Rational Overoptimism and Limited Liability

Luca Gemmi

HEC Lausanne

T2M 2023

Exuberance in credit boom-and-busts

- Existing evidence on credit boom-and-bust:
  1. **Credit booms** *predict* **higher risk of financial crisis** (Schularick & Taylor 2012)

Exuberance in credit boom-and-busts

- Existing evidence on credit boom-and-bust:
    1. **Credit booms** *predict* **higher risk of financial crisis** (Schularick & Taylor 2012)
    2. . . . but they are characterized with **lower risk premia** (Krishamurthy & Muir, 2017)

Exuberance in credit boom-and-busts

- Existing evidence on credit boom-and-bust:
  1. **Credit booms** *predict* **higher risk of financial crisis** (Schularick & Taylor 2012)
  2. . . . but they are characterized with **lower risk premia** (Krishamurthy & Muir, 2017)
  3. . . . and they *predict* **negative excess return** on bank stock (Baron and Xiong, 2017)

⇒ ***Systematic* excess risk taking** during credit booms

Existing theories

- Two alternative narratives in the literature:

1. **Limited liability** (Martinez-Miera & Repullo, 2017; Coimbra & Rey, 2020)
    - Motivated by risk taking incentives in payoff structure

Existing theories

- Two alternative narratives in the literature:

1. **Limited liability** (Martinez-Miera & Repullo, 2017; Coimbra & Rey, 2020)
   - Motivated by risk taking incentives in payoff structure
2. ***Behavioral* overoptimism** (Bordalo et al, 2020; Krishnamurthy & Li, 2021)
   - Motivated by evidence of systematic overoptimistic beliefs in booms

$\Rightarrow$ I show how overoptimism can be a result of limited liability

This paper/1

- Theory of procyclical ***rational* overoptimism** driven by **limited liability**

This paper/1

- Theory of procyclical ***rational* overoptimism** driven by **limited liability**

1. ***Rational* overoptimism** from *information frictions*
    1. Aggregate factors increase default risk in booms
    2. Agents don't perfectly observe aggregate risk factors

    ⇒ Rational overoptimism about revenues during credit booms

This paper/1

- Theory of procyclical ***rational* overoptimism** driven by **limited liability**

1. ***Rational* overoptimism** from *information frictions*

    1. Aggregate factors increase default risk in booms

    2. Agents don't perfectly observe aggregate risk factors

    $\Rightarrow$ Rational overoptimism about revenues during credit booms

2. *Information frictions* can result from **limited liability**

    1. Agents can acquire information on risk factors

    2. Limited liability on payoff structure (e.g. managers compensation)

    $\Rightarrow$ Limited liability disincentives attention to risk factors

This paper/2

3. Model reproduces **key empirical features** of credit booms
    1. Financial crises more likely after credit booms (Schularick and Taylor, 2012)
    2. Financial crises more likely after decline in risk premia (Krishamurthy and Muir, 2017)
    3. Banks make systematic losses after credit booms (Baron and Xiong, 2017)

This paper/2

3. Model reproduces **key empirical features** of credit booms
   1. Financial crises more likely after credit booms (Schularick and Taylor, 2012)
   2. Financial crises more likely after decline in risk premia (Krishamurthy and Muir, 2017)
   3. Banks make systematic losses after credit booms (Baron and Xiong, 2017)
4. Model reproduces **quantitatively** *macro* evidence on credit and spreads

This paper/2

3. Model reproduces **key empirical features** of credit booms ← **Today**
    1. Financial crises more likely after credit booms (Schularick and Taylor, 2012)
    2. Financial crises more likely after decline in risk premia (Krishamurthy and Muir, 2017)
    3. Banks make systematic losses after credit booms (Baron and Xiong, 2017)
4. Model reproduces **quantitatively** *macro* evidence on credit and spreads

Policy implications

- Overoptimism results from risk-taking incentives in payoff structure

⇒ **Reducing limited liability** (e.g. regulating compensation)

  - Encourage managers and shareholders to acquire information on risk
  - Reduces overoptimism in booms and mitigates boom&bust

Contribution to the literature

1. Behavioral models of overoptimism

   Gennaioli and Shleifer (2018), Bordalo et al (2018, 2020), Gabriel Chodorow-Reich et al (2021)

   - Overoptimism from *behavioral overreaction* to good news
   - **This paper:** Overoptimism from *rational underreaction* to bad news

2. Dispersed information with strategic interactions

   Morris and Shin (2002), Angeletos and Lian (2017), Kohlhas and Walther (2020)

   - Strategic substitutability + dispersed information $\Rightarrow$ amplification
   - **This paper:** Inattention from limited liability

3. Compensation incentives and information

   Mackowiak and Wiederholt (2012), Lindbeck and Weibull (2017), Cole et al (2014)

   - Limited liabilities lead to lower attention
   - **This paper:** Embed in macro-finance model & empirical micro-evidence

Model environment

Model environment

- Continuum of "islands" inhabited by one firm and one bank

Model equations

- *Local* **firm**
  - Start with zero capital, borrow to finance production
  - If can't repay, default

