Countercyclical credit market tightness and macroprudential regulation

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Main argument of the paper

- We develop a simple macro-finance model, with agency problems in both banks and firms.
- Key dynamic relationship: countercyclical credit market tightness (excess spread).
  - credit supply is more volatile/cyclical than credit demand
  - depends on aggregate bank leverage
- These credit market dynamics
  - exacerbate agency problems in banks
  - but mitigate agency problems in firms

Main argument of the paper

- We compare the market equilibrium to the second-best social optimum
- We show that in the market equilibrium bank leverage is too high
  - banks have too little equity and too much debt
- This is due to a pecuniary externality: banks do not fully internalize how their leverage choice affects agency problems
- $=>$ Room for macroprudential regulation
- We also consider partial regulation, with unregulated shadow banks.

Related literature

- Financial frictions and pecuniary externalities: Gertler, Kiyotaki and Queralto (2012), Stein (2012), Bianchi and Mendoza (2018), Jeanne and Korinek (2019).
- Macroprudential regulation: Van den Heuvel (2008), Repullo and Suarez (2013), Bianchi and Mendoza (2018), Malherbe (2020)
- Banking and shadow banking: Martinez-Miera and Repullo (2019)
- Macro-at-risk: Adrian, Boyarchenko, Giannone (2019)
- Macro applications of Holmström-Tirole (1997): Chen (2001), Meh and Moran (2011), Chang, Fernandez and Gulan (2017), Silvo (2019).

Macro framework

- Simplest possible macro framework
- Representative consumption good can be produced with two alternative technologies
  1. Modern technology: more efficient but involves agency problems (entrepreneurs carry out production, bankers monitor)
  2. Traditional technology (or home production): less efficient, but no agency problems
- Both techonologies use the same factor of production, which is of fixed supply (which can be thought of as land, or 'Lucas tree')
- Ideally, one would like to use only the modern technology, but this is not possible, due to the agency problems (agency problems limit the size of the modern sector)
- Inifinite horizon model (in macro tradition)

Macro framework

- Alternative interpretation: open economy framework
- Only modern technology used in production (in the home country)
- Agency problems limit / set the (maximum feasible) scale of production (in the home country)
- The inputs needed in production are bought from abroad
- Same analysis, and same results also from this interpretation

Households

- Representative households, with three types of members
  1. Entrepreneurs
  2. Bankers
  3. Outside financiers
- Derive utility from consumption

$$E_t \left[\sum_{j=0}^{\infty} \beta^j \frac{C_{t+j}^{1-\eta}}{1-\eta} \right]$$

Dual moral hazard in Holmström and Tirole (1997)

- Entrepreneur produces the good, and wants to increase the size of a project by borrowing.
- **Moral hazard between entrepreneurs and lenders**
  - Entrepreneurs face incentives to choose a socially non-optimal pet project
  - The pet project has a lower success rate (p_L) than the socially optimal rate (p_H), but it offers the entrepreneurs some private benefits.
- Banks' monitoring may alleviate the moral hazard problem: monitoring prevents the most outrageous pet projects
- Monitoring is costly: bankers have to be given proper incentives to monitor $=>$ **second moral hazard problem**

'Informed capital' in Holmström and Tirole (1997)

- Both entrepreneurs and bankers must be given proper incentives
- => Entrepreneurs and bankers must have some 'skin in the game': they must invest their own money in the project
- => Role for entrepreneurial capital and bankers' capital ('informed capital')
- => Outside funding (from depositors/money market funds etc.) depends positively on 'informed capital'
- => Production scale depends positively on 'informed capital'

Loan supply and loan demand

- Key implications of the Holmström-Tirole framework for our analysis:
  1. Aggregate loan supply is proportional to aggregate bank capital.
  2. Aggregate loan demand is proportional to aggregate firm capital.

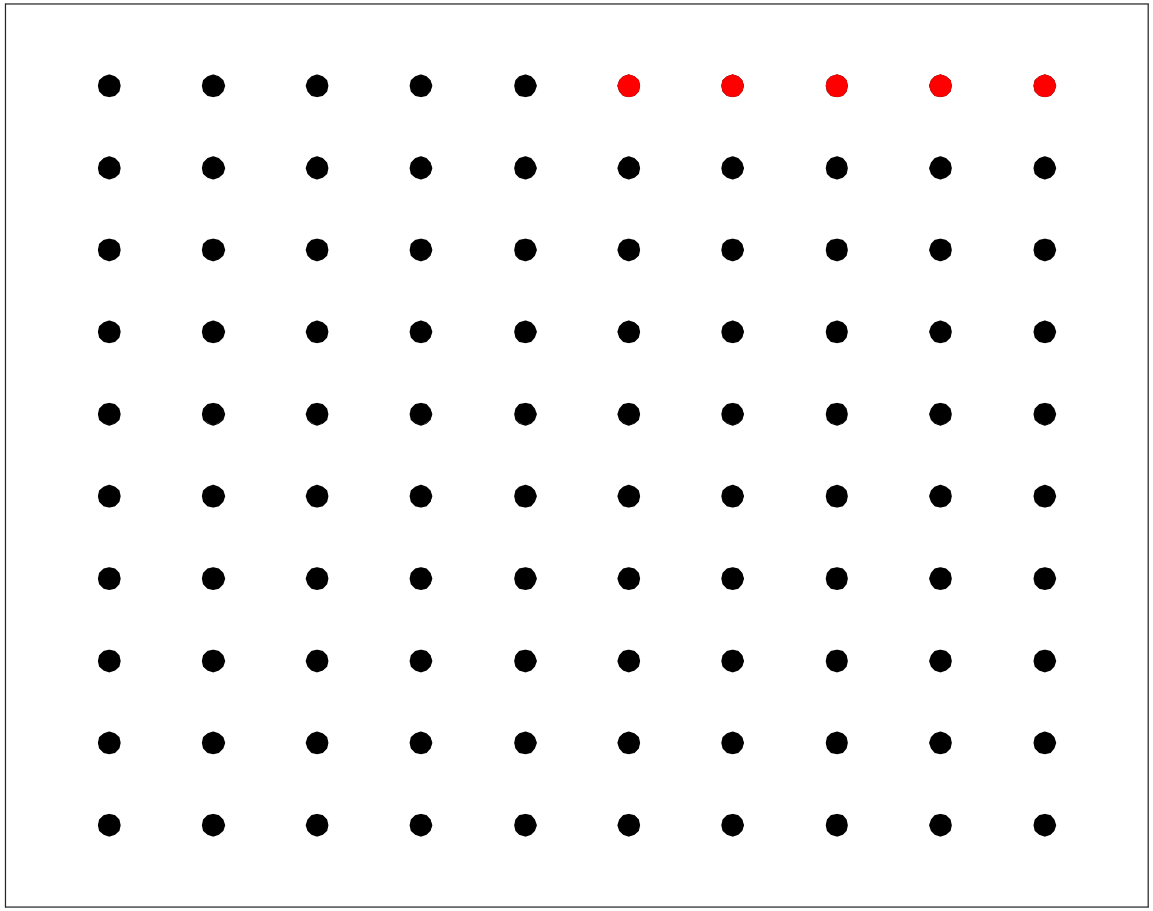
- $=>$ If aggregate bank capital is more (pro)cyclical than firm capital, loan supply is more procyclical than loan demand.
- $=>$ Then credit market tightness is countercyclical.

