Credit Frictions and Optimal Monetary Policy

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IMF Research Department Macro-Modeling Workshop
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- Representative household
- Complete (frictionless) financial markets
- Single interest rate (which is also the policy rate) relevant for all decisions
Motivation

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- Single interest rate (which is also the policy rate) relevant for all decisions

But in actual economies (even financially sophisticated), there are different interest rates, that do not move perfectly together
Spreads
(Sources: FRB)

Prime Spread to FF
C&I Spread to FF
Motivation

Questions:

- How much is monetary policy analysis changed by recognizing existence of spreads between different interest rates?

- How should policy respond to “financial shocks” that disrupt financial intermediation, dramatically widening spreads?
Motivation

- John Taylor (Feb. 2008) has proposed that “Taylor rule” for policy might reasonably be adjusted, lowering ff rate target by amount of increase in LIBOR-OIS spread

  — Essentially, Taylor rule would specify operating target for LIBOR rate rather than ff rate

  — Would imply automatic adjustment of ff rate in response to spread variations, as under current SNB policy
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- Is a systematic response of that kind desirable?
The Model

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  - *heterogeneity* in spending opportunities
  - *costly* financial intermediation
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  - costly financial intermediation

- Each household has a type $\tau_t(i) \in \{b, s\}$, determining preferences

$$E_0 \sum_{t=0}^{\infty} \beta^t \left[ u^{\tau_t(i)}(c_t(i); \zeta_t) - \int_0^1 v^{\tau_t(i)}(h_t(j; i); \zeta_t) \, dj \right],$$
The Model

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- Each period type remains same with probability $\delta < 1$; when draw new type, always probability $\pi_\tau$ of becoming type $\tau$
Marginal utilities of the two types
The Model

- Aggregation simplified by assuming intermittent access to an “insurance agency”
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- Other times, can borrow or lend only through intermediaries, at a one-period, riskless nominal rate, different for savers and borrowers
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- **Aggregation** simplified by assuming **intermittent** access to an “insurance agency”
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- Consequence: **long-run** marginal utility of income **same** for all households, regardless of history of spending opportunities
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Consequence: **long-run** marginal utility of income **same** for all households, regardless of history of spending opportunities

- MUI and expenditure **same** each period for all households of a given type: hence only increase state variables from 1 to 2
Euler equation for each type $\tau \in \{b, s\}$:

$$
\lambda_t^\tau = \beta E_t \left\{ \frac{1 + i_t^\tau}{\Pi_{t+1}} \left[ \delta \lambda_{t+1}^\tau + (1 - \delta) \lambda_{t+1} \right] \right\}
$$

where

$$
\lambda_t \equiv \pi_b \lambda_t^b + \pi_s \lambda_t^s
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  $$

- **Aggregate demand** relation:

  $$
  Y_t = \sum_{\tau} \pi_{\tau} c^\tau(\lambda_t^\tau; \xi_t) + G_t + \Xi_t
  $$

  where $\Xi_t$ denotes resources used in intermediation
Log-Linear Equations

- **Intertemporal IS relation:**

\[ \hat{Y}_t = E_t \hat{Y}_{t+1} - \bar{\sigma} \left[ \hat{i}_t^{avg} - \pi_{t+1} \right] - E_t \left[ \Delta g_{t+1} + \Delta \hat{\Xi}_{t+1} \right] - \bar{\sigma} s_{\Omega} \hat{\Omega}_t + \bar{\sigma} (s_{\Omega} + \psi_{\Omega}) E_t \hat{\Omega}_{t+1}, \]

where

\[ \hat{i}_t^{avg} \equiv \pi_b \hat{i}_t^b + \pi_s \hat{i}_t^s, \]

\[ \hat{\Omega}_t \equiv \hat{\lambda}_t^b - \hat{\lambda}_t^s, \]

\[ g_t \] is a composite exogenous disturbance to expenditure of type \( b \), type \( s \), and government,

\[ \bar{\sigma} \equiv \pi_b s_b \sigma_b + \pi_s s_s \sigma_s > 0, \]

and \( s_{\Omega}, \psi_{\Omega} \) depend on asymmetry
Determination of the marginal-utility gap:

$$\hat{\Omega}_t = \hat{\omega}_t + \hat{\delta} E_t \hat{\Omega}_{t+1},$$

where $\hat{\delta} < 1$ and

$$\hat{\omega}_t \equiv \hat{i}_t^b - \hat{i}_t^d$$

measures deviation of the credit spread from its steady-state value.
The Model

- **Financial intermediation** technology: in order to supply loans in (real) quantity $b_t$, must obtain (real) deposits

\[ d_t = b_t + \Xi_t(b_t), \]

where $\Xi_t(0) = 0$, $\Xi_t(b) \geq 0$, $\Xi'_t(b) \geq 0$, $\Xi''_t(b) \geq 0$ for all $b \geq 0$, each date $t$. 
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- **Competitive** banking sector would then imply equilibrium credit spread

  \[ \omega_t(b_t) = \Xi_{bt}(b_t) \]
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\[
\omega_t(b_t) = \Xi_{bt}(b_t)
\]

