ECON 4335 The economics of banking

Lecture 8, 20/3-2013: Credit rationing, importance of initial wealth, and pecuniary externalities

Bent Vale,
Norges Bank*

*Views and conclusions are those of the lecturer and can not be attributed to Norges Bank

- Credit rationing:
  - Among seemingly identical borrowers who are willing to pay the prevailing loan rate in the market some are *denied any* credit.
    There is an excess demand for credit.[†]
  - Among identifiable different groups of borrowers some groups are denied credit at any loan rate. I.e., they are considered not creditworthy.
- How can such rationing appear in an unregulated market? Why cannot the price of credit, the interest rate, clear the market?

[†]Another type of credit rationing: All borrowers get some credit, but not as much as they demand at the prevailing loan rate in the market. Also excess demand, but we do not look at this type of rationing in this lecture.

Theories explaining credit rationing

- Adverse selection (Stiglitz and Weiss (1981))
  - But Arnold and Riley (2009) showed that adverse selection can hardly generate credit rationing as in SW.
- Moral hazard, i.e., unobservable actions (also in Stiglitz and Weiss (1981))
  - risk shifting (SW), unobservable effort (this lecture)
- Unobservable state, or bankruptcy cost.

- These theories implies: initial distribution of wealth matters for efficiency.
  - At odds with standard new classical welfare theory: a first best, i.e., PO, equilibrium can arise from any initial distribution of goods. This welfare theorem is only valid under complete and perfect markets.

- When distribution of wealth matters for efficiency $\Rightarrow$ pecuniary externalities will have effects on the efficiency of the real economy.

- This can explain how changes in asset prices can have macroeconomic impacts.

Model

- The demand side, behavior of non-financial firms as borrowers.
- Banks and the supply schedule in the credit market.
- Derive a demand schedule.
- Characterize the market
- How firms' equity position influences the credit market.

- Credit rationing, creditworthiness

Some implications for effects of pecuniary externalities

Borrowers

- N identical (except for one characteristic) risk neutral firms each have an initial wealth $a < 1$. Each of them has access to a project where they in period 1 can invest 1. The project will yield $y > 1$ in period 2 with probability p, and 0 with probability $(1 - p)$.

- Success probability depends on the borrowers unobservable effort e, s.t.

$$0 \leq p = p(e) \leq 1, \quad p'(e) > 0, \quad p''(e) < 0 \ .$$

- Since $a < 1$ a firm needs to borrow at interest rate r to be able to invest. Assume the borrowing firm's cost of effort is e.

- Borrowing firms have limited liability.

- In addition, in order to carry out the investment each borrower needs to do some installation effort β right before e in period 1.

- β varies continuously among borrowers. So far, the only difference between borrowers. Introduced in order to get a downward sloping demand curve.

- Distribution β described by a density function $g(\beta)$, where $\beta \in [\underline{\beta}, \overline{\beta}]$. Hence:

$$\int_{\underline{\beta}}^{\overline{\beta}} g(\beta) d\beta \equiv G(\overline{\beta}) = N.$$

- Period 2 profit of the borrowing firm is

$$E\pi = p(e)[y - (1-a)(1+r)] - a(1+i) - (1+i)(e+\beta) \equiv V(e)$$

where i is the risk-free interest rate. For the given β, the firm decides its optimal effort according to 1. order condition

$$\frac{\partial E\pi}{\partial e} = [y - (1-a)(1+r)]p'(e) - (1+i) = 0$$

with 2nd. order condition

$$\frac{\partial^2 E\pi}{\partial e^2} = [y - (1-a)(1+r)]p''(e) < 0$$

Note that the firm's optimal e is independent of β.

Effect of a and r on the borrowing firm's optimal effort e^*

- Regarding a, from the 1. order condition we get
$$\frac{\partial e^*}{\partial a} = -\frac{(1+r)p'(e^*)}{[y-(1-a)(1+r)]p''(e^*)} = \frac{(1+r)p'(e^*)}{-\partial^2 E\pi/\partial e^2} > 0$$
The higher equity the more effort is optimal for the borrowing firm.

- Effect of r on the borrowing firm's optimal effort e^*
$$\frac{\partial e^*}{\partial r} = \frac{-(1-a)p'(e^*)}{-\partial^2 E\pi/\partial e^2} < 0$$
The higher interest rate, the lower effort.

- Moral hazard at work. If e was observable borrower and lender could contract on e, it would have been higher.

