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

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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 booms.
   - 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.
   - Borio et al. (2015): "disappointing US [pre-crisis] growth ... because of the [financial] boom."

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US experienced a Decline in Productivity during pre-crisis Boom

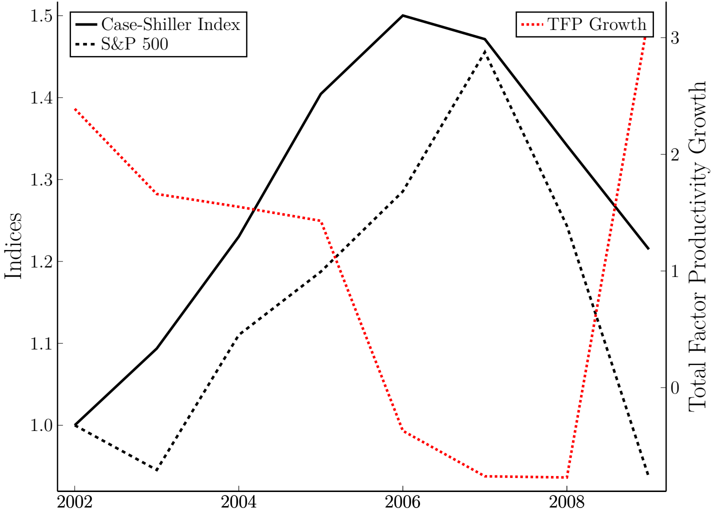

Figure: Asset price boom during slowdown in total factor productivity growth. Spain Source TFP

This Paper: Overview

- This paper: Study role of information in financial markets in allocating scarce capital.
- In the spirit of Hayek (1945), markets aggregate information:

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

- To avoid Grossman-Stiglitz paradox: Overconfidence. Paradox
  - Common bias in a broad variety of settings. Literature
  - Yields a tractable macroeconomic framework.

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This Paper: Framework

- Households (HH) save by investing in firms through stocks.
- Information frictions: HH do not know firm productivity; can acquire costly information.
- Two sources of firm-specific and aggregate fluctuations:
  - Fundamental (Productivity).
  - Non-Fundamental (Sentiments as waves of optimism/pessimism).
- In many ways, productivity and sentiment booms look similar:
  - They increase output, investment and asset prices.
  - Yet, they have different impacts on capital allocation.

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Positive Results

- Relationship between asset price booms and misallocation depends on source of boom.
- Fundamental booms, e.g. which are driven by productivity, decrease misallocation.
  - Information production $\uparrow \Rightarrow$ Endogenous TFP component $\uparrow$
  - Productivity shocks get amplified.
- Non-fundamental booms, e.g. which are driven by sentiment, increase misallocation.
  - Information production $\downarrow \Rightarrow$ Endogenous TFP component $\downarrow$
  - Sentiment booms get dampened.

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Normative Results

- Laissez-faire equilibrium is constrained inefficient.
  - Info production can be too high (rent-extracting behavior).
  - Info production can be 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

- 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.**
- Credit Cycles: Gorton and Ordoñez (2014), Asriyan, Laeven, and Martin (2019), Gorton and Ordoñez (2020)
  - **New information mechanism between booms and misallocation.**
- 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:

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

  - 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 $[0,2]$.
  - Choose information precision β_{ijt} to inform trading decision at cost $IA(\beta_{ijt})$:

$$IA(0) = 0 \quad IA'(0) = 0 \quad IA'(\cdot) \geq 0 \quad IA''(\cdot) > 0.$$

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Final Good Producers

- Final good firms combine intermediate goods with labor to produce the final good,

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

- α : Intermediate good share.
- θ : Elasticity of substitution between intermediate goods.
  - Linked to the cost of misallocation.

Intermediate Good Sector

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

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

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

- Capital takes time to build: Investment in t, production in $t+1$.

- As in Peress (2014), firms sell claims to firm revenue and invest proceeds,

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

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

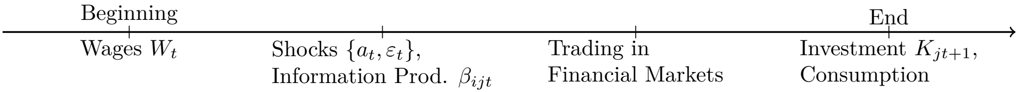

Figure: Information production takes place after aggregate shocks are revealed.

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

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

Household i's Problem

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

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

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

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

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

- Optimal saving decision:

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

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Trader ij's Trading Problem

- Plugging B_{it+1} into the household's problem leads to trader ij's trading problem:

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

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

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

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Trader *ij*'s Information Production Problem

- Optimal buying decision leads to information production problem:

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

where $\lambda_t = \max\left\{1, R_{t+1}\delta\right\}$.

- 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.