More generally, we allow

\[
1 + \omega_t(b_t) = \mu^b_t(b_t)(1 + \Xi_{bt}(b_t)),
\]

where \( \{\mu^b_t\} \) is a markup in the banking sector (perhaps a risk premium)
Example of a (microfounded) intermediation technology of this general form: CSV model as in Bernanke-Gertler-Gilchrist (1999) — but with the financial contracting between savers and intermediaries, rather than “households” and “entrepreneurs”
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Key relation of this model:

\[ k_t = \psi(s_t; \mu_t) \]

where \( k_t = \text{leverage ratio of banks} = b_t/n_t \)
\( n_t = \text{net worth of banks} \)
\( s_t = \text{external finance premium} = 1 + \omega_t \)
\( \mu_t = \text{(exogenously varying) bankruptcy costs} \)
Can alternatively write:

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Resources used in intermediation: bankruptcy costs also a function of \( \mu_t \) and \( b_t/n_t \) (which determine fraction of states in which bankruptcy occurs)
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Purely financial disturbances: exogenous variation in $n_t, \mu_t$
Monetary policy: central bank can effectively control deposit rate $i_t^d$, which in the present model is equivalent to the policy rate (interbank funding rate)
Log-Linear Equations

- **Monetary policy**: central bank can effectively control deposit rate \( i_d^t \), which in the present model is equivalent to the policy rate (interbank funding rate)

- Lending rate then determined by the \( \omega_t(b_t) \): in log-linear approximation,

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\hat{i}_t^b = \hat{i}_t^d + \hat{\omega}_t
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$$\hat{i}^b_t = \hat{i}^d_t + \hat{\omega}_t$$

- Hence the rate $\hat{i}^{avg}_t$ that appears in IS relation is determined by

$$\hat{i}^{avg}_t = \hat{i}^d_t + \pi_b \hat{\omega}_t$$
Supply side of model: same as in basic NK model, except must aggregate labor supply of two types.
The Model

- Supply side of model: same as in basic NK model, except must aggregate labor supply of two types

- Only difference: labor supply depends on both MUI: $\lambda^b_t, \lambda^s_t$, or alternatively on $\Omega_t$ as well as $\lambda_t$
Log-linear AS relation: generalizes NKPC:

$$\pi_t = \kappa(\hat{Y}_t - \hat{Y}_t^n) + u_t + \zeta(s_\Omega + \pi_b - \gamma_b)\hat{\Omega}_t - \zeta \tilde{\sigma}^{-1}\hat{\Xi}_t + \beta E_t \pi_{t+1}$$

where

$$\gamma_b \equiv \pi_b \left( \frac{\bar{\lambda}^b}{\bar{\lambda}} \right)^{1/\nu}$$

depends on $\tilde{\Omega}$
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depends on \( \hat{\Omega} \)

— other coefficients, and disturbance terms \( \hat{Y}_t^n, u_t \), defined as in basic NK model, using \( \bar{\sigma} \) in place of the rep hh’s elasticity
Natural objective for stabilization policy: average expected utility:

$$E_0 \sum_{t=0}^{\infty} \beta U(Y_t, \lambda_{t}^b, \lambda_{t}^s, \Delta_t; \tilde{\xi}_t)$$

where

$$U(Y_t, \lambda_{t}^b, \lambda_{t}^s, \Delta_t; \tilde{\xi}_t) \equiv \pi_b u^b(c^b(\lambda_{t}^b; \xi_t); \tilde{\xi}_t) + \pi_s u^s(c^s(\lambda_{t}^s; \xi_t); \tilde{\xi}_t)$$

$$- \frac{\psi}{1 + \nu} \left( \frac{\tilde{\lambda}_t}{\tilde{\Lambda}_t} \right)^{-\frac{1+\nu}{\nu}} \bar{H}_t^{-\nu} \left( \frac{Y_t}{A_t} \right)^{1+\omega} \Delta_t,$$

and $\tilde{\lambda}_t / \tilde{\Lambda}_t$ is a decreasing function of $\lambda_{t}^b / \lambda_{t}^s$, so that total disutility of producing given output is increasing function of the MU gap.
Optimal Policy: LQ Approximation

- Compute a **quadratic approximation** to this welfare measure, in the case of small fluctuations around the **optimal steady state**.
Optimal Policy: LQ Approximation

- Compute a quadratic approximation to this welfare measure, in the case of small fluctuations around the optimal steady state.