Key assumption: banks are larger than firms

- Each firm is small and specialized
- If the firm's production project fails, the firm goes bankrupt
- Each bank is associated with a continuum of (small) firms
- Each bank has a diversified loan porfolio $=>$ provides protection against idiosyncratic risks/shocks
  - If the bank has lent money to a firm and the firm defaults, the bank does not fail
- However, aggregate bank capital is more sensitive to aggregate shocks than aggregate firm capital

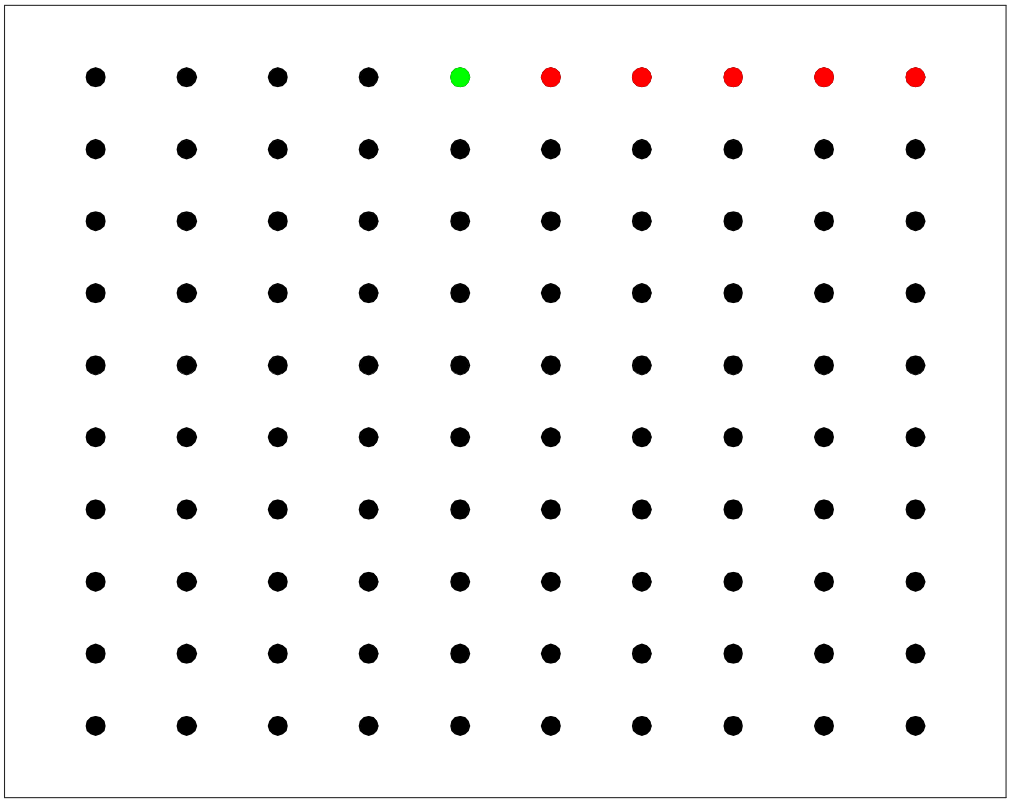
Firms are small and specialized

- Assume that in normal times 95% of projects succeed, and 5% of projects fail
  - Failing projects return 0, failing firms go bankrupt



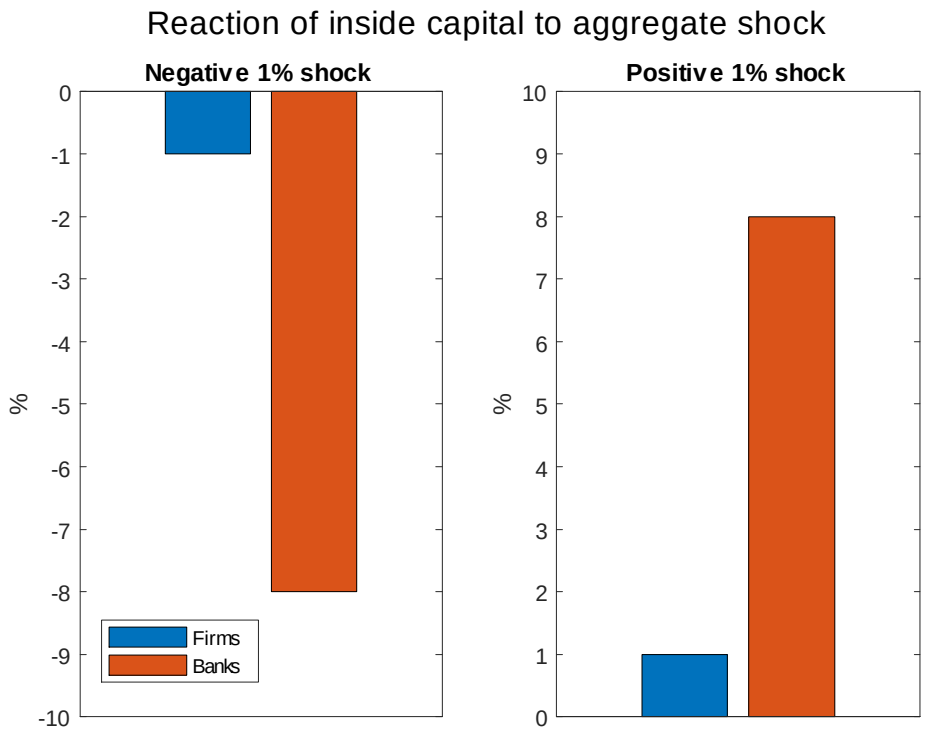
Firms are small and specialized

- Assume that in normal times 95% of projects succeed, and 5% of projects fail
  - Failing projects return 0, failing firms go bankrupt
- Negative aggregate shock: the success rate drops by 1 pp