Model environment

Model equations

- Continuum of "islands" inhabited by one firm and one bank
- *Local* **firm**
  - Start with zero capital, borrow to finance production
  - If can't repay, default
- *Local* **bank**
  - Deep-pockets, risk neutral
  - Zero expected profit condition $\rightarrow$ risk premium $\approx$ perceived default probability

Model environment

- Continuum of "islands" inhabited by one firm and one bank

Model equations

- *Local* **firm**
  - Start with zero capital, borrow to finance production
  - If can't repay, default
- *Local* **bank**
  - Deep-pockets, risk neutral
  - Zero expected profit condition $\rightarrow$ risk premium $\approx$ perceived default probability
- *Aggregate* **final good producer**
  - Buy intermediate goods from all firms
  - **Strategic substitutability**: $\uparrow$ aggregate production, $\downarrow$ interm price & $\downarrow$ revenues

Tiimeline

- Three stages
  1. Information choice Stage 1 eq
  2. Observe information, decide borrowing and investment Stage 2 eq
  3. Shocks realization and payoff

PE and GE effects

- Aggregate booms associated with a *positive* and *negative* effect

$$\underbrace{lnA_j}_{local\ \ TFP} = \underbrace{e_j}_{local\ \ shock} + \underbrace{\theta}_{aggregate\ \ TFP}$$

- After an aggregate shock θ
  - $\uparrow$ *Local* TFP lnA_j: **positive PE effect**
    - Stronger fundamentals: $\uparrow$ expected revenues, $\uparrow$ investment
  - $\uparrow$ *Aggregate* TFP θ: **negative GE effect**
    - Endogenous $\uparrow$ in aggregate supply, $\downarrow$ price $\Rightarrow \downarrow$ expected revenues, $\downarrow$ investment

PE and GE effects

- Aggregate booms associated with a positive and negative effect

$$\underbrace{lnA_j}_{local\ \ TFP} = \underbrace{e_j}_{local\ \ shock} + \underbrace{\theta}_{aggregate\ \ TFP}$$

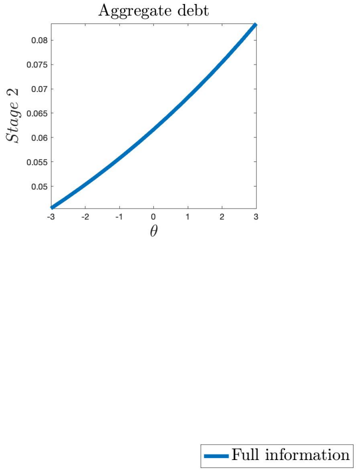
- After an aggregate shock θ
  - ↑ *Local* TFP lnA_j: **positive PE effect**
    - Stronger fundamentals: ↑ expected revenues, ↑ investment
  - ↑ *Aggregate* TFP θ: **negative GE effect**
    - Endogenous ↑ in aggregate supply, ↓ price ⇒ ↓ expected revenues, ↓ investment
- Aggregate TFP θ (i.e. competitors decisions) harder to observe
- First limit cases: θ observed *(FI)* and not *(DI)*, then I endogenize info choice

Full information model

Full information

- Suppose all islands decide to observe θ

  1. Investment and debt $\uparrow$ in agg shock

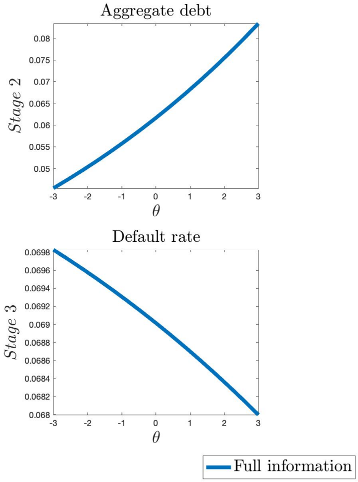


Calibration

Full information

- Suppose all islands decide to observe θ

  1. Investment and debt ↑ in agg shock
  2. Default risk lower after booms
     ~~(Schularick and Taylor, 2012)~~

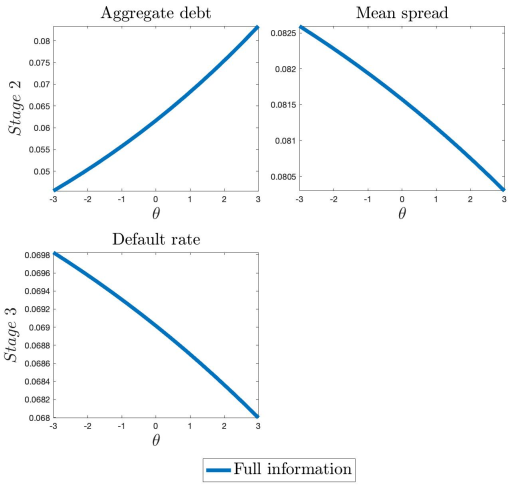


Calibration

Full information

- Suppose all islands decide to observe θ

1. Investment and debt ↑ in agg shock
2. Default risk lower after booms ~~(Schularick and Taylor, 2012)~~
3. Lower spreads predict lower default rate ~~(Krishamurthy and Muir, 2017)~~



