Default risk and credit

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In the past lectures we discussed how monetary policy was set using the interest rate, but we didn't really define what this interest rate actually represents. The rate, as included in the model, is a particular interest rate, specifically the short-term risk-free overnight rate that banks charge each other. So that's a bit different from the consumer interest rate. In essence, the rates that the central bank sets isn't really that representative of the economy as, in contrast, most consumer lending involves some element of risk. How risk operates and changes over time is of course important for understanding the economy, especially the interaction with the financial sector. Discussing risky lending, we will focus on three aspects

The financial sector will be discussed in a future lecture.

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

Default risk and collateral

For many investors a relatively risk-free asset are government bonds. An alternative to this would be to lend to households and firms. In contrast with government, this type of lending involves a little bit more risk as the loans can be defaulted on. As a result of this increased risk, these loans need to have higher interest rates. Suppose that the following assets are available to an investor

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

This means that the expected return on the loan will be

Rp is expected to be very small.

$$\begin{aligned} R - Rp - p \\ R - p \end{aligned}$$

To deliver the same expected return as the risk-free bond the interest rate needs to be

$$\begin{aligned} R - p &= r \\ R &= r + p \end{aligned}$$

Now if the loan has some sort of collateral, the default will imply a return of

$$c - 1 < 0$$

where the loan needs a return of approximately

$$R = r + (1 - c)p$$

This means that collateralised loans have lower interest rates and the interest rate depends on the type of collateral. Let's consider some of the loans that are available to households

1. Credit cards (no collateral)

2. Personal loans (no collateral)

3. Car loans (collateral)

4. Mortgages (collateral)

This suggest the following ordering of interest rates

$$credit\ cards > personal\ loans > \ car\ loans > mortgages$$

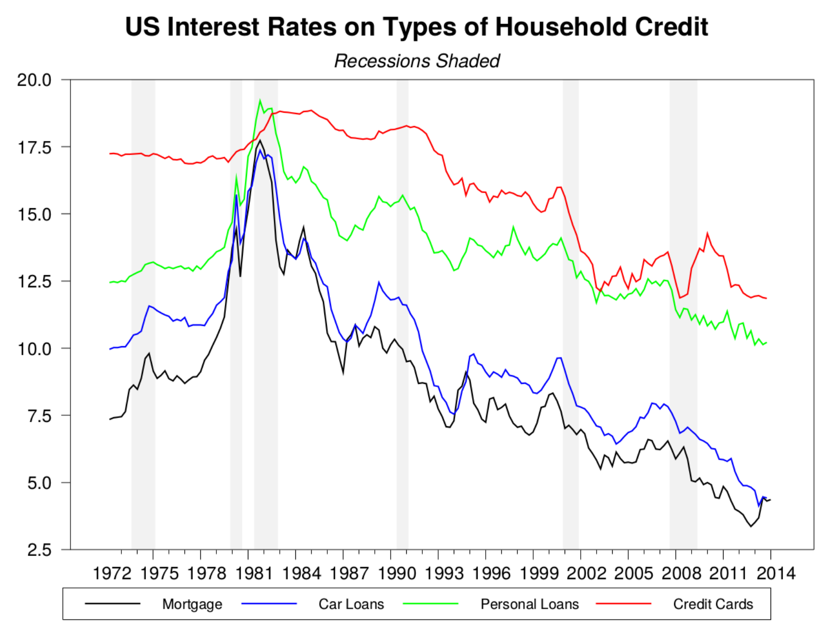

Figure 1: US interest rates on types of household credit. Figure produced by Karl Whelan.

Corporate bond rates

Large public corporations, those that are traded on the stock exchange, have their credit rated by agencies such as Standard & Poor, Moody's, and Fitch Group. Companies are rated on a scale from CCC, which implies a high default rate, to AAA. Corporate bonds tend to move in line with the rates of the treasury. Note that the default risk will vary over the business cycles, where the risk spread tends to exhibit a cyclical pattern; rising during and after recession when the risk of a corporate default is highest.

Or similar maturities, typically around seven years.