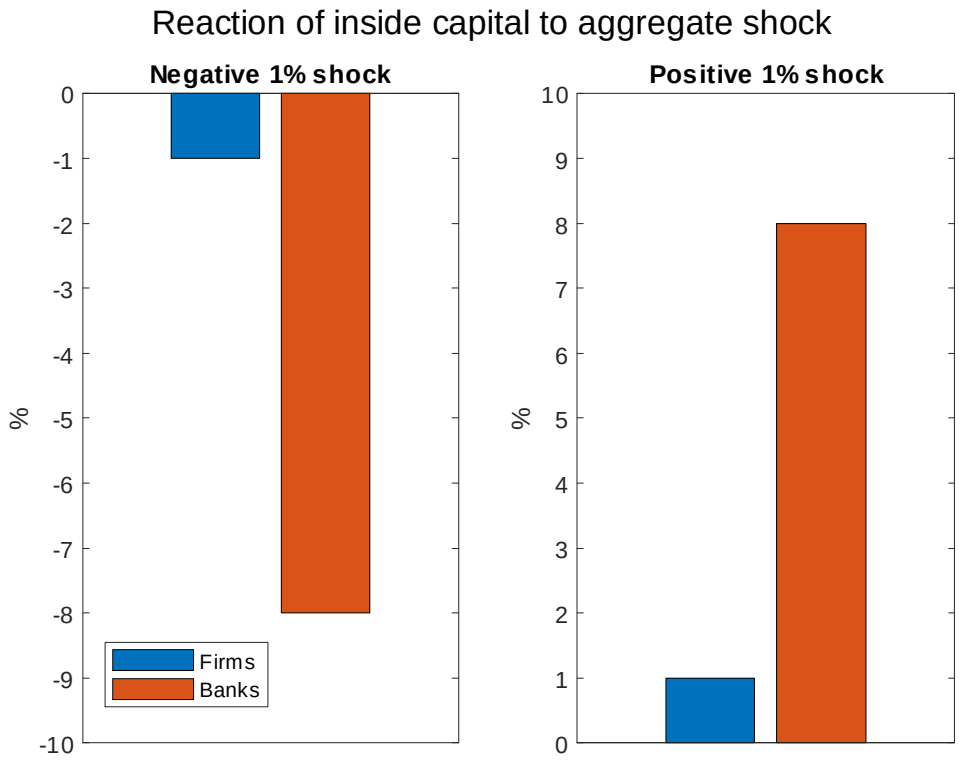
Aggregate bank capital is more sentive to aggregate shocks than aggregate firm capital

- Assume that bank leverage is 8. If the default rate of the bank's customers rises by 1 pp, bank capital takes a 8% hit.



Loan supply and loan demand

- Note: Aggregate loan demand $\sim$ aggregate entrepreneurial capital
- ... aggregate loan supply $\sim$ aggregate banker-owned capital
- $=>$ aggregate shock has a stronger effect on (next period) loan supply than loan demand

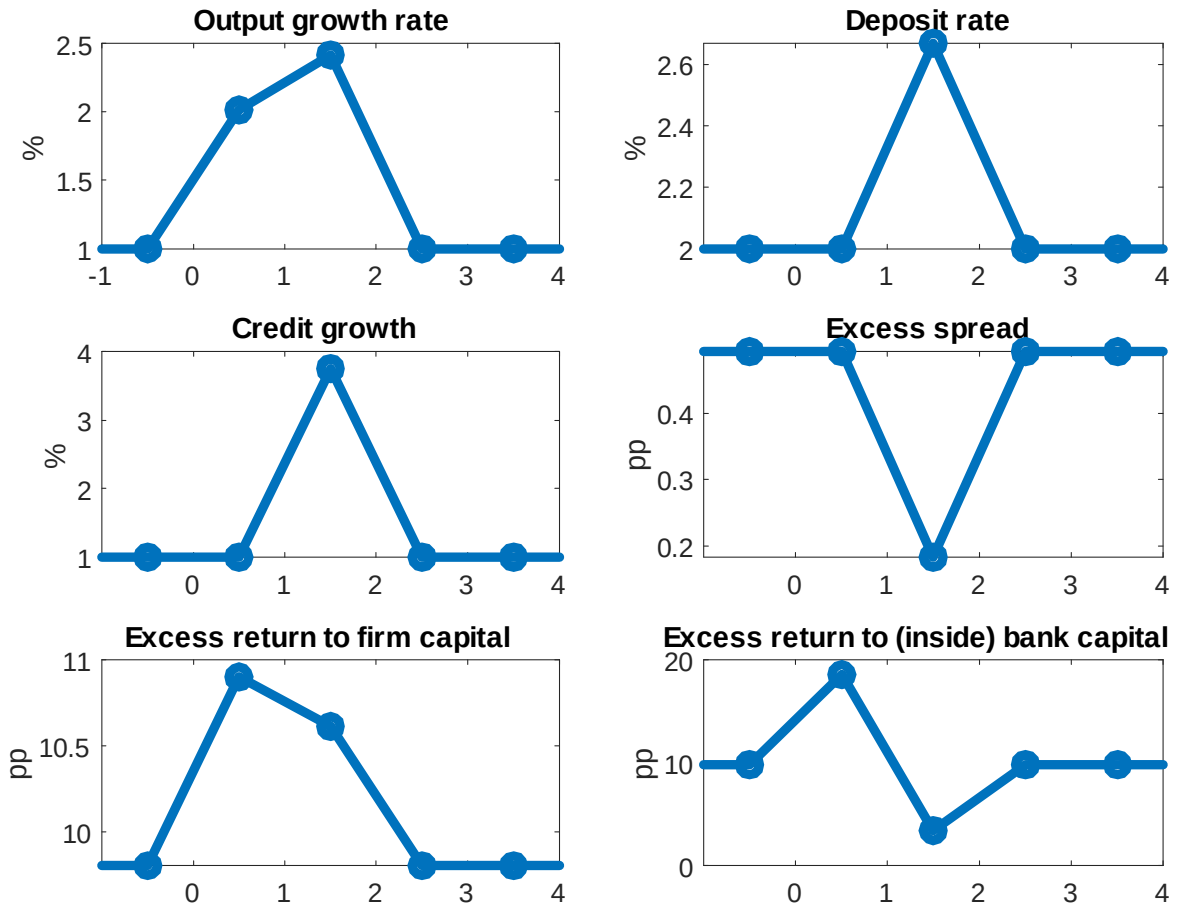


Excess spread

- Spread = banks' lending rate - deposit rate
- Spread = firms' default risk + excess spread
- Excess spread derives from agency problems in banks and firms
  - excess spread reflects the relative scarcity of bankers capital and entrepreneurial capital

