Exuberant and Uninformed: How Financial Markets (Mis-)Allocate Capital during Booms

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Job Talk EPFL, 01.02.2021

Motivation

- Financial markets play an important role in the allocation of capital.
- Growing concerns that markets do not always fulfill this role well:

1. Misallocation often increases during asset price / credit booms. Example US Housing Boom
   - Gopinath et al. (2017), Doerr (2018), García-Santana et al. (2020), and Gorton and Ordoñez (2020).
2. Which may lead to a slowdown in productivity growth. Example US Example Spain
   - Borio et al. (2015): "disappointing US [pre-crisis] growth ... because of the [financial] boom."
3. Some argue that a decline in information production in financial markets is responsible. Literature
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This Paper: Overview

- This paper: Study relationship between booms and misallocation.
  - Channel: Information production in financial markets.
- In the spirit of Hayek (1945), markets aggregate information:

$$\text{Information Production} \Rightarrow \text{Capital Allocation} \Rightarrow \text{Overall Productivity}$$

The Model in One Picture

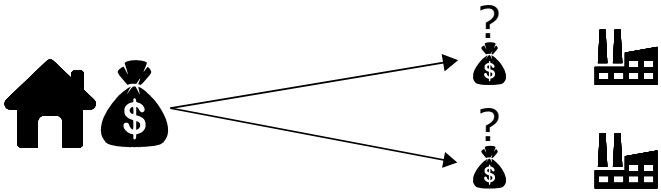

Figure: Households save and need to decide in which firms to invest.

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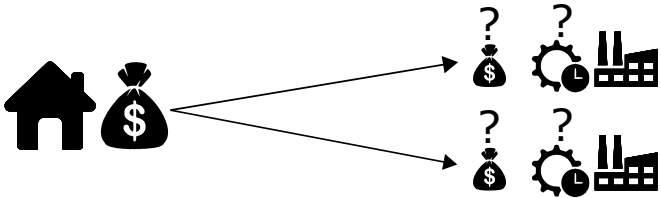

Figure: Information friction: households do not observe firm productivity.

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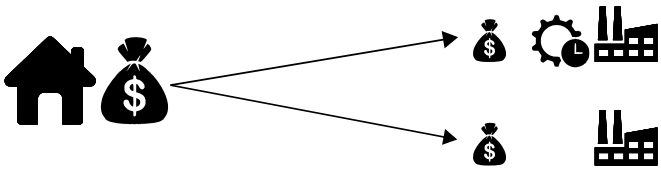

Figure: If households do not produce information, investment will lead to misallocation.

The Model in One Picture

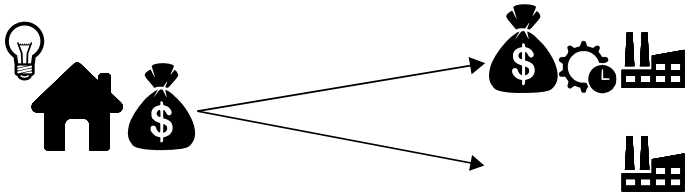

Figure: Precise information leads to more capital being allocated to more productive firms.

The Model in One Picture

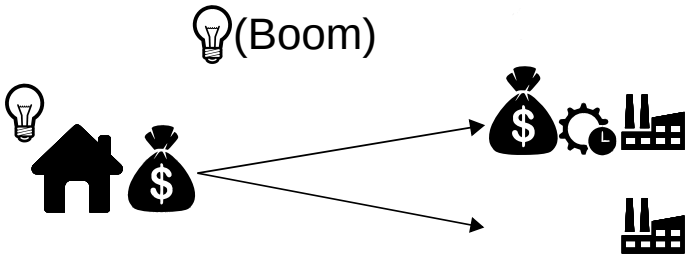

Figure: I study how information production and misallocation change during booms.

Positive Results: Fundamental and Non-Fundamental Booms

- Two sources of firm-specific and aggregate fluctuations:
  - Fundamental (Productivity).
  - Non-Fundamental (Sentiments as waves of optimism/pessimism).
- For both booms: output, investment and asset prices ↑
- Fundamental (productivity) booms decrease misallocation.
  - Information production ↑ ⇒ Endogenous TFP component ↑
  - Productivity shocks get amplified.
- Non-Fundamental (sentiment) booms increase misallocation.
  - Information production ↓ ⇒ Endogenous TFP component ↓
  - Sentiment booms can get dampened.
- The source of a boom is crucial for its effect on misallocation and policy prescriptions depend on it.

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Normative Results

- Laissez-faire equilibrium is constrained inefficient.
  - Info production can be too high (rent-extracting behavior) or too low (information spillover).
- Application: large scale asset purchases and sales.
  - Used intensively by central banks during past decade.
- Do large-scale asset purchases harm market efficiency?
  - They can distort prices and increase misallocation.
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Literature

- Credit Cycles: Gorton and Ordoñez (2014), Asriyan, Laeven, and Martin (2019), Gorton and Ordoñez (2020)
  - **New information mechanism between booms and misallocation.**
- Macro and Information: Veldkamp (2005) and Van Nieuwerburgh and Veldkamp (2006), Peress (2014), David, Hopenhayn, and Venkateswaran (2016)
  - **New: Study two-way relationship between the cycle and information production.**
- Noisy Rational Expectations: Grossman and Stiglitz (1980), Kyle (1985), Vives (2010), Albagli, Hellwig, and Tsyvinski (2011)
  - **Novel methodology: Overconfidence facilitates application to GE and macro.**

Agents

- Infinite horizon OLG model.
- Households $i \in [0,1]$ live for two periods:

$$U_{it} = C_{it,t} + \delta \tilde{\mathbb{E}}_t \{C_{it,t+1}\} - \int_0^1 IA(\beta_{ijt})\, dj.$$

  - Consume during youth and old age, discount factor $\delta \in (0,1)$.
  - $\int_0^1 IA(\beta_{ijt})dj$ are information production costs.
  - Buy/issue bonds with return R_{t+1}.

- Household i is composed of a unit mass of Traders $ij \in [0,1] \times [0,1]$.
  - Endowed with one unit of labor, supplied inelastically during youth, earn W_t.
  - Buy stocks of firm j subject to position limits $[0,2]$.
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Real Economy

- Intermediate good firms indexed by $j \in [0,1]$:

$$Y_{jt} = A_{jt-1}^{\frac{\theta}{\theta-1}} K_{jt}.$$

  - Firm productivity/demand shifter $\ln(A_{jt-1}) \overset{iid}{\sim} \mathcal{N}\left(a_{t-1}, \sigma_a^2\right)$.

- Capital takes time to build and depreciates fully.
- As in Peress (2014), firms sell claims to firm revenue and invest proceeds,

$$K_{jt+1} = P_{jt}.$$

- Final good sector:

$$Y_t = L^{1-\alpha} \left(\int_0^1 Y_{jt}^{\frac{\theta-1}{\theta}} dj \right)^{\frac{\alpha\theta}{\theta-1}}.$$

Information Structure

- Trader ij receives the signal

$$s_{ijt} = a_{jt} + \frac{\eta_{ijt} + \varepsilon_{jt}}{\sqrt{\beta_{ijt}}}.$$

- Firm productivity $a_{jt} = \ln A_{jt} \sim \mathcal{N}\left(a_t, \sigma_a^2\right)$.
- Idiosyncratic noise $\eta_{ijt} \sim \mathcal{N}(0, 1)$.
- Firm-specific sentiment $\varepsilon_{jt} \sim \mathcal{N}\left(\varepsilon_t, \sigma_\varepsilon^2\right)$.
- Information precision β_{ijt}.

Overconfidence

Assumption (***Overconfidence***)

Trader ij believes the information structure to be

$$s_{ijt} = a_{jt} + \frac{\hat{\eta}_{ijt}}{\sqrt{\beta_{ijt}}}$$
$$s_{-ijt} = a_{jt} + \frac{\eta_{-ijt} + \varepsilon_{jt}}{\sqrt{\beta_{-ijt}}}.$$

- where $\hat{\eta}_{ijt} \sim \mathcal{N}(0,1)$.
- Trader *ij* thinks that sentiment drives the beliefs of all traders except her own. Overconfidence
- Traders choose information precision β_{ijt} to maximize trading rents.

Two Aggregate Shocks: Productivity and Sentiment

- Aggregate productivity shock

$$a_{jt} \sim \mathcal{N}\left(a_t, \sigma_a^2\right).$$

- Aggregate sentiment shock

$$\varepsilon_{jt} \sim \mathcal{N}\left(\varepsilon_t, \sigma_\varepsilon^2\right).$$

  - Captures phenomena such as herding, informational cascades, social learning, bubbles, liquidity trading, ... (see Kindleberger and Aliber, 2015; Shiller, 2015, 2017).

- For simplicity, a_t and ε_t are publicly observable.

  - What is crucial are the traders' expectations about aggregate shocks.