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Financial Market Clearing, Intuition

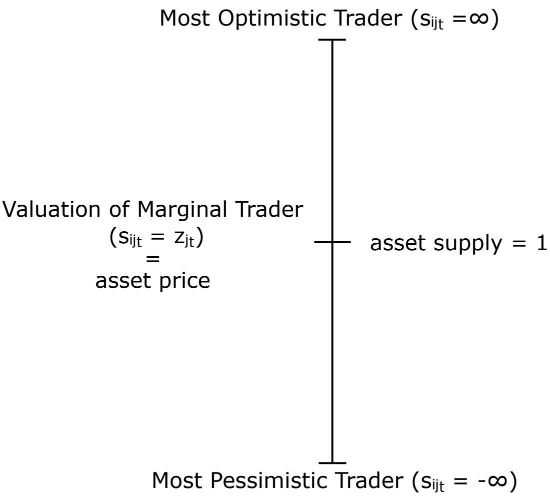

Figure: Price P_{jt} is equal to the marginal trader's valuation, who is indifferent between buying or not.

Financial Market Clearing, Formal

- 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

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

- Price signal

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

- 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.

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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 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.

Productivity Shock with fixed Info

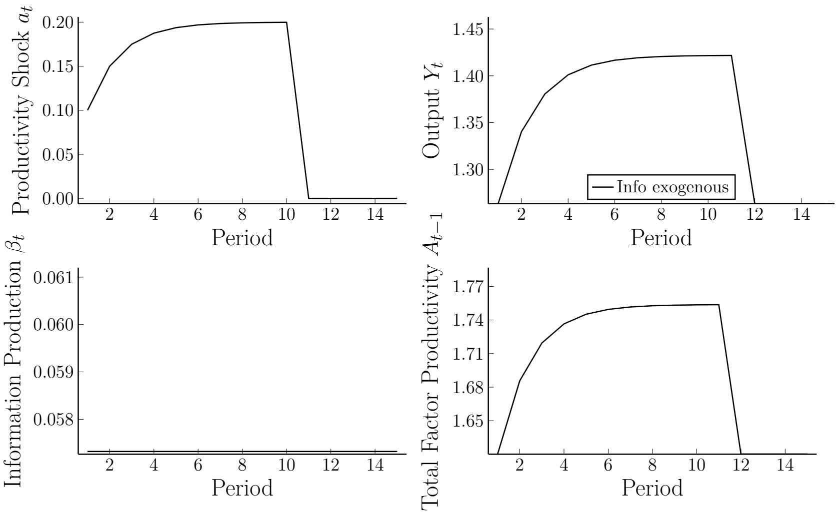


Figure: Productivity shocks increase exogenous TFP and investment.

Productivity Booms are Amplified by Information Production

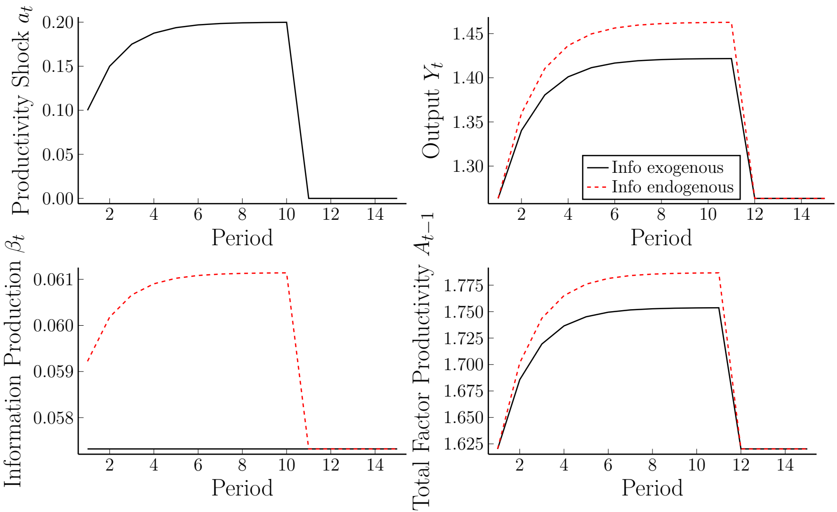


Figure: Productivity booms encourage information production, which amplifies the boom. Detail Misallocation

Sentiment 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.

Sentiment Booms with fixed Info leave TFP unaffected

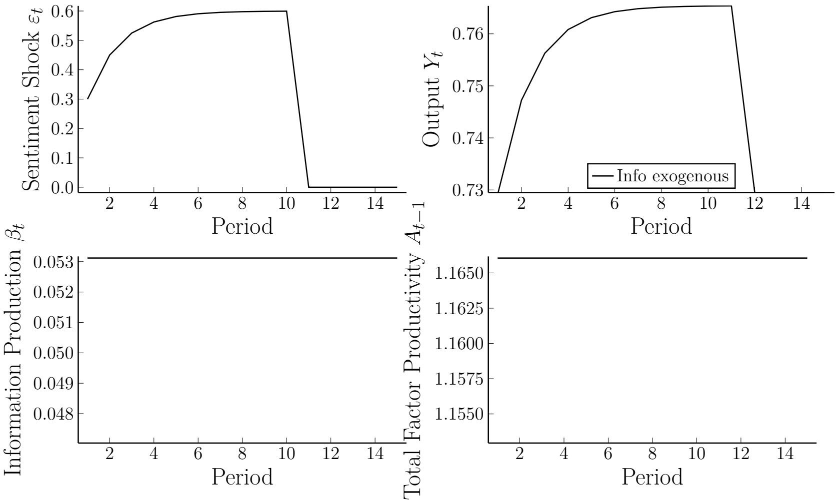


Figure: Sentiment booms increase investment and output.

