AFIN8003 - Workshop 6

Banking and Financial Intermediation

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! Workshop 6: deciding who gets the money

Last week's lecture answered three questions in order: what do we earn if the loan performs, what is the chance it does not, and so do we lend. Today you sit on the committee that has to actually decide.

Plan for the hour:

1. **Part A: Concept check** (about 10 min). Ten questions. Self-mark.
2. **Part B: The AdriaBank Credit Committee** (about 25 min). Three applications, three rounds, one uncomfortable discovery.
3. **Part C: A first look at credit risk modelling** (about 15 min). Where the numbers come from in practice, and a preview of the **group assignment**.
4. **Part D: Take-home practice set.** The full drill. Do these before next week.

Bring a calculator.

1 Part A: Concept check

1. The risk that the borrower is unwilling or unable to fulfil the terms promised under the loan contract is:

   ☐ liquidity risk
   ☐ interest rate risk
   ☐ default risk
   ☐ market risk

2. A loan which is made and taken down immediately is a:

   ☐ syndicated loan
   ☐ loan commitment
   ☐ spot loan
   ☐ secured loan

3. A portion of a loan which a borrower may not use but which must be kept on deposit at the lending institution is a:

   ☐ compensating balance
   ☐ revolving credit line
   ☐ loan commitment
   ☐ minimum reserve requirement

4. The process of restricting the quantity of loans to an individual borrower is:

   ☐ leverage lending
   ☐ covenants

- ☐ using implicit contracts
- ☐ credit rationing

5. A bank's *contractually promised* return on a loan is higher than its *expected* return because the promised return:

   - ☐ excludes origination fees
   - ☐ ignores the probability that the borrower defaults
   - ☐ is measured after tax
   - ☐ assumes the compensating balance is zero

6. Which of the following factors may affect the promised return an FI receives on a loan?

   - ☐ fees relating to the loan
   - ☐ the interest rate on the loan
   - ☐ the credit risk premium on the loan
   - ☐ all of the listed options are correct

7. Which of the following refers to restrictions in bond and loan contracts that either encourage or limit certain actions by the borrower?

   - ☐ mortality rates
   - ☐ RAROC
   - ☐ covenants
   - ☐ credit rationing

8. Credit scoring models include all of the following broad types except:

   - ☐ linear discriminant models
   - ☐ linear probability models
   - ☐ term structure models
   - ☐ logit models

9. According to Altman's credit scoring model, which of the following Z-scores would indicate a high default risk firm?

   - ☐ less than 1.81
   - ☐ between 1 and 1.81
   - ☐ between 1.81 and 2.99
   - ☐ greater than 2.99

10. The logit model is generally preferred to the linear probability model for credit scoring because it:

    - ☐ requires fewer explanatory variables
    - ☐ does not require historical default data
    - ☐ constrains the estimated default probability to lie between 0 and 1
    - ☐ is a discriminant rather than a probability model

11. Under the internal ratings-based (IRB) approach, the three risk parameters that drive the capital calculation for each exposure are:

    - ☐ duration, convexity and yield
    - ☐ probability of default, loss given default and exposure at default
    - ☐ VaR, expected shortfall and stressed VaR
    - ☐ CET1, Tier 1 and Tier 2

12. A borrower is refused a loan even though it offers to pay a higher interest rate than any other applicant. This is best described as:

    - ☐ a covenant
    - ☐ credit rationing
    - ☐ a compensating balance
    - ☐ a loan commitment

2 Part B: The AdriaBank Credit Committee

! AdriaBank: the lending desk

You survived the APRA capital review in Week 3 and the rate decision in Week 4. You have now been moved to the **credit committee**, which meets on Thursdays to approve or decline business loans.

Three applications are on the table this morning. Each wants **$10 million for one year**. AdriaBank's base rate is **6%**, it charges a **0.125%** origination fee on every loan, and its cost of funds is **5%**.

How the game works. Three rounds. In Round 1 you rank the applications *before* you are allowed to see their default probabilities. In Round 2 the probabilities are revealed and you compute what the loans are really worth. In Round 3 you decide what to do about the one you got wrong.

i A note on the reserve requirement

Set $RR = 0$ throughout. Australia has had no reserve requirement since 1999, so the term drops out of the formula here. See the appendix to the Week 6 lecture.

