Collateral Booms and Information Depletion

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Introduction

- Fluctuations in credit are common (more so in recent years).
  Claessens et al. 2011, Mendoza and Terrones 2012, Bakker et al. 2012.
- Good things happen during credit booms...
  - Asset prices, GDP growth and investment are higher than in normal times.
- Yet, credit booms are often viewed with suspicion...
  - Fall in lending standards/information quality on borrowers,
    Asea and Blomberg 1998; Keys et al. 2010; Becker et al. 2018.
  - Rise in factor misallocation,
    Gopinath et al. 2017; Garcia-Santana et al. 2017; Doerr 2018.
  - Often followed by crises and low growth.
    Schularick and Taylor 2012.

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- Model: financial frictions and imperfect information.
    - Entrepreneurs need credit to undertake long-term projects.
        - Projects are heterogeneous in "quality," low or high.
        - Low quality projects allow entrepreneurs to extract rents.
    - Lenders have two ways of protecting themselves:
        - *Collateralization*: ask entrepreneurs to put up assets as collateral.
        - *Screening*: produce costly but durable information about project quality.
    - Collateralization-screening mix depends on aggregate value of collateral.

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  - How do credit booms shape investment and its composition?
  - Does the source of the credit boom matter?
  - Is information production efficient during credit booms?

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  - Is information production efficient during credit booms?
- Evidence in support of the main mechanism using US firm-level data.

The Model

Environment, preferences and endowments

- Time is infinite, $t = 0, 1, ...$ Small-open economy.
- OLG of agents, of constant size and two-period lifetimes.
- Entrepreneurs and households, unit mass each, with preferences

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  - Supply one unit of labor when young, and receive wage w_t.
  - Supply expert services, which are used in screening.
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- Entrepreneurs:
  - Endowed with collateral with value q_t at time t (e.g. land, real estate).
  - When young: purchase and invest in capital.
    - Finance these activities by borrowing from lenders.
  - When old: hire labor to produce consumption goods.

Technology

- Investment: one consumption good at $t \to$ one unit of capital at $t+1$.
  - Two types of capital, $\theta \in \{L, H\}$, but more on this shortly...
  - A unit's type persists throughout its life.
  - Capital depreciates at rate δ and is reversible.
- Production: Cobb-Douglas technology

$$F_t(k_{it}, l_{it}) = A_t \cdot k_{it}^{\alpha} \cdot l_{it}^{1-\alpha},$$

where A_t is aggregate TFP, k_{it} are units of capital and l_{it} are units of labor.

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  - Entrepreneur can run away with all the resources generated by it.
  - Thus, L-type capital is effectively less pledgeable.
- Baseline: H- and L- types of capital are equally productive.
  - In the paper: productivity differences $\rightarrow$ factor "misallocation."

Screening and information production

- Ex-ante, the quality of each unit of investment is uncertain.
  - $\mathbb{P}(\theta = H) = \mu \in (0, 1)$ and quality iid across units.
- Before investing, each unit can be "screened" at cost ψ_t, in which case its type is publicly revealed.
- Screening requires expertise, which is scarce:
  - Each household has expertise to screen up to $n > 0$ projects at unit cost ψ_i.
  - $F(\cdot)$ is the distribution of costs in the population, with support $(0, \infty)$.
  - Expertise market is competitive: ψ_t is the expert "wage" rate.
- Past performance of a unit is not publicly observable.

Markets

Notation: θ-type capital k_{it}^{θ}, unscreened capital k_{it}^{μ}, and effective capital $k_{it} = k_{it}^{H} + k_{it}^{L} + k_{it}^{\mu}$. The aggregate capital stock is $k_t = \int_i k_{it} di$.

Marginal product of capital: $r_t = A_t \alpha k_t^{\alpha-1}$.

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Marginal product of capital: $r_t = A_t \alpha k_t^{\alpha-1}$.

1. Expertise market: young entrepreneurs hire experts at wage ψ_t.
2. Labor market: old entrepreneurs hire workers at market wage w_t.
3. Capital market:
   - Old entrepreneurs sell capital to young at prices p_t^j for $j \in \{H, L, \mu\}$.
   - Since capital is reversible, the old strictly prefer to sell only if $p_t^j > 1$.
4. Credit market:
   - Young entrepreneur borrows from lenders and invests $q_t + f_{it}$.
   - Contracts are state-contingent, but pledgeability is endogenously limited:

$$R_{it+1} f_{it} \leq \left(r_{t+1} + (1-\delta) \max\{p_{t+1}^{H}, 1\} \right) k_{it+1}^{H} + \left(r_{t+1} + (1-\delta) \max\{p_{t+1}^{\mu}, 1\} \right) \mu k_{it+1}^{\mu}.$$

Equilibrium prices

- Expertise market clearing:

$$\psi_t = \psi(s_t) \equiv F^{-1}\left(\frac{s_t}{n}\right),$$

  where s_t denotes the aggregate units screened in period t.