Timing

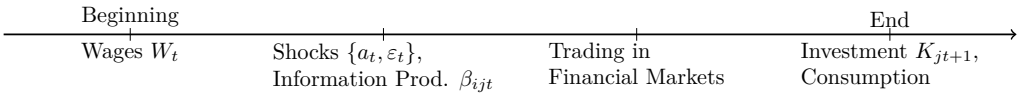

Figure: Information production takes place after aggregate shocks are revealed.

Factor Market Clearing

- Prices for labor and intermediate goods are determined competitively,

$$W_t = \frac{\partial Y_t}{\partial L} = (1-\alpha)\frac{Y_t}{L}$$
$$\rho_{jt} = \frac{\partial Y_t}{\partial Y_{jt}} = \alpha Y_t^{\alpha_Y} Y_{jt}^{-\frac{1}{\theta}},$$

  where $\alpha_Y = \frac{\alpha\theta-\theta+1}{\alpha\theta}$.
- Firm revenue is

$$\Pi_{jt} = \rho_{jt} Y_{jt}.$$

Trader ij's Trading Problem

- Trader ij's trading problem: Household Problem

$$\max_{x_{ijt} \in [0,2]} \quad \tilde{\mathbb{E}} \left\{ x_{ijt} \left(\frac{1}{R_{t+1}} \Pi_{jt+1} - P_{jt} \right) | s_{ijt}, P_{jt} \right\}$$

- Trader ij buys two units whenever her valuation exceeds the prize,

$$x_{ijt} \begin{cases} = 0 & \text{if } \frac{1}{R_{t+1}} \tilde{\mathbb{E}} \{ \Pi_{jt+1} | s_{ijt}, P_{jt} \} < P_{jt} \\ \in [0,2] & \text{if } \frac{1}{R_{t+1}} \tilde{\mathbb{E}} \{ \Pi_{jt+1} | s_{ijt}, P_{jt} \} = P_{jt} \\ = 2 & \text{if } \frac{1}{R_{t+1}} \tilde{\mathbb{E}} \{ \Pi_{jt+1} | s_{ijt}, P_{jt} \} > P_{jt} \end{cases}.$$

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Trader ij's Information Production Problem

- Optimal buying decision leads to information production problem:

$$\max_{\beta_{ijt}} \tilde{\mathbb{E}}_t \left\{ \underbrace{\mathcal{P}\left(x_{ijt}=2\right)}_{\text{Probability of Buying}} \underbrace{\left(\frac{1}{R_{t+1}} \Pi_{jt+1} - P_{jt} \right)}_{\text{Rents}} \right\} - IA\left(\beta_{ijt}\right),$$

- Producing more precise information makes buying more likely when rents are positive / large.

Marginal Benefit

Financial Market Clearing, Intuition

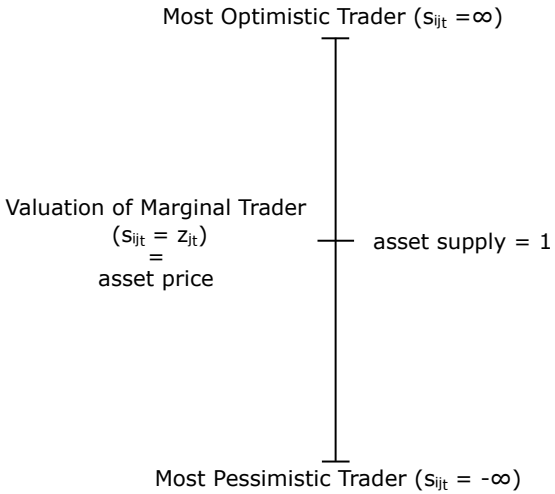

Figure: Price P_{jt} is equal to the marginal trader's valuation, who is indifferent between buying or not.

Financial Market Clearing

- Price equal to the valuation of the marginal trader ($s_{ijt} = z_{jt}$),

$$P_{jt} = \frac{1}{R_{t+1}} \tilde{\mathbb{E}} \left\{ \Pi_{jt+1} | s_{ijt} = z_{jt}, z_{jt} \right\}.$$

- Observing P_{jt} or z_{jt} is informationally equivalent:

$$z_{jt} = a_{jt} + \frac{\varepsilon_{jt}}{\sqrt{\beta_{jt}}}.$$

Market Clearing Condition

Financial Market Clearing

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Market Clearing Condition

Productivity and Allocative Efficiency

Proposition (**Market Allocation**)

(i) Firm-capital is given by

$$K_{jt+1} = \frac{\tilde{\mathbb{E}}\left\{A_{jt} | s_{ijt} = z_{jt}, z_{jt}\right\}^{\theta}}{\int_0^1 \tilde{\mathbb{E}}\left\{A_{jt} | s_{ijt} = z_{jt}, z_{jt}\right\}^{\theta} dj} K_{t+1}.$$

(ii) The aggregate production function is

$$Y_t = A\left(a_{t-1}, \beta_{t-1}\right) K_t^{\alpha}$$

with total factor productivity

$$\ln A\left(a_{t-1}, \beta_{t-1}\right) = \underbrace{A^{ex}\left(a_{t-1}\right)}_{\text{exogenous}} + \underbrace{A^{end}\left(\beta_{t-1}\right)}_{\text{allocative efficiency}}.$$

(iii) $A\left(a_{t-1}, \beta_{t-1}\right)$ is monotonically increasing in β_{t-1} if σ_{ε}^2 is small enough. Assumption Non-monotonic TFP

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Productivity Shock with fixed Info

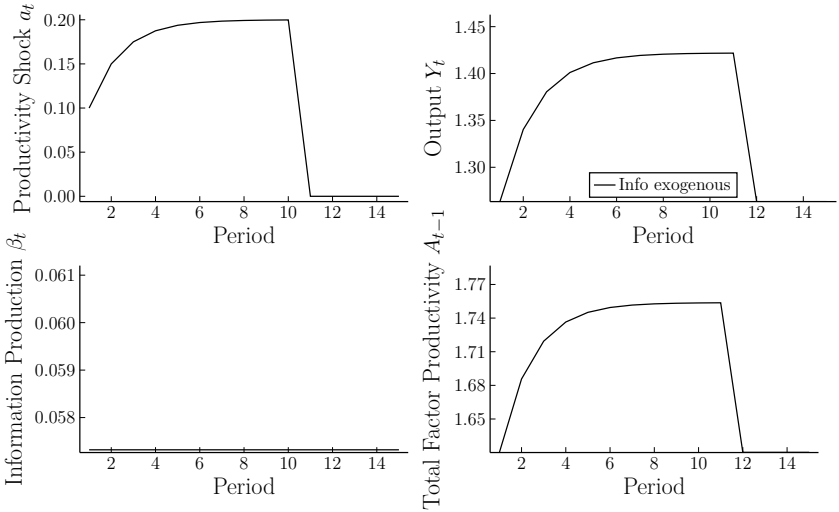

Figure: Productivity shocks increase exogenous TFP and investment.

Productivity Booms are Amplified by Information Production

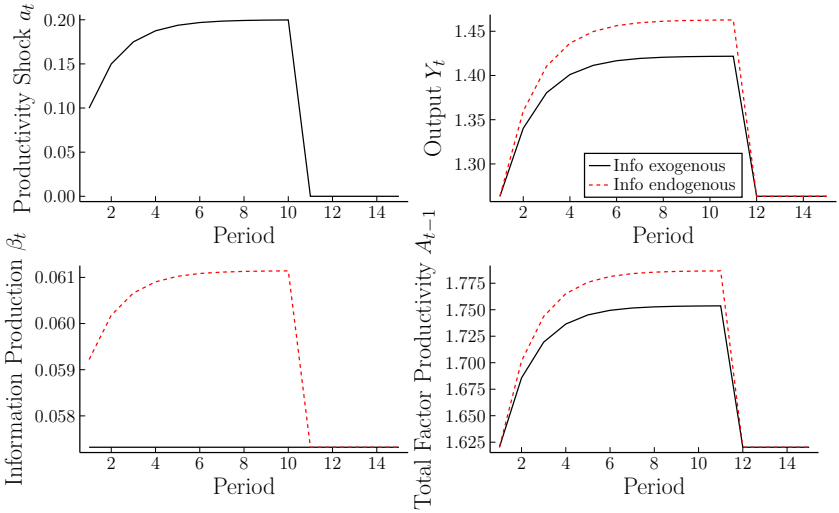

Figure: Productivity booms encourage information production, which amplifies the boom. Detail Misallocation

Sentiment Booms with fixed Info leave TFP unaffected

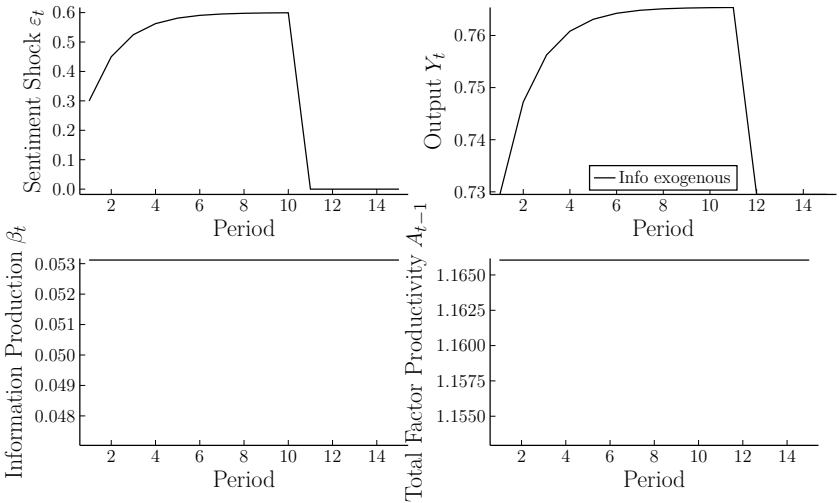

Figure: Sentiment booms increase investment and output.