Sentiment Booms are Dampened by Information Production

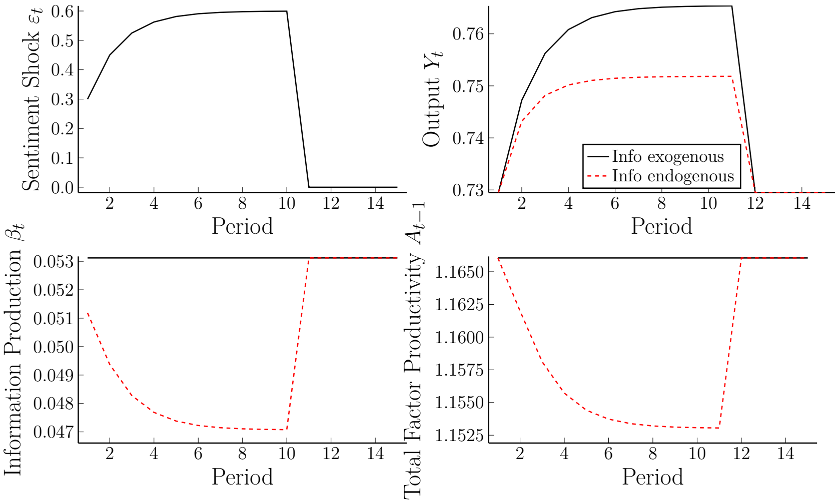


Figure: Sentiment booms increase misallocation by discouraging information production, which dampens the boom. Detail Misallocation

Sentiment Shocks make Trading less information-sensitive

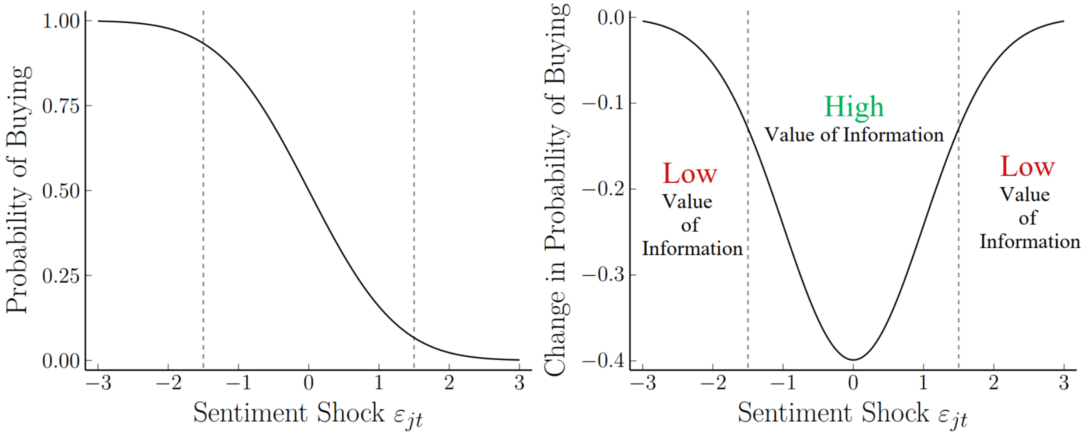
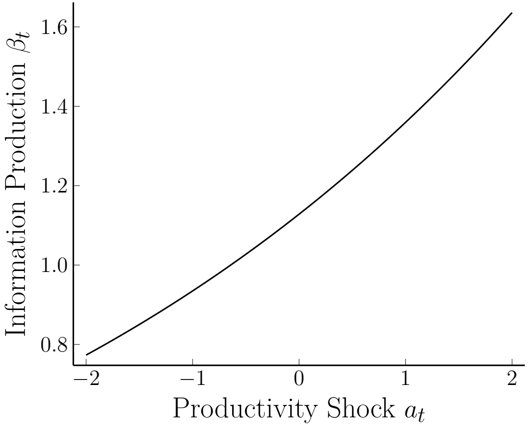


Figure: Positive and negative sentiment shocks make assets more mispriced.