Banks and the supply side in the credit marked.

- Several risk neutral banks compete a la Bertrand in offering loans to the firms. Banks fund themselves at the risk-free interest rate (no equity in the banks). I.e. in this market banks lend at zero expected profits.

$$p(e^*)(1-a)(1+r) - (1-a)(1+i) = 0$$

i.e.

$$1 + r = \frac{1+i}{p(e^*)} \qquad \text{or} \qquad p(e^*)(1+r) = 1+i$$

Note that r is independent of how much the bank lends, a horizontal supply schedule.
I.e., we cannot have credit rationing as defined in the first bullet point on the first slide in this model.

- However, can have an equilibrium where an identifiable group of borrowers do not receive loans, i.e., not considered creditworthy.

- Denote banks' gross return on lending $p(e^*)(1+r)$ by $\rho(r)$. Then we have
$$\rho'(r) = p(e^*) + (1+r)p'(e^*)\frac{\partial e}{\partial r} \lesseqgtr 0$$
Thus, we can have concave relation between ρ and r. Since banks cannot observe borrowers' effort e, in setting r banks have to take into account the negative effect of higher r on e. Let ρ_{max} be the maximum value of ρ.

- If, nevertheless, $1 + i > \rho_{\text{max}}$ then lending will be unprofitable. These borrowers not creditworthy. Will return to this case.

Demand side in the credit market.

- Firms have different βs, and only firms with $E(\pi) \geq 0$ will demand a loan. Define β^* s.t. $E(\pi \mid \beta^*) = 0$.

$$\beta^* = \frac{[y - (1-a)(1+r)]p(e^*)}{1+i} - a - e^*$$

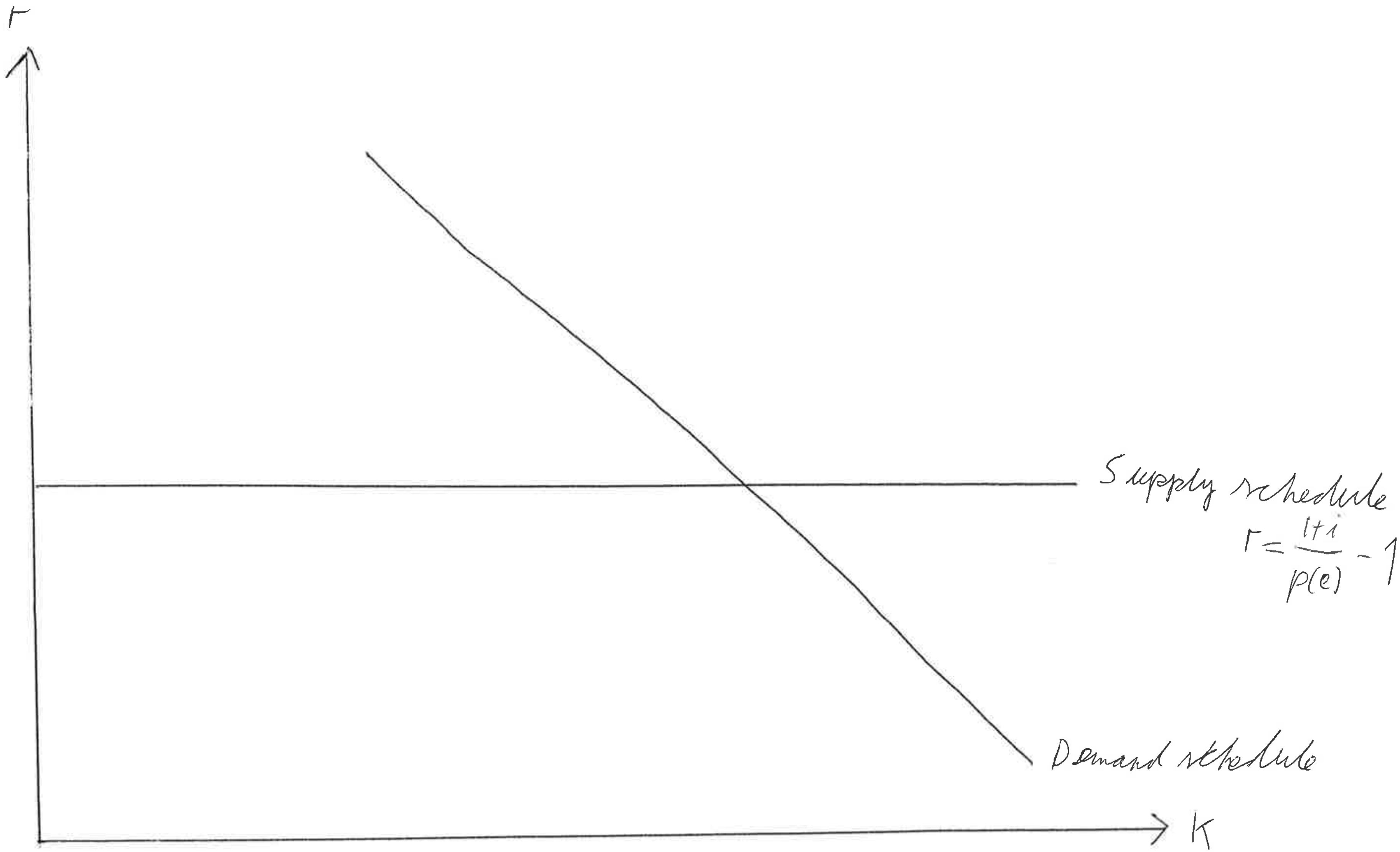
I.e., only borrowers with $\beta < \beta^*$ will demand a loan.