Sentiment Booms are Dampened by Information Production

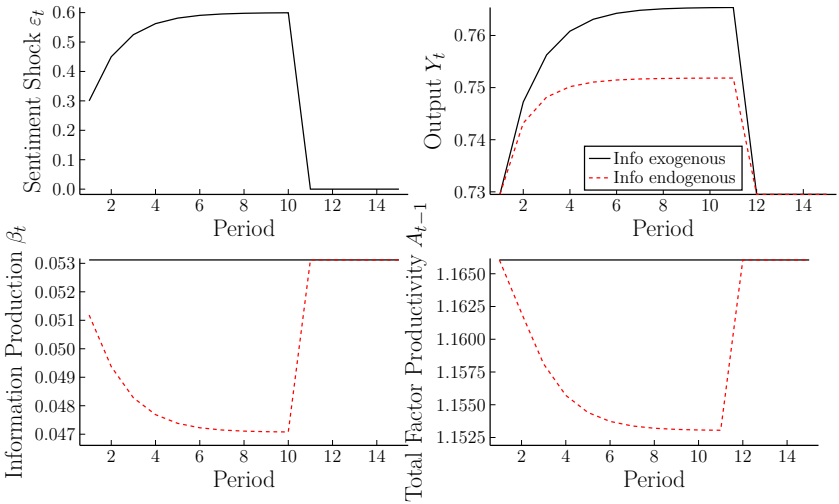

Figure: Sentiment booms increase misallocation by discouraging information production, which dampens the boom. Misallocation Analytical Dampening Boom and Bust

Sentiment Shocks make Trading less information-sensitive

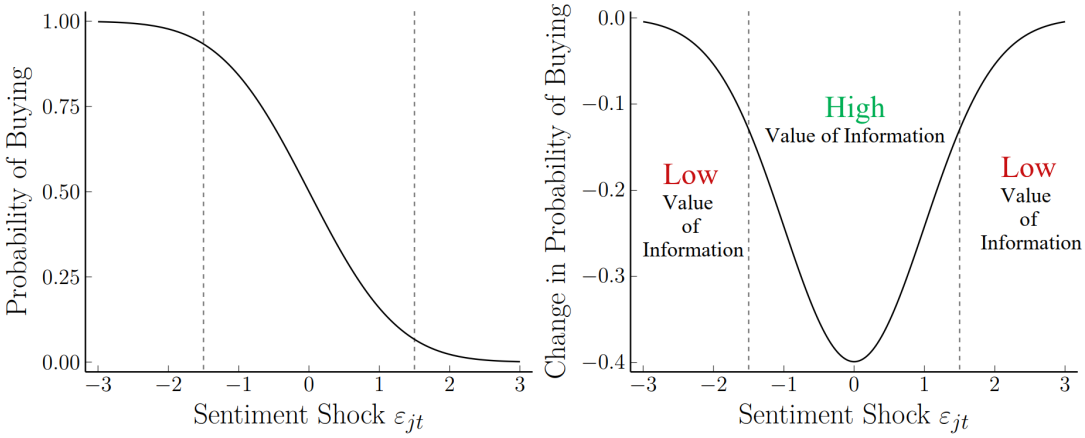

Figure: Positive and negative sentiment shocks make assets more mispriced.

Taking Stock

- Two sources of fluctuations: Productivity and Sentiment.
- More information improves capital allocation among firms $\Rightarrow$ higher TFP.
- Booms have different effects depending on their source:
  - Productivity boom: information $\uparrow \Rightarrow$ TFP $\uparrow$, amplifying the initial shock.
  - Sentiment boom: information $\downarrow \Rightarrow$ TFP $\downarrow$, can dampen the boom.
- Rationalizes empirical evidence of "good" and "bad" booms (Gorton and Ordoñez, 2020).
- Policy prescriptions depend on type of boom and the model can help us distinguish between them.

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Positive Co-Movement between Price Informativeness and TFP growth

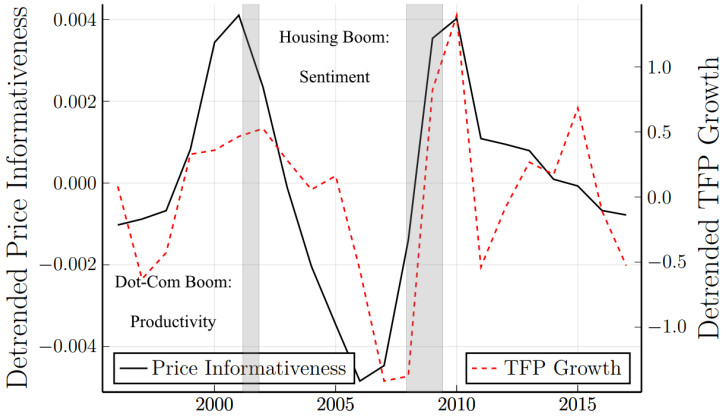

Figure: Detrended Price Informativeness (Dávila and Parlatore, 2020) and TFP growth (San Francisco Fed) for the US. Not Detrended Dispersion Derivation Source TFP

Planner vs. Laissez-faire Information Production

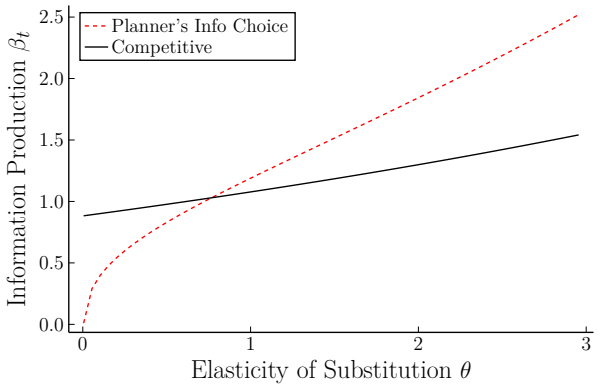

Figure: Low elasticity: Too much information production. High elasticity: Too little information production.

Two Externalities | No Substitution | High Substitution | Social Planner Problem | Implementation Tax | Shocks

Application: Asset Purchases

- In the past decade, asset purchases have been used to stabilize financial markets and stimulate growth and inflation:
  - US: QE1 - QE4, Government bonds and mortgage backed securities.
  - UK, Eurozone: Government and corporate bonds.
  - Japan: Variety of assets, also stock ETFs (Okimoto, 2019).
- This raised concerns that asset purchases lift asset prices and growth, but destroy market efficiency.
  - DNB (2017): *"The large-scale purchase programmes and the flood of liquid assets has set the risk compass in financial markets spinning, with misallocations as a result."*
  - Model confirms this concern: asset purchases can decrease market efficiency.
  - But: Asset purchases can increase market efficiency when used against non-fundamental busts.

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Problem

Optimal Asset Purchases: Leaning against Sentiment

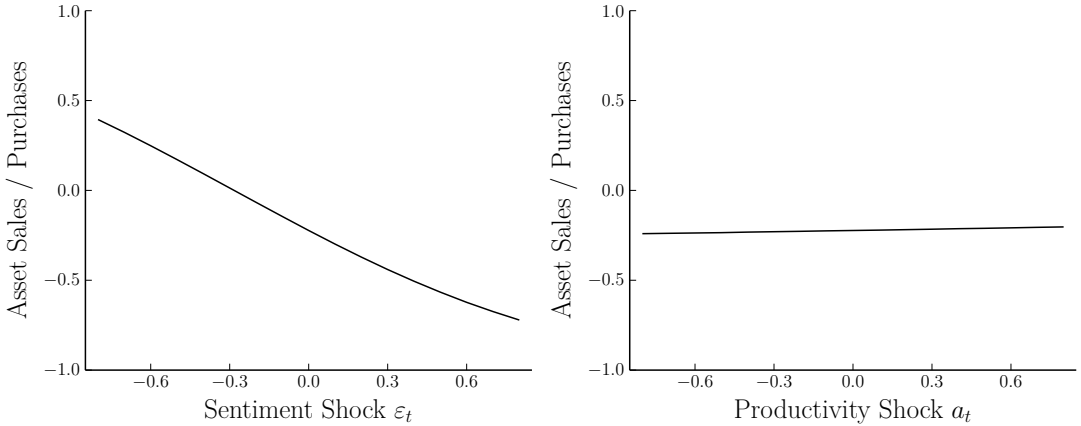

Figure: Social planner buys (sells) assets in response to negative (positive) sentiment shocks. Mechanism Uncertainty

Conclusion

- I develop a tractable macroeconomic model with info production in financial markets.
  - Information is important for the allocation of capital and therefore productivity.
- Not all booms are alike and the difference matters:
  - Productivity booms decrease misallocation by encouraging info production.
  - Sentiment booms increase misallocation by discouraging info production.
- Rationalizes dichotomy of "good" and "bad" booms as in Gorton and Ordoñez (2020).
- Knowing the boom type is crucial for policymakers, as optimal policy depends on it!
  - Asset purchase increase market efficiency only during non-fundamental depressions.