2.1 Round 1: rank them on price alone (5 min)

Here is what the credit committee sees first. Notice what is missing.

	Applicant	Risk premium ϕ	Compensating balance b
A	Harbour Logistics (25-year-old freight firm)	1.5%	5%
B	Ridgeline Manufacturing (mid-size, recently expanded)	4.0%	10%
C	Vertex Nutraceuticals (three-year-old, fast growing)	12.0%	10%

Task. Compute the contractually promised gross return k for each, using

$$1 + k = 1 + \frac{f + (BR + \phi)}{1 - [b(1 - RR)]}$$

Then rank them from most to least attractive, and **write your ranking down before Round 2**.

	A	B	C
k			
Rank			

2.2 Round 2: the credit team reveals the default probabilities (10 min)

	Applicant	k	Probability of default $(1 - p)$
A	Harbour Logistics	8.03%	1%
B	Ridgeline Manufacturing	11.25%	3%
C	Vertex Nutraceuticals	20.14%	22%

Task. Compute the expected return on each loan, assuming no recovery in default:

$$1 + E(r) = p(1 + k)$$

	A	B	C
$E(r)$			
New rank			

Then answer: **which loans clear AdriaBank's 5% cost of funds?**

2.3 Round 3: Vertex comes back (10 min)

Vertex Nutraceuticals is told it has been declined. Its CFO calls back the same afternoon:

> "We will pay an **18% risk premium** instead of 12%. That is a promised return well above anything else on your book. Surely at some price this loan is worth doing?"

Your credit analyst adds one line to the file: *at that rate Vertex will have to take on the riskiest of its three expansion projects to service the debt, and our estimated default probability rises to 35%.*

(a) Recompute k and $E(r)$ under the CFO's offer. Is the bank better off?

(b) So what should the committee do instead? List two things AdriaBank could change about the loan, other than its price, that would make Vertex bankable.

(c) Suppose one of your suggestions in (b) works and cuts Vertex's default probability to 8%, at the original 12% premium. Recompute $E(r)$. Where does Vertex now rank?

3 Part C: A first look at credit risk modelling

> **Why this section exists**
>
> In Part B the default probabilities were handed to you. In a real bank somebody has to **estimate** them from data. That is what your **group assignment** asks you to do.
> This is a short orientation, not the method. The assignment is released in **Week 8**, and **Workshop 7** walks through it in detail.

Under the **internal ratings-based (IRB)** approach, three parameters for each exposure feed a regulatory formula that returns risk-weighted assets:

$$\text{PD, LGD, EAD} \longrightarrow \text{RWA}$$

Term	Name	The question it answers
PD	Probability of default	How likely is this borrower to default within a year?
LGD	Loss given default	If they do default, what fraction do we lose after recovery?
EAD	Exposure at default	How much will be owed at the moment they default?

Multiply the three and you get the **expected loss**, the same quantity you netted off the spread in Part B. The subtle one is EAD. For a fully drawn term loan it is close to today's balance, but for a credit card or an undrawn line it is *higher*, because borrowers draw down what is available to them on the way into trouble.

That RWA is the denominator of the capital ratio you met in Week 3, so how a bank models PD determines how much capital it has to hold.

Estimating PD runs roughly as: **screen the candidate variables, fit a logistic regression, then calibrate the scores into rating grades.** The logit model from the lecture is only the middle step. Below is the first one.

3.1 Micro-exercise: screen the variables (5 min)

A bank has 100,000 loans and eight candidate predictors. The **information value (IV)** of a variable measures how well it separates defaulters from non-defaulters. The rule of thumb is to keep variables with IV ≥ 0.1.

Variable	IV	Variable	IV
EBITDA to debt	1.622	Net profit volatility	0.264
Leverage	1.012	Board size	0.033
Net worth	0.475	CEO tenure	0.012
Net profit margin	0.264	Big 4 auditor	0.001

(a) Which variables survive the screen?

