Andreas Krause

Chapter 7.1

The consequences of uncertain outcomes

Financing investments

Financing investments

- Companies can fund investment using debt

Financing investments

- Companies can fund investment using debt and equity

Financing investments

- Companies can fund investment using debt and equity
- Companies choose the optimal combination of these funding sources

Financing investments

- Companies can fund investment using debt and equity
- Companies choose the optimal combination of these funding sources
- With uncertain outcomes, banks cannot be sure to be repaid their loan

Financing investments

- Companies can fund investment using debt and equity
- Companies choose the optimal combination of these funding sources
- With uncertain outcomes, banks cannot be sure to be repaid their loan
- Larger loans imply larger repayments

Financing investments

- Companies can fund investment using debt and equity
- Companies choose the optimal combination of these funding sources
- With uncertain outcomes, banks cannot be sure to be repaid their loan
- Larger loans imply larger repayments, which requires higher outcomes

Financing investments

- Companies can fund investment using debt and equity
- Companies choose the optimal combination of these funding sources
- With uncertain outcomes, banks cannot be sure to be repaid their loan
- Larger loans imply larger repayments, which requires higher outcomes

Company profits

Company profits

- Companies retain the outcome
- $\Pi_C =$ $\pi\left(1+R\right)L$

Company profits

- Companies retain the outcome once the loan has been repaid
- $\Pi_C = \int_{(1+r_L)L}^{+\infty} \pi\,(1+R)\,L dF\,(\pi\,(1+R)\,L)$

Company profits

- Companies retain the outcome once the loan has been repaid, taking into account their own investment
- $\Pi_C = \int_{(1+r_L)L}^{+\infty} \pi\,(1+R)\,L dF\,(\pi\,(1+R)\,L)\,-\,E$

Company profits

- Companies retain the outcome once the loan has been repaid, taking into account their own investment
- $\Pi_C = \int_{(1+r_L)L}^{+\infty} \pi (1+R) L dF (\pi (1+R) L) - E$
- Companies seek loans if $\Pi_C \geq 0$, which gives a maximum loan rate $\overline{r}_L$

Company profits

- Companies retain the outcome once the loan has been repaid, taking into account their own investment
- $\Pi_C = \int_{(1+r_L)L}^{+\infty} \pi\,(1+R)\,L dF\,(\pi\,(1+R)\,L)\,-E$
- Companies seek loans if $\Pi_C \geq 0$, which gives a maximum loan rate $\overline{r}_L$

$$\Rightarrow \frac{\partial(1+\overline{r}_L)}{\partial L} = -\frac{\frac{\partial \Pi_C}{\partial L}}{\frac{\partial \Pi_C}{\partial(1+\overline{r}_L)}} = \frac{1-(1+\overline{r}_L)^2 L f(\pi(1+\overline{r}_L)L)}{(1+\overline{r}_L)L^2 f(\pi(1+\overline{r}+L)L)}$$

Company profits

- Companies retain the outcome once the loan has been repaid, taking into account their own investment
- $\Pi_C = \int_{(1+r_L)L}^{+\infty} \pi\,(1+R)\,L dF\,(\pi\,(1+R)\,L)\,-E$
- Companies seek loans if $\Pi_C \geq 0$, which gives a maximum loan rate $\overline{r}_L$

$$\Rightarrow \frac{\partial(1+\overline{r}_L)}{\partial L} = -\frac{\frac{\partial \Pi_C}{\partial L}}{\frac{\partial \Pi_C}{\partial(1+\overline{r}_L)}} = \frac{1-(1+\overline{r}_L)^2 L f(\pi(1+\overline{r}_L)L)}{(1+\overline{r}_L)L^2 f(\pi(1+\overline{r}+L)L)}$$