- Labor market clearing:

$$w_t = A_t\,(1-\alpha)\,k_t^{\alpha}.$$

- Credit market clearing:

$$E_t\{R_{it+1}\} = \rho.$$

- Capital market clearing:

$$p_t^H = 1 + \frac{\psi(s_t)}{\mu} \geq 1 = p_t^{\mu} = p_t^L.$$

Intuition: price equals production cost.

Equilibrium dynamics

Given $\{k_0^H, k_0^L, k_0^\mu\}$ and process $\{q_t, A_t\}_{t\geq 0}$, equilibrium is characterized by:

- Zero expected profits on H-type investment:

$$1 + \frac{\psi(s_t)}{\mu} = \frac{E_t\left\{r_{t+1} + (1-\delta)\left(1 + \frac{\psi(s_{t+1})}{\mu}\right)\right\}}{\rho},$$

- H-type investment: $s_t = \max\left\{0, \frac{k_{t+1}^H - (1-\delta)k_t^H}{\mu}\right\}$,
- No L-type investment: $k_{t+1}^L = 0$.
- Unscreened investment constrained by collateral:

$$k_{t+1}^\mu = \min\left\{\frac{\rho}{\rho - \mu E_t\{r_{t+1} + 1 - \delta\}} \cdot q_t,\ k_{t+1}^*\right\},$$

where $r_{t+1} = A_{t+1}\alpha(k_{t+1}^H + k_{t+1}^\mu)^{\alpha-1}$.

Collateral booms and busts

Boom-bust episodes

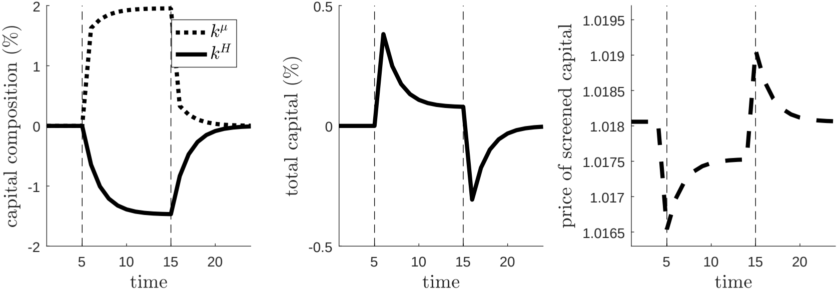
We consider the following illustrative experiments:

- Collateral q takes values in $\{\underline{q}, \overline{q}\}$ with $\mathbb{P}(q_{t+1} = \overline{q} | q_t = \underline{q}) \in (0, \frac{1}{2})$ and $\mathbb{P}(q_{t+1} = \underline{q} | q_t = \overline{q}) \in (0, \frac{1}{2})$.

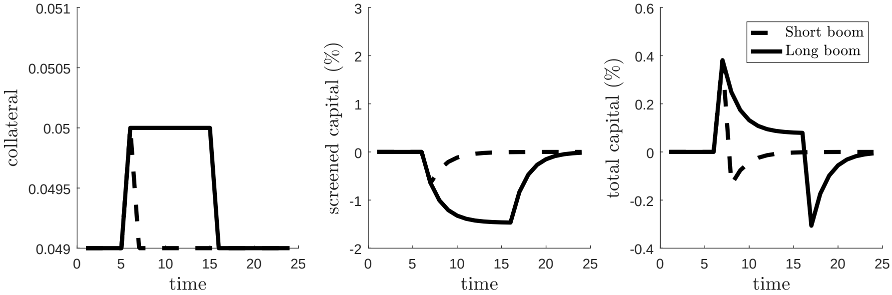
- For comparison, productivity A takes values in $\{\underline{A}, \overline{A}\}$ with $\mathbb{P}(A_{t+1} = \overline{A} | A_t = \underline{A}) \in (0, \frac{1}{2})$ and $\mathbb{P}(A_{t+1} = \underline{A} | A_t = \overline{A}) \in (0, \frac{1}{2})$.

Suppose throughout that parameters are such that borrowing constraints bind $\forall t$.

