Lending

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Recall interest rate equation from NK model

$$i_t = r_t^n + \phi_\pi \pi_t + \phi_x x_t \tag{1}$$

i_t is a specific interest rate

- Short-term risk-free overnight rate that banks charge each other
- Quite different from consumer interest rates

To understand consumer interest rates need to understand risk involved with consumer lending.

Will focus on three aspects

1. Default risk and collateral
2. Credit rationing by banks
3. Sovereign default

Suppose investor can choose between following two assets

1. Risk-free bond with interest rate r
2. Loan with interest rate R and probability of default p
   - Return of R with probability $1 - p$
   - Return of -1 (losing all your money) with probability p

Expected return on loan

$$R - Rp - p \tag{2}$$
$$R - p$$

For same expected return, interest rate needs to be

$$R - p = r \tag{3}$$
$$R = r + p$$

If loan comes with collateral, default implies return

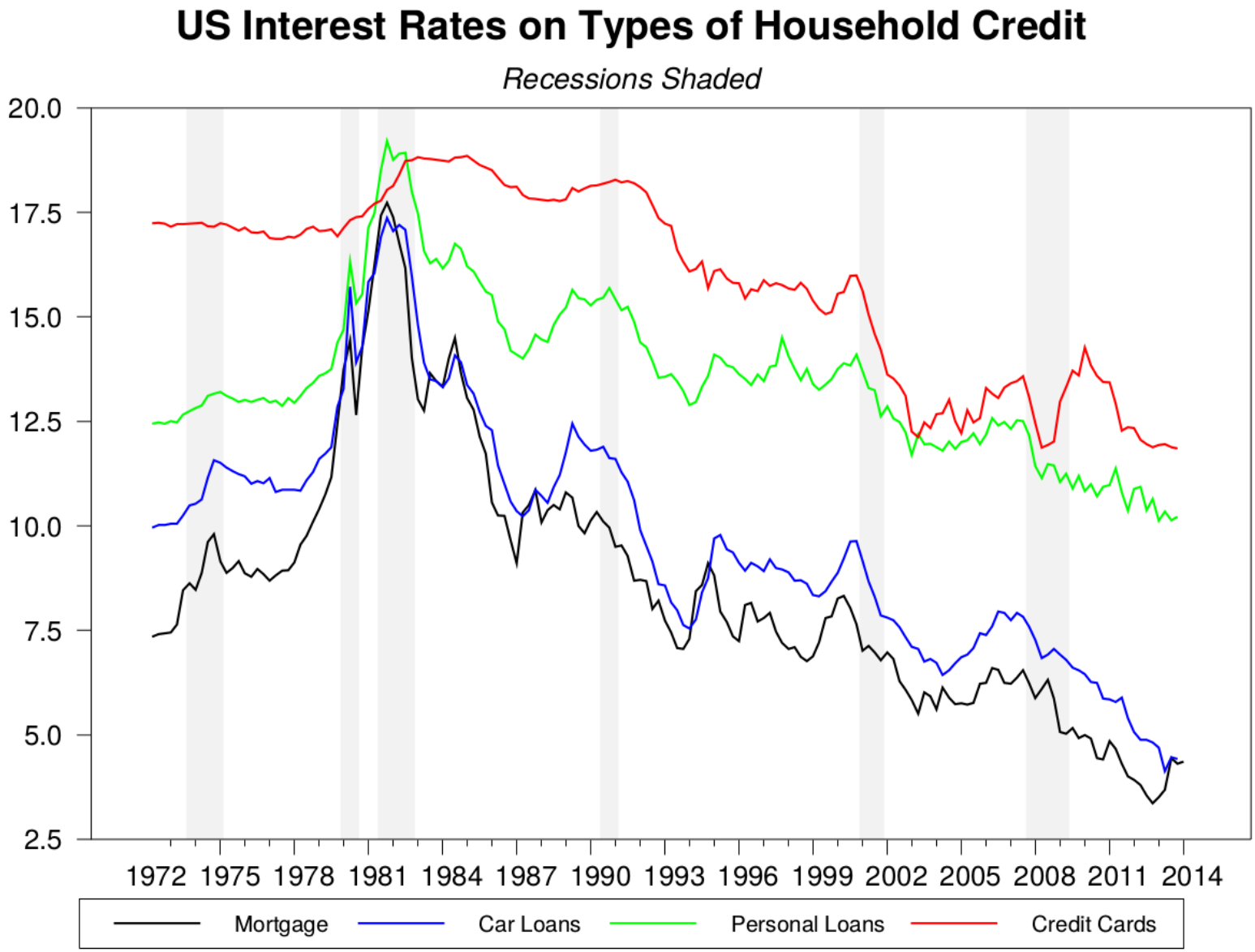
$$c - 1 < 0 \tag{4}$$

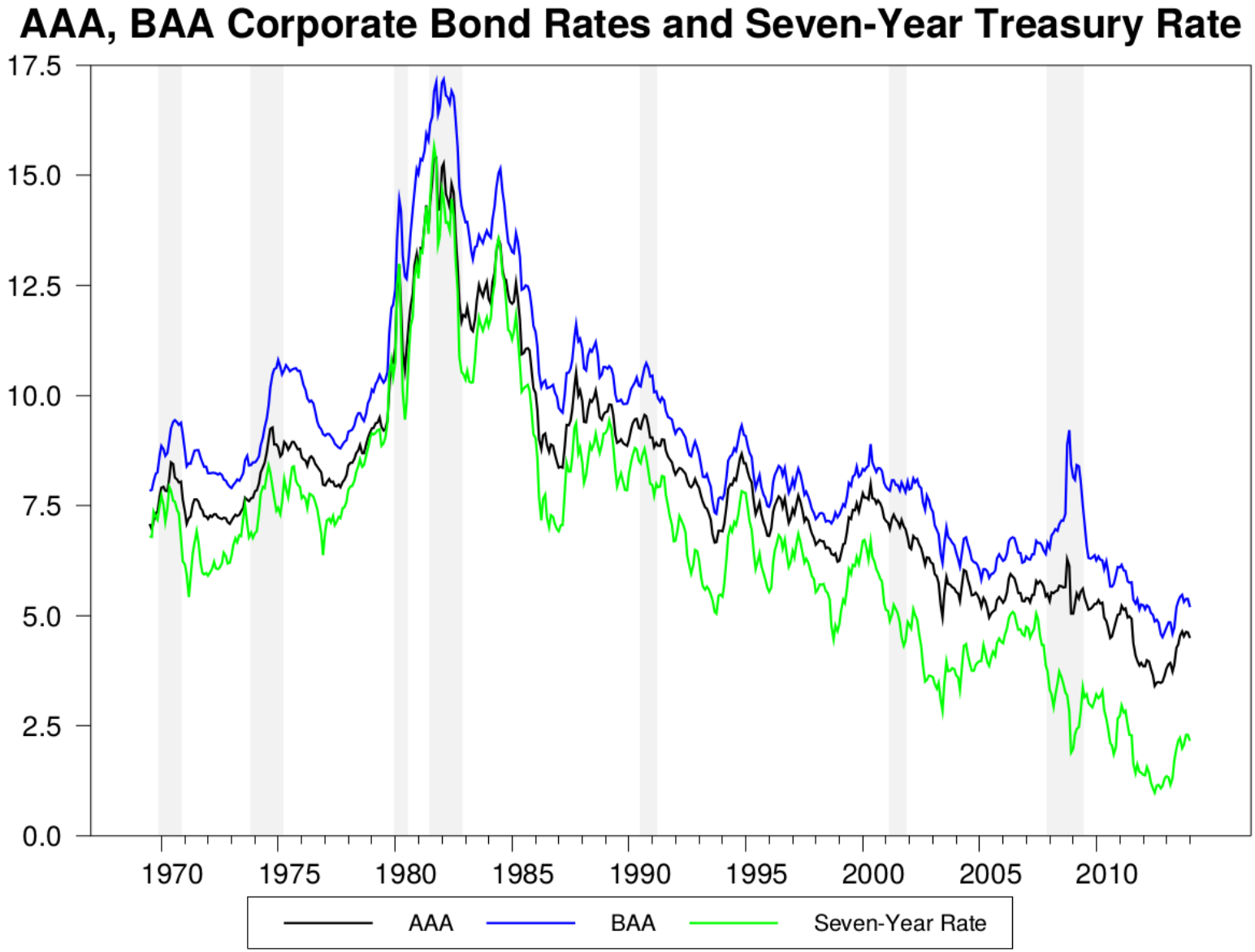
We get

$$R = r + (1 - c)p \tag{5}$$

This entails that

1. Collateralised loans have lower interest rates
2. Interest rate depends on type of collateral


US Interest Rates on Types of Household Credit
Recessions Shaded
20.0
17.5
15.0
12.5
10.0
7.5
5.0
2.5
1972 1975 1978 1981 1984 1987 1990 1993 1996 1999 2002 2005 2008 2011 2014
Mortgage
Car Loans
Personal Loans
Credit Cards