- The isoprofit curve has a negative slope

Company profits

- Companies retain the outcome once the loan has been repaid, taking into account their own investment
- $\Pi_C = \int_{(1+r_L)L}^{+\infty} \pi\left(1+R\right) L dF\left(\pi\left(1+R\right)L\right) - E$
- Companies seek loans if $\Pi_C \geq 0$, which gives a maximum loan rate $\overline{r}_L$

$$\Rightarrow \frac{\partial(1+\overline{r}_L)}{\partial L} = -\frac{\frac{\partial \Pi_C}{\partial L}}{\frac{\partial \Pi_C}{\partial(1+\overline{r}_L)}} = \frac{1-(1+\overline{r}_L)^2 L f(\pi(1+\overline{r}_L)L)}{(1+\overline{r}_L)L^2 f(\pi(1+\overline{r}+L)L)}$$

- The isoprofit curve has a negative slope

Bank profits

Bank profits

- Banks obtain the outcome if the loan cannot be repaid

- $\Pi_B = \int_0^{(1+r_L)L} \pi \left(1 + R\right) L dF \left(\pi \left(1 + R\right) L\right)$

Bank profits

- Banks obtain the outcome if the loan cannot be repaid and are repaid for higher outcomes

- $\Pi_B = \int_0^{(1+r_L)L} \pi\,(1+R)\,L dF\,(\pi\,(1+R)\,L)$
  $+ \int_{(1+r_L)L} (1+r_L)\,L dF\,(\pi\,(1+R)\,L)$

Bank profits

- Banks obtain the outcome if the loan cannot be repaid and are repaid for higher outcomes, up to the maximum loan rate at which companies demand loans

- $\Pi_B = \int_0^{(1+r_L)L} \pi\,(1+R)\,L dF\,(\pi\,(1+R)\,L)$
  $+ \int_{(1+r_L)L}^{(1+\bar{r})L} (1+r_L)\,L dF\,(\pi\,(1+R)\,L)$

Bank profits

- Banks obtain the outcome if the loan cannot be repaid and are repaid for higher outcomes, up to the maximum loan rate at which companies demand loans, and repay deposits
- $\Pi_B = \int_0^{(1+r_L)L} \pi\,(1+R)\,L dF\,(\pi\,(1+R)\,L)$
  $+ \int_{(1+r_L)L}^{(1+\bar{r})L} (1+r_L)\,L dF\,(\pi\,(1+R)\,L) - (1+r_D)\,L$

Bank profits

- Banks obtain the outcome if the loan cannot be repaid and are repaid for higher outcomes, up to the maximum loan rate at which companies demand loans, and repay deposits
- $\Pi_B = \int_0^{(1+r_L)L} \pi\,(1+R)\,L dF\,(\pi\,(1+R)\,L)$
  $+ \int_{(1+r_L)L}^{(1+\overline{r})L} (1+r_L)\,L dF\,(\pi\,(1+R)\,L) - (1+r_D)\,L$

$\Rightarrow \frac{\partial \Pi_B}{\partial (1+r_L)} = \left(F\left(\left(1+\overline{r}_L\right)L\right) - F\left(\left(1+r_L\right)L\right)\right)L > 0$

Bank profits

- Banks obtain the outcome if the loan cannot be repaid and are repaid for higher outcomes, up to the maximum loan rate at which companies demand loans, and repay deposits
- $\Pi_B = \int_0^{(1+r_L)L} \pi\,(1+R)\,L dF\,(\pi\,(1+R)\,L)$
  $+ \int_{(1+r_L)L}^{(1+\overline{r})L} (1+r_L)\,L dF\,(\pi\,(1+R)\,L)\; - (1+r_D)\,L$

$\Rightarrow \frac{\partial \Pi_B}{\partial (1+r_L)} = (F\,((1+\overline{r}_L)\,L) - F\,((1+r_L)\,L))\,L > 0$

$\frac{\partial \Pi_B}{\partial L} = (F\,((1+\overline{r}_L)\,L) - F\,((1+r_L)\,L))\,(1+r_L) + \frac{1+r_L}{1+\overline{r}_L} - (1+r_D)$