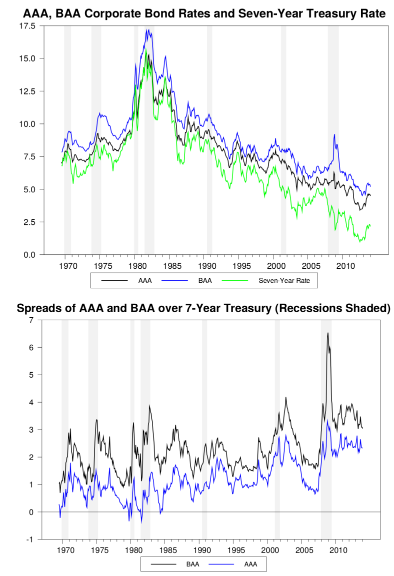

Figure 2: Corporate bond rates (upper) and risk spreads (bottom). Figures produced by Karl Whelan.

The financial accelerator

There are two important observations with regard to 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

This suggests that there is a mechanism by which the financial sector can propagate business cycle shocks, which is bad news. It means that a shock that produces a recession will lead to higher interest rate spreads for borrowers which will worsen the recession. Bernanke & Gertler (1989) introduced collateral-based risk spreads into a real business cycle model and illustrated how it produced more substantial impulse responses to shocks. This mechanism is now known as the financial accelerator.[1]

[1] The main model is the one reported in Bernanke, Gertler, & Gilchrist (1999) which, besides the financial accelerator accounts for capital, imperfect competition, and nominal price rigidities.

Figure 3: Figures from Bernanke, Gertler, & Gilchrist (1999). *Top*: Shows impact of 25 basis points decline in nominal interest rate. *Middle*: Effect of three different shocks. Similar to other figure the central mechanism in shock propagation is the rise in asset prices associated with the investment boom. Extra persistence comes from fact that net worth reverts slowly to trend. *Bottom*: Same as *top* figure only with one period delay in investment. There is an immediate response for the premium due to investment anticipation.

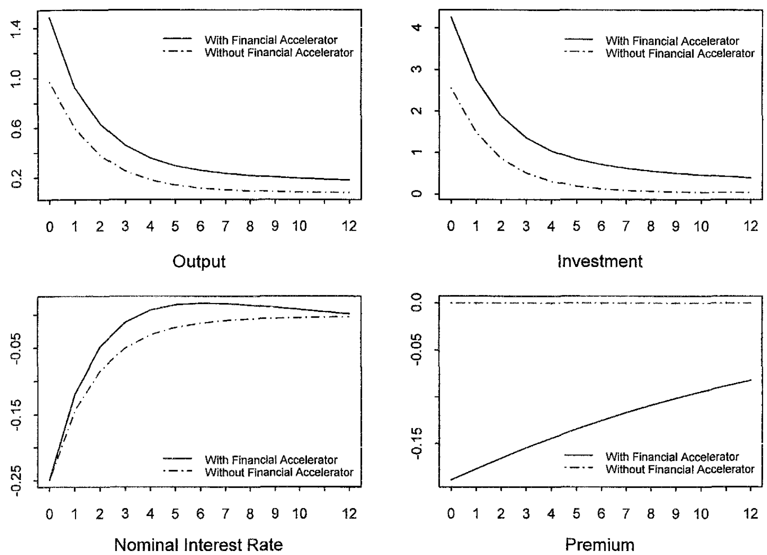

Fig. 3. Monetary shock – no investment delay. All panels: time horizon in quarters.

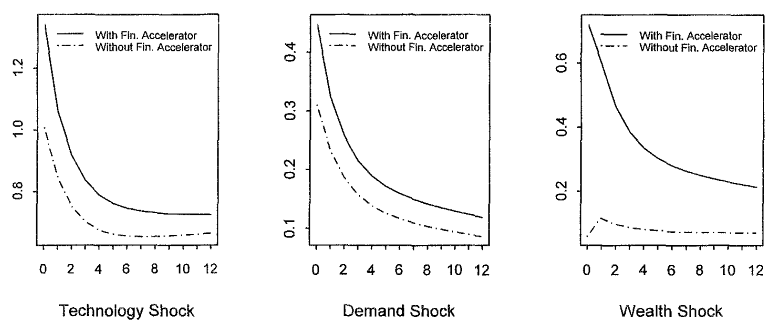

Fig. 4. Output response – alternative shocks. All panels: time horizon in quarters.

