Financial Intermediation and Credit Policy

In

Business Cycle Analysis

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Old Motivation (for BGG 1999)

- Great Depression

- Emerging market crises over the past quarter century
New Motivation (for GK 2009)

- Global economy during Bernanke’s tenure as Fed Chair
Figure 1: Selected Corporate Bond Spreads

Note: The black line depicts the average credit spread for our sample of 5,269 senior unsecured corporate bonds; the red line depicts the average credit spread associated with very long maturity corporate bonds issued by firms with low to medium probability of default (see text for details); and the blue line depicts the standard Baa credit spread, measured relative to the 10-year Treasury yield. The shaded vertical bars denote NBER-dated recessions.
lending standards (left)
real GDP growth (right)
Challenges for Writing a Handbook Chapter

- Much of the relevant literature predates August 2007

- Most of the work afterwards is still in preliminary working paper form.
Our Approach: Look both Forward and Backward

- Present Canonical Framework relevant to thinking about current crisis.
  - Not a comprehensive or complete description
  - Only a first pass at organizing thinking
  - Goal is to lay out issues for future research

- Build heavily on earlier research.
Aspects of the Current Crisis We Try to Capture

- Disruption of Financial Intermediation
  - Much of the recent macro literature has emphasized credit frictions on non-financial borrowers and has treated intermediaries largely as a veil.

- Unconventional Monetary Policy
Unconventional vs. Conventional Monetary Policy

Conventional: The central bank adjusts the short term rate to affect the market structure of interest rates.

Unconventional: The central bank lends directly in private credit markets.

Section 13.3 of the Federal Reserve Act: "In unusual and exigent circumstances.. the Federal Reserve may lend directly to private borrowers to the extent it judges the loans to be adequately secured."
Liquidity Facilities

**CPFF and Commercial Paper Outstanding**

- Billions of Dollars
- Source: Federal Reserve Board, Haver, FDIC

**3-month CP Rates over OIS**

- Basis Points
- Source: Federal Reserve Board, Haver, Bloomberg

**TSLF Schedule 1 & 2 Total Outstanding**

- Billions of Dollars
- Source: Federal Reserve Board

**Overnight Financing Spreads**

- Basis Points
- Source: Bloomberg
  - Note: Spreads are between overnight agency debt and MBS and Treasury general collateral repo rates

**Agency MBS Transactions**

- Billions of Dollars
- Source: Federal Reserve Board, Haver

**Agency MBS to Average 5y and 10y Yields**

- Basis Points
- Source: FRB, Haver, Bloomberg
  - Note: Spreads are agency 30 year on-the-run coupon to average of 5 and 10 year yields
What We Do

- Develop a quantitative DSGE model that allows for financial intermediaries that face endogenous balance sheet constraints.

- Use the model to simulate a crisis that has some of the features of the current downturn.

- Assess how unconventional monetary policy (direct central bank intermediation) could moderate the downturn.

- Discuss Open Issues and Extensions
Model: Physical Environment

- Firm dispersed across islands, with perfectly mobile labor:

\[ Y_t = A_t K_t^\alpha L_t^{1-\alpha} \]

- I.I.D. prob. \( \pi^i \) of arrival of investment opportunities across islands.

\[ K_{t+1} = \psi_t(I_t + \pi^i(1 - \delta)K_t) + [(1 - \pi^i)\psi_t(1 - \delta)K_t] \]

\[ = \psi_t[I_t + (1 - \delta)K_t] \]

- Resource Constraint

\[ Y_t = C_t + [1 + f\left(\frac{I_t}{I_{t-1}}\right)]I_t + G_t \]

- Preferences

\[ E_t \sum_{i=0}^{\infty} \beta^i \left[ \ln(C_{t+i} - hC_{t+i-1}) - \frac{\chi}{1 + \varphi} L_{t+i}^{1+\varphi} \right] \]
Households \hspace{1cm} \text{Retail financial market} \hspace{1cm} \text{Deposit} \hspace{1cm} \text{Banks}

Beginning of the period
During the period

Bank with fund shortage

New and old loans

Firms with new investment opportunity

Investing regions

Interbank market

Old loans

Firms without new investment opportunities

Non-investing regions

Banks with surplus fund
Households

- Within each household, $1 - f$ "workers" and $f$ "bankers".

