# CREDIT SEARCH AND CREDIT CYCLES

Feng Dong Pengfei Wang Yi Wen

Shanghai Jiao Tong U Hong Kong U Science and Tech STL Fed & Tsinghua U

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The usual disclaim applies.

# Motivation

- The supply and demand are not always well aligned and matched in our real life.
  - labor, finance, monetary, etc.
  - credit.
- Data pattern:
  - excess reserve-to-deposit ratio Data
  - interest spread Data
- Austrian school and many others: credit supply and financial intermediation plays a critical role in generating and amplifying the business cycle.

# Preview

- This paper provides a framework to rationalize the Austrian theory and the observed credit cycles.
- We develop a search-based theory of credit allocation.
- Credit search can lead to endogenous increasing returns to scale and variable capital utilization,
  - even in a model with constant returns to scale production technology and matching functions.
  - a micro-foundation for the indeterminacy literature of Benhabib and Farmer (1994) and Wen (1998).

Literature Review

# Intuition

- Prevalence of and the essential role played by intermediation.
  - people carry money but no investment opportunity.
  - investors carry investment projects but no money.
- Intuition:
  - Amplification.
  - Propagation.
  - Sunspot.

# Setup

- Continuous time; infinite horizon.
- Players:
  - a representative household (HH).
    - unit measure of workers/depositors.
  - a representative and perfectly competitive bank (FI).
    - unit measure of loan officers.
    - intermediation between HH and firms.
  - firms.
    - free entry into credit market by paying a fixed cost.

# Household and Deposit Search (I)

- The constrained optimization by HH:

$$\max \mathbb{E}\left\{\int_0^{+\infty} e^{-\rho t}\left[log\left(C_t\right)-\psi\frac{N_t^{1+\xi}}{1+\xi}\right]\right\}$$

subject to

$$C_t+\dot{S}_t=W_tN_t+eR_t^dS_t-\delta\left(e\right)S_t+\left(\text{profits from banks and firms}\right)_t$$

  - $e\in[0,1]$: the proportion of savings transferred to deposit,
  - $\delta\left(e\right)$: the convex “depreciation” function w.r.t. $e$.

# Household and Deposit Search (II)

- We use household's deposit search to rationalize $\delta(e)$.
- Denote $x$ as the search effort by household such that
  - cost: $\delta = \phi^H x_t$,
  - benefit: $e_t$ part of savings successfully transferred to deposit,

$$e(x_t) = M^H(x_t H, B),$$

  - $H$,$B$: measure of household and bank officers,
  - $e$ is concave in $x$ and thus $\delta$ is convex in $e$.

# Bank, Firms and Loan Search (I)

- Matching between loan officers and firms:

$$
\begin{aligned}
q &\equiv \frac{M(B,V)}{V} = M(\theta,1), \\
u &\equiv \frac{M(B,V)}{B} = M\left(1,\frac{1}{\theta}\right).
\end{aligned}
$$

- Banks are fully competitive:

$$R_t^d = u_t \cdot R_t^l$$

- *Given* matched, the total surplus is

$$\Pi_t = \max_{n_t \geq 0} \left\{ A_t \widetilde{S}_t^{\alpha} n_t^{1-\alpha} - W_t n_t \right\} \equiv \pi_t \widetilde{S}_t.$$

  - $\widetilde{S}_t = e_t S_t$.

# Bank, Firms and Loan Search (II)

- Bargaining: $(\eta, 1-\eta)$, firm vs bank.

$$R_t^l = (1-\eta)\,\pi_t.$$

- Firm's free entry condition into the credit market:

$$\phi_t = q_t \eta \Pi_t = q_t \eta \pi_t \widetilde{S}_t.$$

- Aggregate profit to the household:

$$\text{profit}_t = \underbrace{\left(-R_t^d + u_t R_t^l\right)\widetilde{S}_t}_{\text{profit from banks}} + \underbrace{\left(-\phi_t + q_t \eta \Pi_t\right) V_t}_{\text{profit from firms}} = 0.$$