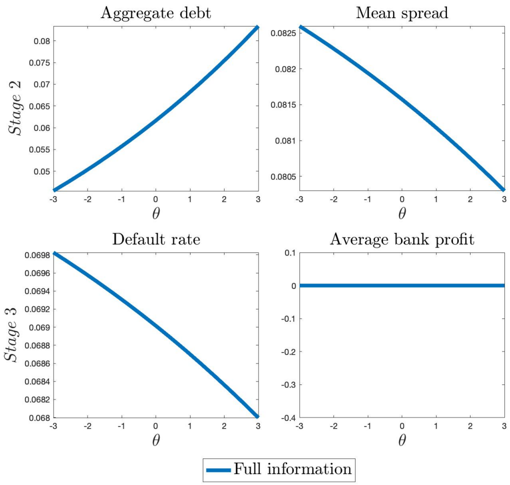
Calibration

Full information

- Suppose all islands decide to observe θ

  1. Investment and debt $\uparrow$ in agg shock
  2. Default risk lower after booms ~~(Schularick and Taylor, 2012)~~
  3. Lower spreads predict lower default rate ~~(Krishamurthy and Muir, 2017)~~
  4. Bank's excess returns equal always zero ~~(Baron and Xiong, 2017)~~

- Economy not riskier after a credit boom $\rightarrow$ **not match the evidence!**



Calibration

Dispersed information model

Dispersed information

- Suppose now agents don't observe aggregates

Evidence on info friction

$$\underbrace{\color{blue}{lnA_j}}_{local\ \ TFP} = \underbrace{e_j}_{local\ \ shock} + \underbrace{\color{red}{\theta}}_{aggregate\ \ TFP}$$

- They can't tell if $lnA_j \uparrow$ due to local shock $e_j \uparrow$ or aggregate shock $\theta \uparrow$

Dispersed information

- Suppose now agents don't observe aggregates

Evidence on info friction

$$\underbrace{\color{blue}{lnA_j}}_{local\ \ TFP} = \underbrace{e_j}_{local\ \ shock} + \underbrace{\color{red}{\theta}}_{aggregate\ \ TFP}$$

- They can't tell if $lnA_j \uparrow$ due to local shock $e_j \uparrow$ or aggregate shock $\theta \uparrow$
- When $\theta \uparrow$, they partially confound it for $e_j \rightarrow$ **rationally confused**

Dispersed information

- Suppose now agents don't observe aggregates

Evidence on info friction

$$\underbrace{lnA_j}_{local\ \ TFP} = \underbrace{e_j}_{local\ \ shock} + \underbrace{\theta}_{aggregate\ \ TFP}$$

- They can't tell if $lnA_j \uparrow$ due to local shock $e_j \uparrow$ or aggregate shock $\theta \uparrow$
- When $\theta \uparrow$, they partially confound it for e_j → **rationally confused**
- Underestimate ↑ in agg supply & ↓ in prices → **overoptimistic** about own profit

Dispersed information

- Suppose now agents don't observe aggregates

Evidence on info friction

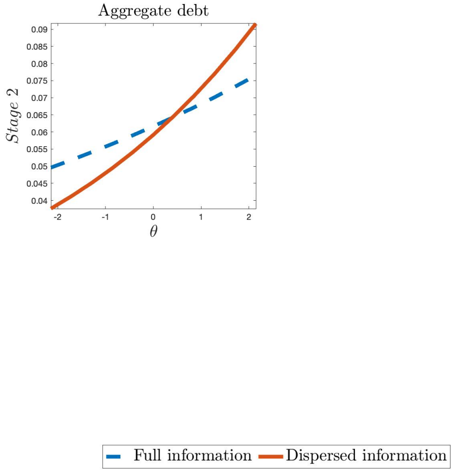
$$\underbrace{\color{blue}{lnA_j}}_{local\ \ TFP} = \underbrace{e_j}_{local\ \ shock} + \underbrace{\color{red}{\theta}}_{aggregate\ \ TFP}$$

- They can't tell if $lnA_j \uparrow$ due to local shock $e_j \uparrow$ or aggregate shock $\theta \uparrow$
- When $\theta \uparrow$, they partially confound it for $e_j \rightarrow$ **rationally confused**
- Underestimate $\uparrow$ in agg supply & $\downarrow$ in prices $\rightarrow$ **overoptimistic** about own profit
- Over-borrow and over-invest, $\uparrow\uparrow$ supply and $\downarrow\downarrow$ prices even more $\rightarrow$ **boom&bust**