- With a horizontal supply schedule, all borrowers demanding credit will obtain it and carry out investments as long as $1 + i \leq \rho_{\text{max}}$. Let K be the number of investment projects that are carried out.

$$K = G(\beta^*) \leq N, \quad \frac{dK}{d\beta^*} = g(\beta^*) > 0$$

- Inserting the expression for β^* into the expression for K we get the following properties of the demand schedule:

$$
\begin{aligned}
\frac{\partial K}{\partial r} &= -\frac{p(e^*)(1-a)}{1+i} g(\beta^*) && < 0 \\
\frac{\partial K}{\partial i} &= -\frac{[y-(1-a)(1+r)]p(e^*)}{(1+i)^2} g(\beta^*) && < 0 \\
\frac{\partial K}{\partial a} &= \left(\frac{p(e^*)(1+r)}{1+i} - 1\right) g(\beta^*) && = 0 \text{ follows from banks' 0-profit condition}
\end{aligned}
$$



r
K
Supply schedule
$r = \frac{1+i}{p(e)} - 1$
Demand schedule

The credit market equilibrium.

- a, i and y are exogenous. Equilibrium e^* and r are determined by borrowers' 1. order condition and banks' zero profit condition. K follows from $G(\beta^*)$ and the expression for β^* with the equilibrium e^* and r inserted.

How lower borrower equity affects market equilibrium.