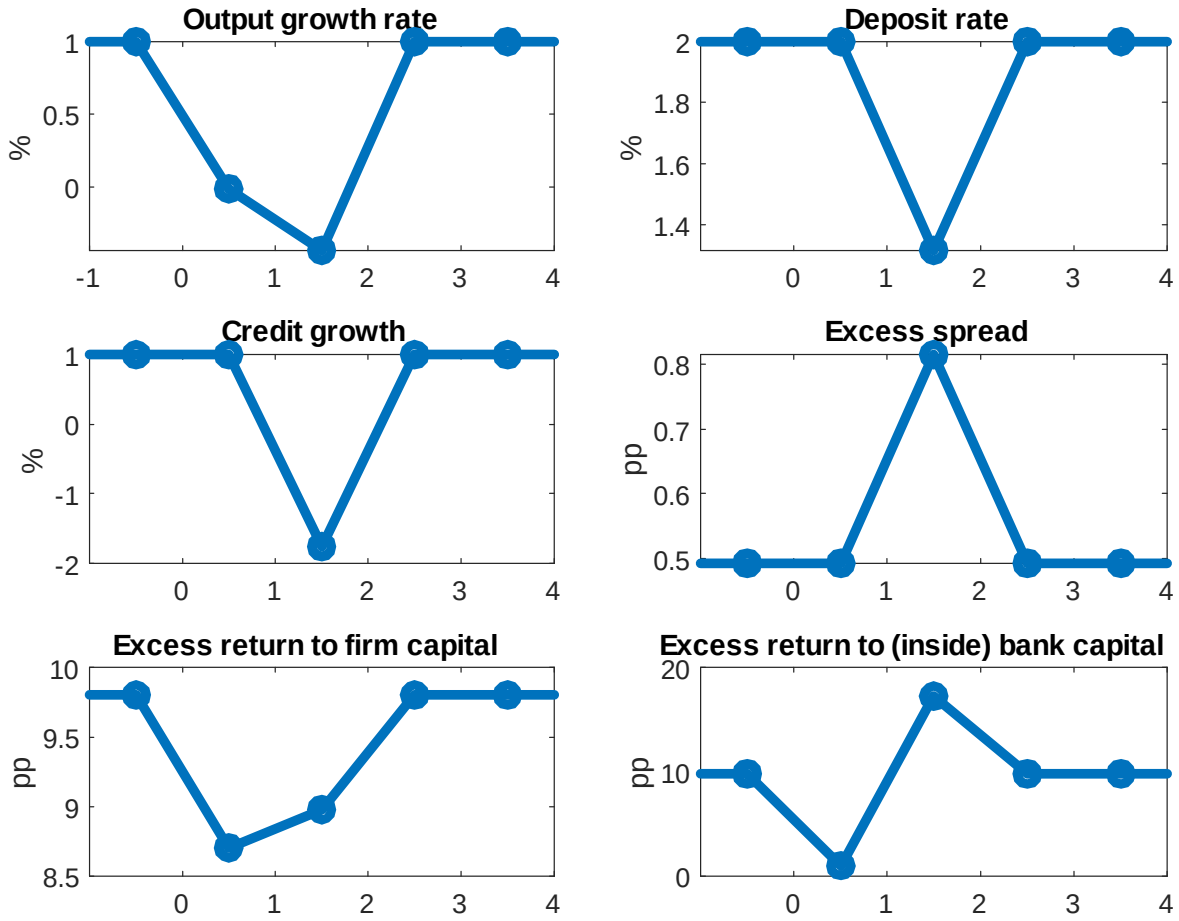
Countercyclical credit market tightness

- Macro and credit market dynamics after a 1 pp shock to firms' success rate in period 1 (i.e. default rate falls by 1 pp).



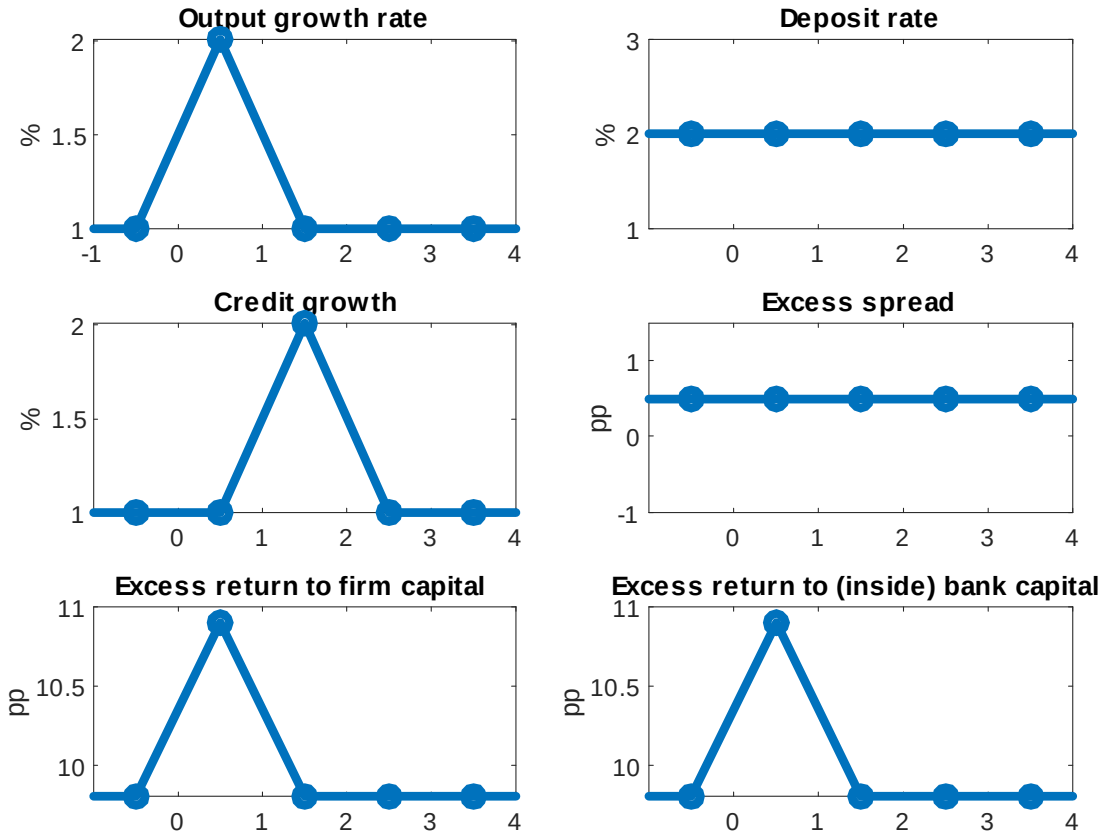
Countercyclical credit market tightness

- Macro and credit market dynamics after a -1 pp shock to firms' success rate in period 1 (i.e. default rate rises by 1 pp).