- Workers supply labor and return their wages to the household.

- Each banker manages a financial intermediary and also transfers earnings back to the household.

- Perfect consumption insurance within the family.
Households (con’t)

To limit bankers’ ability to save to overcome financial constraints:

• With i.i.d prob. $1 - \sigma$, a banker exits next period. (average survival time $= \frac{1}{1-\sigma}$)

• Upon exiting, a banker transfers retained earnings to the household and becomes a worker.

• Each period, $(1 - \sigma)f$ workers randomly become bankers, keeping the number in each occupation constant

• Each new banker receives a "start up" transfer from the family.
Households (con’t)

\[
\max E_t \sum_{i=0}^{\infty} \beta^i \left[ \ln(C_{t+i} - hC_{t+i-1}) - \frac{\chi}{1 + \varphi} L_{t+i}^{1+\varphi} \right]
\]

s.t.

\[
C_t = W_t L_t + \Pi_t + T_t + R_t D_t - D_{t+1}
\]

- \(D_t \equiv \) short term bonds (intermediary deposits and government debt)
- \(\Pi_t \equiv \) payouts to the household from firm ownership net the transfer it gives to its new bankers.
Financial Intermediaries: Case of No Idiosyncratic Risk (i.e. $\pi = 1$) 

(equivalent to $\pi < 1$ with perfect interbank market)

- Intermediary Balance Sheet

\[ Q_{ts_t} = n_t + d_t \]

- Evolution of Net Worth

\[
\begin{align*}
  n_{t+1} & = R_{kt+1}Q_{ts_t} - R_{t+1}d_t \\
  & = (R_{kt+1} - R_{t+1})Q_{ts_t} + R_{t+1}n_t
\end{align*}
\]
Financial Intermediaries (con’t)

\[
V_t = \max \mathbb{E}_t \sum_{i=1} (1 - \sigma) \sigma^i \Lambda_{t,t+i} n_{t+i}
\]

\[
= \max \mathbb{E}_t \sum_{i=1} (1 - \sigma) \sigma^i \Lambda_{t,t+i} [(R_{kt+i} - R_{t+i}) Q_{t+i} s_{t+i} + R_{t+i} n_{t+i}]
\]

• With Frictionless Capital Markets:

\[
\mathbb{E}_t \Lambda_{t,t+1+i}(R_{kt+1+i} - R_{t+1+i}) = 0
\]

• With Capital Market Frictions:

\[
\mathbb{E}_t \Lambda_{t,t+1+i}(R_{kt+1+i} - R_{t+1+i}) \geq 0
\]
Financial Intermediaries (con’t)

- **Agency Problem:** After the banker/intermediary borrows funds at the end of period $t$, it may divert the fraction $\theta$ of total assets back to its family.

- If the intermediary does not honor its debt, depositers can liquidate the intermediate and obtain the fraction $1 - \theta$ of initial assets.

- **Incentive Constraint:**

$$V_t \geq \theta Q_t s_t$$
Financial Intermediaries (con’t)

One can show:

\[ V_t = \mu_t Q_t + \nu_t n_t \]

with

\[ \nu_t = E_t \Omega_{t+1} \]

\[ \mu_t = E_t \Lambda_{t,t+1} (R_{kt+1} - R_{t+1}) \Omega_{t+1} \]

where \( \Omega_{t+1} \) is the shadow value of a unit of net worth at \( t + 1 \).