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Factor Misallocation increased during the US Housing Boom

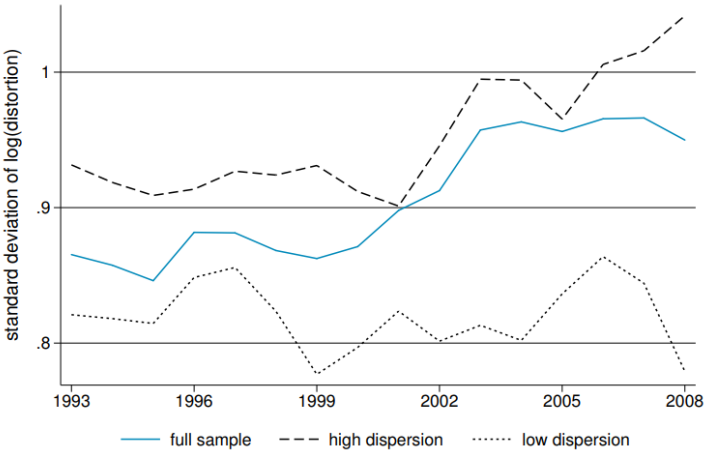

Figure: "Yearly median of within industry-year standard deviation of log distortions. log (distortions) refers to the residual of a regression of $\ln(k/l)$ on industry-year dummies. *dispersion* stands for dispersion in initial real estate value, split into top and bottom tercile." Source: Doerr (2018). Back

US experienced a Decline in Productivity during pre-crisis Boom

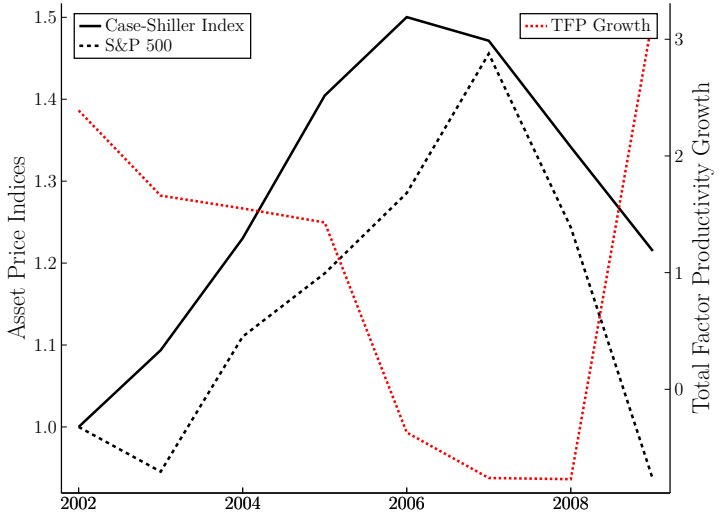

Figure: Asset price boom during slowdown in total factor productivity growth. Spain Source TFP Back

Similar experience in Southern Europe, for example Spain

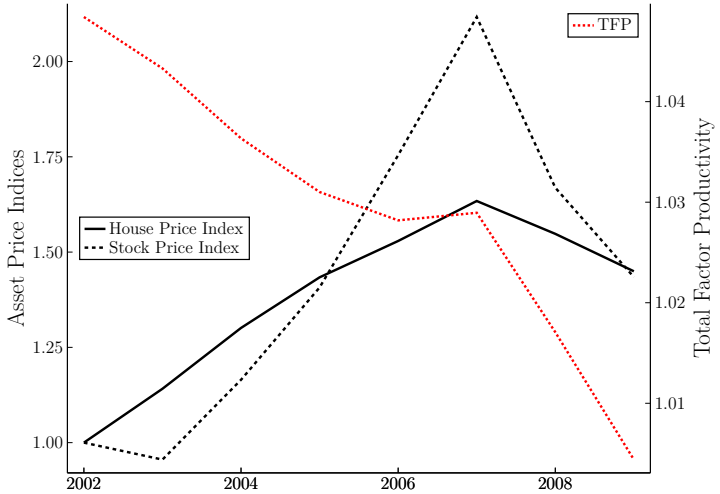

Figure: Total factor productivity declined, although asset prices were booming. Back

Decline in Information Production

- Asea and Blomberg (1998):
  - Sample: Panel dataset of 2 million loans by 580 banks between 1977-1993.
  - Finding: Banks systematically change their lending behavior from tight to lax over the cycle.
  - Conclusion: Banks decrease screening efforts / provide credit on easier terms during expansions.
- Keys et al. (2010):
  - Sample: Securitized subprime mortgage loan contracts in the US.
  - Finding: Portfolios that are easier to securitize default 10%-25% more often.
  - Conclusion: Incentives for screening declined during US housing boom because of securitization.
- Becker, Bos, and Roszbach (2020):
  - Sample: Credit, internal ratings by one of the four largest Swedish cross-border banks + external ratings from a credit bureau.
  - Finding: Internal credit rating more predictive of default during recessions.
  - Conclusion: The bank has worse info / info frictions are more severe during expansions. Back

Utilization-Adjusted TFP

- Source: San Francisco FED.
- Both labor and capital inputs are utilization adjusted following Basu, Fernald, and Kimball (2006).
- Industry-level production function: Back Intro Back Empirical

$$Y_i = F^i\left(\underbrace{A_i}_{\text{utilization}}\ \underbrace{K_i}_{\text{capital}}, \underbrace{E_i}_{\text{effort}}\ \underbrace{H_i}_{\text{hours}}\ \underbrace{N_i}_{\text{labor}}, \underbrace{M_i}_{\text{inputs}}, \underbrace{Z_i}_{\text{technology}}\right)$$

Overconfidence

- Overconfidence is one of the most-studied behavioral biases. (Glaser and M. Weber, 2010; Daniel and Hirshleifer, 2015). Back Results Back Overconfidence

- Has been observed
  - with managers in financial companies (Ben-David, Graham, and Harvey, 2013),
  - with traders and investment bankers (Glaser, Langer, and M. Weber, 2013),
  - in experimental settings (Biais et al., 2005; Huffman, Raymond, and Shvets, 2019).

- Similar to correlation neglect due to imperfect understanding of signals' correlation structure.
  - Generally agents put too much weight on correlated signals.
  - Chandrasekhar, Larreguy, and Xandri (2012), Brandts, Giritligil, and R. A. Weber (2015), Eyster et al. (2018), Grimm and Mengel (2018), and Enke and Zimmermann (2019).

Household i's Problem

- Household i chooses bond savings B_{it+1}:

$$\max_{B_{it+1}} \quad C_{it,t} + \delta \tilde{\mathbb{E}}_t \{C_{it,t+1}\} - \int_0^1 IA(\beta_{ijt})\, dj$$

$$s.t. \quad C_{it,t} = W_t - \int_0^1 x_{ijt} P_{jt} dj - B_{it+1}$$

$$C_{it,t+1} = \int_0^1 x_{ijt} \Pi_{jt+1} dj + R_{t+1} B_{it+1}$$

$$C_{it,t}, C_{it,t+1} \geq 0.$$

- Optimal saving decision: Back

$$B_{it+1} \begin{cases} = -\frac{\int_0^1 x_{ijt} \Pi_{jt+1} dj}{R_{t+1}} & \text{if } R_{t+1} < \frac{1}{\delta} \\ \in \left[-\frac{\int_0^1 x_{ijt} \Pi_{jt+1} dj}{R_{t+1}}, W_t - \int_0^1 x_{ijt} P_{jt} dj \right] & \text{if } R_{t+1} = \frac{1}{\delta} \\ = W_t - \int_0^1 x_{ijt} P_{jt} dj & \text{if } R_{t+1} > \frac{1}{\delta} \end{cases}.$$

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Grossman-Stiglitz Paradox in one Slide

- Following Grossman and Stiglitz (1980):
  - Assume asset prices reflect all available information.
  - Then, investors do not have any incentive to produce private information.
  - However, if investors are uninformed, prices cannot reflect any information.