- Results especially simple in special case:
  - No steady-state distortion to level of output \((P = MC, \frac{W}{P} = MRS)\) (Rotemberg-Woodford, 1997)
  - No steady-state credit frictions: \(\bar{\omega} = \bar{\Xi} = \bar{\Xi}_b = 0\)
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  - No steady-state credit frictions: \( \omega = \Xi = \Xi_b = 0 \)

  —Note, however, that we do allow for shocks to the size of credit frictions
Optimal Policy: LQ Approximation

- Approximate objective: max of expected utility equivalent (to 2d order) to minimization of quadratic loss function

\[
\sum_{t=0}^{\infty} \beta^t \left[ \pi_t^2 + \lambda_y (\hat{Y}_t - \hat{Y}_t^n)^2 + \lambda_\Omega \hat{\Omega}_t^2 + \lambda_\Xi \Xi_{bt} \hat{b}_t \right]
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- Weight \( \lambda_y > 0 \), definition of “natural rate” \( \hat{Y}_t^n \) same as in basic NK model
Approximate objective: max of expected utility equivalent (to 2d order) to minimization of quadratic loss function

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- Weight \( \lambda_y > 0 \), definition of “natural rate” \( \hat{Y}_t^n \) same as in basic NK model
- New weights \( \lambda_\Omega, \lambda_\Xi > 0 \)
Approximate objective: max of expected utility equivalent (to 2d order) to minimization of quadratic loss function

$$\sum_{t=0}^{\infty} \beta^t [\pi^2_t + \lambda_y (\hat{Y}_t - \hat{Y}^n_t)^2 + \lambda_\Omega \hat{\Omega}^2_t + \lambda_{\Xi} \Xi b_t \hat{b}_t]$$

- Weight $\lambda_y > 0$, definition of “natural rate” $\hat{Y}^n_t$ same as in basic NK model
- New weights $\lambda_\Omega, \lambda_{\Xi} > 0$

- LQ problem: minimize loss function subject to log-linear constraints: AS relation, IS relation, law of motion for $\hat{b}_t$, relation between $\hat{\Omega}_t$ and expected credit spreads
Consider special case:

- **No resources** used in intermediation ($\Xi_t(b) = 0$)
- Financial markup $\{\mu_t^b\}$ an **exogenous** process
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Result: optimal policy is characterized by the same **target criterion** as in basic NK model:

\[
\pi_t + \left( \frac{\lambda y}{\kappa} \right)(x_t - x_{t-1}) = 0
\]

"flexible inflation targeting"

However, state-contingent path of policy rate required to implement the target criterion is not the same
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Instrument rule to implement the above target criterion:

Given lagged variables, current exogenous shocks, and observed current expectations of future inflation and output, solve the AS and IS relations for target $i^d_t$ that would imply values of $\pi_t$ and $x_t$ projected to satisfy the target relation.
Implementing Optimal Policy: Interest-Rate Rule

- **Instrument rule** to implement the above target criterion:
  - Given lagged variables, current exogenous shocks, and observed current expectations of future inflation and output, solve the AS and IS relations for target $i_t^d$ that would imply values of $\pi_t$ and $x_t$ projected to satisfy the target relation.
  - Desirable properties:
    - ensures that there are no REE other than those in which the target criterion holds
    - hence ensures determinacy of REE
    - in this example, also implies “E-stability” of REE, hence convergence of least-squares learning dynamics to REE.
Implementing Optimal Policy: Interest-Rate Rule

\[ i_t^d = r_t^n + \phi_u u_t + [1 + \beta \phi_u] E_t \pi_{t+1} + \bar{\sigma}^{-1} E_t x_{t+1} - \phi_x x_{t-1} \]

\[ -[\pi_b + \hat{\delta}^{-1} s_\Omega] \hat{\omega}_t + [(\hat{\delta}^{-1} - 1) + \phi_u \xi] s_\Omega \hat{\Omega}_t \]

where \( \phi_u \equiv \frac{\kappa}{\bar{\sigma}(\kappa^2 + \lambda_y)} > 0, \quad \phi_x \equiv \frac{\lambda_y}{\bar{\sigma}(\kappa^2 + \lambda_y)} > 0 \)
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where \( \phi_u \equiv \frac{\kappa}{\bar{\sigma}(\kappa^2 + \lambda_y)} > 0, \quad \phi_x \equiv \frac{\lambda_y}{\bar{\sigma}(\kappa^2 + \lambda_y)} > 0 \)