\[ \Omega_{t+1} = 1 - \sigma + \sigma (\nu_{t+1} + \phi_{t+1} \mu_{t+1}) \]
Financial Intermediaries (con’t)

- Re-writing the incentive constraint:

\[ \mu_t Q_{ts} + \nu_t n_t \geq \theta Q_{ts} \]

- Endogenous leverage constraint:

\[ Q_{ts} \leq \phi_t n_t \]

with

\[ \phi_t = \frac{\nu_t}{\theta - \mu_t} \]

- \( \phi_t \) = Maximum leverage ratio
Financial Intermediaries (con’t)

• Since the leverage ratio $\phi_t$ does not depend on firm-specific factors, we can aggregate:

$$Q_t S_{pt} = \phi_t N_t$$

$S_{pt} \equiv$ total assets privately intermediated

$N_t \equiv$ total intermediary capital

• Evolution of Net Worth:

$$N_t = \sigma[(R_{kt} - R_t)\phi_t + R]N_{t-1} + \xi R_{kt}Q_{t-1}S_{t-1}$$

where $\xi$ is the fraction of gross assets transferred to new entrepreneurs
Credit Policy
(Case of Direct Lending)

• Central bank intermediation supplements private intermediation:

\[ Q_tS_t = Q_tS_{pt} + Q_tS_{gt} \]

• The central bank issues government debt that pays \( R_{t+1} \) and then lends to non-financial firms at \( R_{kt+1} \).

• Efficiency cost of \( \tau \) per unit of gov’t credit provided.

• Unlike private intermediaries, the central bank is not "balance-sheet" constrained.
Credit Policy (con’t)

\[ Q_t S_{gt} = \varphi_t Q_t S_t \]

\[ \implies \]

\[ Q_t S_t = Q_t S_{pt} + Q_t S_{gt} \]
\[ = \phi_t N_t + \varphi_t Q_t S_t \]

\[ \implies \]

\[ Q_t S_t = \frac{1}{1 - \varphi_t} \phi_t N_t \]

\( Q_t S_t \) is increasing in the intensity of credit policy, as measured by \( \varphi_t \).
Non-financial Firms

- Goods Producers:
  - Issue state-contingent claims (equity)

\[
S_t = K_{t+1}
\]

\[
R_{kt+1} = \psi_{t+1}[Z_{t+1} + (1 - \delta)Q_{t+1}] / Q_t
\]

with \( Z_t = \alpha \frac{Y_t}{K_t} \)

- Hire Labor

\[
(1 - \alpha) \frac{Y_t}{L_t}
\]
Non-financial Firms (con’t)

- Capital producers:

\[
\max E_t \sum_{\tau=t}^{\infty} \Lambda_{t,\tau} \left\{ Q^i_{\tau} I_{\tau} - \left[ 1 + f \left( \frac{I_{\tau}}{I_{\tau-1}} \right) \right] I_{\tau} \right\}
\]

- Investment increasing in \( Q_t \):

\[
Q^i_t = 1 + f \left( \frac{I_t}{I_{t-1}} \right) + \frac{I_t}{I_{t-1}} f' \left( \frac{I_t}{I_{t-1}} \right) - E_t \Lambda_{t,t+1} \left( \frac{I_{t+1}}{I_t} \right)^2 f' \left( \frac{I_{t+1}}{I_t} \right)
\]
Government Budget Constraint and Credit Policy

- Government Budget Constraint

\[ G + \tau \psi_t Q_t K_{t+1} = T_t + (R_{kt} - R_t) B_{gt-1} \]

- Credit Policy (contingent on a "crisis")

\[ \psi_t = \nu [E_t(R_{kt+1} - R_{t+1}) - (R_k - R)] \]
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Figure 1. Crisis Experiment: Perfect Interbank Market
Figure 3. Lending Facilities: Perfect Interbank Market
Liquidity Risk ($\pi^i < 1$) and Imperfect Interbank Market