$\Rightarrow$ To incentivize information production, financial markets have to be imperfect.

  - Some source of noise/irrationality is necessary.

- Most literature: noise traders.
- My paper: "micro-found" noise via overconfidence. Back

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Marginal Benefit of Information Production

- Trader ij's marginal benefit of increasing β_{ijt} is the central object of the model:

$$\widetilde{MB}\left(\beta_{ijt}, \beta_{jt}\right) \propto \tilde{\mathbb{E}}_t \left\{ \underbrace{\frac{\partial \mathcal{P}\left(x_{ijt}=2\right)}{\partial \beta_{ijt}}}_{\text{Change in Probability of Buying}} \underbrace{\left(\frac{1}{R_{t+1}}\Pi_{jt+1} - P_{jt}\right)}_{\text{Rents}} \right\}.$$

- Producing more precise information makes buying more likely when rents are large. Back

Entrepreneur's Problem

Assumption

Entrepreneurs can only sell claims to a fraction $\lambda_{jt} \in [0,1]$ of firm-revenue.

- The entrepreneur solves

$$\max_{\lambda_{jt}, K_{it+1}} \quad \mathbb{E}\left\{\Pi\left(a_{jt}, K_{jt+1}, Y_{t+1}\right) - D\left(a_{jt}, K_{jt+1}, Y_{t+1}\right) | P_{jt}\right\} \tag{P2}$$

$$D\left(a_{jt}, K_{jt+1}, Y_{t+1}\right) = \lambda_{jt} \Pi\left(a_{jt}, K_{jt+1}, Y_{t+1}\right)$$

$$0 \leq K_{jt+1} \leq P_{jt},$$

where

$$\Pi\left(a_{jt}, K_{jt+1}, Y_{t+1}\right) = \rho_{jt+1} Y\left(a_{jt}, K_{jt+1}, Y_{t+1}\right)$$

- The optimal decision by the entrepreneur is to choose $K_{jt+1} = P_{jt}$ and $\lambda^* = \frac{\theta-1}{\theta}$. Back

Equilibrium Definition

Definition

A symmetric, competitive equilibrium consists of prices $\{W_t, \rho_{jt+1}, P_{jt}, P_t, R_{t+1}\}$ *and allocations* $\{B_{it+1}, x_{ijt}, \beta_{ijt}, K_{jt+1}\}$ *such that:*

1. *Given prices* $\{W_t, \rho_{jt+1}, P_{jt}, R_{t+1}\}$ *and allocations* $\{x_{ijt}, \beta_{ijt}\}$, B_{it+1} *solves the household's problem.*
2. *Given prices* $\{P_{jt}, R_{t+1}\}$ *and allocations* $\{B_{it+1}, \beta_{jt}, K_{jt+1}\}$, $\{x_{ijt}, \beta_{ijt}\}$ *solve the trader's problem.*
3. *Prices are such that markets for shares, labor, intermediate goods, bonds and capital clear.*

Assumption: Information increases TFP and Investment

Assumption

The variance of firm-specific sentiment shocks σ_ε^2 is low enough such that
(i) $\frac{\partial A(a_t,\beta_t)}{\partial \beta_t} > 0$.
(ii) for $\varepsilon_t = 0$: $\frac{\partial K_{t+1}(\beta_t)}{\partial \beta_t} \geq 0$. Back

Financial Market Clearing Condition

- In eq ($\forall i : \beta_{ijt} = \beta_{jt}$), trader ij demands two shares when s_{ijt} is above a threshold z_{jt},

$$x_{ijt} = 2 \iff s_{ijt} > z_{jt}.$$

- Market clearing

$$2\left[1 - \Phi\left(\sqrt{\beta_{jt}}\left(z_{jt} - a_{jt}\right) - \varepsilon_{jt}\right)\right] = 1.$$

- Which leads to the threshold and price signal z_{jt}

$$z_{jt} = a_{jt} + \frac{\varepsilon_{jt}}{\sqrt{\beta_{jt}}}.$$

Price equal to the valuation of the marginal trader ($s_{ijt} = z_{jt}$), Back

$$P_{jt} = \frac{1}{R_{t+1}}\tilde{\mathbb{E}}\left\{\Pi_{jt+1} | s_{ijt} = z_{jt}, z_{jt}\right\}.$$

TFP

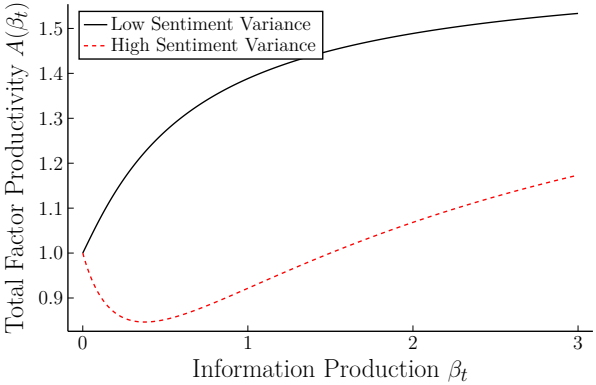

Figure: Total factor productivity can be locally decreasing in β_t under the market allocation. Back

Productivity Shocks and Information

Proposition

Productivity booms decrease misallocation by encouraging information production.

- Positive productivity shocks make all trades proportionally more valuable.
- Productivity-driven booms increase information production and TFP's endogenous component.

Amplification - Productivity Shock

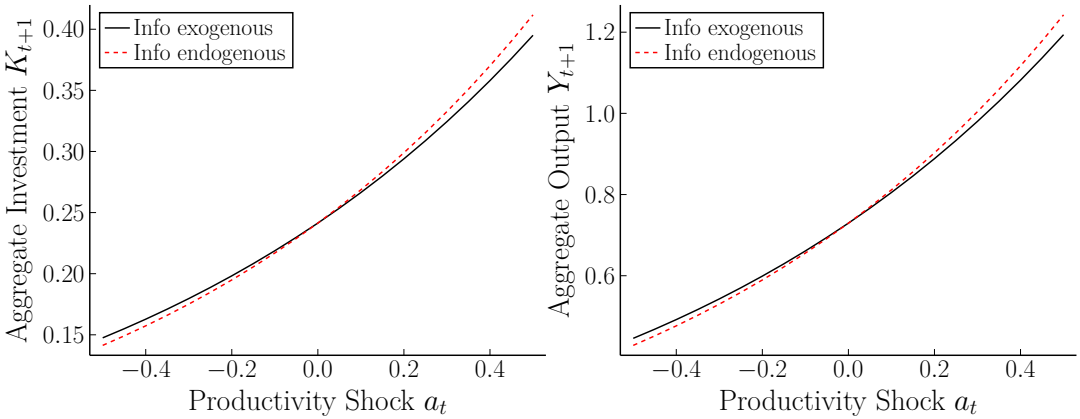

Figure: Information production amplifies productivity shocks. Back

Sentiment Shocks crowd out Information Production

Proposition

Sentiment shocks, whether positive or negative, tend to increase misallocation by discouraging information production.

- Private information becomes less likely to guide the trading decision.
- Sentiment booms decrease information production and TFP's endogenous component. Back

Dampening - Sentiment Shock

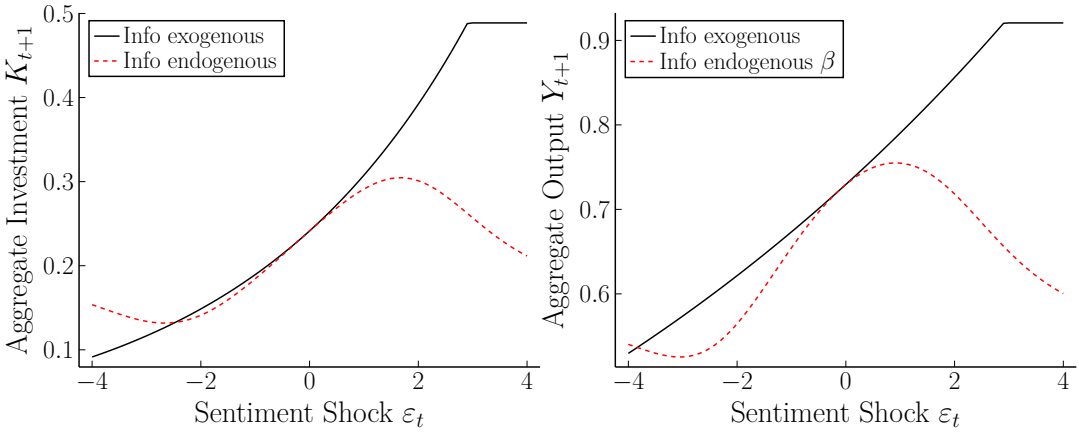

Figure: Information production dampens positive sentiment shocks. Back

Dampening - Sentiment Shock

Proposition

(i) If $\theta > \frac{1}{1-\alpha}$ *and* $\beta^* < \frac{\sigma_a^{-2}}{1+\sigma_\varepsilon^{-2}}$, *information production dampens positive sentiment shocks.*
(ii) If $\lim_{\varepsilon_t \to \infty} \sqrt{\beta_t(\varepsilon_t)}\varepsilon_t = 0$, *large positive sentiment shocks eventually lead to a decrease in aggregate investment.*