AAA, BAA Corporate Bond Rates and Seven-Year Treasury Rate
17.5
15.0
12.5
10.0
7.5
5.0
2.5
0.0
1970
1975
1980
1985
1990
1995
2000
2005
2010
AAA
BAA
Seven-Year Rate

Concerning default risk and collateral

1. Interest rate is affected by the value of the collateral
2. Value of assets fluctuate with the state of the economy

Suggests mechanism by which financial sector can propagate business cycle shocks: **financial accelerator**

- shock that produces a recession will lead to higher interest rate spreads for borrowers which will worsen the recession.

Bernanke & Gertler (1989)
Aggregated demand is given by

$$y_t = \frac{C}{Y} c_t + \frac{I}{Y} inv_t + \frac{G}{Y} g_t + \frac{C^e}{Y} c_t^e + ... \tag{6}$$

$$c_t = -\sigma r_{t+1} + E_t c_{t+1} \tag{7}$$

$$c_t^e = \frac{1-\phi}{\phi} n_{t+1} \tag{8}$$

$$q_t = \phi(i_t - k_t) \tag{9}$$

$$E_t r_{kt+1} = (1-\rho) E_t(p_{wt+1} - p_{t-1} + y_{t-1} - k_{t+1}) + \rho E_t q_{t+1} - q_t \tag{10}$$

$$E_t r_{kt+1} - r_{t+1} = -v(n_t - q_t - k_{t+1}) \tag{11}$$

And aggregate supply is given by

$$y_t = a_t + \alpha k_t + (1 - \alpha) l_t \tag{12}$$

$$y_t - l_t = \mu_t + \gamma_l l_t + c_t \tag{13}$$

$$\pi_t = \kappa(p_{wt} - p_t) + \beta E_t \pi_{t+1} \tag{14}$$

The evolution of the state variable is described by

$$k_{t+1} = \delta inv_t + (1 - \delta)k_t \tag{15}$$

$$n_t = \frac{\theta RK}{N}[r_t^k - r_t] + \theta R(r_t + n_{t-1}) \tag{16}$$

$$r_t = i_{t-1} - \pi_{t-1} \tag{17}$$

And finally the monetary policy rule is given by

$$i_t = \rho i_{t-1} + (1-\rho)[\gamma_\pi \pi_t + \gamma_y (y_t - y_t^n)] + \epsilon_t^{rn} \tag{18}$$

$$i_t = r_{t+1} - E_t \pi_{t+1} \tag{19}$$

Borrowers with higher risk pay higher interest rates.

- Assumption: for each risk level, someone willing to lend at high enough rates
- Credit suppliers can refuse to make a loan, rather than trying to balance the loss by raising the interest rate.

This is called **credit rationing**

> *Lenders provide a smaller amount of loans than is demanded at the market interest rate.*

Credit rationing can be quite severe, turning down credit-worthy borrowers The problem here is that there is asymmetric information due to the fact that

- Banks can't always tell good borrowers from bad
- From bank's point of view borrowers worsen as interest rates increase

Issue of information asymmetry

Stiglitz & Weiss (1981); Suppose number of borrowers each with a project to undertake

1. All borrowers look to borrow B and put up collateral C
2. Projects deliver a sum of R
3. Interest rate on bank loans r is determined endogenously

Return R is uncertain

- Outcome distribution varies across borrowers

Return distribution type θ borrowers

$$f(R, \theta) \tag{20}$$

Distribution mean identical across borrowers, but greater θ values correspond to greater riskiness

- High values of θ induce a mean-preserving spread in the distribution of projected payoffs
- Borrowers are observably identical to banks: don't observe an individual's value of θ

Mechanism: bank sets r which might affect risk of loan through

1. **Adverse selection**: Sorting potential borrowers
2. **Moral hazard**: Affecting the actions of the borrowers

Default occurs when

$$C + R \leq B(1 + r) \tag{21}$$

where B being the amount borrowed, and C the collateral.