Information Production depending on Aggregate Shocks



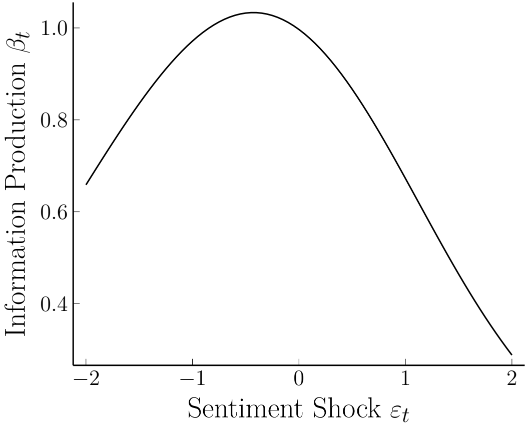


Figure: Productivity booms *crowd in* information. Sentiment shocks (positive or negative) *crowd out* information. Detail Sentiment

Taking Stock

- Information plays a key role in the allocation of capital.
    - Two forces at firm-level: Productivity and Sentiment.
    - More information improves capital allocation among firms $\Rightarrow$ higher TFP.
- Similarly, aggregate booms can be driven by these two forces.
    - Productivity-Booms *crowd in* information and increase TFP, amplifying the initial shock.
    - Sentiment-Booms *crowd out* information and decrease TFP, dampening the shock.
    - Rationalizes evidence for "good" and "bad" booms (Gorton and Ordoñez, 2020).
- Can the social planner improve on the laissez-faire equilibrium? Yes!

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- Similarly, aggregate booms can be driven by these two forces.
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    - Sentiment-Booms *crowd out* information and decrease TFP, dampening the shock.
    - Rationalizes evidence for “good” and “bad” booms (Gorton and Ordoñez, 2020).
- Can the social planner improve on the laissez-faire equilibrium? Yes!

Taking Stock

- Information plays a key role in the allocation of capital.
  - Two forces at firm-level: Productivity and Sentiment.
  - More information improves capital allocation among firms $\Rightarrow$ higher TFP.
- Similarly, aggregate booms can be driven by these two forces.
  - Productivity-Booms *crowd in* information and increase TFP, amplifying the initial shock.
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Social Planner's Two-Period Problem

- Two-period problem to abstract from inter-generational trade-offs.
- Focus on information frictions. Full Planner Problem

- Social planner dictates information production for each trader:

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

Information Production: Planner vs. Market

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

$$\text{Gain of Trader } ij = \text{Loss of other Traders (Rent Extraction)}.$$

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

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

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Planner vs. Laissez-faire Information Production

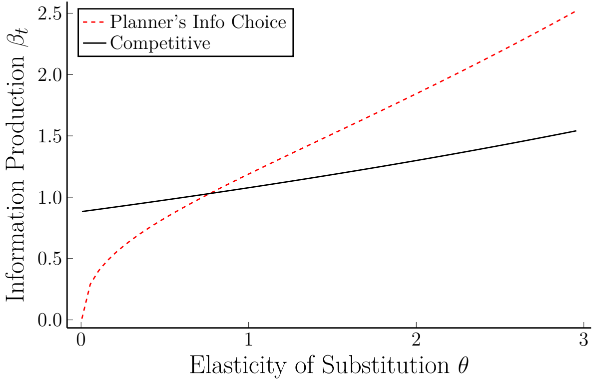

Figure: Low elasticity: Too much information production. High elasticity: Too little information production.

No substitution: Information Unimportant 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}:

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

Perfect Substitution: Information Very Important 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.

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High θ: Planner's Response to Shocks

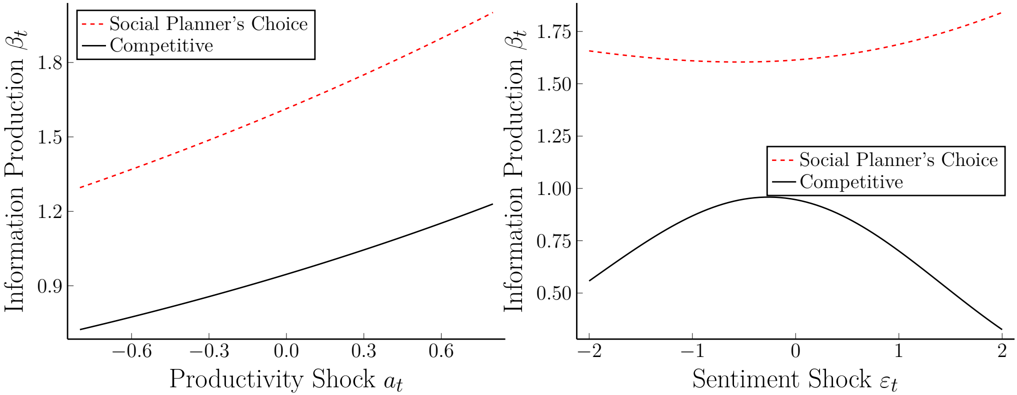

Figure: Social planner increases info production in response to productivity booms. In contrast, social planner increases information production in response to positive and negative sentiment shocks. Implementation

