Credit and Banking in a DSGE Model

A. Gerali, S. Neri, L. Sessa, and F. Signoretti
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A. GERALI, S. NERI, L. SESSA, F. SIGNORETTI
Banca d’Italia

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This paper is an attempt to (meaningfully?) introduce a banking sector into a DSGE model.
WHY is it interesting?

1. **Banks are (still) very important in the funding of real activity**
   - Bank loans/total firm non-equity finance
     - 90% in the Euro Area
     - 60% in the US
   → Thus, bank rates are the relevant interest rates for a large part of the economy

2. **Retail bank rates differ from policy rate**
   i. Slow pass-through to retail rates of changes in the policy rate (Lown and Morgan, 19XX)
   ii. Banks actively set credit-supply terms and conditions (interest rates, LTV) during the cycle
   → So, loan spreads move over the cycle

3. **Bank B-S items display cyclical movements, e.g. ...**
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FACTS

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US GDP growth and Credit Conditions
(y-o-y % change; net percentage of respondents)

Source: Federal Reserve
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US Commercial Banks' Balance-sheet Items and Asset Prices
(y-o-y % change)

Source: Federal Reserve and BIS
Objectives/what do we want to study?

1. Have a model that accounts for stylized facts in credit/financial markets and their interactions with the real economy

2. Answer questions such as:
   1. How do bank rate-setting decisions affect the monetary policy transmission mechanism?
   2. What are the effects of a credit-supply shock in a model with an explicit role for banks?
   3. How do banking capital react to various types of shocks?
   4. Financial stability and monetary policy: should CBs respond to asset prices, credit or bank equity [work in progress]?
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The Rest of the Talk

1. The Model

2. Applications
The model: two key ingredients

1. **Financial frictions** and **heterogeneous agents**, to generate credit flows in the first place (Kyotaki and Moore, 1998; Iacoviello, 2005)

2. **Monopolistic competition** in the banking sector, so that banks make decisions when setting interest rates
Related work

- Christensen et. al (2007)
- Cúrdia and Woodford (2008)
- Christiano et al. (2007); Goodfriend and McCallum (2007)
- ...many other central banks
The Model in a Nutshell

Entrepreneurs

Banks

Impatient HH

Central bank

Patient HH

Bankers
Two types of Households

- Consume, enjoy housing services and work
  \[ E_0 \sum_{t=0}^{\infty} \beta_T \left[ \log(c_t^T(i) - a^T c_{t-1}^T) + \varepsilon_t^h \log h_t^T(i) - \frac{l_t^T(i)^{1+\phi}}{1 + \phi} \right] \]

  \[ T = \{ \text{Patient, Impatient} \} \]

- Budget constraint is

  \[ P_t c_t^T(i) + Q_t^h \Delta h_t^T(i) + D_t^T(i) + R_{t-1}^{BH} B_{t-1}^T(i) \leq W_t l_t^T(i) + B_t^T(i) + R_t^{D} D_t^T(i) + Lump_t \]

- Housing (in fixed supply) is also used as collateral for bank loans (Kyotaki and Moore, 1998), i.e. borrowing constraint is:

  \[ R_t^{BH} B_t^T(i) \leq m^T E_t[Q_{t+1}^h h_t^T(i)] \]
Entrepreneurs

- Consume, choose labor, K and utilization rate

\[
\begin{align*}
    \text{Max} & \quad E_0 \sum_{t=0}^{\infty} \beta_t E \log(c_t^E(i) - a^E c_{t-1}^E) \\
    \text{s.t.} & \quad P_t c_t^E(i) + W_t l_t^E(i) + D_t^E(i) + R_{t-1}^{BE} B_{t-1}^E(i) + P_t^k k_t^E(i) - P_t^k (1-\delta) k_{t-1}^E(i) \\
    & \quad \leq P_t^w y_t^E(i) + B_t^E(i) + R_{t-1}^D D_{t-1}^E(i) + P_t \psi[u_t(i)] k_{t-1}^E(i) + S_d(i)
\end{align*}
\]

and a borrowing constraint, tied to the value of capital

\[
R_t^{BE} B_t^E(i) \leq m^E E_t(Q_{t+1}^k (1-\delta) k_t^E(i))
\]
Banks

Obtain funding from {HH deposits (D) \ Central Bank or Interbank market (M)}

Issue loans to HHs and Entrepreneurs

Production function for loans

\((T^W + T^D)f = T^B\)

Obtain funding from HH deposits (D)
Banks (& Bankers)

- Obtain funding from
  - HH deposits ($D$)
  - Central Bank or Interbank market ($M$)
  - Reinvested earnings ($K^b$)

  To introduce bank capital, we model ‘Bankers’. Bankers own the banks (get the profits), consume, and accumulate bank capital.