Return to firm $\pi(R, r)$ given by

$$\pi(R, r) = Max(R - (1 + r)B; -C) \tag{22}$$

Return to the bank can be written as

$$\rho(R, r) = min(R + C; B(1 + r)) \tag{23}$$

The worst a firm can do is default on the loan and lose the collateral when the project has a bad return

- After that the return increases one for one with outcome R
- Return depends negatively on borrowing rate r
- Not all firms decide to go ahead and borrow as not all firms have a positive expected value.

Firm borrows if

$$\mathbb{E}[\pi(R, r)] = \int_0^\infty \pi(R, r) f(R, \theta) dR > 0 \tag{24}$$

Main question is how

$$\mathbb{E}[\pi(R, r)] \tag{25}$$

varies with type θ

Borrower pool: Decide to borrow if

$$\theta > \hat{\theta}(r) \tag{26}$$

From utility theory;

- If $U(C)$ is concave: mean-preserving spread in C distribution reduces expected utility because people are risk averse

In this case outcome is a convex function of R, so more uncertainty increases the expected return.

- Bad case:outcome still C but increased risk raises the chance of a really good outcome.

How does r increase affect loan demand?

- Project returns depend negatively on r: increase in r reduces everyone's expected project returns
- Expected project returns depend positively on θ: some firms still have positive expected value for going ahead with borrowing and doing the project
- Increase in r raises the cut-off $\hat{\theta}(r)$ for potential borrowers

Interest rate increases; borrowers pool changes consisting of more risky project (adverse selection)

- Moral hazard problem: risk-neutral investors prefer project with higher bankruptcy probability

Bank pay off given by

$$Min(R + C; (1 + r)B) \tag{27}$$

If bank knows it is lending to type θ; expected return

$$\rho(\theta, r) = \int_0^{\infty} [Min(R + C; (1 + r)B)] f(R, \theta) dR \tag{28}$$

Bank's pay off concave function of R: increases in θ reduces bank's expected return.

1. Best case: bank gets principal and interest
2. Worst case: only get collateral

More risk is bad, but bank cannot tell if borrowers is risky

- Expected payoff can be calculated averaging across all types that look for loans at interest rate r

$$\mathbb{E}[\rho(\theta, r)] = \frac{\int_{\hat{\theta}(r)}^{\infty} \rho(\theta, r) dG(\theta)}{1 - G(\hat{\theta})} \tag{29}$$

r increase has two effects on bank's pay off

1. +ve: higher interest revenues from each project that pays off
2. -ve: adverse selection.

At some point second effect dominates: bank profits rise as the interest rate goes up, reach a maximum and then decline

Assume there are only two types of borrowers, low and high risk. Profits drop at the point where the low-risk types drop out. Extended to a continuous number of types, this implies a particular interest rate r^*, which is consistent with a maximum level of profits. We assume that loan supply depends positively on the expected pay off. Note however, that banks can't simply choose the interest rate r^*, simply because they'd like this outcome. If there isn't sufficient demand to meet this supply, then this can't be an equilibrium: Banks would be chasing customers offering them r^* and lots of people would be turning them down.

Equilibrium outcome determined by supply/demand interaction

1. Low loan demand
   - Loan demand curve intersects loan supply curve below r^*.
   - Market functions normally: all who request a loan receive one
2. High loan demand
   - Loan demand and supply curves do not intersect: bank pick optimal interest rate r^*
   - Credit rationing: More demand than banks are willing to supply

Sovereign defaults (textitincomplete list):

Early 1800s: number of countries after the Napoleonic Wars, e.g. Denmark, France, the Netherlands, and Sweden
1875: Ottoman Empire
1932: Germany
1982: Mexico
1998: Russia
2006: Zimbabwe
1982, 1989, 2001: Argentina
1826, 1843, 1860, 1894, 1932, 2015: Greece

figure

Consider country has $P(default) = 0.1$ over next year; leading to 50% default on outstanding debt

- Country needs to pay 5% premium on debt relative to safe assets

Premium imposes additional burden on government

- Interest costs rise above the funds that country can access to pay off the interest payments
- Alternatively the country's GDP could expand in order to keep debt stable

Market for government bonds might cease to operate as the country is deemed not credit-worthy: risk goes from unlikely to likely

- Closing of a bond market is an rare and abrupt events: People often don't see it coming

After a default a country needs to restructure it debt which often involves writing off part of it, in order to restore the debt level to a more sustainable level.