# Equilibrium (I)

- Given $(e_t, u_t, A_t, S_t, N_t)$,

$$Y_t = A_t\left(e_t u_t S_t\right)^{\alpha} N_t^{1-\alpha}.$$

- Feedback:
  - If $M^H(xH,B) = \gamma_H (x_t H)^{\varepsilon_H} B^{1-\varepsilon_H}$, then

$$e_t \propto \left(\frac{Y_t}{S_t}\right)^{\varepsilon_H}.$$

  - If $M(B,V) = \gamma B^{1-\varepsilon} V^{\varepsilon}$, then

$$u_t \propto Y_t^{\varepsilon}.$$

# Equilibrium (II)

- Derivation on $e$:

$$\delta'(e) = R^d = uR^l = u(1-\eta)\pi = u(1-\eta)\left(\alpha\frac{Y}{u\widetilde{S}}\right),$$
$$\widetilde{S} = eS.$$

- Derivation on $u$:

$$V = \left(\frac{B}{\theta}\right) = \frac{1}{\theta} = \left(\frac{u}{\gamma}\right)^{\frac{1}{\varepsilon}}$$
$$\phi = q\eta\pi\widetilde{S} = q\eta\left[\alpha\left(\frac{Y}{Vq\widetilde{S}}\right)\right]\widetilde{S} = \frac{\alpha\eta Y}{V}.$$

# Equilibrium (III)

- In equilibrium,

$$Y_t \propto A_t^{\tau} S_t^{\alpha_s} N_t^{\alpha_n}.$$

where $\tau = \frac{1}{1-\alpha(\varepsilon+\varepsilon_H)}$, $\alpha_s = \alpha(1-\varepsilon_H)\tau$, $\alpha_n = (1-\alpha)\tau$.

  - Increasing return to scale:

$$\alpha_s + \alpha_n = \frac{1-\alpha\varepsilon_H}{1-\alpha(\varepsilon+\varepsilon_H)} > 1.$$

  - indeterminacy region:
    - Sunspot Condition
    - Sunspot Figure
  - dual search is indispensable to sustain sunspot.

# Welfare (I)

- Under what condition does $\eta$ maximize the HH's welfare, *i.e.*,

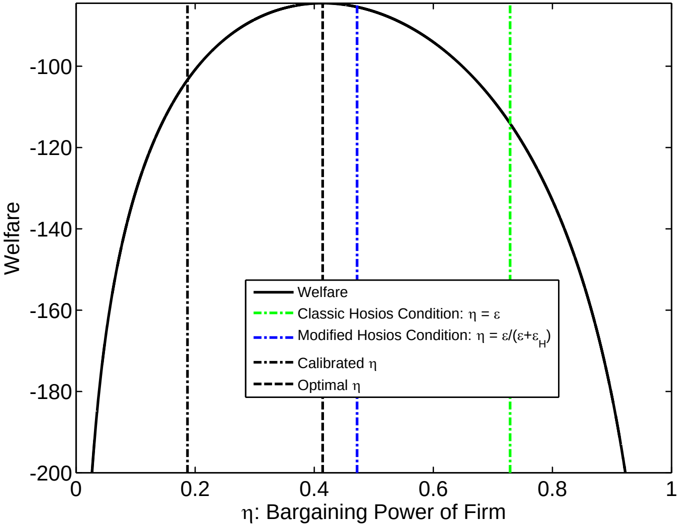
$$\Omega \equiv \max \mathbb{E} \left\{ \int_0^{+\infty} e^{-\rho t} \left[ log\left(C_t\right) - \psi \frac{N_t^{1+\xi}}{1+\xi} \right] \right\}.$$

- *Given* $\left(S_t, N_t\right)$,

$$\eta^* = \arg\max_{\eta \in [0,1]} \left( \frac{Y_t^{DE}}{Y_t^{SP}} \right) = \frac{\varepsilon}{\varepsilon + \varepsilon_H}.$$

- Unlike the standard labor search, capital and labor supply is endogenous here.
    - in *steady state*, $\arg\max_{\eta \in [0,1]} \left( \frac{\Omega^{DE}}{\Omega^{SP}} \right) \neq \frac{\varepsilon}{\varepsilon + \varepsilon_H}$ in general.