- Direct effect: sentiment shocks increase investment.
- But two indirect effects of decrease in info acq:

1. TFP $\downarrow \Rightarrow$ investment $\downarrow$.
2. Do beliefs get more or less noisy? Back

Sentiment Shocks II

- Marginal benefit of increasing β_{ijt} can be expressed as Analytical Expressions

$$\widetilde{MB}\left(\beta_{ijt},\beta_{jt}\right)\Big|_{\beta_{ijt}=\beta_{jt}} \propto \tilde{\mathbb{E}}_t\left\{\underbrace{\frac{\partial \mathcal{P}\left\{x_{ijt}=2\right\}}{\partial \beta_{ijt}}\Big|_{\beta_{ijt}=\beta_{jt}}}_{\text{Information-Sensitivity}}\left(\frac{K_{jt+1}}{K_{t+1}}\right)^{\frac{\theta-1}{\theta}} K_{t+1}^{\alpha}\left(A_{jt}-\tilde{\mathbb{E}}\left\{A_{jt}|s_{ijt}=z_{jt},z_{jt}\right\}\right)\right\}$$

- There are three mechanisms:

1. Information-Sensitivity: How likely is the private signal to change the trading decision?
2. Relative Size: How large are firms for which information is valuable ($\varepsilon_{jt} \approx 0$)?
3. Absolute Size: How large are firms on average? Back

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Sentiment Shocks II: Analytical Expressions

- Marginal benefit of increasing β_{ijt} can be expressed as

$$\widetilde{MB}\left(\beta_{ijt}, \beta_{jt}\right)\Big|_{\beta_{ijt}=\beta_{jt}} \propto \exp\left\{ \underbrace{-\frac{\varepsilon_t^2}{2\left(1+\sigma_\varepsilon^2\right)}}_{\textit{Information-Sensitivity}} \underbrace{-\left(\theta-1\right)\omega_{s\varepsilon}\varepsilon_t}_{\textit{Relative Size}} + \underbrace{\frac{\alpha}{1-\alpha}\omega_{s\varepsilon}\varepsilon_t}_{\textit{Absolute Size}} \right\}$$

- There are three mechanisms that drive this result:

1. Information-Sensitivity: How likely is the private signal to change the trading decision?
2. Relative Size: How large are firms for which information is valuable ($\varepsilon_{jt} \approx 0$)?
3. Absolute Size: How large are firms on average? Back Sentiment

Information Production depending on Aggregate Shocks

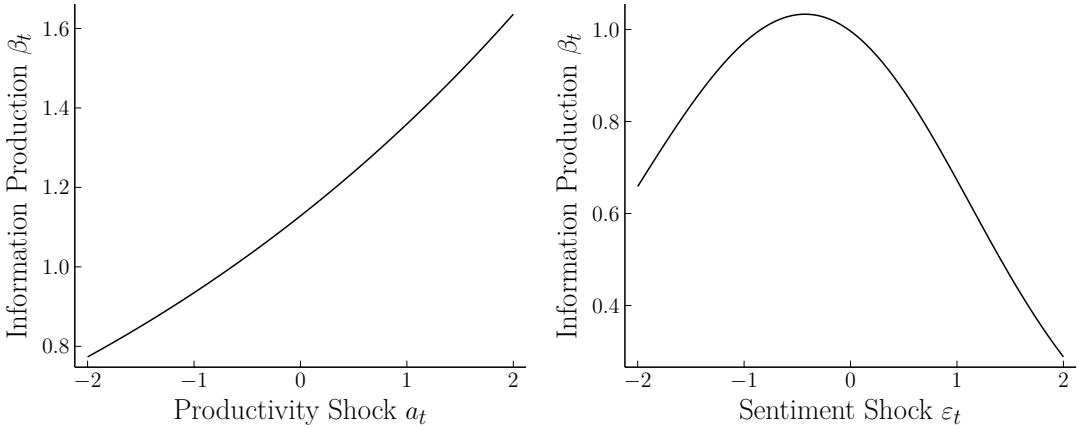

Figure: Productivity booms *crowd in* information. Sentiment shocks (positive or negative) *crowd out* information. Back

Relative Size

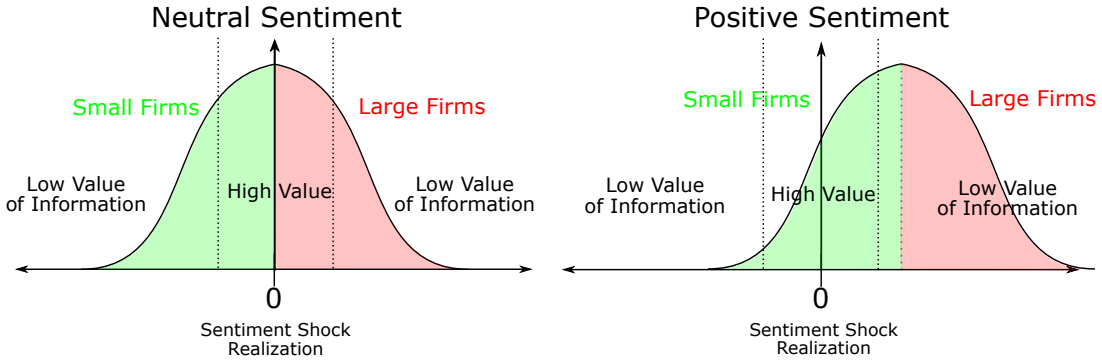

Figure: Firms with $\varepsilon_{jt} \approx 0$ must appear unproductive when $\varepsilon_t > 0$. Back

High θ: Planner's Response to Shocks

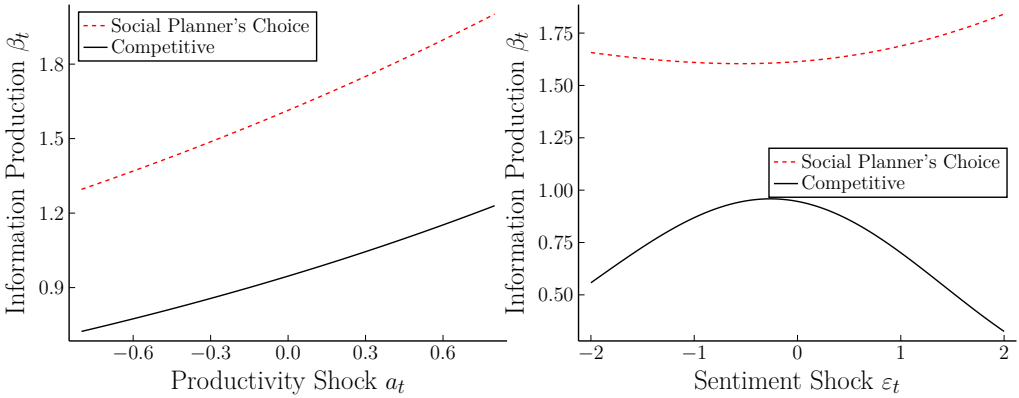

Figure: Social planner increases info production in response to productivity booms. In contrast, social planner increases information production in response to positive and negative sentiment shocks. Back

Asset Purchases

- Asset purchases affect investment and info production.
  - Exploit dispersed information; changes to asset supply change the identity of marginal trader.
  - Decrease in asset supply makes the marginal trader more optimistic.
  - Introduces a bias in asset prices.
- Therefore, model supports arguments for and against asset purchases:
  - Purchases can counter negative sentiment shocks (negative bias + positive bias = no bias).
  - However, asset purchases also source of bias in absence of sentiment shocks.
- Non-Ricardian effect: Asset purchases can increase investment. Back

Asset Purchases

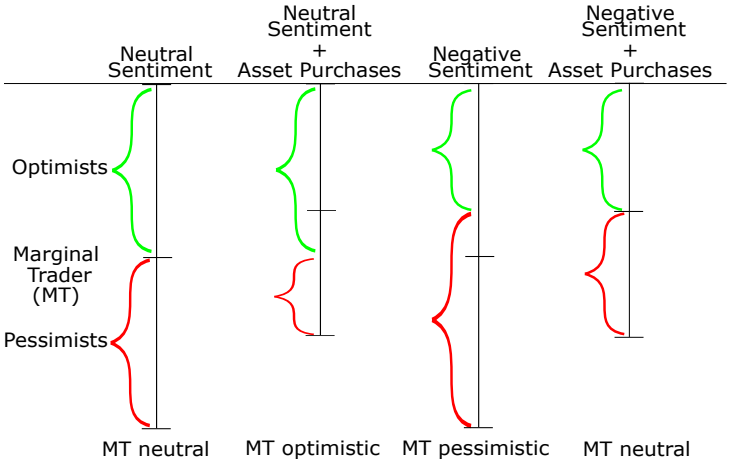

Figure: Asset purchases introduce a positive bias in asset prices and can therefore offset negative sentiment shocks. Back

Uncertainty: Revelation after Info Production

- Aggregate shocks get revealed after information production. Back
  - Traders' expectations about sentiment shocks distort information production.
  - Social planner can intervene perfectly if she shares same information set.
  - Contingent taxes/subsidies can fix investment.
- Surveys can be used to measure expectations about sentiment among traders.
  - "Do you expect markets to be driven by sentiment?"
- Similarly, dispersion of asset prices can be used to disentangle productivity and sentiment booms.
  - Asset prices increase and firms appear more similar → sentiment boom.
  - Asset prices increase and firms appear less similar → productivity boom.