- Asset returns on "investing" islands exceed returns on "non-investing" islands
- The spread between inter-island returns increases during a crisis.
Liquidity Risk ($\pi^i < 1$), con’t

• for $h = i, n$

$$Q^h_t s^h_t = n^h_t + b^h_t + d_t.$$  

where $b^h_t$ is interbank borrowing

• net worth:

$$n^h_t = [Z_t + (1 - \delta)Q^h_t]\psi_t Q^{h-1}_{t-1} s_{t-1} - R_{bt} b^h_{t-1} - R_t d_{t-1},$$

$$R^h_{kt} = \frac{[Z_t + (1 - \delta)Q^h_t]\psi_t}{Q^{h-1}_{t-1}}$$
Liquidity Risk ($\pi^i < 1$), con't

- **objective**

\[
V_t = E_t \sum_{i=1}^{\infty} (1 - \sigma)\sigma^{i-1}\lambda_{t,t+i}n_{t+i},
\]

- the bank chooses $d_t$ before liquidity risk realized; $s_t^h, b_t^h$ after.

- **incentive constraint**

\[
V(s_t^h, b_t^h, d_t) \geq \theta(Q_t^h s_t^h - \omega b_t^h).
\]

where $\omega \in [0, 1]$ measures the efficiency of the interbank market.
Perfect Interbank Market ($\omega = 1$)

- arbitrage $\rightarrow Q^i_t = Q^n_t = Q_t \Rightarrow$
  $$E_t R_{kt+1}^{hh'} = E_t R_{kt+1} = \psi_{t+1} \frac{Z_{t+1} + (1 - \delta)Q_{t+1}}{Q_t}$$

- incentive constraint
  $$Q_{st} - b^h_t = \phi_{tn_t}$$

where $\phi_t = \frac{\nu_t}{\theta - \mu_t} = \text{the case of no liquidity risk}$
Perfect Interbank Market ($\omega = 1$)

- aggregating and given $b^i_t + b^n_t = 0$,

$$Q_t S_t = \phi_t N_t$$

liquidity risk and a perfect interbank market $\iff$ no liquidity risk case

- results from perfect arbitrage in the inter-bank market

$$E_t \Lambda_{t,t+1} R_{kt+1} \Omega_{t+1} = E_t \Lambda_{t,t+1} R_{bt+1} \Omega_{t+1} > E_t \Lambda_{t,t+1} R_{t+1} \Omega_{t+1}.$$
Imperfect Interbank Market ($\omega = 0$)

• Imperfect arbitrage $\rightarrow Q^i_t < Q^n_t \rightarrow$ A lower asset price on the investing island, of course, means a higher expected return.

• Let $\mu^h_t \equiv$ be the excess value of assets on a type $h$ island

$$\mu^i_t > \mu^n_t \geq 0.$$ 

with

$$\mu^h_t = E_t \Lambda_{t,t+1}(R_{k,t+1}^{hh'} - R_{t+1})\Omega_{t+1}^{h'}; \quad h = i.n$$
Imperfect Interbank Market \((\omega = 0)\)

\[ Q_t^i S_t^i = \phi_t^i N_t^i \]

\[ Q_t^n S_t^n \leq \phi_t^n N_t^n, \quad \text{and} \quad (Q_t^n S_t^n - \phi_t^n N_t^n) \mu_t^n = 0, \]

with

\[ \phi_t^h = \frac{\nu_t}{\theta - \mu_t^h} \]

\[ \rightarrow \]

\[ E_t \Lambda_{t,t+1} R_{kt+1}^{i h'} \Omega_{t+1}^{h'} > E_t \Lambda_{t,t+1} R_{kt+1}^{n h'} \Omega_{t+1}^{h'} \]

\[ \geq E_t \Lambda_{t,t+1} R_{bt+1}^{h'} \Omega_{t+1}^{h'} = E_t \Lambda_{t,t+1} R_{t+1}^{h'} \Omega_{t+1}^{h'}. \]
Credit Policy with Imperfect Inter-bank Market

\[ Q_t^h S_t^h = Q_t^h (S_{pt}^h + S_{gt}^h) \]

\[ S_{gt}^h = \varphi_t^h S_t^h \]

where \( \varphi_t^h \) may be thought of as an instrument of central bank credit policy.