Application: Asset Purchases

- In the past decade, asset purchases have been repeatedly 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, when used appropriately, can increase market efficiency. Problem

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Optimal Asset Purchases: Leaning against Sentiment

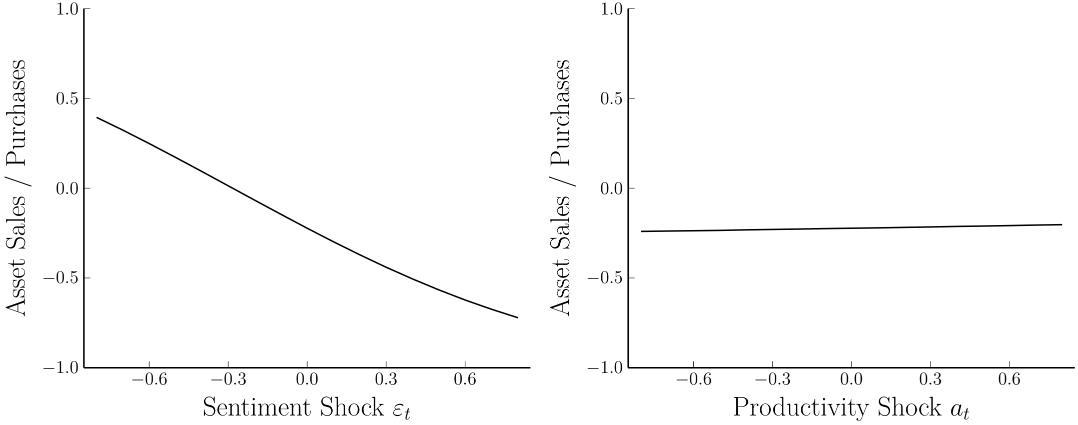

Figure: Social planner buys (sells) assets in response to negative (positive) sentiment shocks. Mechanism Uncertainty

Positive Co-Movement between Price Informativeness and TFP growth

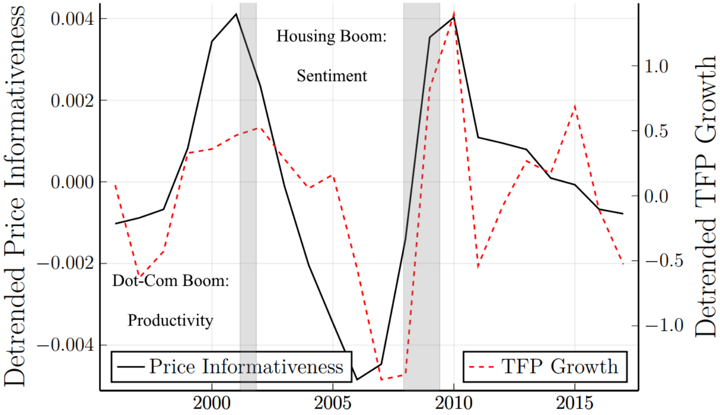

Figure: Detrended Price Informativeness (Dávila and Parlatore, 2020) and TFP growth (San Francisco Fed) for the US. Not Detrended Dispersion Derivation Source TFP

Conclusion

- I develop a tractable macroeconomic model with info production in financial markets.
  - Information is important for the allocation of capital and productivity.
- Booms have different effects on misallocation depending on their source.
  - Productivity booms *decrease misallocation by encouraging info production.*
  - Sentiment booms *increase misallocation by discouraging info production.*
- Dichotomy of "good" and "bad" booms as in Gorton and Ordoñez (2020).
- Information production in markets constrained inefficient:
  - Rent extraction behavior and information spillover.
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Similar experience in Southern Europe, for example Spain

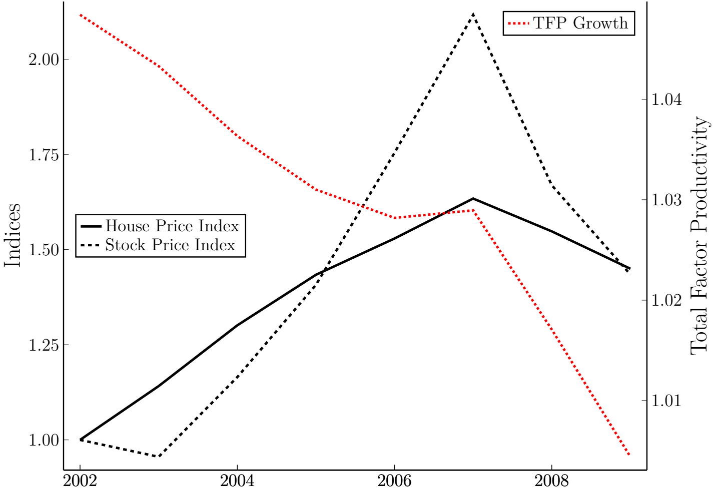

Figure: Total factor productivity declined, although asset prices were booming. Back

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).