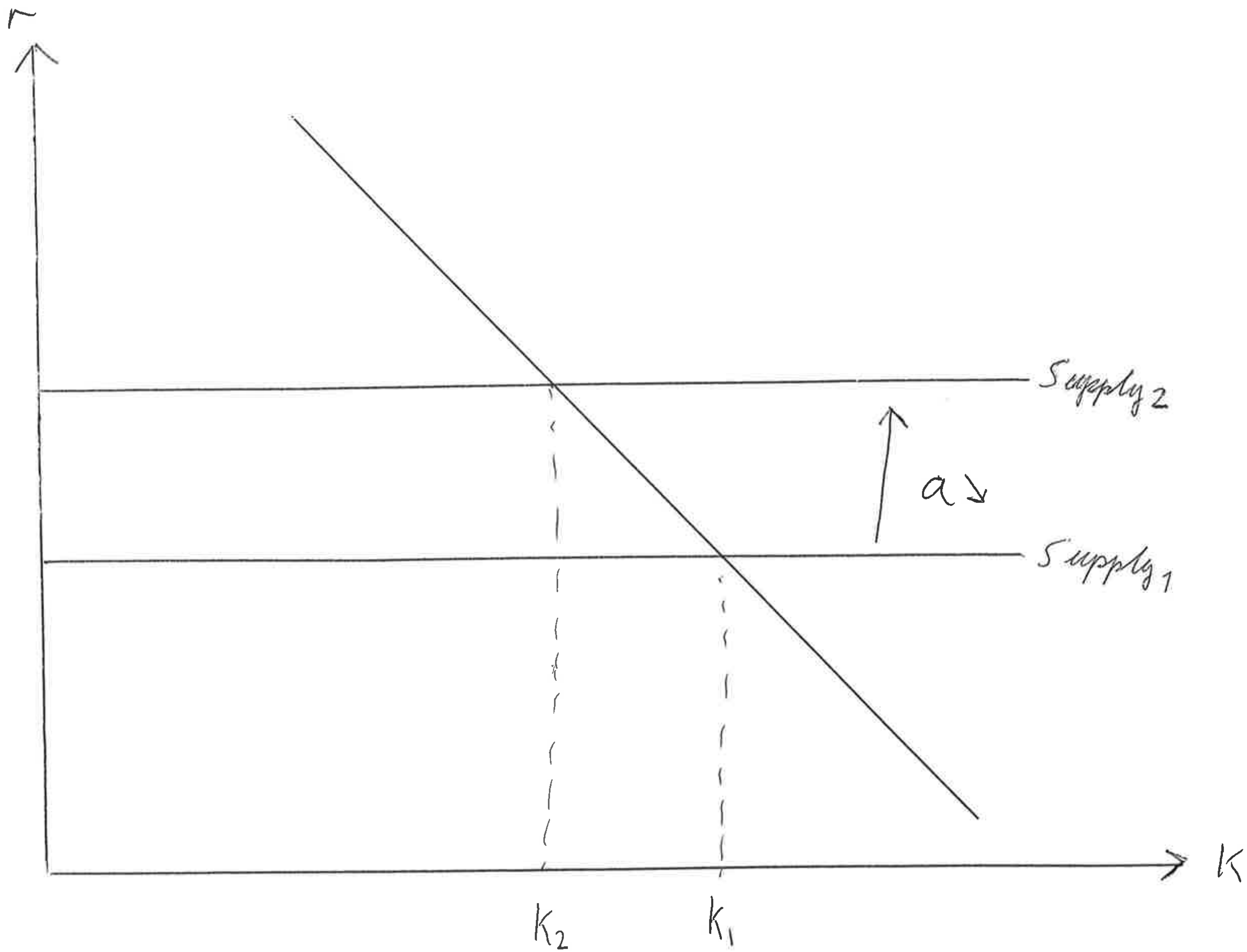
- The demand schedule is unaffected

- The supply schedule
  - Know that for a given r lower equity will reduce e^* thus $p(e)$ down. Banks raise r to maintain zero-profit condition.
  - Higher r implies further reduction in e^*, and higher r, and so on. Total differentiation of banks' zero-profit condition

    $$\frac{dr}{da} = \frac{-(1+r)p'(e^*)\frac{\partial e}{\partial a}}{p(e^*) + (1+r)p'(e^*)\frac{\partial e}{\partial r}} < 0$$

    I.e., lower a shifts the supply schedule upwards.

- Lower a implies higher r and fewer firms that demand loan and carries out investment projects, $K \searrow$.



r
K
Supply 2
Supply 1
a ↘
K2
K1

If effort could be observed perfectly

- The borrowing firm could commit to a certain effort. The contract between a bank and a borrowing firm would specify both r and e.
  - The equilibrium contract would be the one that maximized firms' expected profits $E(\pi)$ s.t. banks' zero expected profit condition. That is the following Lagrange problem

$$\begin{aligned}\max_{e,r} H(e,r) &= p(e)[y-(1-a)(1+r)] - a(1+i) - (1+i)(e+\beta) \\ &\quad -\lambda[(1+i)(1-a) - (1-a)(1+r)p(e)]\end{aligned}$$

Solution:

$$\begin{aligned} yp'(e) &= 1+i \\ (1+r)p(e) &= 1+i \end{aligned}$$

- Note, if effort was observable and contractable equilibrium e and r and thus K would be independent of a.

- In a first best equilibrium initial distribution of goods does not matter for the efficiency of the equilibrium.

Back to unobservable effort.

