Lecture 3

Financial Intermediation, Dynamic Contracting and

Unconventional Monetary Policy

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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."
Issues

Current crisis has featured a disruption of financial intermediation.

The Fed has used unconventional monetary policy to combat it:

However, existing quantitative models not adequate:

- Baseline models (Christiano/Eichenbaum/Evans, Smets/Wouters) have frictionless capital markets
- Models with financial frictions (Bernanke/Gertler/Gilchrist, Christiano, Motto, Rostagno) consider frictions on non-financial firms and do not model credit policy.
Gertler/Karadi 2009

- Develop a quantitative monetary 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.

- Compute the optimal "unconventional" response to the downturn and the welfare gains.
Model

Monetary DSGE with Balance-Sheet Constrained Financial Intermediaries

Agents

- Households
- Financial Intermediaries (face financial constraints)
- Intermediate Goods Producer
- Capital Producers
- Monopolistically competitive retailers (set nominal prices on a staggered basis)
- Central Bank
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 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. $1 - \theta$, a banker exits next period. (average survival time $= \frac{1}{1-\theta}$)
- Upon exiting, a banker transfers retained earnings to the household and becomes a worker.
- Each period, $(1 - \theta)f$ 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)

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

s.t.

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

- \(B_t \equiv \) short term debt (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

- Intermediary Balance Sheet

\[ Q_tS_{jt} = N_{jt} + B_{jt} \]

- Evolution of Net Worth

\[ N_{jt+1} = R_{kt+1}Q_tS_{jt} - R_{t+1}B_{jt} \]
\[ = (R_{kt+1} - R_{t+1})Q_tS_{jt} + R_{t+1}N_{jt} \]
Financial Intermediaries (con’t)

\[ V_{jt} = \max E_t \sum_i (1 - \theta) \theta^i \beta^i \Lambda_{t,t+i} (N_{jt+1+i}) \]

\[ = \max E_t \sum_i (1 - \theta) \theta^i \beta^i \Lambda_{t,t+i} [ (R_{kt+1+i} - R_{t+1+i}) Q_{t+i} S_{jt+i} + R_{t+1+i} N_{jt+i} ] \]

• With Frictionless Capital Markets:

\[ E_t \beta \Lambda_{t,t+1+i} (R_{kt+1+i} - R_{t+1+i}) = 0 \]

• With Capital Market Frictions:

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

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

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

- Incentive Constraint:

$$V_{jt} \geq \lambda Q_t S_{jt}$$
Financial Intermediaries (con’t)

• Simplifying $V_{jt}$:

$$V_{jt} = v_t \cdot Q_t S_{jt} + \eta_t N_{jt}$$

$$v_t = E_t\{(1 - \theta)\beta\Lambda_{t,t+1}(R_{kt+1} - R_{t+1}) + \beta\Lambda_{t,t+1}\theta x_{t,t+1}v_{t+1}\}$$

$$\eta_t = E_t\{(1 - \theta) + \beta\Lambda_{t,t+1}\theta z_{t,t+1}\eta_{t+1}\}$$

with $x_{t,t+i} \equiv Q_{t+i} S_{jt+i}/Q_t S_{jt}$, $z_{t,t+i} \equiv N_{jt+i}/N_{jt}$. 
Financial Intermediaries (con’t)

• The incentive constraint becomes:

\[ v_t \cdot Q_t S_{jt} + \eta_t N_{jt} \geq \lambda Q_t S_{jt} \]

• When constraint binds:

\[
Q_t S_{jt} = \frac{\eta_t}{\lambda - v_t} N_{jt} \\
= \phi_t N_{jt}
\]

where \( \phi_t \) is the intermediaries "leverage" ratio.
Financial Intermediaries (con’t)

\[ \phi_t = \frac{\eta_t}{\lambda - v_t} \]

\[ v_t = E_t\{(1 - \theta)\beta\Lambda_{t,t+1}(R_{kt+1} - R_{t+1}) + \beta\Lambda_{t,t+1}\theta x_{t,t+1}v_{t+1}\} \]

\[ \eta_t = E_t\{(1 - \theta) + \beta\Lambda_{t,t+1}\theta z_{t,t+1}\eta_{t+1}\} \]

\[ z_{t,t+i} \equiv \frac{N_{jt+i}}{N_{jt}} = (R_{kt+1} - R_{t+1})\phi_t + R_{t+1} \]

\[ x_{t,t+i} \equiv \frac{Q_{t+i}S_{jt+i}}{Q_tS_{jt}} = \frac{\phi_{t+1}N_{t+1}}{\phi_tN_t} = \frac{(\phi_{t+1}/\phi_t)}{z_{t,t+i}} \]

\[ \Rightarrow \text{Leverage ratio } \phi_t \text{ does not depend on firm specific factors.} \]
Financial Intermediaries (con’t)

