Collateral Booms and Information Depletion

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Conference on Monetary Economics and Reality
Bank of Finland, 12-13 October 2019
Introduction

- Fluctuations in credit are common (more so in recent years).

- 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,
  - Rise in factor misallocation,
  - Often followed by crises and low growth.
    Schularick and Taylor 2012.
This paper

Our focus: role of information production during credit booms.
Introduction

This paper

- **Our focus**: role of information production during credit booms.

- **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.

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

Evidence in support of the main mechanism using US firm-level data.
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- **Collateral-driven boom:**
  - Raises overall credit, investment and economic activity.
  - Affects *composition* of investment
    - ↑ unscreened investment, ↓ return to screened investment.
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  - Credit booms and misallocation.
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- Normative implications:
  - In baseline, due to pecuniary externalities, there is too much information!
Related literature


- **Collateral and investment**: Peek and Rosengreen (2000), Gan (2007), Chaney et al. (2012).


The Model
Environment, preferences and endowments

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

$$U_t = E_t C_{t,t+1}.$$
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- Households:
  - Supply one unit of labor when young, and receive wage $w_t$.
  - Supply expert services, which are used in screening.
  - Save abroad or lend to entrepreneurs at (expected) gross return $\rho$.  

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.
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The Model

Technology

- **Investment**: one consumption good at $t \rightarrow$ 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 $\delta$ 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.
Quality of projects

- *L*-type suffers from an agency problem.
  - Entrepreneur can run away with all the resources generated by it.
  - Thus, *L*-type capital is effectively less pledgeable.
Quality of projects

- $L$-type suffers from an agency problem.
  - 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 \( \psi_t \), 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 \( \psi_i \).
  - \( F(\cdot) \) is the distribution of costs in the population, with support \((0, \infty)\).
  - Expertise market is competitive: \( \psi_t \) is the expert “wage” rate.

- Past performance of a unit is not publicly observable.
Markets

Notation: \( \theta \)-type capital \( k^\theta_{it} \), unscreened capital \( k^U_{it} \), and effective capital \( k_{it} = k^H_{it} + k^L_{it} + k^U_{it} \). The aggregate capital stock is \( k_t = \int_i k_{it} di \).

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

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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 $\psi_t$.

2. Labor market: old entrepreneurs hire workers at market wage $w_t$.

3. Capital market:
   - Old entrepreneurs sell capital to young at prices $p_{jt}$ for $j \in \{H, L, U\}$.
   - Since capital is reversible, the old strictly prefer to sell only if $p_{jt} > 1$.

4. Credit market:
   - Young entrepreneur borrows from lenders and invests $q_{t} + f_{it}$.
   - Contracts are state-contingent, but pledgeability is endogenously limited:

$$R_{it+1} f_{it} \leq \left( r_{t+1} + (1 - \delta) \max\{p_{t+1}^H, 1\} \right) k_{it+1}^H + \left( r_{t+1} + (1 - \delta) \max\{p_{t+1}^U, 1\} \right) \mu k_{it+1}^U.$$
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:
  \[ w_t = A_t \left(1 - \alpha\right) k_t^\alpha. \]

- Credit market clearing:
  \[ E_t\{R_{it+1}\} = \rho. \]

- Capital market clearing:
  \[ p_t^H = 1 + \frac{\psi(s_t)}{\mu} \geq 1 = p_t^U = p_t^L. \]

**Intuition:** price equals production cost.
Equilibrium dynamics

Given \( \{k^H_0, k^L_0, k^U_0\} \) 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**: \( s_t = \max \left\{ 0, \frac{k^H_{t+1} - (1 - \delta)k^H_t}{\mu} \right\} \),

- **No** \( L \)-type investment: \( k^L_{t+1} = 0 \).

- **Unscreened investment constrained by collateral**:
  \[
  k^U_{t+1} = \min \left\{ \frac{\rho}{\rho - \mu E_t \{ r_{t+1} + 1 - \delta \} \cdot q_t}, k^*_t, k^U_t \right\},
  \]

where \( r_{t+1} = A_{t+1} \alpha(k^H_{t+1} + k^U_{t+1})^{\alpha - 1} \).
Collateral booms and busts
Consider $\delta \rightarrow 1$, and $(q_t, A_t) = (q, A)$ for all $t$.