Countercyclical credit market tightness

- Macro and credit market dynamics after a 1 pp shock to firms' success rate in period 1 (i.e. default rate falls by 1 pp).
- Dynamics if banks were not levered (i.e. here we assume that banks finance themselves with equity only)



Incentives, shocks and cycles: banks

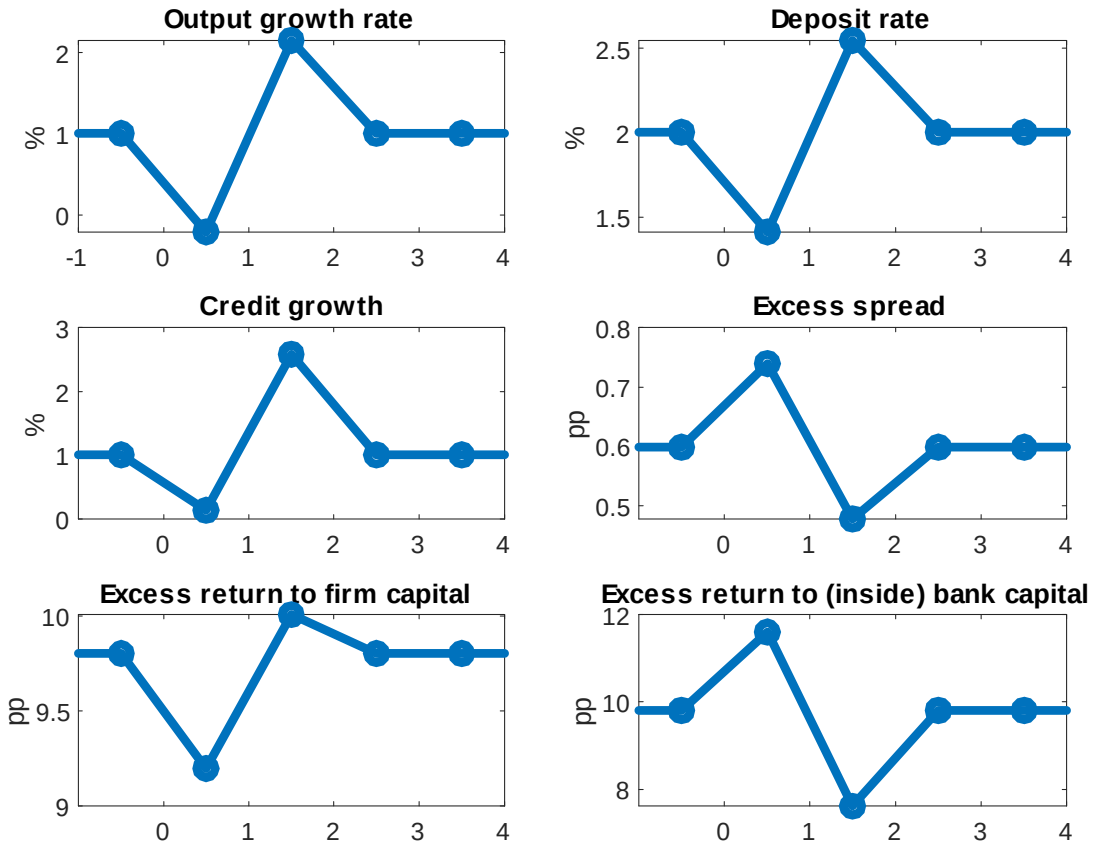
- After a positive (aggregate) shock, a bank is well capitalized; i.e. bankers have lots of money
- However, also other banks are well capitalized, and other bankers have lots of money
- But then in the next period
  - aggregate credit supply is high
  - the credit spread is low
  - the (expected) yield on bankers' capital is low
- After a negative (aggregate) shock, we have the opposite situation
- These **cyclical properties** of rewards and yields make the **incentive problem** **more serious on the bank side**.

Incentives, shocks and cycles: firms

- After a positive (aggregate) shock, entrepreneurs (as an aggregate) have lots of money
- ... and credit spreads are low $=>$ good time to (re)invest entrepreneurs's money in production
- After a negative (aggregate) shock, we have the opposite situation
- These **cyclical properties** of rewards and yields make the **incentive problem** **less serious on the firm side**.

Uncertainty lowers credit supply on impact

- Macro and credit market dynamics when there is uncertainty in period 0 (regarding the default rate in period 1).



Aggregate bank leverage

- Aggregate bank leverage is the key variable in the model
- The higher the aggregate bank leverage
  - the more pro-cyclical the credit supply
  - the more counter-cyclical the credit market tightness
  - the more severe the agency problems in banks
  - the less severe the agency problems in firms
- Key question: How is aggregate bank leverage determined
  - in the market equilibrium
  - in the social optimum

Banks' capital structure

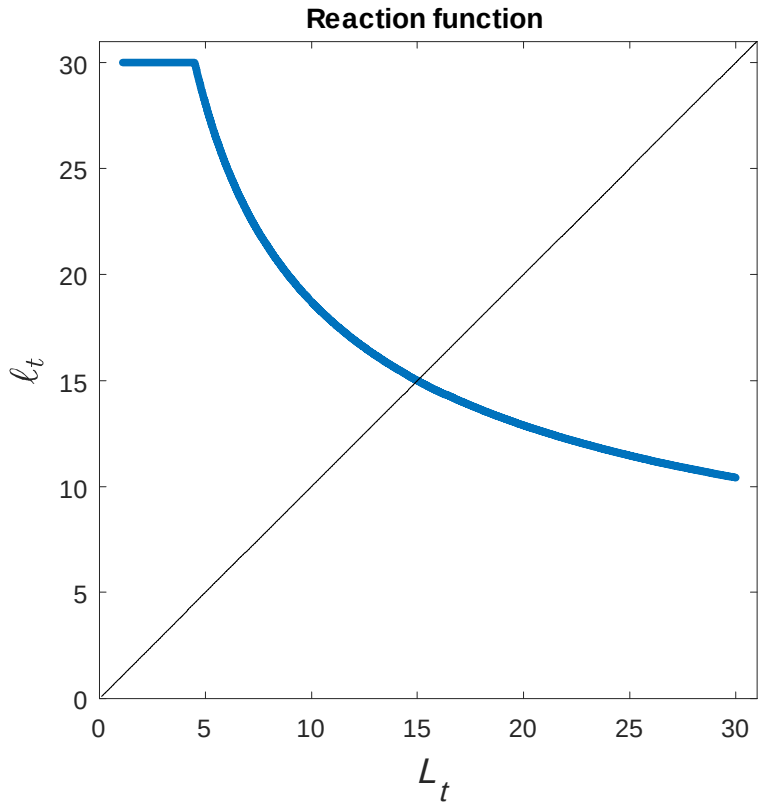
- A bank has a certain amount of banker-owned (informed) capital (or inside equity)
  - 'skin in the game'
  - In each period, this is a predetermined variable
- The bank can raise outside funding from households
  - outside equity
  - debt (either deposit funding or whole sale funding)

