ million}$

Change in assets = $-5 \times (-0.0075/1.09) \times \$180 \text{ million} = \$6.192 \text{ million}$

New cap ratio = $(20 + 3.988)/(180 + 6.192) = 12.88\%$

14. The manager for Tyler Bank and Trust has the following assets to manage:

Asset	Value	Duration (in years)	Liability	Value	Duration (in years)
Bonds	115,000,000	9.00	Demand Deposits	690,000,000	1.00
Consumer Loans	345,000,000	2.00	Saving Accounts	??	0.50
Commercial Loans	575,000,000	5.00			

If the manager wants a duration gap of 3.00, what level of Saving Accounts should the bank raise? Assume that any difference between assets and liabilities is held as cash (duration = 0).

Solution:

$$DUR_a = (9.00 \times 115/1035) + (2.00 \times 345/1035) + (5.00 \times 575/1035) = 4.44$$

Assume that the Saving Account value = Y .

$$DUR_l = [1.00 \times 690/(690 + Y)] + [0.50 \times Y/(690 + Y)]$$

$$DUR_{\text{gap}} = DUR_a - \left(\frac{L}{A} \times DUR_l \right)$$

$$3.00 = 4.44 - [(690 + Y)/1035] \times [1.00 \times 690/(690 + Y) + 0.50 \times Y/(690 + Y)]$$

$$Y = \$1,600,000,000$$

Solution:

$$DUR_a = (9.00 \times 75/1650) + (2.00 \times 875/1650) + (5.00 \times 700/1650) = 3.59$$

Assume that the Saving Accounts value = Y .

$$DUR_l = [1.00 \times 300/(300 + Y)] + [0.50 \times Y/(300 + Y)]$$

$$DUR_{\text{gap}} = DUR_a - (L/A \times DUR_l)$$

$$3.00 = 3.59 - [(300 + Y)/1650] \times [1.00 \times 300/(300 + Y) + 0.50 \times Y/(300 + Y)]$$

$$Y = 1347$$

15. The following financial statement is for the current year:

Second National Bank					
Assets		Duration	Liabilities		Duration
Reserves	5,000,000	0.00	Checkable Deposits	15,000,000	2.00
Securities			Money Market Deposits	5,000,000	0.10
< 1 Year	5,000,000	0.40	Savings Accounts	15,000,000	1.00
1 to 2 Years	5,000,000	1.60	CDs		
> 2 years	10,000,000	7.00	Variables-rate	10,000,000	0.50
Residential Mortgages			< 1 Year	15,000,000	0.20
Variables-rate	10,000,000	0.50	1 to 2 Years	5,000,000	1.20
Fixed-rate	10,000,000	6.00	> 2 years	5,000,000	2.70
Commercial Loans			Interbank Loans	5,000,000	0.00
< 1 Year	15,000,000	0.70	Borrowings		
1 to 2 Years	10,000,000	1.40	< 1 Year	10,000,000	0.30
> 2 years	25,000,000	4.00	1 to 2 Years	5,000,000	1.30
Buildings, etc.	5,000,000	0.00	> 2 years	5,000,000	3.10
			Bank Capital	5,000,000	
Total	\$100,000,000		Total	\$100,000,000	

Calculate the duration gap for the bank.

Solution:

$$DUR_a = (0.40 \times 0.05) + (1.60 \times 0.05) + (7.00 \times 0.10) + (0.50 \times 0.10) + (6.00 \times 0.10) + (0.70 \times 0.15) + (1.40 \times 0.10) + (4.00 \times 0.25)$$

$$DUR_a = 2.695$$

By the same technique, using total liabilities of 95,000,000,

$$DUR_l = 1.03$$

$$DUR_{\text{gap}} = DUR_a - \left(\frac{L}{A} \times DUR_l \right) = 2.695 - (95/100 \times 1.03) = 1.7165$$