Rationally extrapolative beliefs

Dispersed information

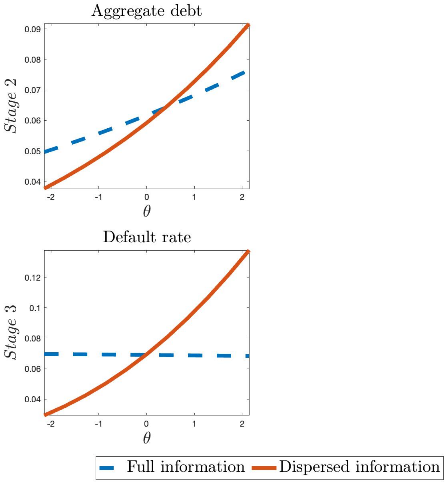
- Suppose no island observes θ
    1. Credit boom *amplified* by info friction



Calibration

Dispersed information

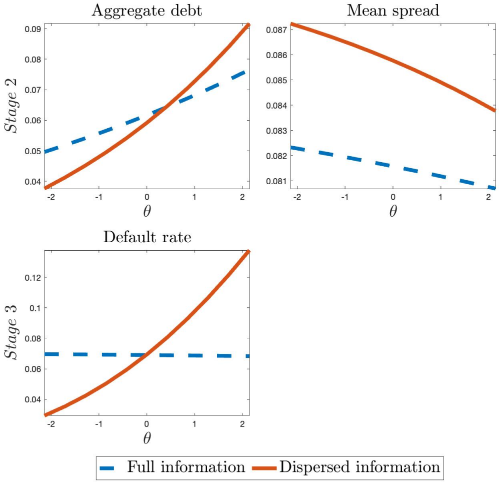
- Suppose no island observes θ
  1. Credit boom *amplified* by info friction
  2. Default risk *increases* after booms (Schularick and Taylor, 2012)



Calibration

Dispersed information

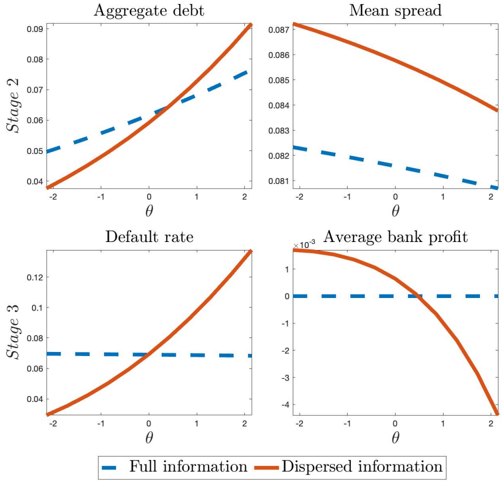
- Suppose no island observes θ
  1. Credit boom *amplified* by info friction
  2. Default risk *increases* after booms (Schularick and Taylor, 2012)
  3. Lower spreads predict *higher* default rate (Krishamurthy and Muir, 2017)



Calibration

Dispersed information

- Suppose no island observes θ
  1. Credit boom *amplified* by info friction
  2. Default risk *increases* after booms (Schularick and Taylor, 2012)
  3. Lower spreads predict *higher* default rate (Krishamurthy and Muir, 2017)
  4. Bank's returns *negative* after a boom (Baron and Xiong, 2017)
- Economy riskier after a credit boom $\rightarrow$ **match the evidence!**



Calibration

Endogenous information choice

Inattention due to limited liability

1. Allow agents to observe aggregates by paying an attention cost (Mackowiak et al, 2020) Info choice problem
   - Set info cost low such that still optimal to collect information

Inattention due to limited liability

1. Allow agents to observe aggregates by paying an attention cost (Mackowiak et al, 2020) Info choice problem
   - Set info cost low such that still optimal to collect information
2. Introduce limited liability on firm and bank payoff structure Payoffs
   - Higher LL ψ, higher insurance from company's losses
   - Interpretation: public bailout, gvnmt guarantees on loan, managers option compensation, . . .

$\Rightarrow$ **Higher limited liability** leads to **lower attention** choice Graph

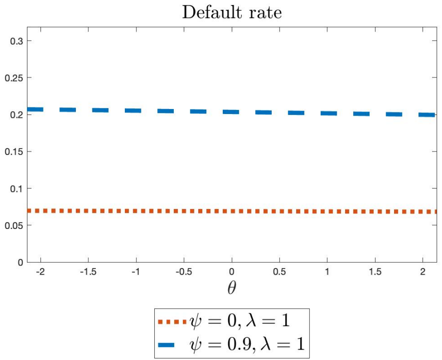
Limited liability incentives in stages 1 & 2

- Limited liability $\psi > 0$ has two effects:
  - **Stage 1:** **Risk-taking in information:** lower information choice
  - **Stage 2:** **Risk-taking in investment:** for a given information
- I show that standard risk taking channel is not enough to match the evidence

Risk taking channels

- **Dotted red**:
  $\psi = 0 \to$ endogenously full info

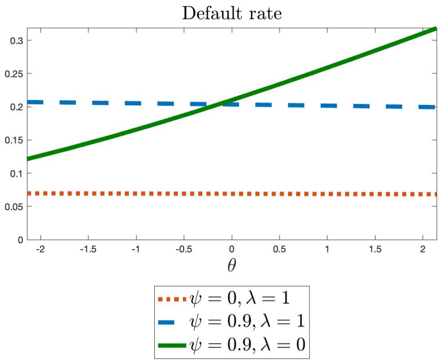
- **Dashed blue**:
  $\psi > 0$ but *assume* full info
  (Risk taking in **investment**)