Pros and cons of outside equity for an individual bank

- Cons:
  - Households demand an equity premium
  - ... and we further assume that issuing outside equity involves some real costs (compared to debt funding)
    - costs of processing and credibly revealing information, unfavorable signalling effects, the liquidity services provided by deposits, or the different tax treatment of equity and debt.
- Pros:
  - Outside equity provides a shock cushion and renders banker-owned inside equity less risky and volatile
    - The credit supply of a well-capitalized bank is less pro-cyclical
    - A well-capitalized bank is in a good position to benefit from high credit spreads (after a negative aggregate shock)

Bank leverage choice in market equilibrium

- L_t aggregate bank leverage in the economy, ℓ_t leverage choice of an individual bank
- **Banks' leverages choices are strategic substitutes.**
  - Intuition: the higher the aggregate bank leverage, the more counter-cyclical is the credit market tightness.



Structure of banks' balance sheets

- Liability side (the main focus of the paper)
  - inside equity (owned by bank insiders): provides incentives + absorbes shocks
  - outside equity: absorbes shocks
  - debt (deposits and/or whole sale funding from money markets)
- Assets side
  - In our simple model just loans to firms/entrepreneurs

Welfare cost of business cycles

$$W_t = \frac{E_t \sum_{j=1}^{\infty} \beta^{j-1} \left[U\left(C_{t+j}\right) - U\left(\overline{C}_{t+j}\right) \right]}{U'\left(\overline{C}_{t+1}\right) \overline{C}_{t+1}}$$

where C_{t+j} is consumption in period $t+j$ and $\overline{C}_{t+j}$ denotes consumption on the balanced growth path, with no aggregate uncertainty.

- Up to second-order approximation,

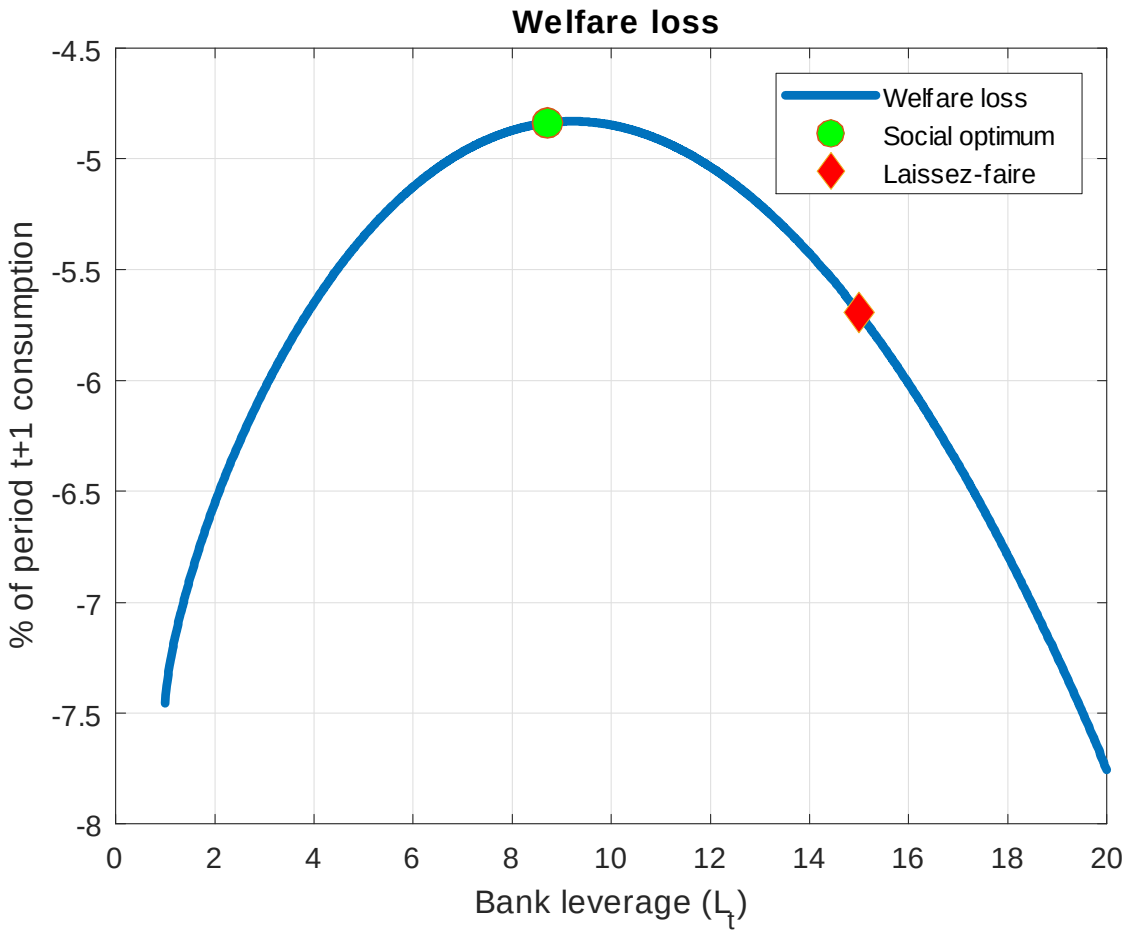
$$W_t = \sum_{j=1}^{\infty} \left(\frac{1+g}{1+r^d} \right)^{j-1} \left[E_t \left[\widehat{c}_{t+j} \right] - \frac{1}{2} \eta \, Var_t \left[\widehat{c}_{t+j} \right] \right]$$

  - where g is growth rate and r^d is household interest rate on the balanced growth path, η measures households' risk aversion, and

$$\widehat{c}_{t+j} = \frac{C_{t+j} - \overline{C}_{t+j}}{\overline{C}_{t+j}}$$

    is detrended consumption.