- **Equilibrium described by:**

\[
1 + \frac{\psi(s)}{\mu} = \frac{r}{\rho},
\]

\[
s = \frac{k^H}{\mu},
\]

\[
k^U = \min \left\{ \frac{\rho}{\rho - \mu r} \cdot q, \left( \frac{\alpha A}{\rho} \right)^{\frac{1}{1-\alpha}} \right\},
\]

where $r = \alpha A(k^H + k^U)^{\alpha-1}$.

- **Question:** How does the equilibrium depend on $q$?
Effect of $q$
Effect of $A$
Collateral booms and busts

Boom-bust episodes

We consider the following illustrative experiments:

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

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

Suppose throughout that parameters are such that borrowing constraints bind $\forall t$. 
Collateral boom-bust episode

The graphs illustrate the changes in capital composition, total capital, and price of screened capital over time. The dotted line represents $k^U$, and the solid line represents $k^H$. The x-axes show time, and the y-axes represent the percentage changes in capital and price.
Longer booms $\rightarrow$ larger busts
Source of the boom matters

Productivity boom-bust episode
Normative properties
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 $\rho$.

- 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:

\[
V(k^H_t, k^\mu_t, q_t, A_t) = \max_{s_t} \left\{ Ak^\alpha_t + (1 - \delta)k_t - k_{t+1} - \int_0^{s_t} \psi(x) dx + q_t \right. \\
+ \rho^{-1} E_t V(k^H_{t+1}, k^\mu_{t+1}, q_{t+1}, A_{t+1}) \right\}
\]

where \( k_t = k^H_t + k^\mu_t \), subject to:

\[
s_t = \max \left\{ 0, \frac{k^H_{t+1} - (1 - \delta)k^H_t}{\mu} \right\},
\]

\[
k^\mu_{t+1} = \frac{\rho}{\rho - \mu E_t \{ A_{t+1} \alpha (k^H_{t+1} + k^\mu_{t+1})^{\alpha-1} + 1 - \delta \}} \cdot q_t.
\]

From borrowing constraint, \( k^\mu_{t+1} = k^\mu(k^H_{t+1}, q_t, A_t) \) is decreasing in \( k^H_{t+1} \).
**Excessive information production**

- **Only difference with competitive equilibrium:**

\[
1 + \frac{\psi(s_t)}{\mu} = \frac{E_t \left\{ A_{t+1} \alpha (k_{t+1}^H + k_{t+1}^\mu)^{\alpha - 1} + \left(1 - \delta\right) \left(1 + \frac{\psi(s_{t+1})}{\mu}\right)\right\}}{\rho}
\]

\[
+ \left(\frac{E_t \left\{ A_{t+1} \alpha (k_{t+1}^H + k_{t+1}^\mu)^{\alpha - 1} + 1 - \delta\right\}}{\rho} - 1\right) \cdot \frac{\partial k_{t+1}^\mu}{\partial k_{t+1}^H} \cdot (k_{t+1}^H, q_t, A_t)
\]

**Distortion**

- **Pecuniary externality:** By screening more, entrepreneurs bid up labor costs and depress return to all investments. This tightens borrowing constraints and crowds out unscreened investment.

- **Implementation:** Pigouvian tax on screened investment, with revenues rebated lump sum to households.
Excessive information production

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- **Broader lesson:** Need additional distortions for “too little information” story.
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 $\lambda$.

▶ Asymmetric information:
  • Entrepreneurs know quality $\theta$ 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.
   - 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

<table>
<thead>
<tr>
<th>VARIABLES</th>
<th>(1) Relationship OLS</th>
<th>(2) Relationship OLS</th>
<th>(3) Relationship IV</th>
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<td>RE Value (State Prices)</td>
<td>-0.0691***</td>
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Conclusions

Model of Collateral Booms and Information Depletion.

- Rising collateral values boost investment and economic activity.
- Affects composition of investment
  - Up unscreened investment, down return to screened investment.
  - Lower incentives to produce information.
  - Information depletion over time...
- Longer booms → more info depletion → larger busts, slower recoveries.

Additional implications:
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- Costs of asset bubbles.
- Credit booms and misallocation.

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Evidence in support of the main mechanism using US firm-level data.
# Empirical findings: summary statistics

<table>
<thead>
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<th>75th percentile</th>
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<td><strong>Initial firm-level data (1993)</strong></td>
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**Empirical findings: first-stage regression**

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<th>VARIABLES</th>
<th>(1) MSA Prices</th>
<th>(2) MSA Prices</th>
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<td>Housing supply elasticity</td>
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<td>(0.00682)</td>
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<td>Second quartile of elasticity</td>
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