Risk management in banks

Econ 4335 Lecture 13

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Types of risk

- Credit risk (default)
- Liquidity risk
- Interest rate risk
- Exchange rate risk
- Market risk
- Counterparty risk
- Operational risk

Mitigating risks

- Risk pricing
- Diversification
- Hedging
- Risk measurement
- Good procedures

The expected cost of default

Consider a marketable loan (e.g. a bond)

- Promised repayments: $C_1, C_2, ..., C_n$ at $t_1, t_2, ... t_n$
- Risk-free interest rate: r, continuous compounding

Value if all repayments on time:

$$P_0 = \sum_{k=1}^{n} C_k e^{-rt_k} \tag{1}$$

Value of loan to risk-neutral investors when positive probability of default:

$$P_N = \sum_{k=1}^{n} E[C_k] e^{-rt_k} \tag{2}$$

Expected cost of default: $P_0 - P_N$.

The yield to maturity

The yield to maturity is the rate of interest that the buyer of a loan implicitly gets if there is no default.

If the loan above is sold for the price P, the yield to maturity R is defined by

$$\sum_{k=1}^{n} C_k e^{-Rt_k} = P \tag{3}$$

If the market is dominated by risk-neutral investors, $P = P_N$ and

$$\sum_{k=1}^{n} C_k e^{-Rt_k} = \sum_{k=1}^{n} E[C_k] e^{-rt_k} = P_N \tag{4}$$

- The credit spread is defined as $s = R - r$.
- Alternative measure of credit risk
- Measure of expected cost of default when investors are risk neutral

Application to banking

- Marginal funding rate replaces the risk-free interest rate
- Risk-neutral bank in a competitive environment then sets repayments that make $P_N = L$.
- The yield to maturity on the loan is then R.

Example

All repayments made in period n. Probability of no default in period n is p_n. No recovery if default. The banks sets the C_n that satisfies

$$P_N = p_n C_n e^{-rn} = L$$

The return to maturity is given by

$$C_n e^{-Rn} = P_N = L$$

Solution: $C_n = Le^{rn}/p_n = Le^{Rn}$, $R = r - (1/n) \ln p_n$

The spread

$$s = R - r \tag{5}$$

- depends positively on default probabilities
- depends negatively on recovery rate
- depends in complicated way on time path of cash flow and default probabilities
- if the probability of default per unit of time is constant, λ (Poisson process) and the recovery rate is zero, $s = \lambda$

- Higher spread for borrowers with high debt-to-asset ratios
- Higher spreads for borrowers with more risky assets or incomes

The spread

- Banks with pricing power will add a profit margin
- Should risk-averse banks add a risk premium?

A digression on accounting

- Default probabilities often start low and increase as the loan matures
- In the beginning the spread is usually more than enough to cover actual losses
- Loan loss provisions are usually not made before a loss is more likely than not (either on an individual loan or a group of loans)
- Fast growing banks tend to show high profits to begin with
- Their accounts may exaggerate their solidity
- Reform proposal: Use spread to make provisions in advance

Another digression on accounting

Spread on bonds sometimes exceed default probabilities by a wide margin

- In many bond market liquidity is low
- Statutory regulations severely limits demand for bonds that are rated beyond a certain levels
- Bond markets sometimes freeze
- Market prices reflect forced sales ("fire sales")
- Value on the basis of "hold to maturity" or market price?

Back to banks' management of credit risk

Suppose

- large number of small borrowers
- default probabilities for the individual borrowers are independent
- the spread is set to cover expected default loss
- loan loss provisions properly reflect the spread and expected losses

Conclusion

- no reason for a risk-averse bank to charge more for the loan
- no need to keep equity in order to offset loan losses.

Or: What about model and statistical uncertainty?

Why equity is needed

- Some borrowers are large
- Losses are highly correlated
- Specialized banks
- Accounts do not always reflect all expected losses

The Basel accords

- Old approach: Minimum capital requirement relative to total liabilities
- Basel I, 1988: Capital requirement 8 per cent of risk-weighted assets.
  - Four different risk weight depending on type of borrower, collateral and maturity
  - Range from 0.0 for OECD-states, via 0.2 for OECD banks, 0.5 for residential mortgages (below 100 per cent), to 100 for loans to businesses
  - Some off-balance sheet items included
- Basel II
  - Banks may use their own risk models to produce weights
  - More types of risk included (market risk)

The Basel accords

Capital requirements can be satisfied with equity, subordinated loans or hybrid capital.

- Tier 1: Minimum 4 per cent. Equity and some hybrids
- Tier 2: Other hybrids and subordinated loans.

Detailed rules differ from country to country.

Capital adequacy rules are supplemented by limits on credits to single customers.

Academic criticism of Basel I

- The risk weights do not represent the actual risks well
- It is macro risk factors that matter, not individual risks
- Fixed weights can never represent more than one macro risk factor well (F&R8.1.3)

The demand for reserves

The bank's expected profits

$$\Pi(R) = r_L(D - R) + rR - r_p E[max(0, \tilde{x} - R)] - r_D D \qquad (6)$$

- R = level of reserves
- r = interest rate on reserves
- r_p = penalty interest rate
- x = net withdrawals

Cost of liquidity shortages

$$C(R) = E[max(0, \tilde{x} - R)] = r_p \int_R^D (x - R) f(x) dx \qquad (7)$$

$$C'(R) = -r_p \int_R^D f(x) dx = -r_p Pr[\tilde{x} \geq R] < 0 \qquad (8)$$

$$C''(R) = r_p f(R) \geq 0 \qquad (9)$$

$C(R)$ decreasing and convex

Choice of R

$$\Pi(R) = r_L(D - R) + rR - C(R) - r_D D \tag{10}$$

First order condition for R

$$-r_L + r - C'(R) = 0$$

$$Pr[\tilde{x} \geq R] = \frac{r_L - r}{r_p} \tag{11}$$

Probability of borrowing at penalty rate equals liquidity premium $r_L - r$ over penalty rate r_p

Marginal costs and benefits

Insert $R = D - L$ in definition of profits:

$$\Pi = r_L(L) + r(D - L) - C(D - L) - r_D D \tag{12}$$

Marginal cost of loans / Marginal benefit from deposits

$$r - C'(D - L) = r + r_p Pr[\tilde{x} \geq R] \tag{13}$$

- Charge more for loans and pay more for deposits
- Marginal costs and gains falls with $D - L$
- Can be incorporated in monopolistic bank model

Liquidity management in practice

- Wholesale deposits more volatile
- Reserves mainly in interbank market
- Premium on longer interbank loans
- Prudent banks who borrow a lot in interbank market must also have deposits there or unused credit lines
- Longer term interbank loans carry a liquidity premium

Interest rate risk

Interest rate risk can in principle be avoided by two methods

- floating interest rates on all deposits and loans
- every loan with fixed interest rate is financed with fixed interest rate bonds or time deposit with the same duration

Reason that banks assume interest rate risk:

- Depositors prefer more liquid deposits
- Deposit financing is cheaper than bond financing
- Some borrowers are willing to pay more for fixed-rate loans

Reserves will be needed