- Issue loans to HHs and Entrepreneurs
  - Production function for loans

\[ B_t = f(D_t + M_t, K_{t}^{bank}) \]
Decisions are made on how much to:

- consume \( (c^p_t, c^i_t, c^e_t, c^b_t) \)
- labor supply/demand \( (l_t) \)
- produce \( (y^e_t) \)

Banks: pay \( r^d_{t-1} \cdot D_{t-1} \)

\[ r^b_{t-1} \cdot B_{t-1} \]

\[ r^{bk}_{t-1} \cdot K^b_{t-1} \]

profits \( J^b_t \)

Banks: produce \( B_t = f(D_t, M_t, K^b_t) \) (borrowing \( M_t \) from CB)

Patients: deposit \( D_t \) to the Banks

Bankers: accumulate \( K^b_t \)

Impatients: borrow \( B^h_t \) from the Banks

Entrepreneurs: borrow \( B^e_t \) from the Banks
The Banking Sector (1)

- Monopolistic competition à la Dixit-Stiglitz
- They collect $D_t$, borrow $M_t$ and accumulate $K_t^B$
- So, banks fix rates on
  - Deposits $\rightarrow$ as a **mark-down** over policy rate
    \[ \hat{r}_t^D = \frac{\varepsilon}{\varepsilon + 1} \hat{r}_t^B \]
  - Loans $\rightarrow$ as a **mark-up** over marginal cost
    \[ \hat{r}_t^B = \frac{\varepsilon}{\varepsilon - 1} \hat{M}_t^C^{bank} \]
The Banking Sector (2)

In the benchmark model, we assume imperfect rate pass-through (quadratic adjustment costs to change rates). Rates are then set according to:

**Deposits**

\[
\hat{r}^D_t = \theta(\kappa, \varepsilon) \hat{r}^D_{t-1} + \theta(\kappa, \varepsilon) \beta_P E_t[\hat{r}^D_{t+1}] + \frac{\theta(\kappa, \varepsilon)(\varepsilon-1)}{\kappa} \hat{r}^{IB}_t
\]

**Loans**

\[
\hat{r}^B_t = \theta(\kappa, \varepsilon) \hat{r}^B_{t-1} + \theta(\kappa, \varepsilon) \beta_P E_t[\hat{r}^B_{t+1}] + \frac{\theta(\kappa, \varepsilon)(\varepsilon-1)}{\kappa} \hat{M}C^\text{bank}_t
\]
The Banking Sector (3)

What determines $MC_{t}^{bank}$ (bank marginal cost?)

We assume, CES loan production function

$$B_t = [\chi^b K_t^P \omega + (1 - \chi^b)(M_t + D_t)^\omega]^{1/\omega}$$

For $\omega \rightarrow 1$ (Cobb-Douglas), we have

$$\hat{MC}_{t}^{bank} = \chi^b \hat{r}_t^{kb} + (1 - \chi^b)\hat{r}_t^{IB}$$
## Calibration

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
<th></th>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\beta^P = \beta^B$</td>
<td>0.9943</td>
<td></td>
<td>$\varepsilon_d (D \text{ demand el.})$</td>
<td>-1.3 (-150bp spread)</td>
</tr>
<tr>
<td>$\beta^I = \beta^E$</td>
<td>0.975</td>
<td></td>
<td>$\varepsilon^H_b (B^H \text{ demand el.})$</td>
<td>5.1 (+160bp spread)</td>
</tr>
<tr>
<td>$m^E$ (Firms’ LTV)</td>
<td>0.25</td>
<td></td>
<td>$\varepsilon^E_b (B^E \text{ demand el.})$</td>
<td>3.5 (+130bp spread)</td>
</tr>
<tr>
<td>$m^I$ (HHs’ LTV)</td>
<td>0.7</td>
<td></td>
<td>$\kappa_d (R^D \text{ stickiness})$</td>
<td>11</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>$\kappa_h (R^{BH} \text{ stickiness})$</td>
<td>6 (2 qrts.)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>$\kappa_e (R^{BE} \text{ stickiness})$</td>
<td>5 (2 qrts.)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>$\chi^b$ (loan inputs el.)</td>
<td>0.09 ($K^b/B = 8%$)</td>
</tr>
</tbody>
</table>
Applications