Welfare loss

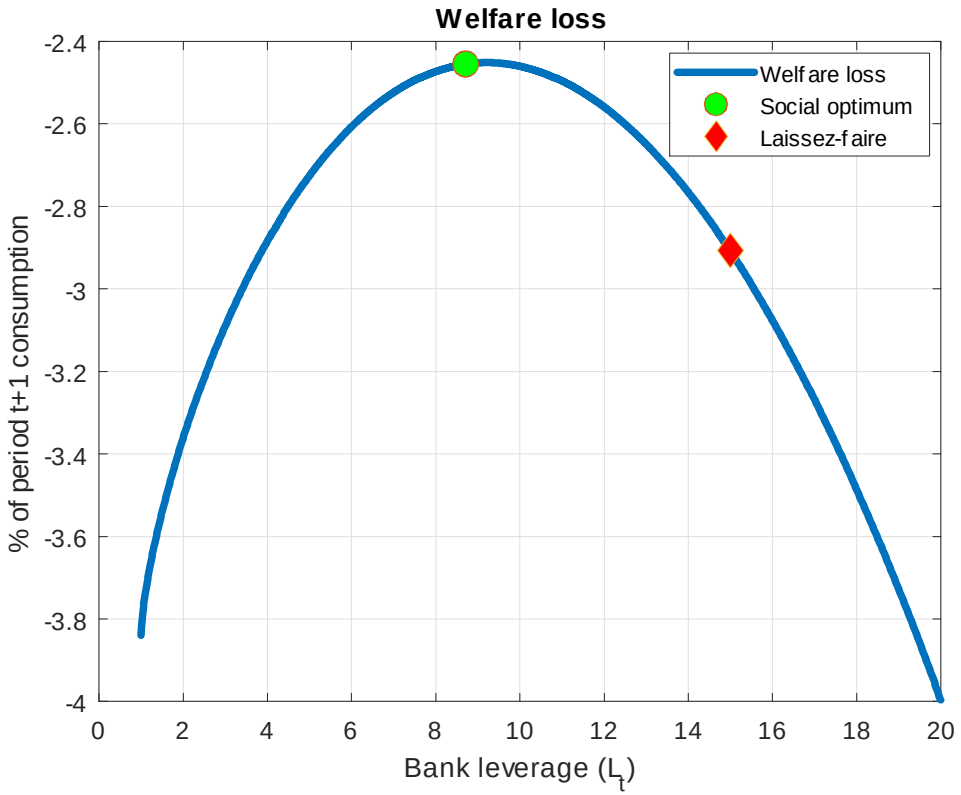


- The figure shows how period t aggregate bank leverage (L_t) affects social welfare

Explaining the magnitude of the welfare loss

- The welfare loss is rather large.
- Key reasons: There are two multipliers
  1. The fiancial multiplier (aggregate bank leverage)
  2. ... which interacts with a **revaluation effect/multiplier**
     - Akin to Fisherian debt deflation
     - Negative shock in period t $=>$ recession in period t but even deeper recession in period $t+1$ $=>$ people want to save in period t $=>$ the price of period t consumption goods (in terms of land/Lucas tree) falls $=>$ banks and firms have even weaker balance sheets in period t (revaluation) $=>$ still deeper recession in period $t+1$
- Furthermore, the shocks have temporary effects on growth rates, but permanent effects on levels (e.g. future consumption levels).

Welfare loss without revaluation multiplier



- Note: The revaluation multiplier (or the lack of it) only changes the scale of welfare losses. In particular, it does not affect aggregate bank leverage in social optimum or under laissez-faire.

Anatomy of market failure

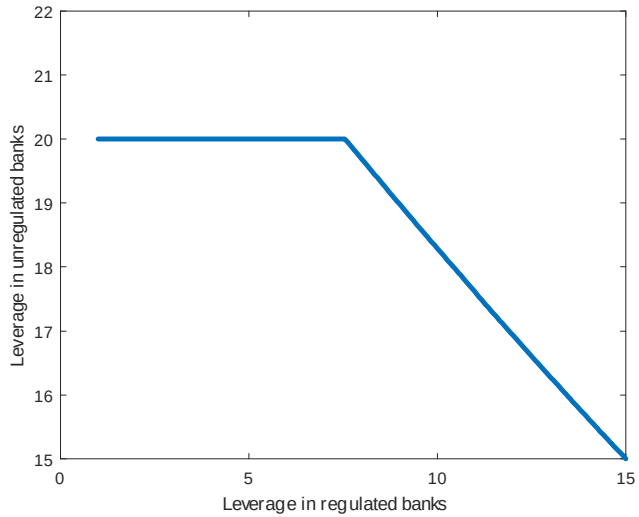
Banks' balance sheets structures and bank leverage are linked to economic outcomes and social welfare through two channels.

1. Higher bank leverage implies higher macro volatility, which lowers social welfare.
2. Higher bank leverage implies more countercyclcal tightness of the credit market. This aggravates the agency problems in finance, which implies worse macroeconomic outcomes and lower social welfare.