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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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

TFP

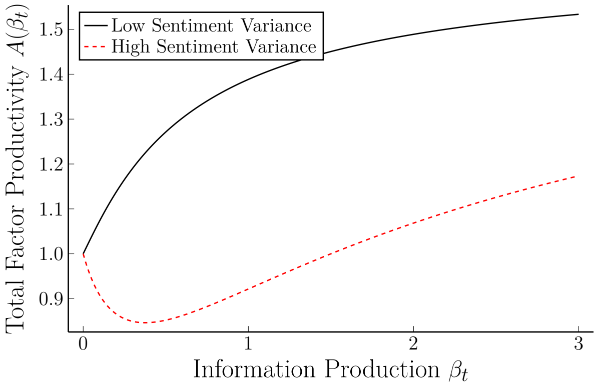

Figure: Total factor productivity can be locally decreasing in β_t under the market allocation. Back

Amplification - Productivity Shock

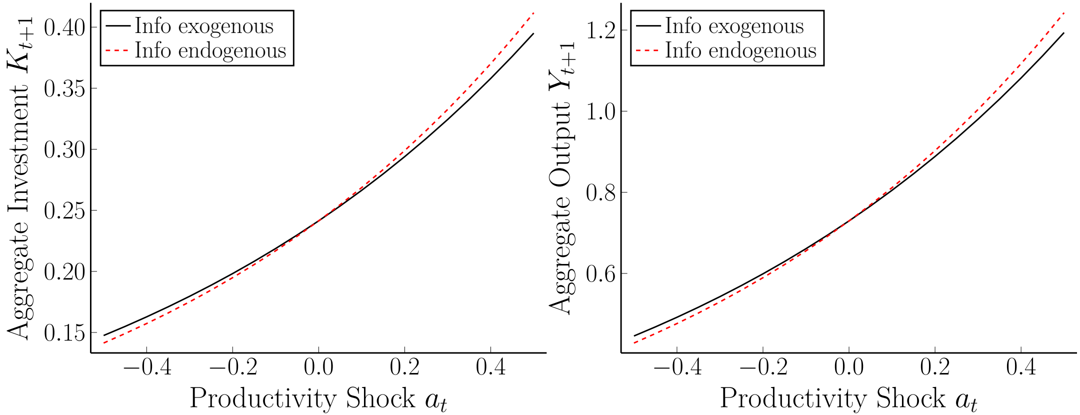

Figure: Information production amplifies productivity shocks. Back

Dampening - Sentiment Shock

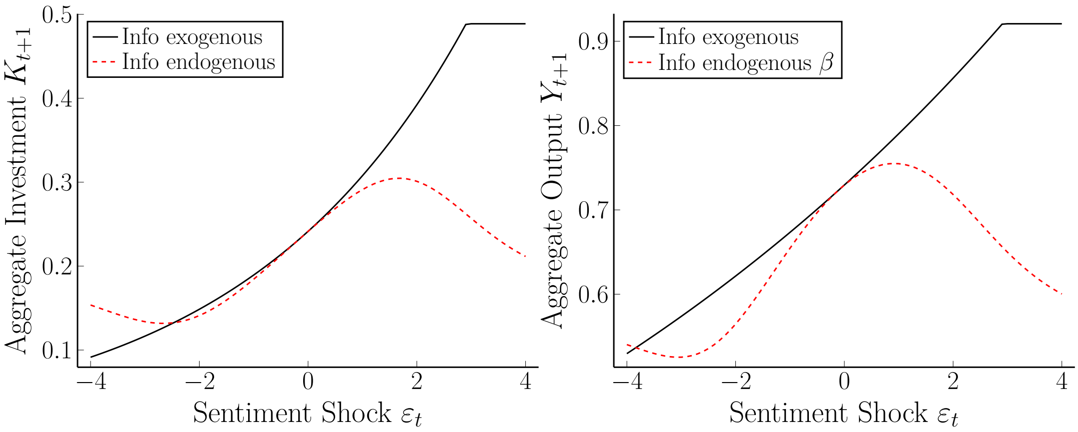

Figure: Information production dampens positive sentiment shocks. Back

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

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

Sentiment Shocks II

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

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

- 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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3. **Absolute Size:** How large are firms on average? Back