Risk taking channels

- **Dotted red**:
  $\psi = 0 \rightarrow$ endogenously full info
- **Dashed blue**:
  $\psi > 0$ but *assume* full info
  (Risk taking in **investment**)
- **Solid green**:
  $\psi > 0 \rightarrow$ endogenously dispersed info
  (Risk taking in **information** and **investment**)

$\Rightarrow$ Limited liability effect on *information* explains evidence



Additional results

1. **Analytical results:** characterization of full & dispersed information equilibrium
2. **Quantitative results:** paths of spread and credit in model consistent with the data

Policy implications

- Model implies **unexpected boom-and-busts**
  - Agents take excessive risk because they are uninformed
  - If agents were fully informed, they would reduce risk-taking
- **Policy implication:** correct risk taking incentives
  - Lower limited liability encourages agents to pay attention to risk factors
  - E.g. regulating managers compensation

$\Rightarrow$ Correcting ***incentives*** reduces ***overoptimism*** and mitigates boom&bust

Conclusion

- I develop a theory of overoptimism-driven credit boom&bust, where
  - **Overoptimism** results ***rationally*** from inattention to risk
  - Inattention to risk may be driven by **risk taking** incentives in information choice
- The model is able to match the existing **macro-evidence** on **credit boom&busts**
- **Attenuating limited liability** can encourage agents to correctly assess risk

Thank you!

- **Contact:** luca.gemmi@unil.ch
- **Website:** sites.google.com/view/lucagemmi

Appendix

Evidence on contemporaneous belief under-reaction

- *Contemporaneous* forecast errors: $fe_t = x_t - f_t(x_t)$
  - $x_t \rightarrow$ average macroeconomic quantity from quarter t to $t+3$ (very short horizon)
  - $f_t(x_t) \rightarrow$ forecast on x_t released in quarter t *(Survey of Professional Forecasters)*

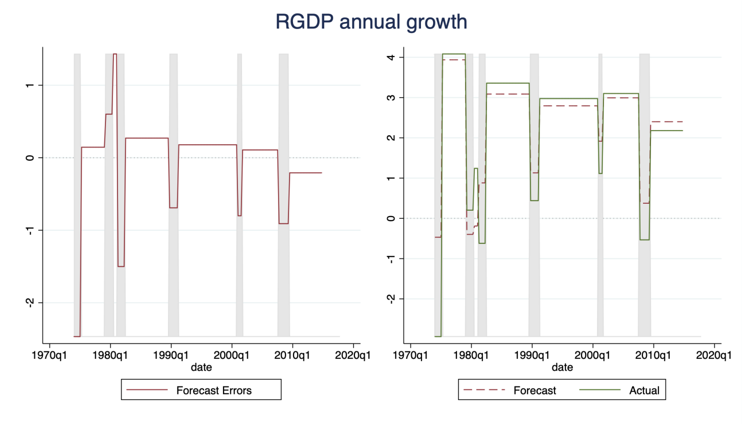
Evidence on contemporaneous belief under-reaction

- *Contemporaneous* forecast errors: $fe_t = x_t - f_t(x_t)$
  - $x_t \rightarrow$ average macroeconomic quantity from quarter t to $t+3$ (very short horizon)
  - $f_t(x_t) \rightarrow$ forecast on x_t released in quarter t *(Survey of Professional Forecasters)*
- $fe_t > 0$ in *booms* (& $fe_t < 0$ in *busts*) $\Rightarrow$ beliefs **under-react** to news
  - When $x \uparrow$, fx don't $\uparrow$ enough (& when $x \downarrow$, fx don't $\downarrow$ enough)
  - Consistent with **information frictions**

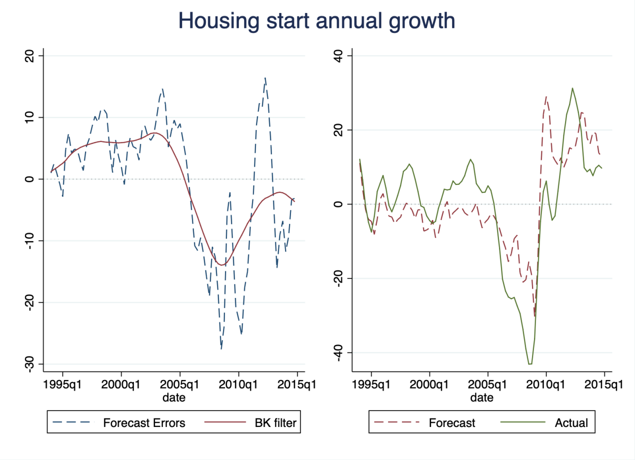
Evidence on contemporaneous belief under-reaction