Bank profits

- Banks obtain the outcome if the loan cannot be repaid and are repaid for higher outcomes, up to the maximum loan rate at which companies demand loans, and repay deposits
- $\Pi_B = \int_0^{(1+r_L)L} \pi (1+R) L dF(\pi (1+R) L) + \int_{(1+r_L)L}^{(1+\overline{r})L} (1+r_L) L dF(\pi (1+R) L) - (1+r_D) L$

$\Rightarrow \frac{\partial \Pi_B}{\partial (1+r_L)} = (F((1+\overline{r}_L) L) - F((1+r_L) L)) L > 0$

$\frac{\partial \Pi_B}{\partial L} = (F((1+\overline{r}_L) L) - F((1+r_L) L))(1+r_L) + \frac{1+r_L}{1+\overline{r}_L} - (1+r_D)$

- If L is small, the first term will be small

Bank profits

- Banks obtain the outcome if the loan cannot be repaid and are repaid for higher outcomes, up to the maximum loan rate at which companies demand loans, and repay deposits
- $\Pi_B = \int_0^{(1+r_L)L} \pi\left(1+R\right) L dF\left(\pi\left(1+R\right)L\right)$
  $+ \int_{(1+r_L)L}^{(1+\overline{r})L} \left(1+r_L\right) L dF\left(\pi\left(1+R\right)L\right) - \left(1+r_D\right)L$

$\Rightarrow$ $\frac{\partial \Pi_B}{\partial (1+r_L)} = \left(F\left(\left(1+\overline{r}_L\right)L\right) - F\left(\left(1+r_L\right)L\right)\right)L > 0$

$\frac{\partial \Pi_B}{\partial L} = \left(F\left(\left(1+\overline{r}_L\right)L\right) - F\left(\left(1+r_L\right)L\right)\right)\left(1+r_L\right) + \frac{1+r_L}{1+\overline{r}_L} - \left(1+r_D\right)$

- If L is small, the first term will be small, the two final terms are negative

Bank profits

- Banks obtain the outcome if the loan cannot be repaid and are repaid for higher outcomes, up to the maximum loan rate at which companies demand loans, and repay deposits
- $\Pi_B = \int_0^{(1+r_L)L} \pi\left(1+R\right) L dF\left(\pi\left(1+R\right)L\right)$
  $+ \int_{(1+r_L)L}^{(1+\overline{r})L} \left(1+r_L\right) L dF\left(\pi\left(1+R\right)L\right) - \left(1+r_D\right)L$

$\Rightarrow$ $\frac{\partial \Pi_B}{\partial (1+r_L)} = \left(F\left(\left(1+\overline{r}_L\right)L\right) - F\left(\left(1+r_L\right)L\right)\right)L > 0$

$\frac{\partial \Pi_B}{\partial L} = \left(F\left(\left(1+\overline{r}_L\right)L\right) - F\left(\left(1+r_L\right)L\right)\right)\left(1+r_L\right) + \frac{1+r_L}{1+\overline{r}_L} - \left(1+r_D\right)$

- If L is small, the first term will be small, the two final terms are negative, making this negative

Bank profits

- Banks obtain the outcome if the loan cannot be repaid and are repaid for higher outcomes, up to the maximum loan rate at which companies demand loans, and repay deposits
- $\Pi_B = \int_0^{(1+r_L)L} \pi\left(1+R\right) L dF\left(\pi\left(1+R\right)L\right)$
  $+ \int_{(1+r_L)L}^{(1+\overline{r})L} \left(1+r_L\right) L dF\left(\pi\left(1+R\right)L\right) - \left(1+r_D\right)L$

$\Rightarrow$ $\frac{\partial \Pi_B}{\partial (1+r_L)} = \left(F\left(\left(1+\overline{r}_L\right)L\right) - F\left(\left(1+r_L\right)L\right)\right)L > 0$

$\frac{\partial \Pi_B}{\partial L} = \left(F\left(\left(1+\overline{r}_L\right)L\right) - F\left(\left(1+r_L\right)L\right)\right)\left(1+r_L\right) + \frac{1+r_L}{1+\overline{r}_L} - \left(1+r_D\right)$