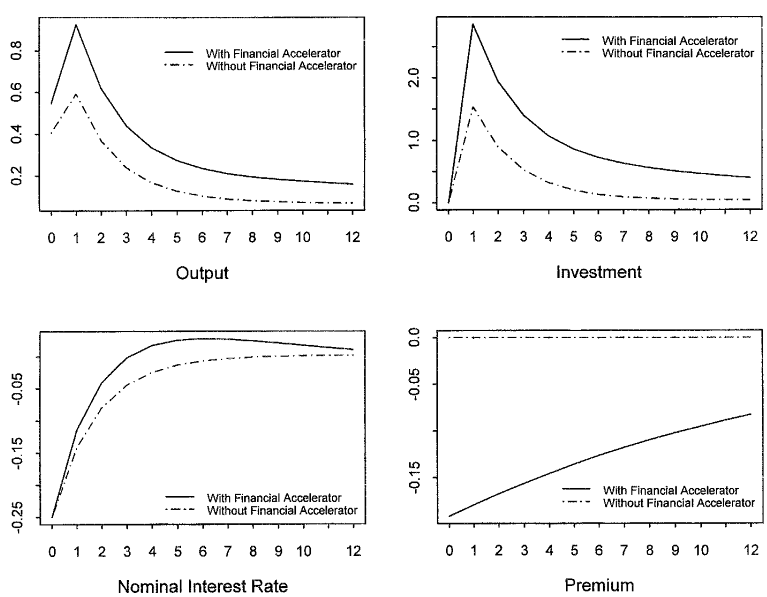

Fig. 5. Monetary shock – one period investment delay. All panels: time horizon in quarters.

Credit rationing

Borrowers with higher risk pay higher interest rates. However, so far we have assumed that at each level of risk there is still someone willing to lend if the interest rates are high enough. Of course in practice, this isn't necessarily the case as credit suppliers, such as banks, can refuse to make a loan, rather than trying to balance the loss by raising the interest rate. This is called credit rationing. Credit rationing can be quite severe and lead to a situation where otherwise credit-worthy borrowers are turned down. The problem here is that there is asymmetric information due to the fact that

Credit rationing is the situation where lenders provide a smaller amount of loans than is demanded at the market interest rate.

- Banks can't always tell good borrowers from bad
- The pool of borrowers worsen, from bank's point of view, as the interest rate rises

A model for credit rationing

Let's examine the classic model for credit rationing by Stiglitz and Weiss (1981). We assume there are a number of borrowers, each of whom have a project to undertake.

e.g. house maintenance, buying a car, enriching uranium.

- All borrowers look to borrow B and put up collateral C
- The projects deliver a sum of R
  - This is uncertain though and the distribution of outcomes varies across borrowers
  - Type θ borrowers have a return distribution with pdf $f(R, \theta)$
  - The mean of the distribution is identical across borrowers but greater θ values correspond to greater riskiness[2]
  - Borrowers are observably identical to banks: They don't observe an individual's value of θ
- The interest rate on bank loans is r and determined endogenously

[2] Specifically high values of θ induce a mean-preserving spread in the distribution of projected payoffs. The pdf for θ is $g(\theta)$ the cdf is $G(\theta)$.

The mechanism of the model is that the interest rate determined by the bank r might affect the level of risk of the loans by

1. Sorting potential borrowers − adverse selection
2. Affecting the actions of the borrowers − moral hazard

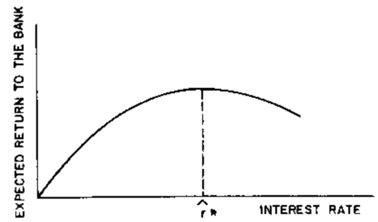

FIGURE 1. THERE EXISTS AN INTEREST RATE WHICH MAXIMIZES THE EXPECTED RETURN TO THE BANK

Decision of the firm

With B being the amount borrowed, and C the collateral a default will occur when

$$C + R \leq B(1 + r)$$

The return to the firm $\pi(R, r)$ is given by

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

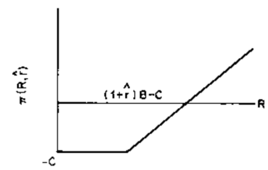

FIGURE 2a. FIRM PROFITS ARE A CONVEX FUNCTION OF THE RETURN ON THE PROJECT

The return to the bank can be written as

$$\rho(R, r) = min(R + C; B(1 + r))$$

- 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
- The 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.