Two types of banking relevant to today's financial system

1. Clearing house banks
2. Fractional reserve banking

Why are financial intermediaries useful?

1. Pooling savings
2. Risk diversification
3. Maturity transformation
4. Information processing

Suppose that one business day the following transactions occur

- Bank A's depositors have accounts credited with EUR 10 million from Bank B's depositors
- Bank B's depositors will be credited with EUR 9 million from Bank A's depositors

Total transfers: EUR 19 million

1. Have couriers transfer money back and forth
2. Settle account at end of the business day

Clearing house bank

- Clearing house will order transfer of EUR 1 million from Bank B to Bank A
- More efficiently: Deduct EUR 1 million from ledger entry for Bank B's account, add it to Bank A's
- All deposits still fully backed by the cash in the vaults

Forerunner of today's central banks

Most of time only small small fraction of bank's total deposits will be demanded on any given time

- "most" being important qualifier here

i.e. not all cash has to be in the vault in order to back up the deposits

- Some of it can be used for loans while keeping some cash reserves to deal with day-today demand.

This practice is called **fractional reserve banking**

Some advantages of fractional reserve banking

1. Saves depository money: banks can charge interest on loans
2. Banks serve as an intermediary

Disadvantage of fractional reserve banking is risk of bank run

- Bank supposed to have assets greater than liabilities owed to non-investors(positive bank capital)
- It could be the case that the bank makes loans to borrowers who default
- When customers suspect that the bank does not have the assets to pay back money they might want to have their money back
- This could lead to a run on the bank: many depositors want their money back.
- Many banks are unable to cope with bank runs

Potential for instability due to maturity mismatch

- People who supply funds want to have it available for return at shorter terms than the people who the bank lends the money to

Bank's balance sheet lists assets and liabilities

- Liabilities: sources of the bank's funds
- Assets: uses of said funds

Some risks of assets

- Borrowers don't pay back loans
- Bad investments are sometimes made in stocks and bonds
- Other assets invested in lose much of their value

Might result in negative equity capital

- Assets go below what it owes to depositors and bond-holders
- Might trigger bank run when bank is suspected to be insolvent

Some recent bank runs

2001: Bank run in Argentina during economic crisis (1999-2002)
2007: Northern Rock, UK
2009: DSB Bank, the Netherlands
2015: Bank runs in Greece and Cyprus

Couple of things happen during a bank run

1. Banks starts paying off depositors; selling off most liquid assets: e.g. cash, excess reserves at central bank, etc.
2. Bank sells non-liquid assets: long-term customer loans, property assets: fire sale

Bank runs often triggered by - assumed- insolvency of bank: makes make more insolvent

- Bank run can be triggered by just rumours
- Banks and governments are always quick to declare that the banks are fully solvent
- Main concern of bank run is contagion risk

Table: Stylised bank balance sheet

Assets (use of funds)	Liabilities (source of funds)
Loans	Deposits
Securities	Other borrowings
Cash and reserves	Equity capital

Banking crisis likely leads to credit squeeze

$$\begin{aligned} \textit{Loans} = \textit{Deposits} + \textit{Other Borrowings} + \textit{Equity Capital} \\ - \textit{Cash and reserves} - \textit{Securities} \end{aligned}$$

1. Loans
   - Hard for bank to call in loans
   - When loan is paid off, bank will keep funds as cash, reserves, or invest in securities
   - Or pay off deposit outflows or maturing bond liabilities
   - Don't make new loans
2. Deposits
   - Customers prefer to keep cash at home
   - Banks will have less funds to loan
3. Other borrowings
   - Bond markets/other fund providers likely reluctant to lend to banks, worrying they might fail
4. Cash and reserves
   - Large amounts of cash and reserves will be kept on balance sheet
   - Needed to survive a potential bank run
5. Securities
   - Banks will prefer to shift towards securities that can be quickly sold to raise cash

Credit crunch result of behaviour of bank and customers

- Bank no longer in position to lend: financial intermediation breaks down

Banking crisis can lead to severe recession

Modern banking system has number of features that make crisis difficult to deal with

- Non-deposit funding
- Interbank linkages
- Financial assets and negative feedbacks

In addition there is a incentive problem

- From risk-averse moneylenders to risk-loving gamblers

1. High leverage (little equity capital relative to assets)
2. Many risky investments
3. Too much short-term non-deposit funding
4. Are too big