- If L is small, the first term will be small, the two final terms are negative
- If L is large, the first term will be small

Bank profits

- Banks obtain the outcome if the loan cannot be repaid and are repaid for higher outcomes, up to the maximum loan rate at which companies demand loans, and repay deposits
- $\Pi_B = \int_0^{(1+r_L)L} \pi (1+R) L dF(\pi (1+R) L) + \int_{(1+r_L)L}^{(1+\overline{r})L} (1+r_L) L dF(\pi (1+R) L) - (1+r_D) L$

$\Rightarrow \frac{\partial \Pi_B}{\partial (1+r_L)} = (F((1+\overline{r}_L) L) - F((1+r_L) L)) L > 0$

$\frac{\partial \Pi_B}{\partial L} = (F((1+\overline{r}_L) L) - F((1+r_L) L))(1+r_L) + \frac{1+r_L}{1+\overline{r}_L} - (1+r_D)$

- If L is small, the first term will be small, the two final terms are negative
- If L is large, the first term will be small, the two final terms are negative

Bank profits

- Banks obtain the outcome if the loan cannot be repaid and are repaid for higher outcomes, up to the maximum loan rate at which companies demand loans, and repay deposits
- $\Pi_B = \int_0^{(1+r_L)L} \pi (1+R) L dF(\pi (1+R) L) + \int_{(1+r_L)L}^{(1+\overline{r})L} (1+r_L) L dF(\pi (1+R) L) - (1+r_D) L$

$\Rightarrow \frac{\partial \Pi_B}{\partial (1+r_L)} = (F((1+\overline{r}_L) L) - F((1+r_L) L)) L > 0$

$\frac{\partial \Pi_B}{\partial L} = (F((1+\overline{r}_L) L) - F((1+r_L) L))(1+r_L) + \frac{1+r_L}{1+\overline{r}_L} - (1+r_D)$

- If L is small, the first term will be small, the two final terms are negative
- If L is large, the first term will be small, the two final terms are negative, making this negative

Bank profits

- Banks obtain the outcome if the loan cannot be repaid and are repaid for higher outcomes, up to the maximum loan rate at which companies demand loans, and repay deposits
- $\Pi_B = \int_0^{(1+r_L)L} \pi (1+R) L dF(\pi (1+R) L)$
  $+ \int_{(1+r_L)L}^{(1+\overline{r})L} (1+r_L) L dF(\pi (1+R) L) - (1+r_D) L$

$\Rightarrow \frac{\partial \Pi_B}{\partial (1+r_L)} = (F((1+\overline{r}_L) L) - F((1+r_L) L)) L > 0$

$\frac{\partial \Pi_B}{\partial L} = (F((1+\overline{r}_L) L) - F((1+r_L) L))(1+r_L) + \frac{1+r_L}{1+\overline{r}_L} - (1+r_D)$

- If L is small, the first term will be small, the two final terms are negative
- If L is large, the first term will be small, the two final terms are negative
- If L is intermediate, the first term will be positive

Bank profits

- Banks obtain the outcome if the loan cannot be repaid and are repaid for higher outcomes, up to the maximum loan rate at which companies demand loans, and repay deposits
- $\Pi_B = \int_0^{(1+r_L)L} \pi (1+R) L dF(\pi (1+R) L) + \int_{(1+r_L)L}^{(1+\overline{r})L} (1+r_L) L dF(\pi (1+R) L) - (1+r_D) L$

$\Rightarrow \frac{\partial \Pi_B}{\partial (1+r_L)} = (F((1+\overline{r}_L) L) - F((1+r_L) L)) L > 0$

$\frac{\partial \Pi_B}{\partial L} = (F((1+\overline{r}_L) L) - F((1+r_L) L))(1+r_L) + \frac{1+r_L}{1+\overline{r}_L} - (1+r_D)$

- If L is small, the first term will be small, the two final terms are negative
- If L is large, the first term will be small, the two final terms are negative
- If L is intermediate, the first term will be positive, the two final terms are negative