Uncertainty: Revelation only ex-post

- Aggregate shocks get revealed ex-post. Back
- Interventions must balance costs and benefits due to uncertainty.
- Aggregate prices send signal $z_t = a_t + \frac{\varepsilon_t}{\sqrt{\beta_t}}$. Prior on $\{a_t, \varepsilon_t\}$ important when interpreting z_t.
- Info production can be used to dampen impact of sentiment shocks.

Social Planner's Two-Period Problem

- Two-period problem to abstract from inter-generational trade-offs: Back

$$\max_{K_{j1}, C_0, C_1, \beta_{j0}} \quad C_0 + \delta \mathbb{E}_0 \left\{ C_1 | \left\{ z_{j0} \right\} \right\} - \int_0^1 IA\left(\beta_{j0}\right) dj$$

$$\begin{aligned} s.t. \quad K_1 &= W_0 - C_0 \\ C_1 &\leq Y_1\left(\left\{K_{j1}\right\}, \left\{\beta_{j0}\right\}\right) \\ C_0 &\leq W_0 \end{aligned}$$

$$C_0, C_1, \beta_{j0}, K_{j1} \geq 0.$$

Constraint-Efficient Capital Allocation

- Firm capital is given by Price Distortion

$$K_{j1}^{SP} = \frac{\mathbb{E}\left\{A_{j0}|z_{j0}\right\}^{\theta}}{\int_0^1 \mathbb{E}\left\{A_{j0}|z_{j0}\right\}^{\theta} dj} K_1^{SP} \ .$$

- Does not overreact to z_{j0} as market allocation,

$$K_{j1}^{CE} = \frac{\tilde{\mathbb{E}}\left\{A_{j0}|x_{ij0} = z_{j0}, z_{j0}\right\}^{\theta}}{\int_0^1 \tilde{\mathbb{E}}\left\{A_{j0}|x_{ij0} = z_{j0}, z_{j0}\right\}^{\theta} dj} K_1^{CE}.$$

- Aggregate output and productivity are given by

$$Y_1^{SP} = A_0^{SP}\left(K_1^{SP}\right)^{\alpha} \quad \text{with } A_0^{SP} = \left(\int_0^1 \mathbb{E}\left\{A_{j0}|z_{j0}\right\}^{\theta} dj\right)^{\frac{\alpha}{\theta-1}} .$$

- Where $A_0^{SP} > A_0^{CE}$ for interior values of β_0. Back

Wedge

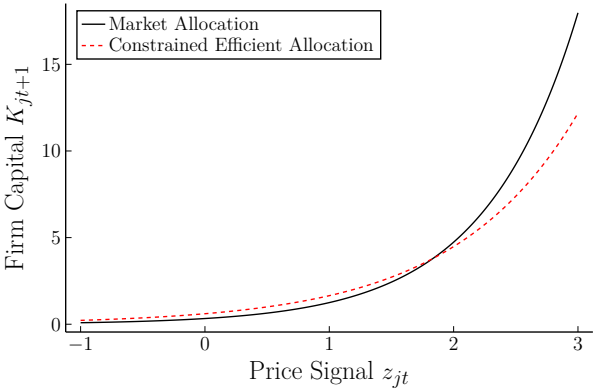

Figure: Market allocation of capital and the constrained-efficient allocation. Back

Decentralized Implementation: Investment

- A combination of taxes and subsidies can be used to implement the social planner's allocation.
  - Taxes are collected lump-sum from young generation.
  - Revenue is rebated lump-sum to same generation when old.
- Tax/subsidy on dividends:

$$\Pi_{j1}^{DE} = \tau^{Bias}(z_{j0})\,\Pi_{j1}, \quad \text{where } \tau^{Bias}(z_{j0}) = \frac{\mathbb{E}\{A_{j0}|z_{j0}\}}{\tilde{\mathbb{E}}\{A_{j0}|x_{ij0} = z_{j0}, z_{j0}\}}.$$

1. Redistributes capital from large to small firms.
2. Tax on investment when sentiment is positive. Back

Decentralized Implementation: Information

- Tax/subsidy on information production:

$$\frac{\partial IA^{DE}\left(\beta_{ij0}\right)}{\partial \beta_{ij0}} = \tau^{Info}\left(\beta_{ij0}\right)\frac{\partial IA\left(\beta_{ij0}\right)}{\partial \beta_{ij0}}, \quad \tau^{Info}\left(\beta_{ij0}\right) = \frac{\widetilde{MB}^{CE}\left(\beta_{ij0},\beta_{j0}\right)\Big|_{\beta_{ij0}=\beta_{j0}}}{\delta\frac{\partial A_0}{\partial \beta_0}K_1^{\alpha}}.$$

1. Makes traders target TFP when acquiring information.
2. Subsidize information production when sentiment shock hits. Back

Implementation of Social Planner's Information Choice

1. Direct subsidies/taxes on information production.
   - For example, tax credits for expenses related to info acq.
2. Use subsidies/taxes to make buying assets riskier/safer:
   - Taxes on profits and deductions for losses $\rightarrow$ flatten payoff function.
   - Taxes on losses and subsidies for profits $\rightarrow$ steepen payoff function.

Implementing more Info Production

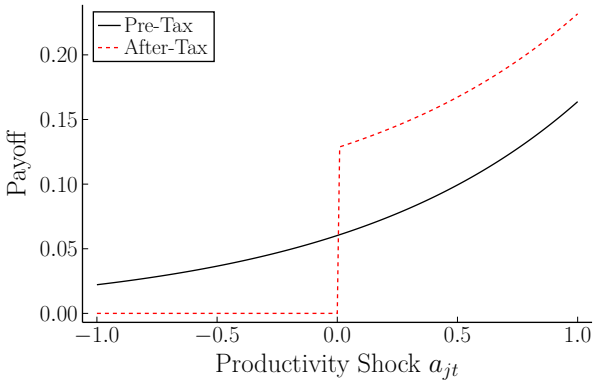

Figure: Tax/subsidy scheme incentivizes info production by increasing exposure to productivity shock. Back

Planner's Problem: Asset Purchases and Sales

- Let social planner use asset purchases / sales: Back

$$\max_{x_0^{SP} \in (-1,1)} \quad C_0 + \delta C_1 - \int_0^1 IA\left(\beta_{j0}\right) dj$$

$$s.t. \quad C_{i0} = W_0 - \int_0^1 x_{ij0} P_{j0} dj - B_{i1} - x_0^{SP} \int_0^1 P_{j0} dj$$

$$C_{i1} = \int_0^1 x_{ij0} \Pi_{j1} dj + R_1 B_{i1} + x_0^{SP} \int_0^1 \Pi_{j1} dj$$

$$C_0, C_1 \geq 0.$$

$x_{ij0}, B_{i1}, P_{j0}, \beta_{j0}$ are determined competitively.