Imagine investment group starts a bank with starting capital of EUR 10 million:

- EUR 1 million on a retail branch network
- Offer 1% interest rate on deposits: attracts EUR 50 million
- EUR 50 million to make loans: interest rate of 5%
- EUR 9 million in cash and reserves

Table: Balance sheet

Assets (use of funds)		Liabilities (source of funds)	
Loans	50	Deposits	50
Branch network building	1	Equity capital	10
Cash and reserves	9		
Total	60		60

1. Revenues
   - Interest income from yloans: 5% of your EUR 50 million
   - Fees charged: EUR 1 million
2. Costs
   - Interest on deposits: EUR 0.5 million
   - Running costs: EUR 1.5 million

Table: Income statement

Revenues		Costs	
Interest income	2.5	Interest paid	0.5
Fees	1	Running costs	1.5
Total	3.5		2

Bank got an investment of EUR 10 million and made a profit of EUR 1.5 million giving a Return on Equity of 15%: Try to expand business

- EUR 0.5 million is paid back to investors in dividends
- EUR 1 million is used to make more loans
- EUR 20 million is issued in debt securities to raise funds to make additional loans

Table: Balance sheet after expanding the business

Assets (use of funds)		Liabilities (source of funds)	
Loans	71	Deposits	50
Branch network building	1	Equity capital	11
Cash and reserves	9	Debt securities	20
Total	81		81

The goal of bank is to expand, but there is one small problem: some people don't pay back their loans. Suppose that of the EUR 21 million that used for new loans EUR 5 million went to a slightly narcissistic real estate developer who went bankrupt.

Table: Balance sheet after expanding the business

Assets (use of funds)		Liabilities (source of funds)	
Loans	66	Deposits	50
Branch network building	1	Equity capital	6
Cash and reserves	9	Debt securities	20
Total	76		6

Can see that the assets exceed deposits and debts by only EUR 6 million. There are a couple of points worth mentioning here.

1. Equity capital is risky; one bad loan removes a fair chunk
2. Investors will get paid dividends when there is a profit, but they are the first to lose money when there is a bad loan
3. Depositors and debt-holders have first claim to getting their money back

The main lesson here is that the bank needs to be very cautious in assessing the credit risk of a loan.

Having established some of the risks faced by a bank, we now move on to analyse how size matters in this respect. Again, suppose that a banks starts with an equity capital of EUR 10 million does the following

- Pays 2% on deposits
- Charges 3% on loans
- Has a 10% of deposits reserve requirements

We will consider two cases here in terms of raising funds

1. Conservative
   - EUR 90 million is raised in deposits
2. Aggressive
   - EUR 90 million is raised in deposits
   - EUR 100 million borrowed from international money markets (2% interest rate)

Table: Balance sheet starting with EUR 100 million

Assets (use of funds)		Liabilities (source of funds)	
Loans	91	Deposits	90
Cash and reserves	9	Equity capital	10
Total	100		100

Table: Balance sheet starting with EUR 200 million

Assets (use of funds)		Liabilities (source of funds)	
Loans	191	Deposits	90
Cash and reserves	9	Equity capital	10
		Borrowings	100
Total	200		200

Using a more conservative approach in fund raising the profits of the bank will be

$$\begin{aligned} \Pi &= 3\% * 91 - 2\% * 90 \\ &= 2.73 - 1.8 = 0.93 \\ RoE &= 9.3\% \end{aligned}$$

With a more aggressive approach, where the bank borrows money on the international market, the profits will be

$$\begin{aligned} \Pi &= 3\% * 191 - 2\% * 190 \\ &= 5.73 - 3.82 = 1.91 \\ RoE &= 19.1\% \end{aligned}$$

Important to note is that the larger bank has a capital to assets ratio which is lower while the profits are higher, and thus also has a higher return to equity. Highly-leveraged banks make larger profits, but they also take on more risks. It has more credit risk since loans could go bad, and there is more liquidity risk as funds from the international money market could dry up. The capital-asset ratio is often discussed in reversed terms as the assets-capital ratio which is called the leverage ratio. For the two banks we have leverage ratios of

1. 10 for the smaller bank: equity capital was 10% of total assets
2. 20 for the larger bank: equity capital was 5% of total assets