Bank profits

- Banks obtain the outcome if the loan cannot be repaid and are repaid for higher outcomes, up to the maximum loan rate at which companies demand loans, and repay deposits
- $\Pi_B = \int_0^{(1+r_L)L} \pi (1+R) L dF(\pi (1+R) L) + \int_{(1+r_L)L}^{(1+\overline{r})L} (1+r_L) L dF(\pi (1+R) L) - (1+r_D) L$

$\Rightarrow \frac{\partial \Pi_B}{\partial (1+r_L)} = (F((1+\overline{r}_L) L) - F((1+r_L) L)) L > 0$

$\frac{\partial \Pi_B}{\partial L} = (F((1+\overline{r}_L) L) - F((1+r_L) L))(1+r_L) + \frac{1+r_L}{1+\overline{r}_L} - (1+r_D)$

- If L is small, the first term will be small, the two final terms are negative
- If L is large, the first term will be small, the two final terms are negative
- If L is intermediate, the first term will be positive, the two final terms are negative, allowing this to be positive

Bank profits

- Banks obtain the outcome if the loan cannot be repaid and are repaid for higher outcomes, up to the maximum loan rate at which companies demand loans, and repay deposits
- $\Pi_B = \int_0^{(1+r_L)L} \pi\left(1+R\right) L dF\left(\pi\left(1+R\right)L\right)$
  $+ \int_{(1+r_L)L}^{(1+\overline{r})L} \left(1+r_L\right) L dF\left(\pi\left(1+R\right)L\right) - \left(1+r_D\right)L$

$\Rightarrow$ $\frac{\partial \Pi_B}{\partial (1+r_L)} = \left(F\left(\left(1+\overline{r}_L\right)L\right) - F\left(\left(1+r_L\right)L\right)\right)L > 0$

$\frac{\partial \Pi_B}{\partial L} = \left(F\left(\left(1+\overline{r}_L\right)L\right) - F\left(\left(1+r_L\right)L\right)\right)\left(1+r_L\right) + \frac{1+r_L}{1+\overline{r}_L} - \left(1+r_D\right)$

- If L is small, the first term will be small, the two final terms are negative
- If L is large, the first term will be small, the two final terms are negative
- If L is intermediate, the first term will be positive, the two final terms are negative, allowing this to be positive

Non-monotonous supply curve

Non-monotonous supply curve

- Isoprofit curve of the bank: $\frac{\partial(1+r_L)}{\partial L} = -\frac{\frac{\partial \Pi_B}{\partial L}}{\frac{\partial \Pi_B}{\partial(1+r_L)}}$

Non-monotonous supply curve

- Isoprofit curve of the bank: $\frac{\partial(1+r_L)}{\partial L} = -\frac{\frac{\partial \Pi_B}{\partial L}}{\frac{\partial \Pi_B}{\partial(1+r_L)}}$
- Positive for small loans

Non-monotonous supply curve

- Isoprofit curve of the bank: $\frac{\partial(1+r_L)}{\partial L} = -\frac{\frac{\partial \Pi_B}{\partial L}}{\frac{\partial \Pi_B}{\partial(1+r_L)}}$
- Positive for small loans, negative for intermediate loans

Non-monotonous supply curve

- Isoprofit curve of the bank: $\frac{\partial(1+r_L)}{\partial L} = -\frac{\frac{\partial \Pi_B}{\partial L}}{\frac{\partial \Pi_B}{\partial(1+r_L)}}$
- Positive for small loans, negative for intermediate loans, positive for large loans

Non-monotonous supply curve

- Isoprofit curve of the bank: $\frac{\partial(1+r_L)}{\partial L} = -\frac{\frac{\partial \Pi_B}{\partial L}}{\frac{\partial \Pi_B}{\partial(1+r_L)}}$
- Positive for small loans, negative for intermediate loans, positive for large loans
- Optimal profits are at $\frac{\partial \Pi_B}{\partial(1+r_L)L} = 0$