Price Informativeness and TFP growth for the US

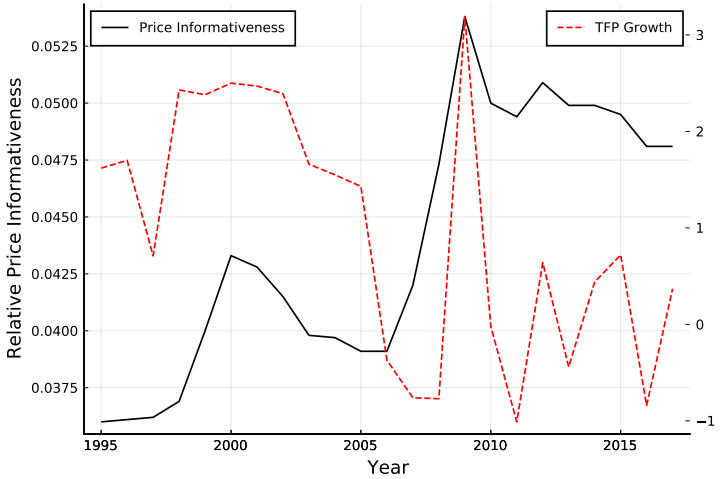

Figure: There is positive co-movement between price informativeness and TFP growth. Back

Dispersion in *mrpk* increase during Sentiment Boom

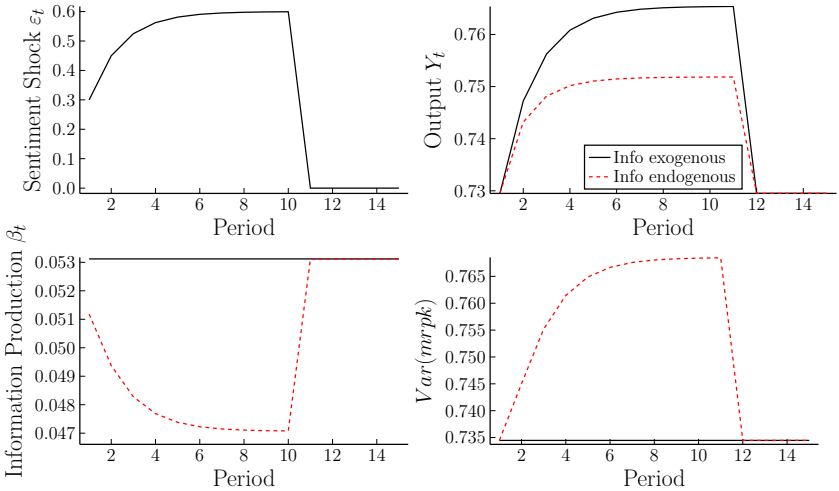

Figure: Capital becomes increasingly misallocated during a sentiment boom. Back

Dispersion in *mrpk* decreases during Productivity Boom

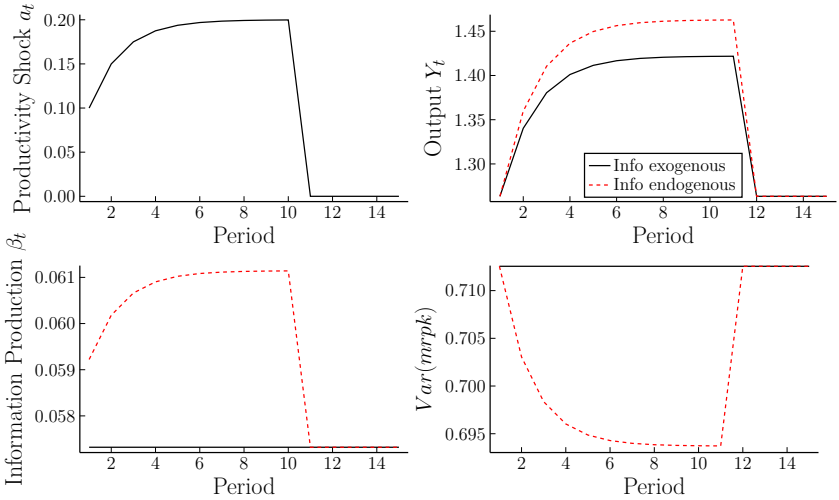

Figure: Capital becomes less misallocated during a productivity boom. Back

Price Informativeness: How informative are Prices about Earnings Tomorrow?

- Relative price informativeness in my model is

$$\frac{\beta\left(1+\sigma_{\varepsilon}^{-2}\right)}{\sigma_{a}^{-2}+\beta\left(1+\sigma_{\varepsilon}^{-2}\right)}.$$

- Dávila and Parlatore (2020) run two regressions at the firm level:

$$\Delta p_t = \bar{\beta} + \beta_0 \Delta x_t + \beta_1 \Delta x_{t+1} + e_t \quad \text{(R1)}$$

$$\Delta p_t = \bar{\zeta} + \zeta_0 \Delta x_t + e_t^{\zeta} \quad \text{(R2)}$$

- Relative price informativeness is then derived as

$$\frac{R^2_{\Delta x, \Delta x'} - R^2_{\Delta x}}{1 - R^2_{\Delta x}}.$$

- where $R^2_{\Delta x, \Delta x'}$ belongs to (R1) and $R^2_{\Delta x}$ to (R2). Back

Alternative Measure of Information: Return Dispersion

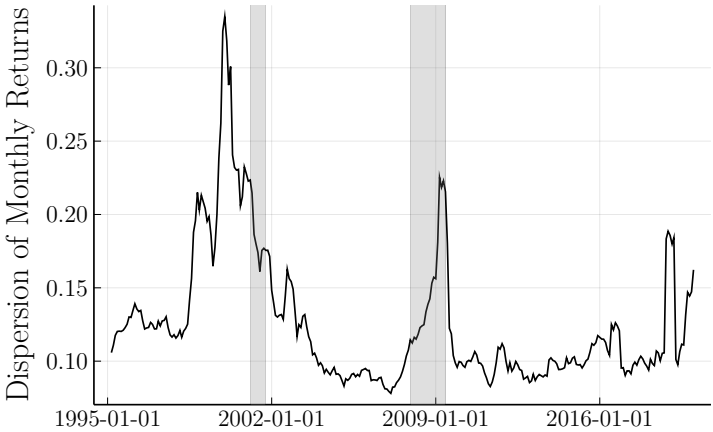

Figure: Return dispersion was high during dot-com boom leading up to 2001, but low during the housing boom.

Back

Social Planner's Two-Period Problem

- Two-period problem to abstract from inter-generational trade-offs.
- Focus on information frictions: Full Planner Problem
  - Is there too much too little information production in the competitive equilibrium?
- Social planner dictates information production for each trader:

$$\begin{aligned} \max_{\{\beta_{ij0}\}} \quad & C_0 + \delta C_1 - \int_0^1 IA\left(\beta_{ij0}\right) dj \\ s.t. \quad & C_1 = A_0\left(\{\beta_{ij0}\}\right) K_1^{\alpha} \\ & C_0 = W_0 - K_1 \\ & K_1 \text{ is determined competitively} \\ & \beta_{ij0} \geq 0. \end{aligned}$$

- Back

Information Production: Planner vs. Market

- Rent-Extracting Behavior: Produce info to extract rents from other traders:

$$\text{Gain of one Trader} = \text{Loss of other Traders.}$$

- Information Spillover: *Collective* info production improves productivity:

$$\frac{\partial A_0(\beta_0)}{\partial \beta_0} > 0.$$

- Back

Information Production: Planner vs. Market

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- Back

No Substitution: Information Irrelevant for Allocation

- No substitution ($\theta \to 0$):

$$\lim_{\theta \to 0} Y_t = L^{1-\alpha} \left(\inf K_{jt+1}\right)^{\alpha} \quad \Rightarrow K_{jt+1} = K_{t+1}.$$

- Information has very little social value.
- Yet, traders produce information as rents depend on A_{jt}:

$$\Pi_{jt+1} = \alpha Y_{t+1}^{\alpha_Y} A_{jt} K_{jt+1}^{\frac{\theta-1}{\theta}}.$$

- Back

Perfect Substitution: Information Crucial for Allocation

- Perfect substitution ($\theta = \infty$):

$$\lim_{\theta \to \infty} Y_t = L^{1-\alpha} \int_0^1 A_{jt} K_{jt+1} dj \quad \Rightarrow \text{all capital to most prod. firm.}$$

- Information has very high social value.
- Yet, traders do not incorporate the social value of information.

- Bottom line: Traders produce too little information when capital allocation is important. Back

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Rational and Noise Traders, building on Albagli, Hellwig, and Tsyvinski (2017)

1. Noise traders/mutual funds have demand $\Phi\left(u_{jt}\right)$, where the noise trader shock u_{jt} is *iid* across time and markets.
2. Rational traders receive a signal $s_{ijt} = a + \frac{\eta_{ijt}}{\sqrt{\beta_{ijt}}}$, where $\eta_{ijt} \sim \mathcal{N}(0,1)$. They can lend and borrow between each other at interest rate R_{t+1}
   1. Position limits are given by $x_{ijt} \in [0,1]$, and the equilibrium strategy is

$$x_{ijt} = 1 \iff s_{ijt} \geq z_{jt} \iff \frac{1}{R_{t+1}} \mathbb{E}\left\{\Pi_{jt+1} | s_{ijt}, P_{jt}\right\} \geq P_{jt}\left(z_{jt}\right).$$

3. The market clearing condition in the symmetric equilibrium is

$$1 - \Phi\left(\sqrt{\beta_{jt}}\left(z_{jt} - a_{jt}\right)\right) + \Phi\left(u_{jt}\right) = 1.$$

$$z_{jt} = a_{jt} + \frac{u_{jt}}{\sqrt{\beta_{jt}}}$$

4. Households allocates $\gamma_t W_t$ to mutual funds

$$\gamma_t W_t = \int_0^1 \Phi\left(u_{jt}\right) P\left(z_{jt}\right) dj.$$

5. Households manage the remaining $(1 - \gamma_t) W_t$ themselves, choosing β_{ijt} and positions x_{ijt}. Back