- *Contemporaneous* forecast errors: $fe_t = x_t - f_t(x_t)$
  - $x_t \rightarrow$ average macroeconomic quantity from quarter t to $t+3$ (very short horizon)
  - $f_t(x_t) \rightarrow$ forecast on x_t released in quarter t *(Survey of Professional Forecasters)*
- $fe_t > 0$ in *booms* (& $fe_t < 0$ in *busts*) $\Rightarrow$ beliefs **under-react** to news
  - When $x \uparrow$, fx don't $\uparrow$ enough (& when $x \downarrow$, fx don't $\downarrow$ enough)
  - Consistent with **information frictions**
- $fe_t < 0$ in *booms* (& $fe_t > 0$ in *busts*) $\Rightarrow$ beliefs **over-react** to news
  - When $x \uparrow$, $fx \uparrow$ too much (& when $x \downarrow$, $fx \downarrow$ too much)
  - Consistent with **behavioral extrapolation**

Belief under-reaction: business cycle



Belief under-reaction: housing boom



Evidence for information frictions

- Belief data consistent with models of **information frictions**
- Additional existing evidence on information friction
  - Large information dispersion measured in forecast surveys *(Coibion and Gorodnichenko, 2015; Gemmi and Valchev, 2021)*
  - Managers' expectations display more disagreement than professional forecasters *(Coibion et al, 2018)*
- I propose a model where **overoptimism** results from *information frictions*

Back

Firm

- **Stage 2** borrow b_j at rate $r_j(b_j)$ to finance purchase of cap k_j

$$b_j = k_j + \phi \frac{k_j^2}{2}$$

Firm

- **Stage 2** borrow b_j at rate $r_j(b_j)$ to finance purchase of cap k_j

$$b_j = k_j + \phi \frac{k_j^2}{2}$$

- **Stage 3** produce interm good $M_j = A_j^{\zeta} k_j^{\tilde{\alpha}} l_j^{1-\tilde{\alpha}}$, with profits $\pi_j = p_j M_j - \overline{w} l_j$

$$d_{firm,j} = \begin{cases} (1-\tau)(\pi_j - (1+r_j)b_j) & \text{if } \pi_j \geq (1+r_j)b_j \quad (repay) \\ -c_d k_j, & \text{if } \pi_j < (1+r_j)b_j \quad (default) \end{cases}$$

where c_d is a default cost

Bank

- Deep-pockets
- **Stage 2:** Borrow at (exogenous) risk free rate r^f to lend to the firm at risky rate r_j
- **Stage 3:** Bank's excess return

$$d_{bank,j} = \begin{cases} (r_j - r^f)b_j & \text{if } \pi_j \geq (1 + r_j)b_j \quad (repay) \\ -b_j(1 + r^f) & \text{if } \pi_j < (1 + r_j)b_j \quad (default) \end{cases}$$

Final good producer

- **Stage 3:** purchase input $M = \left[\int^j M_j^\xi dj\right]^{\frac{1}{\xi}}$ and produce $Y = M^\nu$
- Demand function for good j

$$p_j = \nu M^{\nu-\xi} M_j^{\xi-1}$$

Final good producer

- **Stage 3:** purchase input $M = \left[\int^j M_j^\xi dj\right]^{\frac{1}{\xi}}$ at price p_j and produce $Y = M^\nu$
- Demand function for good j

$$p_j = \nu M^{\nu-\xi} M_j^{\xi-1}$$

- I assume $\nu < \xi \Rightarrow$ **strategic substitutability** between islands
  - If $\uparrow M$, then $\downarrow p_j$ and $\downarrow M_j$
  - It holds with standard calibration and consistent with IO estimates Conditions for $\nu < \xi$

Technology shocks

- **Stage 3:** island's technology realizes

$$\underbrace{lnA_j}_{local\ \ TFP} = \underbrace{\epsilon_j}_{local\ \ shock} + \underbrace{\theta}_{aggregate\ \ shock}$$

  - Local shock $\epsilon_j \sim N(0, \sigma_\epsilon^2)$, $\int^j \epsilon_j dj = 0$
  - Aggregate shock $\theta \sim N(0, \sigma_\theta^2)$

$\Rightarrow$ Heterogeneous investment decisions

Back

Strategic substitutability through prices

- Suppose final good sector
  - production function $Y = M^{\tilde{\nu}} X^{1-\tilde{\nu}}$ with $\tilde{\nu} = 0.5$
  - face a demand function $P = Y^{\frac{1}{\mu^F}-1}$ where $\mu^F > 1$ is the markup
  - Maximizing X out, profit function equal $\pi \propto M^{\frac{\tilde{\nu}}{\mu^F-(1-\tilde{\nu})}} \equiv M^{\nu}$
- Therefore $\nu < \xi$ implies

$$\mu^F > \frac{1+\mu^I}{2}, \qquad \mu^I \equiv 1/\xi > 1$$

- Satisfied as long as μ^F is **not** much lower μ^I
- In data, retail sector has the largest markup *(De Loecker et al, 2020)*

Back

Stage 1: Information choice

- Pay cost c_{info} to observed θ perfectly in next stage
  - Firm and bank managers decide through Nash bargaining
- Pay cost if

$$E[d^*_{firm,j}(\theta \in \Omega_j, \lambda) - c_{info}] > E[d^*_{firm,j}(\theta \notin \Omega_j, \lambda)]$$