Non-monotonous supply curve

- Isoprofit curve of the bank: $\frac{\partial(1+r_L)}{\partial L} = -\frac{\frac{\partial \Pi_B}{\partial L}}{\frac{\partial \Pi_B}{\partial(1+r_L)}}$
- Positive for small loans, negative for intermediate loans, positive for large loans
- Optimal profits are at $\frac{\partial \Pi_B}{\partial(1+r_L)L} = 0$

$\Rightarrow 1 + r_D = \left(F\left(\left(1+\overline{r}_L\right)L\right) - F\left(\left(1+r_L\right)L\right)\right)\left(1+r_L\right)$

Non-monotonous supply curve

- Isoprofit curve of the bank: $\frac{\partial(1+r_L)}{\partial L} = -\frac{\frac{\partial \Pi_B}{\partial L}}{\frac{\partial \Pi_B}{\partial(1+r_L)}}$
- Positive for small loans, negative for intermediate loans, positive for large loans
- Optimal profits are at $\frac{\partial \Pi_B}{\partial(1+r_L)L} = 0$

$\Rightarrow 1 + r_D = \left(F\left(\left(1+\overline{r}_L\right)L\right) - F\left(\left(1+r_L\right)L\right)\right)\left(1+r_L\right)$

$\Rightarrow \frac{\partial \Pi_B}{\partial L} = \frac{1+r_L}{1+\overline{r}_L} > 0$

Non-monotonous supply curve

- Isoprofit curve of the bank: $\frac{\partial(1+r_L)}{\partial L} = -\frac{\frac{\partial \Pi_B}{\partial L}}{\frac{\partial \Pi_B}{\partial(1+r_L)}}$
- Positive for small loans, negative for intermediate loans, positive for large loans
- Optimal profits are at $\frac{\partial \Pi_B}{\partial(1+r_L)L} = 0$

$\Rightarrow 1 + r_D = \left(F\left(\left(1+\overline{r}_L\right)L\right) - F\left(\left(1+r_L\right)L\right)\right)\left(1+r_L\right)$

$\Rightarrow \frac{\partial \Pi_B}{\partial L} = \frac{1+r_L}{1+\overline{r}_L} > 0$

$\Rightarrow$ Maximal profits where the supply curve is decreasing

Non-monotonous supply curve

- Isoprofit curve of the bank: $\frac{\partial(1+r_L)}{\partial L} = -\frac{\frac{\partial \Pi_B}{\partial L}}{\frac{\partial \Pi_B}{\partial(1+r_L)}}$
- Positive for small loans, negative for intermediate loans, positive for large loans
- Optimal profits are at $\frac{\partial \Pi_B}{\partial(1+r_L)L} = 0$

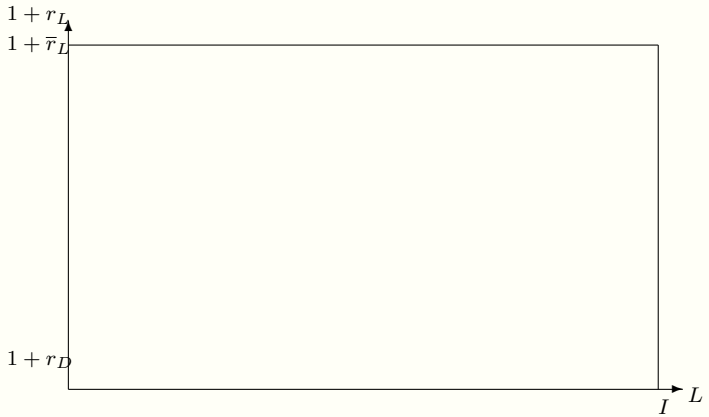
$\Rightarrow 1 + r_D = \left(F\left(\left(1+\overline{r}_L\right)L\right) - F\left(\left(1+r_L\right)L\right)\right)\left(1+r_L\right)$

$\Rightarrow \frac{\partial \Pi_B}{\partial L} = \frac{1+r_L}{1+\overline{r}_L} > 0$