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

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

• where:

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

$N_t \equiv$ total intermediary capital
Credit Policy

• Central bank intermediation supplements private intermediation:

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

• 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)

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

\[ \Rightarrow \]

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

\[ \Rightarrow \]

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

- \( Q_t S_t \) is increasing in the intensity of credit policy, as measured by \( \psi_t \).
Evolution of Net Worth

\[ N_t = N_{et} + N_{nt} \]

\[ N_{et} = \theta [(R_{kt} - R_t)\phi_t + R_t]N_{t-1} \]

\[ N_{nt} = \frac{\xi}{1 - \theta (1 - \theta)} Q_t S_{t-1} \]

\[ \Rightarrow \]

\[ N_t = \theta [(R_{kt} - R_t)\phi_t + R]N_{t-1} + \xi Q_t S_{t-1} \]
Intermediate Goods Firms

- At the end of period $t$, an intermediate goods producer acquires capital $K_{t+1}$ for use in $t+1$

- No adjustment costs and no financing frictions

- The firm finances $K_{t+1}$ by obtaining funds from intermediaries.

- It issues $S_t$ claims equal to the number of units of capital acquired $K_{t+1}$ and prices each claim at the price of a unit of capital $Q_t$:

  $$Q_t K_{t+1} = Q_t S_t$$
Intermediate Goods Firms (con’t)

• Production

\[ Y_{t+1} = A_{t+1}(U_{t+1}K_{t+1})^\alpha L_{t+1}^{1-\alpha} \]

• Objective

\[
\max E_t \beta \Lambda_{t,t+1} \left[ P_{mt+1}Y_{t+1} + (Q_{t+1} - \delta(U_{t+1}))\xi_{t+1} K_{t+1} \\
- R_{kt+1} Q_t K_{t+1} - W_{t+1} L_{t+1} \right]
\]

• \( \xi_{t+1} \) is a shock to "capital quality."

in the aggregate

\[ K_{t+2} = I_{t+1} + (1 - \delta(U_{t+1}))\xi_{t+1} K_{t+1} \]
Intermediate Goods Firms (con’t)

F.O.N.C.

\[ E_t \beta \Lambda_{t,t+1} R_{kt+1} = E_t \{ \beta \Lambda_{t,t+1} \frac{P_{mt+1} \alpha \frac{Y_{t+1}}{K_{t+1}} + (Q_{t+1} - \delta(U_{t+1})) \xi_{t+1}}{Q_t} \} \]

\[ P_{mt+1} \alpha \frac{Y_{t+1}}{U_{t+1}} = \delta'(U_{t+1}) \]

\[ P_{mt+1} \alpha \frac{Y_{t+1}}{L_{t+1}} = W_{t+1} \]
Capital Producing Firms

- Produce new capital to sell to the market, subject to adjustment costs on the rate of net investment.

- $Q_t$ relation for investment:

$$Q_t[1 - S \left( \frac{I_{nt}}{I_{nt-1}} \right) - S' \left( \frac{I_{nt}}{I_{nt-1}} \right)] = [1 - \beta E_t \Lambda_{t,t+1} \cdot Q_{t+1} S' \left( \frac{I_{nt+1}}{I_{nt}} \right) \left( \frac{I_{nt+1}}{I_{nt}} \right)^2]$$

$$I_{nt} = I_t - \delta(U_t)\psi_t K_t$$
Retail Firms

• Monopolistically competitive retailers by input from intermediate goods producers and re-package as final output.

• Set nominal prices on a staggered basis

• $P_{m,t}$ is marginal cost ($(P_{m,t})^{-1}$ is the markup).
Resource and Government Budget Constraints

- Resource Constraint

\[ Y_t = C_t + I_t + G + \tau \psi_t Q_t K_{t+1} \]

- Government Budget Constraint

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

• Interest Rate Policy

\[ i_t = (1 - \rho)[\bar{i} + \nu_{\pi}\pi_t + \nu_y(\log Y_t - \log Y^*_t) + \rho i_{t-1} + \epsilon_t] \]

with

\[ 1 + i_t = R_{t+1} \frac{P_{t+1}}{P_t} \]

• Credit Policy

\[ \psi_t = \psi + \nu[E_t(R_{kt+1} - R_{t+1}) - (R_k - R)] \]
Table 1: Parameter Values for Baseline Model