  - Ω_j island j's information set: $\theta \in \Omega_j$ or $\theta \notin \Omega_j$

Back

Stage 1: Information choice

- Pay cost c_{info} to observed θ perfectly in next stage
  - Firm and bank managers decide through Nash bargaining

- Pay cost if

$$E[d^*_{firm,j}(\theta \in \Omega_j, \lambda) - c_{info}] > E[d^*_{firm,j}(\theta \notin \Omega_j, \lambda)]$$

  - Ω_j island j's information set: $\theta \in \Omega_j$ or $\theta \notin \Omega_j$
  - $\lambda \in [0, 1]$ Share of islands that pay the cost and are informed
    - $\lambda = 1$: Full information case
    - $\lambda = 0$: Dispersed information case

- Equilibrium λ^* st everybody is indifferent:
  $E[d^*_{firm,j}(\theta \in \Omega_j, \lambda^*) - c] = E[d^*_{firm,j}(\theta \notin \Omega_j, \lambda^*)]$

Back

Stage 2 - Information structure

- Firm and bank in island j share all information
- They receive up to two signals

(1) *Free* signal on **local technology**

$$z_j = ln(A_j) + \eta_j, \qquad \eta_j \sim N(0, \sigma_\eta^2)$$

Stage 2 - Information structure

- Firm and bank in island j share all information
- They receive up to two signals

(1) *Free* signal on **local technology**

$$z_j = ln(A_j) + \eta_j, \qquad \eta_j \sim N(0, \sigma_\eta^2)$$

(2) *Costly* signal on **aggregate technology** θ (or quantity M)

- Lucas island setting $\rightarrow$ aggregates not freely observable
- They are able to observe aggregates if they paid information cost in stage 1

Stage 2 - Lending and borrowing

- Firm and bank decide debt b_j and loan rate r_j
  - I assume Nash bargaining with all bargaining power on firms
  - **Loan rate:** $E[d_{bank}|\Omega_j] = 0 \rightarrow$ spread $\propto$ perceived default prob

$$\frac{1 + r_j}{1 + r^f} = \frac{1}{1 - p(default(A_j, b_j, r_j, M)|\Omega_j)}$$

Stage 2 - Lending and borrowing

- Firm and bank decide debt b_j and loan rate r_j
  - I assume Nash bargaining with all bargaining power on firms
  - **Loan rate:** $E[d_{bank}|\Omega_j] = 0 \rightarrow$ spread $\propto$ perceived default prob

$$\frac{1 + r_j}{1 + r^f} = \frac{1}{1 - p(default(A_j, b_j, r_j, M)|\Omega_j)}$$

  - **Loan quantity:** The firm internalizes $r_j(b_j)$ and maximize expected profit

$$b_j = argmax \; E[d_{firm}(A_j, b_j, r_j(b_j), M)|\Omega_j]$$

Stage 2 - Lending and borrowing

- Firm and bank decide debt b_j and loan rate r_j
  - I assume Nash bargaining with all bargaining power on firms
  - **Loan rate:** $E[d_{bank}|\Omega_j] = 0 \rightarrow$ spread $\propto$ perceived default prob

$$\frac{1 + r_j}{1 + r^f} = \frac{1}{1 - p(default(A_j, b_j, r_j, M)|\Omega_j)}$$

  - **Loan quantity:** The firm internalizes $r_j(b_j)$ and maximize expected profit

$$b_j = argmax \; E[d_{firm}(A_j, b_j, r_j(b_j), M)|\Omega_j]$$

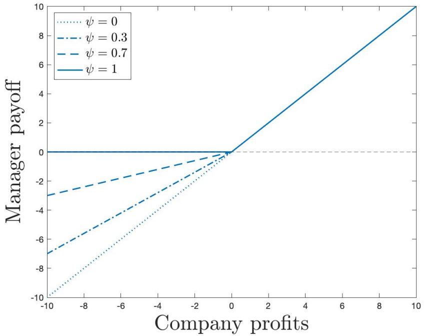
- **Strategic substitutability:** $\uparrow M(\theta), \downarrow p_j \Rightarrow \downarrow b_j$ and M_j

Back

Manager's compensation

- Firms and banks run by managers
- Managers own $(1-\psi)$ shares and ψ options
  - Assume zero exercise price and option in the money when $\pi > 0$

$$w = \begin{cases} \pi & \text{if } \pi \geq 0 \quad (\textit{repay}) \\ (1-\psi)\pi & \text{if } \pi < 0 \quad (\textit{default}) \end{cases}$$