# Welfare (II)

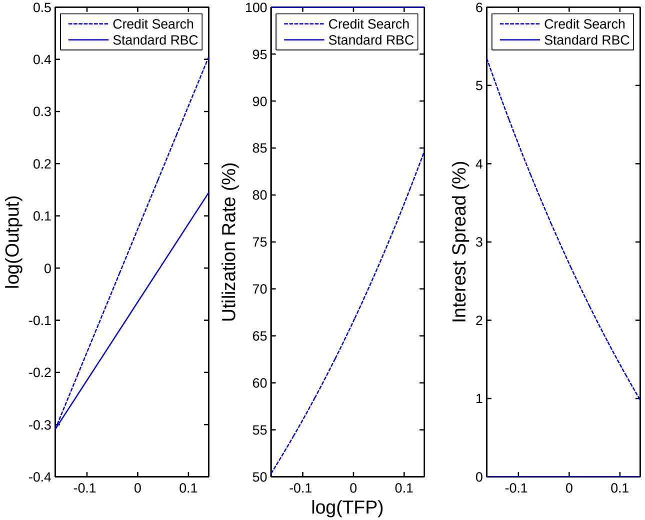

Welfare
η: Bargaining Power of Firm
-100
-120
-140
-160
-180
-200
0
0.2
0.4
0.6
0.8
1
Welfare
Classic Hosios Condition: η = ε
Modified Hosios Condition: η = ε/(ε+ε_H)
Calibrated η
Optimal η

# Calibration

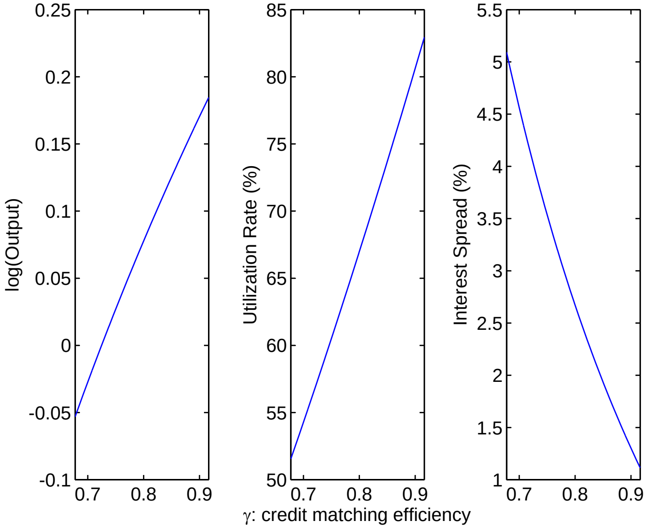
**Table 1. Calibration**

| **Parameter** | **Value** | **Description** |
|---|---|---|
| $\rho$ | 0.01 | Discount factor (quarterly) |
| $A$ | 1 | Normalized aggregate productivity |
| $\alpha$ | 0.33 | Capital income share |
| $\psi$ | 1.75 | Coefficient of labor disutility |
| $\xi$ | 0.2 | Inverse Frisch elasticity of labor supply |
| $\varepsilon_H$ | 0.82 | Matching elasticity in 1st Stage Search |
| $\delta$ | 0.04 | Depreciation rate |
| $\eta$ | 0.187 | Firm's bargaining power |
| $\phi$ | 0.086 | Vacancy cost to search for credit. |
| $\gamma$ | 0.797 | Matching efficiency in 2nd stage search |
| $\varepsilon$ | 0.729 | Matching elasticity in 2nd stage search |