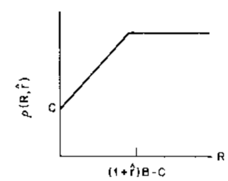

FIGURE 2b. THE RETURN TO THE BANK IS A CONCAVE FUNCTION OF THE RETURN ON THE PROJECT

The firm borrows if[3]

[3] This is given as theorem 1

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

Since Borrowers only differ according to their θ, the question is how $E[\pi(R, r)]$ varies with θ?

The pool of borrowers

Let's assume that only those with a value of θ above a critical value $\hat{\theta}(r)$ decide to borrow. From utility theory we get that if the function $U(C)$ is concave, then a mean-preserving spread in the distribution of C reduces expected utility because people are risk averse. In this case, the outcome is a convex function of R, so more uncertainty increases the expected return. In bad cases, the outcome is still C but increased risk raises the chance of a really good outcome.

Question is how an increase in r will affect the loan demand?

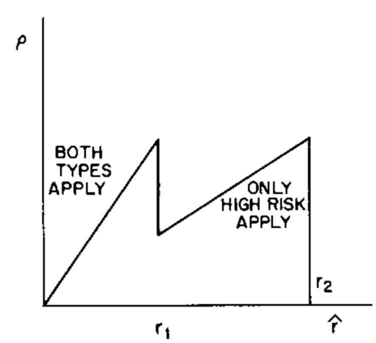

FIGURE 3. OPTIMAL INTEREST RATE r_1

- Project returns depend negatively on r , so an increase in r reduces everyone's expected project returns
- However, the expected project returns also depend positively on θ, so some firms will still have positive expected value for going ahead with borrowing and doing the project

- The increase in r raises the cut-off $\hat{\theta}(r)$ for potential borrowers.

As the interest rate for the bank rises, the pool of borrowers changes so that it increasingly consists of those people with risky projects. This is an example of adverse selection.

As mentioned, there is also a moral hazard problem where a risk-neutral investor will prefer the project with a higher bankruptcy probability after an increase in the interest rate.

Profits for the bank

The pay off to the bank is $Min(R + C; (1 + r)B)$ If the bank knows it is lending to type θ then the expected return would be.

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

The bank's pay off is a concave function of R, so increases in θ reduce the bank's expected return. In a best case scenario, the bank will get its principal and interest, but in a worst case scenario it will only get its collateral. More risk is bad for the bank, but remember that the bank can't actually tell if the borrower is a risky type or not. Therefore the expected payoff can be calculated averaging across all types that look for loans at interest rate r

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

An increase in interest rates has two effects on the bank's pay off

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

1. A positive effect due to higher interest revenues from each project that pays off
2. A negative effect due to adverse selection.
    - As interest rates rise, the pool of borrowers changes so that only riskier borrowers remain and this lowers the expected return.

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.

Loan supply and credit rationing

Ultimately, the interaction of supply and demand will determine an equilibrium outcome. There are two possible outcomes

1. Low loan demand
    - The demand curve for loans intersects with the part of the loan supply curve below r^*.

- The market functions normally and all who request a loan receive one

2. High loan demand

- The supply and demand curves don't intersect
- Banks can pick their optimal interest rate r^*.
- At this point there will be more demand than banks are willing to supply so there will be credit rationing.

During recessions, the demand for credit may be high and credit rationing more likely. Reductions in the value of collateral that occur during a recession also reduces bank expected profits and will increase the extent of credit rationing.

Sovereign default

Governments can also default on their obligations. Some historical examples of this include

- A number of countries after the Napoleonic Wars, e.g. France, the Netherlands, and Sweden
- The Ottoman Empire in 1875
- Germany in 1932
- Mexico 1982
- Russia in 1998
- Zimbabwe 2006
- Argentina 2001, as well as in 1982 and 1989
- Greece in 2015

A number of Latin American countries were hit hard by a debt crisis in the 1980s.