Main takeaway here is that it is not in the self-interest of the bankers to maintain sufficient capital levels to protect against losses as higher credit and liquidity risk means higher bank profits. There are two sets of incentives to consider here

1. Investors
   - People differ in the amount of risk they are willing to accept
   - Shareholders of highly-leveraged banks be willing to lose all their money in the prospect of high returns most of the time
   - By the time things go pear-shaped they may have made a decent enough return from all the dividends
2. Bank management
   - There are strong incentives for the management to take on high leverage, even when investors are risk averse
   - E.g. profit-linked bonuses, which means that they want to maximise profit today
   - When a bank blows up they don't have to pay back bonuses

In terms of systemic risk a bank may be perceived to be too bit got fail because its failure could bring down the whole financial system. This provides incentives for banks to grow lager as the larger they get the higher the probability that the state will intervene when things go wrong. An interesting paper on this topic is "Banking on the state" by Alessandri and Haldane (2009). They document how

- The banking sector has grown in size relative to the economy
- Banks have become more leveraged and less liquid
- Have engaged in more risky trading activities

A measure for the level of risk of the investments of a bank is the Value at Risk. The VaR estimates how much a bank could lose under normal market conditions using a statistical distribution of the bank's credit losses

- Expected loss is the average of the distribution
  - Banks should deal with these by writing down part of their loans each year as loan loss provision
  - i.e. valuing assets at less than their current book value in anticipation of future losses
- Right hand side line (stress loss) is the extreme tail of the distribution
  - 1% tail is commonly used
  - e.g. at a weekly VaR of EUR 50 million, there is 1% chance that your portfolio will lose more than EUR 50 million over the course of a week

Using the IRB approach as set out by Basel II, banks are required to have a minimum level of regulatory capital equal to some multiple of the unexpected losses indicated by the VaR.[1]

$$Capital\ required = 3 * VaR$$

The Basel regulations also require banks to have capital equal to at least 8% of risk weighted assets. The VaR can be used to calculate the value of risk weighted assets as

$$RWA = \frac{3 * VaR}{0.08}$$

[1] Usually by a factor of three.

Some additional adjustments need to be made to arrive at the final RWA figure

1. An upward adjustment for market risk[2]
2. An adjustment for operational risk[3]

[2] "...pertaining to interest rate related instruments, equities, foreign exchange risk and commodities risk."

[3] "...inadequate or failed internal processes, people and systems or from external events."

One caveat implementing VaR

1. Figure is usually determined by using a distribution of past returns of the assets held

Two issues with this approach

1. Estimation sample
   - True distribution is not know, can only be estimated from historical data
   - Banks mainly rely on using returns from recent years
2. Tail risk
   - Financial markets generate extreme losses more often than predicted by a normal distribution
   - Fat tails are not properly accounted for

Interbank markets make it easier for banks to cope with reserve requirements by

- Lending and borrowing short-term funds
- Allowing banks with lots of deposits but without good loan opportunities to lend to banks with good loan opportunities but limited deposits

Despite advantage, interbank lending can make system unstable

Consider three banks (A, B, C), each with a equity capital of EUR 10M[4]

1. A borrows EUR 25M from B
2. B borrows EUR 15M from C

A loses EUR 35M in loans: wipes out equity capital

1. Bank A loses
2. A becomes insolvent $\rightarrow$ B loses EUR 25M
3. B becomes insolvent $\rightarrow$ cannot pay C
4. C becomes insolvent and has no equity capital left

Insolvency of one bank can bring down whole system: **systemic risk**

[4]Note that this example is not entirely realistic as the amount of capital lost by the first bank is greater than the total amount of capital in the system.

Single bank can pose risk for whole financial system through

1. Contagion (interbank lending)
2. Spillovers (asset sales)
   - Troubled bank sells liquid assets
   - Fire sale puts downward pressure on asset price
   - Due to regulation asset value other banks marked down
   - Fire sale reduces equity capital $\rightarrow$ increasing risk other banks

Prudential regulation are rules put into place to maintain stability: can actually lead to financial instability

1. During boom times asset prices increase, loans are paid back and this increases equity for banks
2. Equity increase allows banks to expand their operation acquiring new assets
3. With lots of demand, liquidity is not an issue and asset boom continues
4. Boom turn into busts however and eventually the cycles plays out and a recession arrives
5. Banks will worry about capital requirement and sell off assets
6. Asset sales drive down prices, eroding equity across the system.