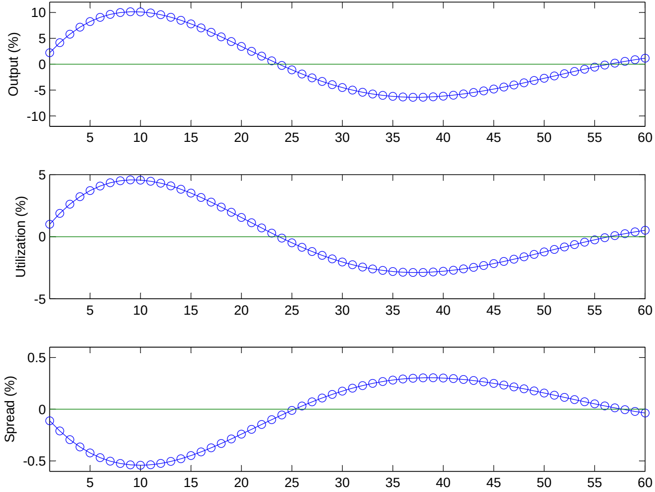
# Comparative Statics: Productivity Shock



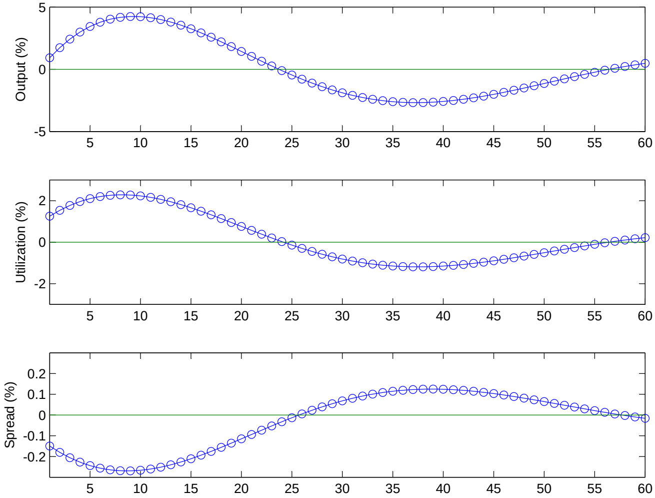
# Comparative Statics: Credit Shock



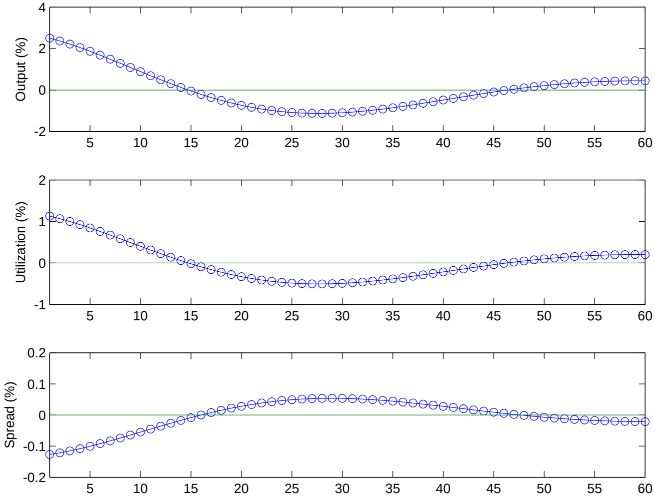
# Impulse Response: Productivity Shock



# Impulse Response: Credit Shock



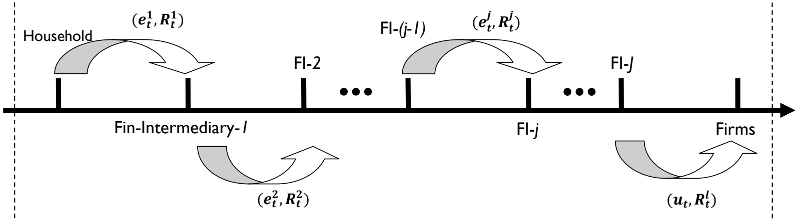
# Impulse Response: Sunspot Shock



# Impulse Response

- $A$-shock, $\gamma$-shock and sunspot shock all imply:
  - procyclical credit utilization.
  - countercyclical interest spread.