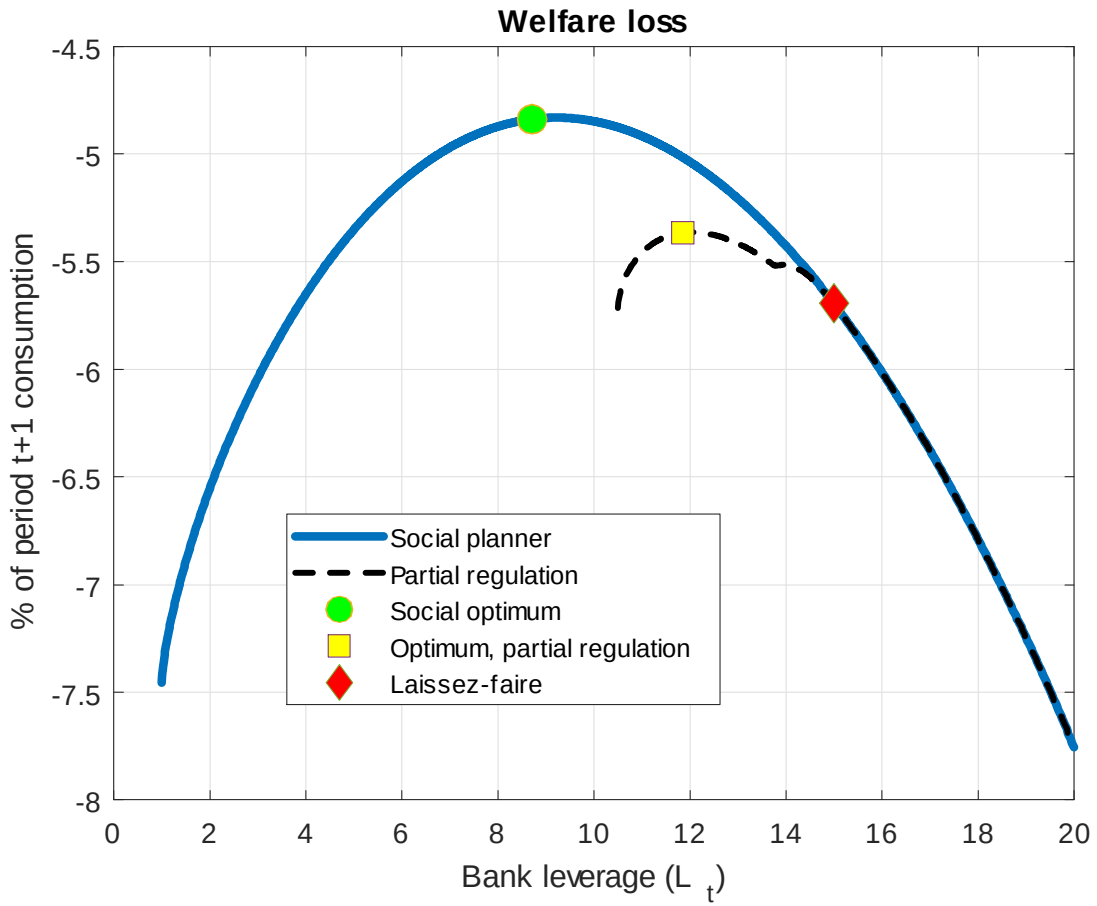
- When choosing their capital structure, so as to maximize the share price, the banks take into account mechanism 1. Essentially: higher leverage of an individual bank also raises the equity premium demanded by households.
- However the individual banks do not take into account mechanism 2.

Partial regulation

- Assume that the government can only regulate a part of the banking sectors
- ... while the remaining (shadow) banks lie beyond regulation
- Problem: banks' capital structure choices are strategic substitutes
- Shadow banks free ride on the stability created by regulation



Welfare loss: partial regulation



Conclusions

1. High bank leverage makes
   - the macro economy more volatile
   - the tightness of the credit market more countercyclical
2. Countercyclical credit market tightness
   - mitigates agency problems in firms
   - exacerbates agency problems in banks
   - overall, aggravates financial frictions
3. Individual banks do not take into account item 2.
   - Bank leverage is too high under laissez-faire
   - Bank regulation can raise social welfare

Aggregate uncertainty: implications for financial contracts

- Revenue shares demanded by insiders. The larger the insiders' shares, the worse the financial frictions.
  - less can be pledged to outsiders => less funding from outsiders => smaller projects => less production
- Entrepreneurs

$$\widehat{R}_t^e = R^e \left(1 + \theta_t^e\right)$$

- Bankers

$$\widehat{R}_t^b = R^b \left(1 + \ell_t \theta_t^b\right)$$

- R^e and R^b are the revenue shares without aggregate uncertainty.
- θ_t^e and θ_t^b are the risk prices of entrepreneurs and bankers.
- ℓ_t leverage in an individual bank

Risk prices

- Households

$$\theta_t^h = \eta \sigma_t^2$$

- Entrepreneurs $\theta_t^e = \theta_t^h + \Delta\theta_t^e$, where

$$\Delta\theta_t^e = -\left(\frac{m}{m+n}\right)\left(\frac{1+g}{1+r^d}\right)(L_t - 1)\,\sigma_t^2 < 0$$

- Bankers $\theta_t^b = \theta_t^h + \Delta\theta_t^b$,where

$$\Delta\theta_t^b = \left(\frac{n}{m+n}\right)\left(\frac{1+g}{1+r^d}\right)(L_t - 1)\,\sigma_t^2 > 0$$

- L_t is aggregate leverage in banks and σ_t^2 is variance of aggregate shock.
- g is growth rate and r^d is household interest rate on the balanced growth path.m is monitoring costs and n is entrepreneurs' non-verifiable income. η measures household risk aversion.

Welfare cost of business cycles (2)

- Short-run detrended growth rate: detrended growth from period t to period $t+1$

$$\widehat{g}^{SR} \equiv \widehat{g}_{t,t+1}$$

- Long-run detrended growth rate: detrended growth from period t to period $t+2$

$$\widehat{g}^{LR} \equiv \widehat{g}_{t,t+2}$$

- One can show that

$$\widehat{c}_{t+1} = \widehat{g}^{SR} \quad \text{and } \widehat{c}_{t+j} = \widehat{g}^{LR} \text{ for } j = 2, 3, ...$$

Welfare cost of business cycles (3)

- Then

$$
\begin{aligned}
W_t &= E_t\left[\widehat{g}^{SR}\right] - \frac{1}{2}\eta\, Var_t\left[\widehat{g}^{SR}\right] \\
&\quad + \sum_{j=1}^{\infty}\left(\frac{1+g}{1+r^d}\right)^j\left\{E_t\left[\widehat{g}^{LR}\right] - \frac{1}{2}\eta\, Var_t\left[\widehat{g}^{LR}\right]\right\} \\
&= E_t\left[\widehat{g}^{SR}\right] - \frac{1}{2}\eta\, Var_t\left[\widehat{g}^{SR}\right] \\
&\quad + \left(\frac{1+g}{r^d-g}\right)\left\{E_t\left[\widehat{g}^{LR}\right] - \frac{1}{2}\eta\, Var_t\left[\widehat{g}^{LR}\right]\right\}
\end{aligned}
$$

- This measure captures the linkages from period t decisions to social welfare.

Anatomy of market failure: Thought experiment

- Assume that the social planner chooses L_t so as to maximize the social welfare function W_t,
- .... but for some reason takes the risk prices θ_t^b, θ_t^e as given.
- Hence in this thought experiment the (pseudo)planner seeks to maximize social welfare, but only takes into account mechanism 1) while ignoring mechanism 2).
- One can show that the (pseudo)planner ends up implementing the *laissez-faire* market equilibrium.
- Pecuniary externality is behind the market failure.

Detrended growth and aggregate bank leverage