- a forward-looking Taylor rule, with adjustments proportional to both the credit spread and the marginal-utility gap
Note that if $s_b \sigma_b \gg s_s \sigma_s$, then $s_\Omega \approx \pi_s$, so that if in addition $\delta \approx 1$, the rule becomes approximately

$$i_t^d = \ldots - \hat{\omega}_t + \phi_\Omega \hat{\Omega}_t$$
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\]
Since for our calibration, $\phi_\Omega$ is also quite small ($\approx .03$), this implies that a 100 percent spread adjustment would be close to optimal, except in the case of very persistent fluctuations in the credit spread.
Essentially, in the case that \( s_b\sigma_b \gg s_s\sigma_s \), it is really only \( i_t^b \) that matters much to the economy, and the simple intuition for the spread adjustment is reasonably accurate.
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But for other parameterizations that would not be true. For example, if \( s_b \sigma_b = s_s \sigma_s \), the optimal rule is

\[
i_t^d = \ldots - \pi_b \hat{\omega}_t
\]

which is effectively an instrument rule in terms of \( i_t^{avg} \) rather than either \( i_t^d \) or \( i_t^b \).
Above target criterion no longer an \textit{exact} characterization of optimal policy, in more general case in which $\omega_t$ and/or $\Xi_t$ depend on the evolution of $b_t$. 
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But numerical results suggest still a fairly good approximation to optimal policy
Calibrated Model

- Calibration of preference heterogeneity: assume equal probability of two types, \( \pi_b = \pi_s = 0.5 \), and \( \delta = 0.975 \) (average time that type persists = 10 years)

- Assume \( C_b / C_s = 1.27 \) in steady state (given \( G/Y = 0.3 \), this implies \( C_s / Y \approx 0.62 \), \( C_b / Y \approx 0.78 \)) — implied steady-state debt: \( \bar{b}/\bar{Y} = 0.8 \) years (avg non-fin, non-gov't, non-mortgage debt/GDP)

- Assume relative disutility of labor for two types so that in steady state \( H_b / H_s = 1 \)
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- Assume relative disutility of labor for two types so that in steady state \( H^b / H^s = 1 \)
Assume $\sigma_b / \sigma_s = 5$

— implies credit contracts in response to monetary policy tightening (consistent with VAR evidence [esp. credit to households])
Calibrated Model

Calibration of financial frictions: Resource costs $\Xi_t(b) = \tilde{\Xi}_t b^\eta$, exogenous markup $\mu_t^b$

Zero steady-state markup; resource costs imply steady-state credit spread $\bar{\omega} = 2.0$ percent per annum (follows Mehra, Piguillem, Prescott) — implies $\bar{\lambda}_b/\bar{\lambda}_s = 1.22$

Calibrate $\eta$ in convex-technology case so that 1 percent increase in volume of bank credit raises credit spread by 1 percent (ann.) — implies $\eta \approx 52$
Calibrated Model

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  — implies $\eta \approx 52$
Numerical Results: Alternative Policy Rules

Compute responses to shocks under **optimal** (i.e., Ramsey) policy, compare to responses under 3 **simple rules**:

- **Simple Taylor rule:**
  \[ \hat{\delta}_t = \phi \pi_t + \phi \hat{Y}_t \]

- **Strict inflation targeting:**
  \[ \pi_t = 0 \]

- **Flexible inflation targeting:**
  \[ \pi_t + \left( \frac{\lambda}{\kappa} \frac{y_t}{x_t} \right) (x_t - x_{t-1}) = 0 \]
Numerical Results: Alternative Policy Rules

Compute responses to shocks under optimal (i.e., Ramsey) policy, compare to responses under 3 simple rules:

- simple Taylor rule:
  \[ \hat{i}_t^d = \phi_\pi \pi_t + \phi_y \hat{Y}_t \]
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- simple Taylor rule:
  \[ \hat{i}_t^d = \phi_\pi \pi_t + \phi_y \hat{Y}_t \]

- strict inflation targeting:
  \[ \pi_t = 0 \]

- flexible inflation targeting:
  \[ \pi_t + (\lambda_y / \kappa)(x_t - x_{t-1}) = 0 \]
Numerical Results: Optimal Policy

Responses to technology shock, under 4 monetary policies
Numerical Results: Optimal Policy

Responses to wage markup shock, under 4 monetary policies
Responses to shock to government purchases, under 4 monetary policies
Numerical Results: Optimal Policy

Responses to shock to demand of savers, under 4 monetary policies
Responses to shock to demand of borrowers, under 4 monetary policies.
Numerical Results: Optimal Policy

Responses to financial shock, under 4 monetary policies
Provisional Conclusions

- Time-varying credit spreads do not require fundamental modification of one’s view of monetary transmission mechanism.
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- For example, recognizing importance of credit frictions does not require reconsideration of the de-emphasis of monetary aggregates in NK models.
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Note: Cúrdia and Woodford (2009) discuss the impacts of credit frictions on monetary policy with a focus on spread-adjusted Taylor rules.
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  - General principle can be expressed more robustly in terms of a **target criterion**.
Provisional Conclusions

- Simple guideline for policy: base policy decisions on a target criterion relating inflation to output gap (optimal in absence of credit frictions)

- Take account of credit frictions only in model used to determine policy action required to fulfill target criterion