CREDIT SEARCH AND CREDIT CYCLES

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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
  - interest spread

- 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.
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:

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

subject to

$$C_t + \dot{S}_t = W_t N_t + e R_t^d S_t - \delta(e) S_t + (\text{profits from banks and firms})_t$$

- $e \in [0, 1]$: the proportion of savings transferred to deposit,
- $\delta(e)$: the convex “depreciation” function w.r.t. $e$. 
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:
  
  \[ q \equiv \frac{M(B, V)}{V} = M(\theta, 1), \]
  
  \[ u \equiv \frac{M(B, V)}{B} = M\left(1, \frac{1}{\theta}\right). \]

- Banks are fully competitive:
  \[ R^d_t = u_t \cdot R^l_t \]

- Given matched, the total surplus is
  
  \[ \Pi_t = \max_{n_t \geq 0} \left\{ A_t\tilde{S}_t^\alpha n_t^{1-\alpha} - W_t n_t \right\} \equiv \pi_t\tilde{S}_t. \]

- \( \tilde{S}_t = e_t S_t. \)
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:

\[ \phi_t = q_t \eta \Pi_t = q_t \eta \pi_t \tilde{S}_t. \]

- Aggregate profit to the household:

\[
\text{profit}_t = \left( -R_t^d + u_t R_t^l \right) \tilde{S}_t + \left( -\phi_t + q_t \eta \Pi_t \right) V_t = 0.
\]

\[
\begin{align*}
\text{profit from banks} & \quad \text{profit from firms}
\end{align*}
\]
Equilibrium (I)

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

\[ Y_t = A_t (e_t u_t S_t) \alpha N_t^{1-\alpha}. \]

- Feedback:
  - If \(M^H(x_H, B) = \gamma_H (x_t H)^{\epsilon_H} B^{1-\epsilon_H}\), then
  \[ e_t \propto \left( \frac{Y_t}{S_t} \right)^{\epsilon_H}. \]
  - If \(M(B, V) = \gamma B^{1-\epsilon} V^{\epsilon}\), then
  \[ u_t \propto Y^\epsilon_t. \]
Equilibrium (II)

- Derivation on $e$:

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

- Derivation on $u$:

\[ V = \left( \frac{B}{\theta} \right) = \frac{1}{\theta} = \left( \frac{u}{\gamma} \right)^{\frac{1}{\bar{e}}} \]
\[ \phi = q\eta \pi \tilde{S} = q\eta \left[ \alpha \left( \frac{Y}{Vq\tilde{S}} \right) \right] \tilde{S} = \frac{\alpha \eta Y}{V}. \]
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, \textit{i.e.},

$$\Omega \equiv \max \mathbb{E} \left\{ \int_{0}^{+\infty} e^{-\rho t} \left[ \log (C_t) - \psi \frac{N_t^{1+\xi}}{1+\xi} \right] \right\}.$$ 

- \textit{Given} $(S_t, N_t)$,

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

- Unlike the standard labor search, capital and labor supply is endogenous here.

- in \textit{steady state}, \arg \max_{\eta \in [0,1]} \left( \frac{\Omega_t^{DE}}{\Omega_t^{SP}} \right) \neq \frac{\varepsilon}{\varepsilon + \varepsilon_H} \text{ in general.}
Welfare (II)

Classic Hosios Condition: \( \eta = \varepsilon \)
Modified Hosios Condition: \( \eta = \frac{\varepsilon}{\varepsilon + \varepsilon_H} \)
Calibrated \( \eta \)
Optimal \( \eta \)
**Calibration**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\rho$</td>
<td>0.01</td>
<td>Discount factor (quarterly)</td>
</tr>
<tr>
<td>$A$</td>
<td>1</td>
<td>Normalized aggregate productivity</td>
</tr>
<tr>
<td>$\alpha$</td>
<td>0.33</td>
<td>Capital income share</td>
</tr>
<tr>
<td>$\psi$</td>
<td>1.75</td>
<td>Coefficient of labor disutility</td>
</tr>
<tr>
<td>$\xi$</td>
<td>0.2</td>
<td>Inverse Frisch elasticity of labor supply</td>
</tr>
<tr>
<td>$\varepsilon_H$</td>
<td>0.82</td>
<td>Matching elasticity in 1st Stage Search</td>
</tr>
<tr>
<td>$\delta$</td>
<td>0.04</td>
<td>Depreciation rate</td>
</tr>
<tr>
<td>$\eta$</td>
<td>0.187</td>
<td>Firm’s bargaining power</td>
</tr>
<tr>
<td>$\phi$</td>
<td>0.086</td>
<td>Vacancy cost to search for credit.</td>
</tr>
<tr>
<td>$\gamma$</td>
<td>0.797</td>
<td>Matching efficiency in 2nd stage search</td>
</tr>
<tr>
<td>$\varepsilon$</td>
<td>0.729</td>
<td>Matching elasticity in 2nd stage search</td>
</tr>
</tbody>
</table>
Comparative Statics: Productivity Shock

![Graphs showing the impact of productivity shocks on log(Output), Utilization Rate, and Interest Spread.](image-url)
Comparative Statics: Credit Shock

- Graphs showing the relationship between output, utilization rate, and interest spread with respect to credit matching efficiency ($\gamma$).

- The graphs illustrate how changes in credit matching efficiency affect the output, utilization rate, and interest spread.
Impulse Response: Productivity Shock

![Impulse Response Graph]

- Output (%)
- Utilization (%)
- Spread (%)
Impulse Response: Credit Shock

- Output (%)
- Utilization (%)
- Spread (%)
Impulse Response: Sunspot Shock

![Graph showing Impulse Response](image-url)
Impulse Response

- A-shock, γ-shock and sunspot shock all imply:
  
  - procyclical credit utilization.
  
  - countercyclical interest spread.
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 serious 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

GDP growth rate

Excess reserve ratio
Data: Interest Spread

Graph showing Interest Spread and GDP growth rate over time.
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**

- **Empirics on Credit Allocation**
  - Contessi, DiCecio and Francis (2015), etc.
Indeterminacy Analysis (I)

- We have
  \[
  \begin{bmatrix}
  \dot{s}_t \\
  \dot{c}_t
  \end{bmatrix}
  = J \cdot
  \begin{bmatrix}
  \hat{s}_t \\
  \hat{c}_t
  \end{bmatrix},
  \]

- Indeterminacy emerges, \textit{i.e.}, \(\text{Trace}(J) < 0\), and \(\text{Det}(J) > 0\) if and only if
  \[
  \varepsilon_H + \varepsilon > \left(\frac{1}{\alpha}\right) \left(\frac{\alpha + \xi}{1 + \xi}\right) > 1.
  \]
Indeterminacy Analysis (II)

\[ \frac{\alpha + \xi}{\alpha(1 + \xi)} \]

\[ 1 \]

\[ 0 \text{ } \alpha + \xi \]

\[ \frac{\alpha + \xi}{\alpha(1 + \xi)} \]

Indeterminacy