Greece also defaulted a couple of times during the 1800s as a result of, amongst others, various wars.

Although in recent years sovereign defaults has been largely associated with countries such as Venezuela and Zimbabwe, it has become a pressing issue in Europe due to the difficulties that countries like Greece, Portugal, and Ireland as well as larger economies like Italy and Spain face on the international market. One constraint of being a member of the Eurozone is that there is a policy that prevents the central bank from buying government bonds, this means that if the financial market is reluctant to buy bonds, the country might not be able to raise money to pay off old bonds. The result of this is a sovereign default. The fear of sovereign default has lead to high interest rate on government bonds for certain countries.

Recently Puerto Rico has defaulted as well.

Note that there has been the suggestion to create so called Eurobonds, but this was rejected by the German government.

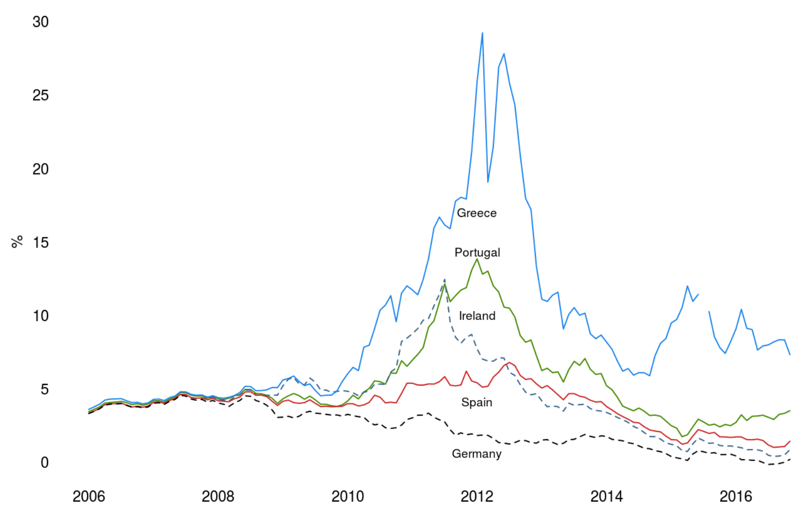

Figure 4: Government bond yields for a selection of countries in the Eurozone. Data: Eurostat

Background: log-linearised model financial accelerator

Taken from lecture notes by Mark Gertler.

Aggregated demand is given by

$$
\begin{aligned}
y_t &= \frac{C}{Y}c_t + \frac{I}{Y}inv_t + \frac{G}{Y}g_t + \frac{C^e}{Y}c_t^e + ... \\
c_t &= -\sigma r_{t+1} + E_t c_{t+1} \\
c_t^e &= \frac{1-\phi}{\phi} n_{t+1} \\
q_t &= \phi(i_t - k_t) \\
E_t r_{kt+1} &= (1-\rho)E_t(p_{wt+1} - p_{t-1} + y_{t-1} - k_{t+1}) + \rho E_t q_{t+1} - q_t \\
E_t r_{kt+1} - r_{t+1} &= -v(n_t - q_t - k_{t+1})
\end{aligned}
$$

And aggregate supply is given by

$$
\begin{aligned}
y_t &= a_t + \alpha k_t + (1-\alpha) l_t \\
y_t - l_t &= \mu_t + \gamma_l l_t + c_t \\
\pi_t &= \kappa(p_{wt} - p_t) + \beta E_t \pi_{t+1}
\end{aligned}
$$

The evolution of the state variable is described by

$$
\begin{aligned}
k_{t+1} &= \delta inv_t + (1-\delta) k_t \\
n_t &= \frac{\theta RK}{N}[r_t^k - r_t] + \theta R(r_t + n_{t-1}) \\
r_t &= i_{t-1} - \pi_{t-1}
\end{aligned}
$$

And finally the monetary policy rule is given by

$$
\begin{aligned}
i_t &= \rho i_{t-1} + (1-\rho)[\gamma_\pi \pi_t + \gamma_y(y_t - y_t^n)] + \epsilon_t^{rn} \\
i_t &= r_{t+1} - E_t \pi_{t+1}
\end{aligned}
$$