(b) The correlation between *EBITDA to debt* and *leverage* is -0.693. What problem does that create, and which of the two would you drop?

Before Week 8

A full worked implementation, with code and an interactive IRB capital calculator:
https://mingze-gao.com/posts/credit-risk-modelling/
Skim it. We work through it properly in Workshop 7.

4 Part D: Take-home practice set

> **Note**
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> These are for your own practice. Attempt them before next week's workshop and bring anything that does not work out.

4.1 Q1 - Loan returns

Metrobank offers one-year loans with a 9 per cent stated or base rate, charges a 0.25 per cent loan origination fee, imposes a 10 per cent compensating balance requirement and must pay a 6 per cent reserve requirement to the central bank. The loans typically are repaid at maturity.

(a) If the risk premium for a given customer is 2.5 per cent, what is the simple promised interest return on the loan?
(b) What is the contractually promised gross return on the loan per dollar lent?
(c) Which of the fee items has the greatest impact on the gross return?

4.2 Q2 - Expected return and the break-even default rate

AdriaBank is asked to lend \$2 000 000 for one year. Its base rate is 6 per cent, the risk premium for this borrower is 3 per cent, it charges a 0.5 per cent origination fee and requires a 10 per cent compensating balance. There is no reserve requirement. AdriaBank's cost of funds is 5 per cent.

(a) What is the contractually promised gross return on the loan per dollar lent?
(b) If the probability of default is 4 per cent and the bank recovers nothing in default, what is the expected return?
(c) At what default probability does this loan just break even against the bank's cost of funds?
(d) In practice the bank would recover part of the loan. Would the true break-even default probability be higher or lower than your answer to (c)? Explain in one sentence.

4.3 Q3 - Altman's Z-score

Redwood Industries, a listed manufacturer, reports the following (\$ millions):

Item	Amount
Working capital	8
Retained earnings	12
Earnings before interest and taxes	9
Market value of equity	60
Book value of total liabilities	50
Sales	95
Total assets	100

(a) Compute X_1 through X_5 and the Z-score. How would Altman's model classify Redwood?
(b) Suppose the equity market falls and Redwood's market capitalisation halves to \$30 million, with nothing else changing. Recompute Z. What changes about the classification?
(c) Your answer to (b) points to a general weakness of the Z-score model. State it, and give one other weakness.

4.4 Q4 - From log-odds to a default probability

A bank estimates the following logit model on its small business portfolio:

$$\ln\left(\frac{PD}{1-PD}\right) = -5.0 + 1.6\left(\frac{D}{E}\right) - 0.5\left(\frac{S}{A}\right)$$

(a) A borrower has a debt-to-equity ratio of 1.5 and a sales-to-assets ratio of 2.0. Compute its estimated probability of default.
(b) The borrower takes on more debt, raising D/E to 2.5 with S/A unchanged. Recompute the PD.
(c) A classmate says "the coefficient on D/E is 1.6, so a one-unit rise in leverage raises the default probability by 1.6." Explain what is wrong with that statement, using your answers to (a) and (b).

4.5 Q5 - Why not just charge more?

Two firms apply to AdriaBank for identical \$1 million one-year loans. The bank approves the first at 9 per cent and declines the second outright, even though the second firm volunteers to pay 15 per cent.

(a) Explain, using adverse selection and moral hazard, why AdriaBank may be unwilling to lend to the second firm **at any interest rate**.
(b) Sketch the relationship between the interest rate charged and the bank's expected return. Mark the rate that maximises expected return.
(c) Name two mechanisms, other than the interest rate, that AdriaBank could use to make the second firm bankable.

4.6 Challenge question

In Round 3 of the Credit Committee, raising the risk premium from 12 per cent to 18 per cent lowered the expected return because the default probability rose with it.

Suppose the relationship is linear over the relevant range: $(1-p) = \alpha + \beta k$, where $\alpha = -0.10$ and $\beta = 1.6$.

(a) Write the bank's expected return $E(r)$ as a function of k alone.
(b) Find the rate k^* that maximises $E(r)$, and the expected return at that rate.
(c) The bank's cost of funds is 5 per cent. What is the highest cost of funds at which this borrower is still worth lending to?