Collateral boom-bust episode

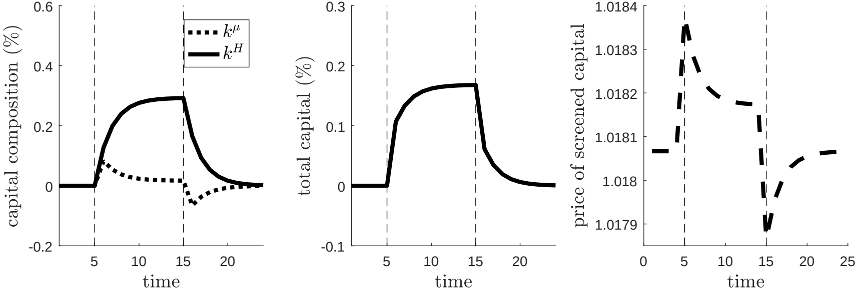


Longer booms → larger busts



Source of the boom matters

Productivity boom-bust episode



Normative properties of equilibrium

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- Consider planner who maximizes discounted consumption subject to same information friction/borrowing constraint as market.
- Planner optimality condition:

$$1 + \frac{\psi(s_t)}{\mu} = \frac{E_t\left\{A_{t+1}\alpha k_{t+1}^{\alpha-1} + (1-\delta)\left(1 + \frac{\psi(s_{t+1})}{\mu}\right)\right\}}{\rho} + \underbrace{\left(\frac{E_t\left\{A_{t+1}\alpha k_{t+1}^{\alpha-1} + 1 - \delta\right\}}{\rho} - 1\right) \cdot \frac{\partial k^{\mu}(k_{t+1}^{H}, q_t, A_t)}{\partial k_{t+1}^{H}}}_{\text{Distortion}}$$

- Source of inefficiency: by screening more, entrepreneurs bid up labor costs, tightening borrowing constraints and crowding out unscreened investment.

Extensions and robustness

- Factor "misallocation" during booms:
  - Suppose H-type projects are also more productive.
  - Dispersion of TFP across projects increases during booms.
- Bubble-driven fluctuations in collateral values:
  - Activity organized within firms $=$ collection of projects.
  - Rational bubbles on firms randomly appear and burst.
- Irreversibilities and "fire-sales" of productive assets during busts:
  - Suppose capital can be converted to $\chi \in (0, 1)$ units of consumption.
  - During the bust, some of the effect is absorbed by project prices.
- Homogenous capital, but heterogenous projects:
  - Each project employs labor and at most $\bar{k}$ units of capital.
  - Projects are of heterogeneous quality; become obsolete at rate λ.
- Asymmetric information:
  - Entrepreneurs know quality θ before investing.

Supporting evidence

Theory is consistent with several strands of stylized evidence:

1. Investment is increasing in collateral values (e.g. Chaney et al. 2012).
2. Lenders' information about borrowers declines in booms (e.g., Becker et al. 2016, Lisowski et al., 2017).
3. Credit booms accompanied by high house prices/low productivity growth are more likely to end in crises (e.g., Schularick and Taylor 2012, Gorton and Ordoñez 2016).

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Theory's core mechanism:

- Collateral booms accompanied by a fall in screening/information production.

Empirical strategy

Two challenges:

1. Identify shocks to collateral:
   - Build on Chaney et al. (2012): effect of real estate prices on investment.
   - Extend sample: COMPUSTAT firms 1993-2012.
   - Real estate assets in 1993: infer market value using local real estate inflation.
2. Measure screening/information production: proxy info on firm i with,
   (i) Length of banking relationship: duration of firm i's main lending relationship.
   (ii) Analyst coverage: number of financial analysts following firm i.

How does collateral affect information production on firm i in location k?

$$Info_{it} = \alpha_i + \delta_t + \beta \cdot RE_{it} + \gamma \cdot P_{kt} + controls_{it} + \varepsilon_{it},$$

Empirical findings

VARIABLES	(1) Relationship OLS	(2) Relationship OLS	(3) Relationship IV	(4) Analysts OLS	(5) Analysts OLS	(6) Analysts IV
RE Value (State Prices)	-0.0691***			-0.136***		
	(0.00869)			(0.00771)		
RE Value (MSA Prices)		-0.0429***	-0.0486***		-0.142***	-0.154***
		(0.00920)	(0.0101)		(0.00838)	(0.00919)
State Prices	-3.127***			-4.992***		
	(1.209)			(1.415)		
MSA Prices		-0.597	-3.378***		-14.33***	-1.294
		(3.624)	(1.008)		(4.792)	(0.865)
Cash	-0.00141	-0.00360	-0.00349	0.0176***	0.0198***	0.0177***
	(0.00409)	(0.00445)	(0.00454)	(0.00376)	(0.00415)	(0.00434)
Market/Book	-0.0315***	-0.0311***	-0.0294***	0.0646***	0.0657***	0.0684***
	(0.00414)	(0.00513)	(0.00541)	(0.00375)	(0.00410)	(0.00426)
Initial Controls x State Prices	Yes	No	No	Yes	No	No
Initial Controls x MSA Prices	No	Yes	Yes	No	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	23 153	19 841	17 031	17 135	14 572	12 529
Adjusted R-squared	0.671	0.668	0.665	0.809	0.810	0.816