# Credit Chains




- The baseline is a special case with $J = 1$.
- Amplification, propagation and the possibility of sunspot increases with $J$.

# Long-Term Credit Relationship

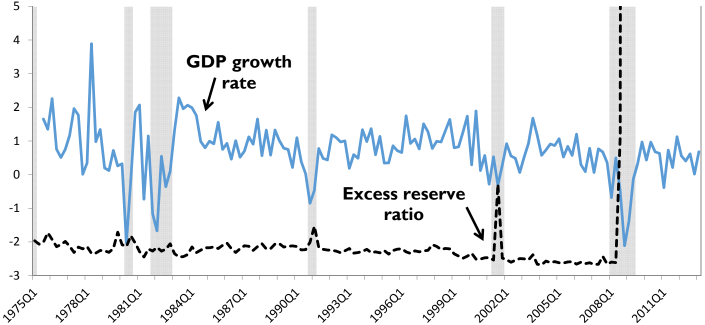
- A strong assumption made so far.
  - credit relationship always terminates by the end of each period.
    - purely for analytical illustration.
- We relax this assumption to build a fully fledged DSGE model, and do more serous quantitative work
  - to address government policy like liquidity injection, etc.
  - to model banking heterogeneity, inter-banking lending, and macro-prudential policy, etc.

# Takeaway

- Supply and demand do not necessarily equal to each other in real life.
    - not only true for labor, but also for credit markets.
- Motivated by the regulated data pattern, we develop a model
    - to show how demand and supply fails to equal each other by using credit search.
    - to show credit supply and financial intermediation plays a critical role in generating and amplifying the business cycle.

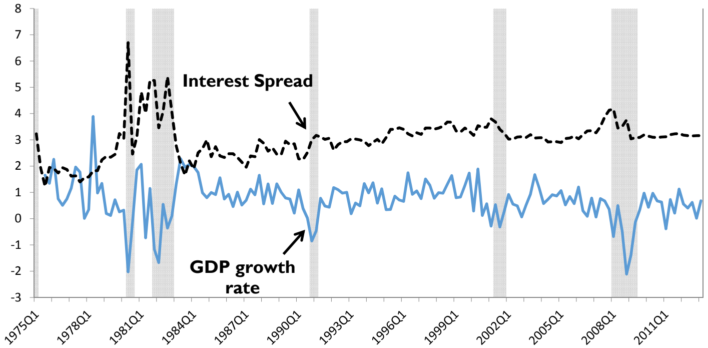
# Thank You

# Data: Excess Reserve




Return

# Data: Interest Spread

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# An Incomplete Sample of Literature

- **Self-fulfilling Business Cycles**
  - sunspot: Cass and Shell (1983), etc.
  - production externality and indeterminacy: Benhabib and Farmer (1994) and Wen (1998), etc.
  - credit market frictions: Gertler and Kiyotaki (2014), Azariadis, Kaas and Wen (2014), and Benhabib, Dong and Wang (2014), etc.
- **Search Frictions in Business Cycles**
  - labor: Merz (1995), Andolfatto (1996), Shimer (2005), etc.
  - credit: Den Haan, Ramey and Waston (2003), Wasmer and Weil (2004), Petrosky-Nadeau and Wasmer (2013), etc.
- **Empirics on Credit Allocation**
  - Contessi, DiCecio and Francis (2015), etc.

# Indeterminacy Analysis (I)

- We have

$$\begin{bmatrix} \dot{s}_t \\ \dot{c}_t \end{bmatrix} = J \cdot \begin{bmatrix} \widehat{s}_t \\ \widehat{c}_t \end{bmatrix},$$

- Indeterminacy emerges, *i.e.*, $\text{Trace}(J) < 0$, and $\text{Det}(J) > 0$ if and only if

$$\varepsilon_H + \varepsilon > \left(\frac{1}{\alpha}\right)\left(\frac{\alpha+\xi}{1+\xi}\right) > 1.$$

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# Indeterminacy Analysis (II)