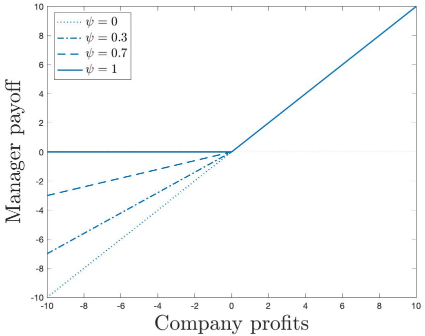


Manager's compensation

- Firms and banks run by managers
- Managers own $(1-\psi)$ shares and ψ options
  - Assume zero exercise price and option in the money when $\pi > 0$

$$w = \begin{cases} \pi & \text{if } \pi \geq 0 \quad (\textit{repay}) \\ (1-\psi)\pi & \text{if } \pi < 0 \quad (\textit{default}) \end{cases}$$

- I map CEO's compensation to the data
- In general, ψ as any source of limited liability (public baylout or guarantees, etc)



Manager's compensation

- Firm manager's payoff is given by

$$w_{firm,j} = \begin{cases} (1-\tau)[\pi(A_j, k_j, M) - (1+r_j)b_j] & \text{if } \pi(A_j, k_j, M) \geq (1+r_j)b_j \\ -(1-\psi)c_d k_j, & \text{if } \pi(A_j, k_j, M) < (1+r_j)b_j \end{cases}$$

  - Alternatively, lower c_d as moral hazard between borrower and lender

- Bank manager's payoff is given by

$$w_{bank,j} = \begin{cases} [(1+r_j) - (1+r^f)]b_j & \text{if } \pi(A_j, k_j, M) \geq (1+r_j)b_j \\ -(1-\psi)(1+r_j)b_j & \text{if } \pi(A_j, k_j, M) < (1+r_j)b_j \end{cases}$$

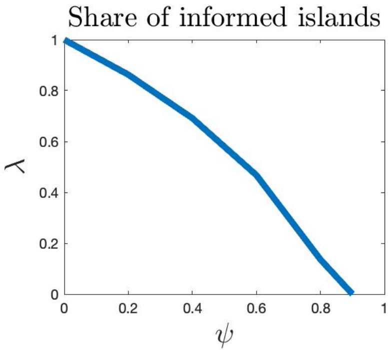
  - Alternatively, ψ from bank's limited liability (deposit vs equity funding or gvnmt guarantees)

Back

Stage 1 - Moral hazard and inattention

- Set c_{info} such that if $\psi = 0$, full information is optimal: $\lambda = 1$
  - $c \approx 3\%$ of average firm profits in full information

$\Rightarrow$ If limited liability $\uparrow \psi$, optimal information $\downarrow \lambda$



- **Intuition:** Lower exposure of manager to losses, lower incentive to collect information *(Mackowiak and Wiederholt, 2012, Lindbeck and Weibull, 2017)*

Back

Calibration

Table: Calibration

Parameter	Interpretation	Value	Source
α	Firm profit function curvature	0.624	Implied by 20% markup and 1/3 cap share
ν	Return to scale final good sector	0.5	Implied by 50% markup and 1/2 interm share
r^f	Risk free rate	0.1	5-year return from quarterly 2%
ϕ	Investment adj cost coefficient	1	Literature (e.g. Gao et al, 2021)
σ_θ	Volatility aggregate shock	0.2	Unconditional volatility implied by $\rho = .995$ and $\sigma = 0.02$
σ_e	Volatility local shock	0.6	Three times aggregate volatility (inside literature interval)
σ_η	Volatility signal noise	0.64	Same as total TFP volatility
ψ	Compensation convexity	0	Normalization
c_d	Default cost	0.5	Baseline
τ	Corporate tax	0.20	(CBO, 2017)
c	Information cost	0.0017	Calibrated such that $\lambda = 1$ if $\psi = 0$

Back

Stage 2 - Dispersed information ($\lambda = 0$): Rational extrapolation

1. **Dotted black line:**
   prior belief on revenues

2. **Dashed red line:**
   posterior revenues of *informed* agents
   (both **PE** and **GE** effect)

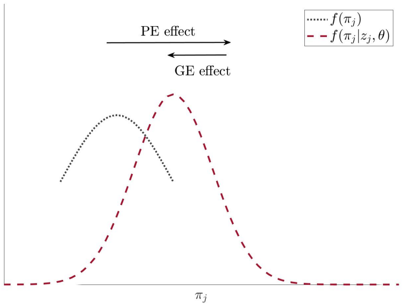


Figure: PE and GE effect after $\theta > 0$ shock

Back

Stage 2 - Dispersed information ($\lambda = 0$): Rational extrapolation

1. **Dotted black line:**
   prior belief on revenues

2. **Dashed red line**:
   posterior revenues of *informed* agents
   (both **PE** and **GE** effect)

3. **Solid blue line**:
   posterior revenues of *uninformed* agents (only **PE** effect)

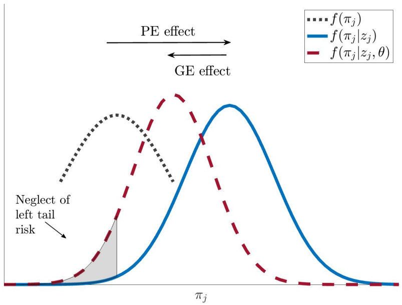


Figure: PE and GE effect after $\theta > 0$ shock

Back