16. Rate sensitive assets increase by \$10 million, so the *GAP* rises by \$10 million to $-\$7.5$ million. If interest rates fall by 3 percentage points, profits rise next year by $\Delta I = GAP \times \Delta i = -\$7.5 \times (-0.03) = + \$0.225$ million = \$225,000.
17. Rate-sensitive assets increase by \$4 million, so *GAP* goes from $-\$17.5$ million to $-\$13.5$ million. (Of the \$5 million of fixed-rate mortgages, \$1 million is rate-sensitive because 20% are repaid within a year, so converting the \$5 million of fixed-rate mortgages into variable-rate mortgages produces a net increase of rate-sensitive assets of \$4 million.) Because *GAP* falls in absolute value, the effect of changes in interest rates on its profits and hence on its interest-rate risk is smaller.
18. She reduces her estimate of rate-sensitive assets by \$1 million (10% of \$10 million) so the *GAP* goes from $-\$17.5$ million to $-\$18.5$ million. If interest rates fall by 2 percentage points, profits next year rise by $\Delta I = GAP \times \Delta i = -\$18.5 \times (-0.02) = + \0.37 million = \$370,000.
19. The manager raises the estimate of rate-sensitive liabilities by \$2.25 million so that *GAP* goes from $-\$17.5$ million to $-\$19.75$ million. Because *GAP* rises in absolute value, the effect of changes in interest rates on its profits and hence its interest-rate risk is larger. If interest rates rise by 5 percentage points, profits next year change by $\Delta I = GAP \times \Delta i = -\$19.75 \text{ million} \times 0.05 = -\0.9875 million.
20. The percentage change in net worth as a percentage of assets is $\% \Delta NW = -DUR_{GAP} \times \Delta i / (1 + i) = -1.72 \times 0.10 / (1 + 0.10) = -0.156 = -15.6\%$. With \$100 million of assets this means net worth declines by \$15.6 million, from \$5 million to $-\$10.6$ million. Since the bank now has negative net worth, it is insolvent and will go out of business.
21. The duration gap is now $DUR_{gap} = DUR_A - (L/A \times DUR_L) = 4 - (95/100 \times 2) = 2.1$ years. The change in net worth as a percentage of assets is $\% \Delta NW = -DUR_{GAP} \times \Delta i / (1 + i) = -2.1 \times 0.02 / (1 + 0.10) = -0.038 = -3.8\%$. With \$100 million of assets, net worth declines by \$3.8 million, from \$5 million to \$1.2 million.
22. It should solve the following equation: $0 = DUR_A - [95/100 \times 2]$. This yields a duration of assets, DUR_A , of 1.9 years.
23. It should solve the following equation: $0 = 4 - (95/100 \times DUR_L)$. This yields a duration of liabilities DUR_L of 4.2 years.
24. Rate-sensitive assets increase by \$5 million so the *GAP* rises by \$5 million to \$17 million. If interest rates fall by 5 percentage points, profits next year change by $\Delta Income = GAP \times \Delta i = \$17 \text{ million} \times (-0.05) = -\$850,000$. Friendly finance could reduce its rate-sensitive assets or increase its rate-sensitive liabilities.
25. Interest-rate risk stays the same because rate-sensitive assets and rate-sensitive liabilities increase by an equal amount, leaving the income gap the same. The Friendly Finance Company still has an income gap of \$12 million, and to eliminate it, it could either reduce its rate-sensitive assets to \$43 million or increase its rate-sensitive liabilities to \$55 million.
26. The percentage change in net worth as a percentage of assets is $\% \Delta NW = -DUR_{GAP} \times \Delta i / (1 + i) = -(-1.33) \times 0.03 / (1 + 0.08) = 0.037 = 3.7\%$. With \$100 million of assets, this means net worth increases by \$5.7 million, from \$10 million to \$15.7 million. Since the bank has an even larger net worth, it is clearly solvent and will certainly stay in business.

27. The duration gap is now $DUR_{GAP} = DUR_A - (L/A \times DUR_L) = 2 - (90/100 \times 4) = -1.6$ years.
The change in net worth as a percentage of assets is $\% \Delta NW = -DUR_{GAP} \times \Delta i / (1 + i) = -(-1.6) \times 0.03 / (1 + 0.08) = 0.044 = 4.4\%$. With \$100 million of assets, net worth increases by \$4.4 million, from \$10 million to \$14.4 million.
28. It should solve the following equation: $0 = DUR_A - [90/100 \times 4]$. This yields a duration of assets, DUR_A , of 3.6 years.
29. It should solve the following equation: $0 = 2 - (90/100 \times DUR_L)$. This yields a duration of liabilities DUR_L of 2.22 years.