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

Relative Size

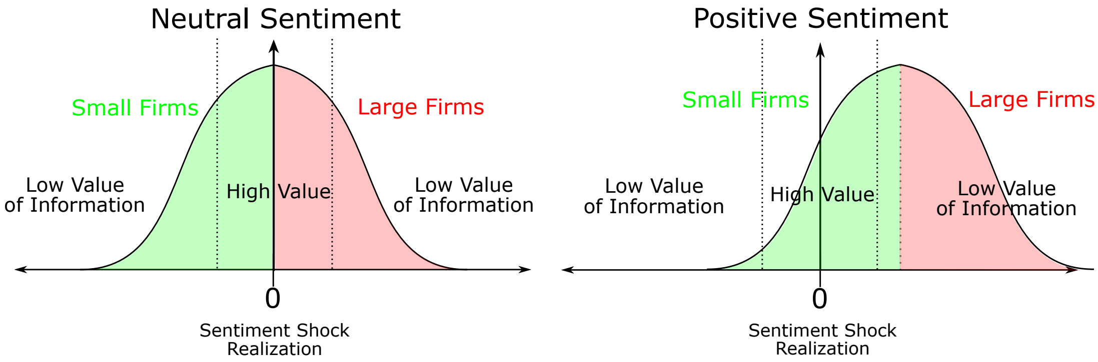

Figure: Firms with $\varepsilon_{jt} \approx 0$ must appear unproductive when $\varepsilon_t > 0$. Back

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

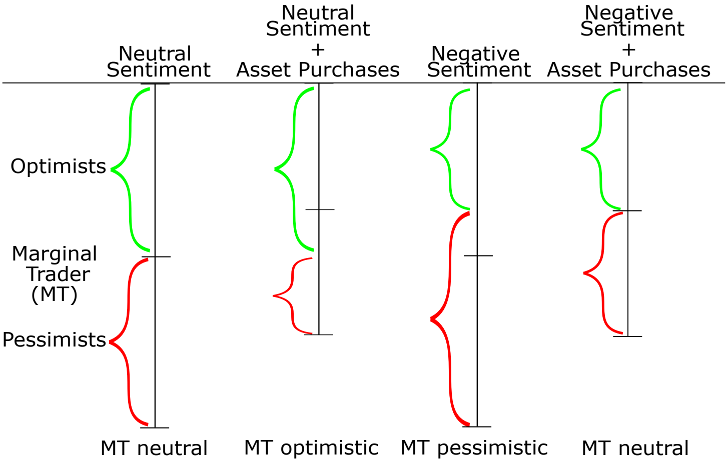

Figure: Asset purchases introduce a positive bias in asset prices and can therefore offset negative sentiment shocks. Back

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 $\rightarrow$ sentiment boom.
  - Asset prices increase and firms appear less similar $\rightarrow$ 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

$$
\begin{aligned}
\max_{K_{j1}, C_0, C_1, \beta_{j0}} \quad & C_0 + \delta \mathbb{E}_0 \left\{ C_1 \middle| \left\{ z_{j0} \right\} \right\} - \int_0^1 IA\left(\beta_{j0}\right) dj \\
s.t. \quad & K_1 = W_0 - C_0 \\
& C_1 \leq Y_1\left(\left\{ K_{j1} \right\}, \left\{ \beta_{j0} \right\} \right) \\
& C_0 \leq W_0 \\
C_0, C_1, \beta_{j0}, & K_{j1} \geq 0.
\end{aligned}
$$

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

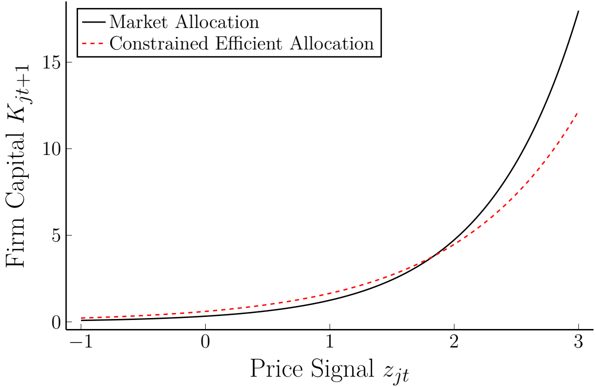

Figure: Market allocation of capital and the constrained-efficient allocation. Back

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:

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

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:

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

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

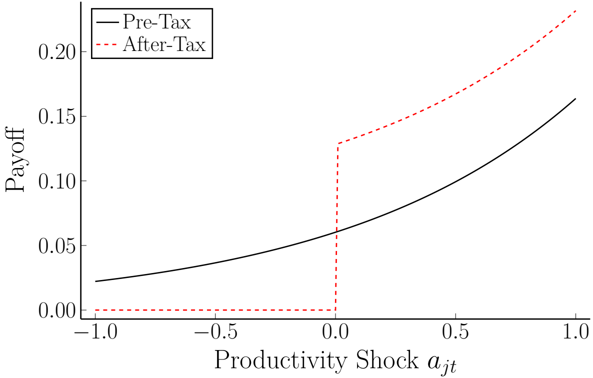

Figure: Tax/subsidy scheme incentivizes info production by increasing exposure to productivity shock. Back