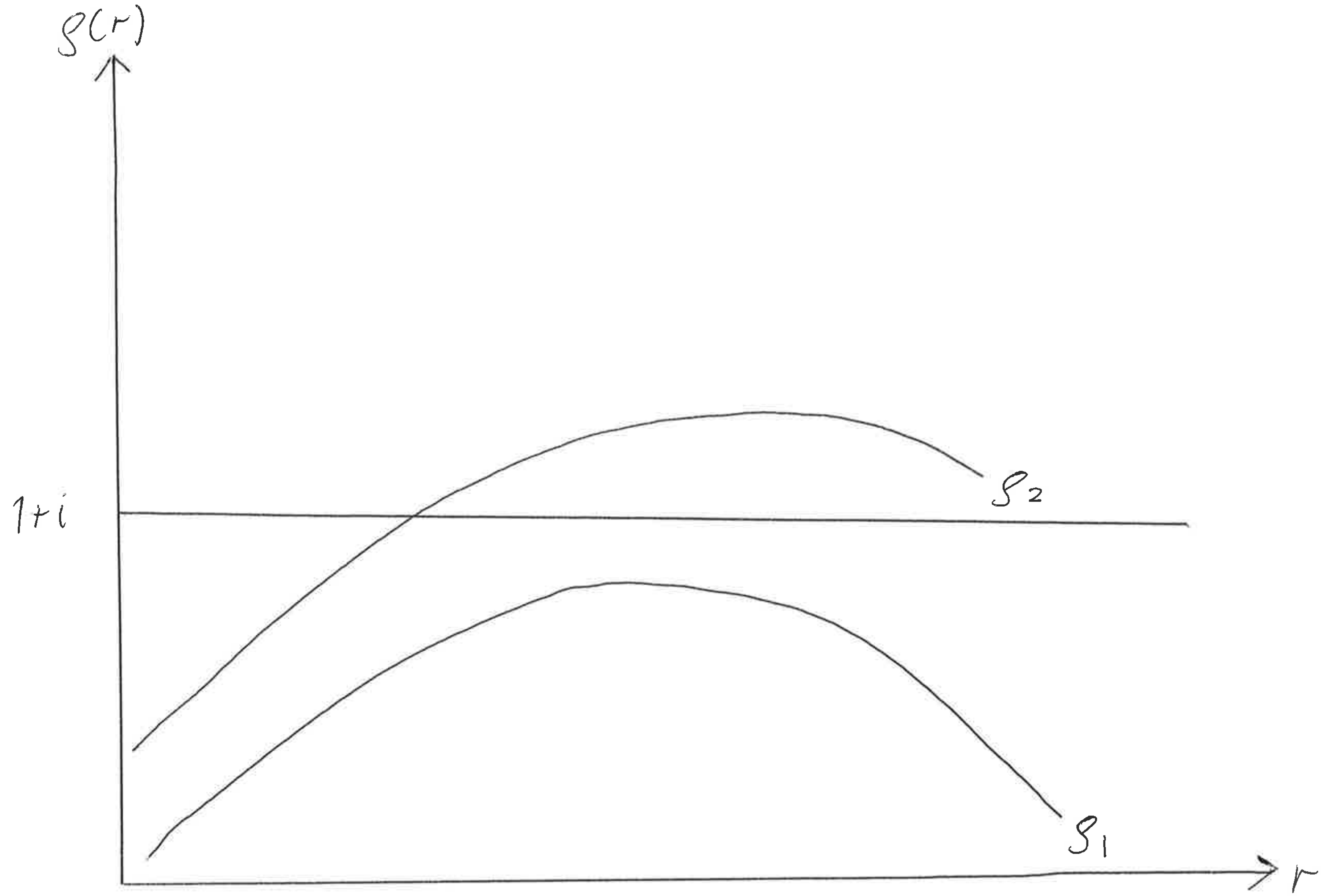
- $\rho(r; a) = p(e^*)(1 + r)$. For any given r we have

$$\frac{\partial \rho}{\partial a} = (1 + r)p'(e^*)\frac{\partial e}{\partial a} < 0$$

- Let a vary between groups of borrowers s.t. $a_1 < a_2$ Then $\rho(r; a_1) < \rho(r; a_2)$ for any r.

- Define r_1^*as the solution to $\max_r \rho(r; a_1)$. Then we may have $\rho(r_1^*; a_1) < 1 + i < \rho(r_2^*; a_2)$.

- Thus group 1 is rationed, all denied credit, but all borrowers in group 2 obtain credit.