Conclusions

- Model of Collateral Booms and Information Depletion.
  - Rising collateral values boost investment and economic activity,
  - But reallocate investment towards less information-intensive activities:
    - Lower incentives to produce information.
    - Information depletion over time...
  - Longer booms $\rightarrow$ more info depletion $\rightarrow$ larger busts.
- Source of the credit boom matters.
  - Productivity-driven booms do not deplete information.
- Normative aspects of credit booms:
  - "Misallocation" may increase during booms, but save on screening costs.
  - If anything, due to a pecuniary externality, there is too much information!
- Evidence in support of the main mechanism using US firm-level data.

Related literature

- Credit booms and lending standards: Manove et al. (2011), Ruckes (2004), Martin (2005), Dell'Ariccia and Marquez (2006), Gorton and He (2008), Favara (2012), Petriconi (2015), Krishnamurthy and Muir (2017), Farboodi and Kondor (2019).
- Information production in macro: Van Nieuwerburgh and Veldkamp (2006), Ordoñez (2013), Gorton and Ordoñez (2014, 2016), Fajgelbaum et al. (2017), Straub and Ulbricht (2017).
- Collateral and investment: Peek and Rosengreen (2000), Gan (2007), Chaney et al. (2012).
- Financial frictions and invest composition: Matsuyama (2007), Diamond et al. (2018).
- Financial frictions and pecuniary externalities: Caballero and Krishnamurthy (2003), Lorenzoni (2008), Dávila and Korinek (2017).

Normative properties of equilibrium

- The social planner's objective is to maximize:

$$E_0 \sum_{t=0}^{\infty} \rho^{-t} C_t,$$

which is equivalent to p.v. of social welfare with relative weight ρ.

- Set $\rho > 1$ so that the economy is dynamically efficient.
- Information friction: needs to screen to invest in H-type capital.
- Financial friction: unscreened investment must be collateralized by q.
- Assume parameters are such that borrowing constraints bind for the planner.

Normative properties of equilibrium

- Formally, the planner's problem is:

$$V(k_t^H, k_t^\mu, q_t, A_t) = \max_{s_t}\{Ak_t^\alpha + (1-\delta)k_t - k_{t+1} - \int_0^{s_t} \psi(x)dx + q_t \\ + \rho^{-1} E_t V(k_{t+1}^H, k_{t+1}^\mu, q_{t+1}, A_{t+1})\}$$

where $k_t = k_t^H + k_t^\mu$, subject to:

$$s_t = \max\left\{0, \frac{k_{t+1}^H - (1-\delta)k_t^H}{\mu}\right\},$$

$$k_{t+1}^\mu = \frac{\rho}{\rho - \mu E_t\{A_{t+1}\alpha(k_{t+1}^H + k_{t+1}^\mu)^{\alpha-1} + 1 - \delta\}} \cdot q_t.$$

- From borrowing constraint, $k_{t+1}^\mu = k^\mu(k_{t+1}^H, q_t, A_t)$ is decreasing in k_{t+1}^H.

Empirical findings: summary statistics

	Mean	Median	SD	25th percentile	75th percentile	Obs.
Firm-level data						
Relationship	4.74	3.58	4.91	0.00	7.42	25 717
Analysts	7.93	5.00	7.46	2.00	11.00	19 921
Cash	0.04	0.26	1.78	-0.09	0.63	35 204
Market / Book	2.16	1.52	1.76	1.10	2.42	32 512
RE Value (State Prices)	0.89	0.26	1.44	0.00	1.14	35 430
RE Value (MSA Prices)	0.88	0.26	1.42	0.00	1.13	34 892
Regional data						
State Prices	0.29	0.26	0.11	0.21	0.35	1 031
MSA Prices	0.14	0.14	0.04	0.11	0.17	3 641
Housing Supply Elasticity	1.66	1.45	0.87	1.01	2.10	1 632
Initial firm-level data (1993)						
Age	8.09	8.00	4.66	3.00	13.00	2 855
ROA	-0.01	0.07	0.25	-0.04	0.12	2 844
Log(Asset)	4.05	3.96	2.19	2.58	5.46	2 852

Empirical findings: first-stage regression

VARIABLES	(1) MSA Prices	(2) MSA Prices
Housing supply elasticity	0.00990***	
	(0.00274)	
First quartile of elasticity		-0.0225***
		(0.00682)
Second quartile of elasticity		-0.00548
		(0.00751)
Third quartile of elasticity		0.00141
		(0.00744)
Year FE	Yes	Yes
MSA FE	Yes	Yes
Observations	2 232	2 232
R-squared	0.892	0.893