Planner's Problem: Asset Purchases and Sales

- Let social planner use asset purchases / sales: Back

$$
\begin{aligned}
\max_{x_0^{SP} \in (-1,1)} \quad & C_0 + \delta C_1 - \int_0^1 IA\left(\beta_{j0}\right) dj \\
s.t. \quad & C_{i0} = W_0 - \int_0^1 x_{ij0} P_{j0} dj - B_{i1} - x_0^{SP} \int_0^1 P_{j0} dj \\
& C_{i1} = \int_0^1 x_{ij0} \Pi_{j1} dj + R_1 B_{i1} + x_0^{SP} \int_0^1 \Pi_{j1} dj \\
& C_0, C_1 \geq 0. \\
& x_{ij0}, B_{i1}, P_{j0}, \beta_{j0} \text{ are determined competitively.}
\end{aligned}
$$

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

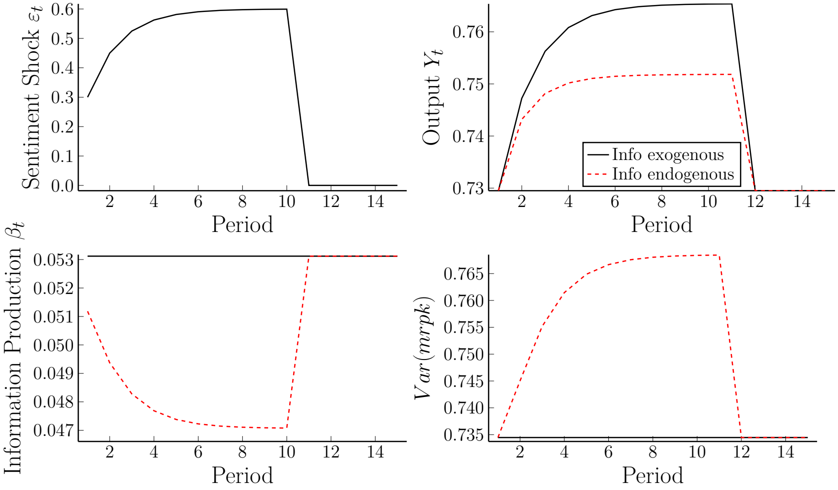

Figure: Capital becomes increasingly misallocated during a sentiment boom. Back

Dispersion in *mrpk* decreases during Productivity Boom

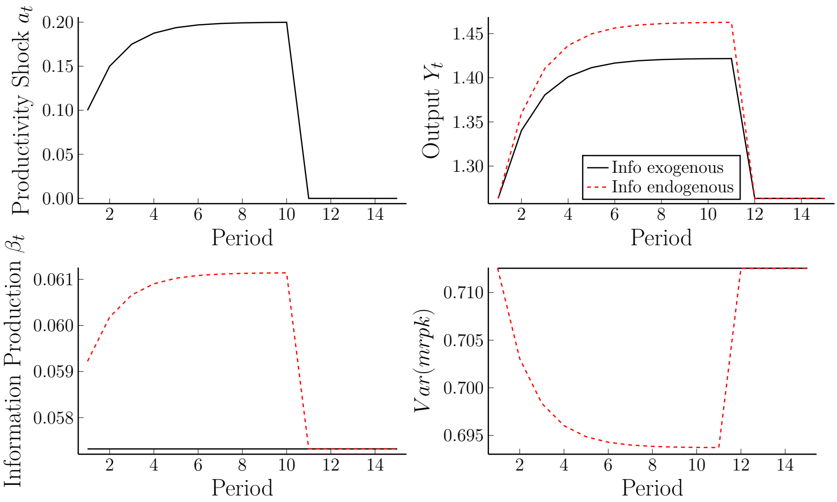

Figure: Capital becomes less misallocated during a productivity boom. Back

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:

$$\Delta p_t = \bar{\beta} + \beta_0 \Delta x_t + \beta_1 \Delta x_{t+1} + e_t \tag{R1}$$

$$\Delta p_t = \bar{\zeta} + \zeta_0 \Delta x_t + e_t^{\zeta} \tag{R2}$$

- 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

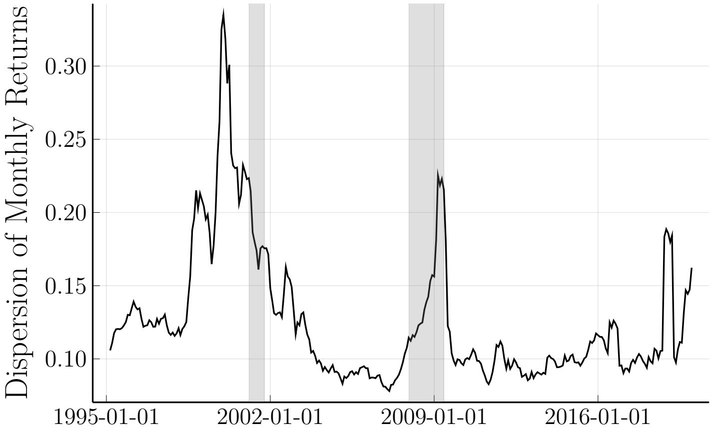

Figure: Return dispersion was high during dot-com boom leading up to 2001, but low during the housing boom.

Back