\[ Q_t^i S_t^i = \frac{1}{1 - \varphi_t^i N_t^i} \]

\[ Q_t^n S_t^n = \frac{1}{1 - \varphi_t^n N_t^n} \text{ if } \mu_t^n > 0. \]

\[ Q_t^n S_t^{n*} = Q_t^n S_{pt}^n + \varphi_t^n Q_t^n S_t^{n*}, \text{ if } \mu_t^n = 0 \]

with \( S_t^{n*} \equiv \text{asset demand consistent with } \mu_t^n = 0. \)
Figure 2. Crisis Experiment: Imperfect Interbank Market
Figure 4. Lending Facilities: Imperfect Interbank Market
Discount Window Policy with Imperfect Inter-bank Market

\[ Q_t^h s_t^h = n_t^h + b_t^h + m_t^h + d_t. \]

with \( m_t^h \geq 0 \).

\[ V(s_t^h, b_t^h, m_t^h, d_t) \geq \theta \left( Q_t^h s_t^h - \omega m_t^h \right). \]
Discount Window Policy with Imperfect Inter-bank Market

define

$$\mu_{mt} = E_t \Lambda_{t,t+1}(R_{mt+1} - R_{t+1})\Omega_{t+1}^{h'}.$$ 

→ discount rate set according to

$$\mu_{mt} = \omega^g \mu^i_t$$

→ set $R_{mt+1} > R_{bt+1} = R_{t+1}$ (Bagehot’s principle)

in the aggregate

$$Q^i_{t}S^i_{pt} = \phi^i_t N^i_t + \omega_g M_t.$$
Equity Injections (case of perfect interbank market)

\[ s_t = s_{pt} + s_{get} \]

\[ Q_t s_t = n_t + b^h_t + d_t + n_{gt} \]

\[ n_{gt} = Q_t s_{get} \]
Equity Injections (case of perfect interbank market)

\[ \mu_{gt} = E_t \Lambda_{t,t+1}(R_{gkt+1} - R_{t+1}) \Omega_{t+1} \]

where \( R_{gkt+1} \equiv \) ross return on a unit of government equity injected at time \( t \) is:

\[ R_{gkt+1} = \psi_{t+1} \frac{Z_{t+1} + (1 - \delta)Q_{t+1}}{Q_{gt}} \]

with, \( Q_{gt} \geq Q_t \).

\[ n_t = [Z_t + (1 - \delta)Q_t] \psi_ts_{pt-1} - R_{bt}b_{t-1} - R_{td}d_{t-1} + (Q_{gt} - Q_t)[s_{get} - (1 - \delta)\psi_t s_{get-1}] \]

where \((Q_{gt} - Q_t)(s_{gt} - s_{gt-1})\) is the "gift" to the bank from new government equity purchases.
Equity Injections (case of perfect interbank market)

\[ V(s_t - s_{get}, b_t, d_t) \geq \theta(Q_t(s_t - s_{get}) - b_t). \]

\[ \rightarrow \]

\[ Q_t S_t = \phi_t N_t + N_{gt} \]

\[ N_t = (\sigma + \xi)[Z_t + (1-\delta)Q_t] \psi_t S_{pt-1} - \sigma R_tD_{t-1} + (Q_{gt} - Q_t)[S_{get} - (1-\delta)\psi_t S_{get-1}] \]
Issues

1. Idiosyncratic Asset Risk and Default
2. Illiquidity and Market Thinness
3. Maturity Structure
4. Bank Equity
5. Capital Requirements and Regulation, and so on....