1  Contractionary Monetary Policy Shock

2  Expansionary Technology Shock

3  'Credit-Supply Shock' Scenario:

   * a tightening of collateral requirements and
   * an exogenous increase in bank rates for both HH's and firms
Contractionary Monetary Policy Shock (25 b.p.)
What difference do banks, sticky rates and bank capital make?

We isolate effects by sequentially removing the corresponding feature from our Benchmark (BK: sticky bank rates & bank capital), i.e. we remove:

4 **Bank capital** and get a model with banks with market power (where $mc_t^b = R_t^{IB}$) and sticky rates (noBK)

3 **Sticky rates** and get a model with banks with market power but flex rates (FR)

2 **Banks** and get Iacoviello model (FF)

1 **Collateral effects and nominal debt** and get as close as possible to an NK model (QNK, still exist borrowing limits)
Output

Quarters after shock

Quasi-New Keynesian
OUTPUT

quarters after shock

QUASI–NEW KEYNESIAN

FINANCIAL FRICTIONS (Iacoviello)
Output

quarters after shock

QUASI-NEW KEYNESIAN
FINANCIAL FRICTIONS (iacoviello)
BANKS WITH FLEX RATES
Output

quarters after shock

QUASI–NEW KEYNESIAN
FINANCIAL FRICTIONS (lacoviello)
BANKS WITH FLEX RATES
BANKS WITH STICKY RATES
A "Banking Attenuator Effect"

Following a contractionary MP shock,

without banks

\[ B_t \leq mE_t \left[ \frac{Q_{t+1}^h h_t}{R_t \uparrow\uparrow} \right] \]

with banks

\[ B_t \leq mE_t \left[ \frac{Q_{t+1}^h h_t}{R_t^B \uparrow} \right] \]

Rate-setting and stickiness attenuate the effects of MP shocks
Output

quarters after shock

QUASI–NEW KEYNESIAN
FINANCIAL FRICTIONS (Iacoviello)
BANKS WITH FLEX RATES
BANKS WITH STICKY RATES
BANKS WITH STICKY RATES & BANK CAPITAL
Expansionary Technological Shock

Positive shock to technology that increases output (at the peak) by 1.0 per cent from its steady state value
'Credit crunch' scenario

- Unexpected reduction in loans supply to HH’s and firms (ex-ante, 5% on average)
  - implemented by increasing collateral requirements, i.e. by decreasing $m^E$ and $m^I$

- Unexpected increase in bank rates on loans to HH’s and firms (ex-ante, 100 b.p.)
  - implemented by increasing markups, i.e. by decreasing $\varepsilon^E_b$ and $\varepsilon^H_b$

- Unexpected increase in bank rates on deposits (ex-ante, 50 b.p.)
  - implemented by increasing markdown, i.e. by decreasing $\varepsilon_d$

- All independent of policy
CONCLUSIONS

- Demand shocks (MP)
  - Stabilizing role of credit market power and rate stickiness (attenuator effect).
  - Amplifying role of bank capital (accelerator effect).
  - Short-lived
CONCLUSIONS

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  - Stabilizing role of *credit market power* and *rate stickiness* (*attenuator effect*).
  - Amplifying role of *bank capital* (*accelerator effect*).
  - Short-lived

- **Supply shocks (TS)**
  - With *banks*, greater *propagation* and *persistence*. 
CONCLUSIONS

- **Demand shocks (MP)**
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- **Supply shocks (TS)**
  - With banks, greater propagation and persistence.

- **Credit crunch**
  - The presence of banks allows to assess the economic impact of changes in bank rates and credit supply to HH’s and firms.
  - Negative effects on output and investment, more severe if tightening is on firms.
EXTENSIONS

■ Risk.
■ Write-offs and valuation effects.
■ Multiperiod loan contracts.
■ Bayesian estimation.