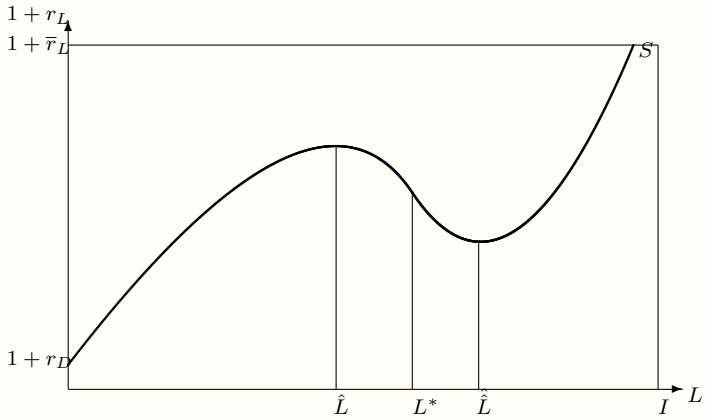
$\Rightarrow$ Maximal profits where the supply curve is decreasing

Demand and supply

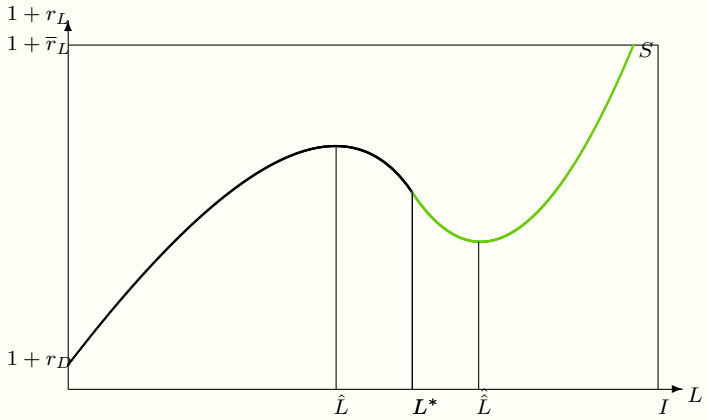
Demand and supply



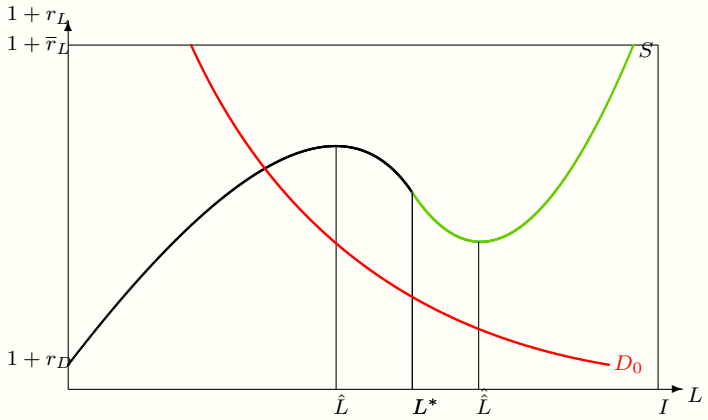
Demand and supply



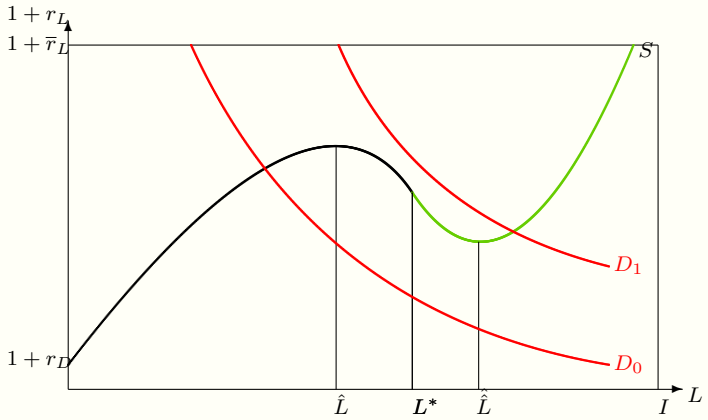
Demand and supply



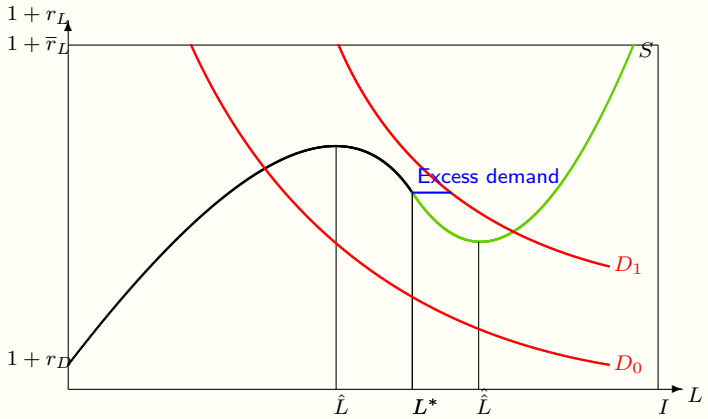
Demand and supply



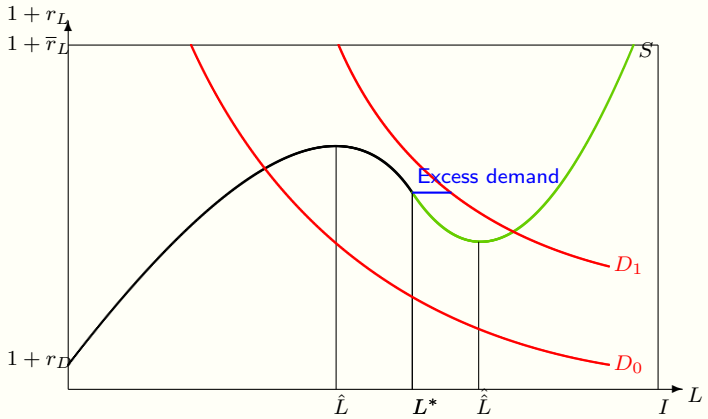
Demand and supply



Demand and supply



Demand and supply



Summary

Summary

- If loan demand is high, credit rationing can occur

Summary

- If loan demand is high, credit rationing can occur
- Banks will reduce loan repayments for large loans

Summary

- If loan demand is high, credit rationing can occur
- Banks will reduce loan repayments for large loans as otherwise they will not be repaid

Summary

- If loan demand is high, credit rationing can occur
- Banks will reduce loan repayments for large loans as otherwise they will not be repaid, increasing losses from default

Summary

- If loan demand is high, credit rationing can occur
- Banks will reduce loan repayments for large loans as otherwise they will not be repaid, increasing losses from default
- Increasing loan rates does not compensate for this risk if loans are not repaid

Summary

- If loan demand is high, credit rationing can occur
- Banks will reduce loan repayments for large loans as otherwise they will not be repaid, increasing losses from default
- Increasing loan rates does not compensate for this risk if loans are not repaid
- Uncertainty about loan repayments induces banks to limit the size of loans and maximize repayments

Summary

- If loan demand is high, credit rationing can occur
- Banks will reduce loan repayments for large loans as otherwise they will not be repaid, increasing losses from default
- Increasing loan rates does not compensate for this risk if loans are not repaid
- Uncertainty about loan repayments induces banks to limit the size of loans and maximize repayments
- Companies seeking a large loan might be rationed and only obtain a smaller loan than they seek

Summary

- If loan demand is high, credit rationing can occur
- Banks will reduce loan repayments for large loans as otherwise they will not be repaid, increasing losses from default
- Increasing loan rates does not compensate for this risk if loans are not repaid
- Uncertainty about loan repayments induces banks to limit the size of loans and maximize repayments
- Companies seeking a large loan might be rationed and only obtain a smaller loan than they seek

This presentation is based on
Andreas Krause: Theoretical Foundations of Banking, 2025

Andreas Krause
Department of Economics
University of Bath
Claverton Down
Bath BA2 7AY
United Kingdom

E-mail: mnsak@bath.ac.uk