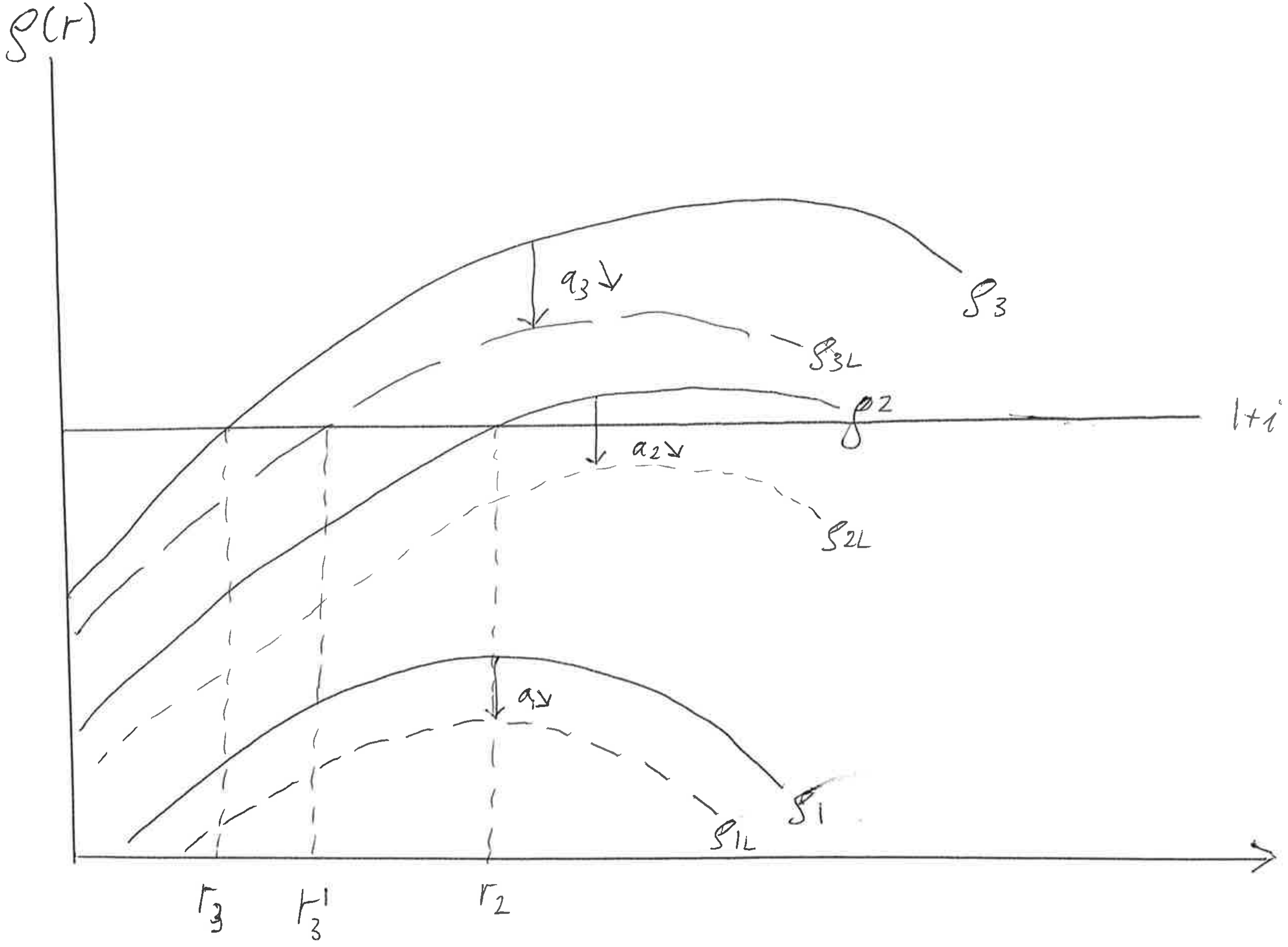


g(r)
1+i
g2
g1
r

Effects of an overall fall in firms' equity

- Situation with three borrower groups as in graph $a_1 < a_2 < a_3$
  Initially Group 3 and 2 all receive credit, Group 1 is rationed, all of them denied credit.

- If a falls in all three groups: Group 2 also get rationed (not considered creditworthy anymore) and do not invest. Interest rate on loans for group 3 increases; not rationed, but fewer borrowers in group 3 demand credit and carry out investments.



ρ(r)
a3
ρ3
ρ3L
ρ2
1+i
a2
ρ2L
a1
ρ1
ρ1L
r
r3
r3'
r2

Example of a pecuniary externality impacting the real economy.

- Firms fail and their banks sell their assets in a fire-sale. Price of these assets drop. Solvent firms holding similar assets, have their net value, i.e., their equity, lowered. With imperfect credit markets like in this model, some of the firms may not be able to borrow anymore, others still receive credit but at higher interest rate. Fewer investment projects carried out. I.e., pecuniary externality from banks' fire sale has real economic impact.