<table>
<thead>
<tr>
<th></th>
<th>Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Households</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\beta$</td>
<td>0.995</td>
<td>Discount rate</td>
</tr>
<tr>
<td>$h$</td>
<td>0.700</td>
<td>Habit parameter</td>
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<tr>
<td>$\chi$</td>
<td>5.584</td>
<td>Relative utility weight of labor</td>
</tr>
<tr>
<td>$\varphi$</td>
<td>0.333</td>
<td>Inverse Frisch elasticity of labor supply</td>
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<tr>
<td><strong>Financial Intermediaries</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\lambda$</td>
<td>0.383</td>
<td>Fraction of capital that can be diverted</td>
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<tr>
<td>$\xi$</td>
<td>0.003</td>
<td>Proportional transfer to the entering bankers</td>
</tr>
<tr>
<td>$\theta$</td>
<td>0.972</td>
<td>Survival rate of the bankers</td>
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<tr>
<td><strong>Intermediate good firms</strong></td>
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<tr>
<td>$\alpha$</td>
<td>0.330</td>
<td>Effective capital share</td>
</tr>
<tr>
<td>$u$</td>
<td>1.000</td>
<td>Steady state utilization rate</td>
</tr>
<tr>
<td>$\delta(u)$</td>
<td>0.025</td>
<td>Steady state depreciation rate</td>
</tr>
<tr>
<td>$\zeta$</td>
<td>1.000</td>
<td>Elasticity of marginal depreciation with respect to utilization rate</td>
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<tr>
<td><strong>Capital Producing Firms</strong></td>
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<td></td>
</tr>
<tr>
<td>$\eta_i$</td>
<td>2.500</td>
<td>Inverse elasticity of net investment to the price of capital</td>
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<tr>
<td><strong>Retail firms</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\varepsilon$</td>
<td>11.000</td>
<td>Elasticity of substitution</td>
</tr>
<tr>
<td>$\gamma$</td>
<td>0.750</td>
<td>Probability of keeping prices fixed</td>
</tr>
<tr>
<td>$\gamma_P$</td>
<td>0.500</td>
<td>Measure of price indexation</td>
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<tr>
<td><strong>Government</strong></td>
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<tr>
<td>$\kappa_\pi$</td>
<td>1.500</td>
<td>Inflation coefficient of the Taylor rule</td>
</tr>
<tr>
<td>$\kappa_X$</td>
<td>-0.500</td>
<td>Output gap coefficient of the Taylor rule</td>
</tr>
<tr>
<td>$\gamma_Y$</td>
<td>0.200</td>
<td>Steady state proportion of government expenditures</td>
</tr>
</tbody>
</table>
Figure 1: Responses to Technology (a), Monetary (m) and Wealth (w) Shocks
Figure 2: Responses to a Capital Quality Shock

- $s$
- $Y$
- $C$
- $I$
- $K$
- $L$
- $Q$
- $N$
- $\pi$
- $i$

FA - SDGE
Figure 3: Responses to a Capital Quality Shock with Credit Policy
Welfare and Optimal Policy

- Household Utility
  \[ \Omega_t = U(C_t, L_t) + \beta E_t \Omega_{t+1} \]

- Take a quadratic approximation and combine with a quadratic of the model.

- Solve numerically for the reduced form, given values of the policy-parameters.

- Find numerically the optimal value of the credit policy parameter \( \nu \) conditional on a "crisis" shock.

- Find the consumption adjustment equivalent that makes the household indifferent between the optimal policy response vs. no response.
Figure 4: One year consumption equivalent welfare gains from optimal credit policy as a function of efficiency costs tau and steady state markup
Figure 5: One year consumption equivalent welfare gains from optimal credit policy as a function of efficiency costs $\tau$ and steady state markup with high labor supply elasticity.
Figure 6: Credit vs. premium policy

- **s**: Premium policy (solid line) vs. Credit policy (dashed line)
- **Y**: Premium policy (solid line) vs. Credit policy (dashed line)
- **C**: Premium policy (solid line) vs. Credit policy (dashed line)
- **I**: Premium policy (solid line) vs. Credit policy (dashed line)
- **K**: Premium policy (solid line) vs. Credit policy (dashed line)
- **L**: Premium policy (solid line) vs. Credit policy (dashed line)
- **Q**: Premium policy (solid line) vs. Credit policy (dashed line)
- **N**: Premium policy (solid line) vs. Credit policy (dashed line)
- **R**: Premium policy (solid line) vs. Credit policy (dashed line)
- **$R^k - R$**: Premium policy (solid line) vs. Credit policy (dashed line)
- **$\pi$**: Premium policy (solid line) vs. Credit policy (dashed line)
- **$i$**: Premium policy (solid line) vs. Credit policy (dashed line)

Legend:
- **Premium policy** (solid line)
- **Credit policy** (dashed line)