Credit Frictions and Optimal Monetary Policy

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¹The views expressed in this paper are those of the author and do not necessarily reflect the position of the Federal Reserve Bank of New York or the Federal Reserve System.
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- Complete (frictionless) financial markets
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But in actual economies (even financially sophisticated)

- different interest rates
- rates do not move perfectly together
Spreads change over time

(Sources: FRB, IMF/IFS)

Cúrdia and Woodford

Credit Frictions and Optimal Monetary Policy
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?
John Taylor (Feb. 2008)

Proposed "Taylor rule" adjustment:
FF rate target lowered by amount of increase in LIBOR-OIS spread
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Credit Frictions and Optimal Monetary Policy
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SNB Interest rates
(source: SNB)
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  - **Question**: Is a systematic response of that kind desirable?
Model: A generalization of the NK model

- Generalizes basic (representative household) NK model:
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  - heterogeneity in spending opportunities
  - costly financial intermediation
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  - **heterogeneity** in spending opportunities
  - **costly** financial intermediation

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

$$E_0 \sum_{t=1}^{\infty} \beta^t \left[ u^{\tau_t(i)} (c_t (i) ; \xi_t) - \int_0^1 v (h_t (j; i) ; \xi_t) \, dj \right]$$
Generalizes basic (representative household) NK 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 $\tau$
Model: Marginal utilities of two types

\[
\begin{align*}
\bar{\lambda}_b &< \bar{\lambda}_s \\
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\end{align*}
\]

\[
\begin{align*}
\bar{c}_b &< \bar{c}_s \\
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\]
Model: Incomplete markets

- Aggregation simplified by assuming intermittent access to an "insurance agency"

- State-contingent contracts enforceable only on those occasions
- Other times:
  - Households borrow or lend only through intermediaries
  - One-period contracts
  - Riskless nominal rate different for savers and borrowers

Consequence:
- Long-run marginal utility of income same for all households (regardless of history of spending opportunities)
- MUI and expenditure same each period for households of a given type
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Euler equation for each type \( \tau \in \{b, s\} \):

\[
\lambda^\tau_t = \beta E_t \left\{ \frac{1 + i^\tau_t}{\Pi_{t+1}} \left[ \delta \lambda^\tau_{t+1} + (1 - \delta) \lambda_{t+1} \right] \right\}
\]

where

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\lambda_t \equiv \pi_b \lambda^b_t + \pi_s \lambda^s_t
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where

$$\lambda_{t} \equiv \pi_{b} \lambda_{t}^{b} + \pi_{s} \lambda_{t}^{s}$$

Aggregate demand relation:

$$Y_{t} = \sum_{\tau} c_{t}^{\tau} (\lambda_{t}^{\tau}; \zeta_{t}) + G_{t} + \Xi_{t}$$

where $\Xi_{t}$ denotes resources used in intermediation
Model: Log-linear IS

- Intertemporal IS relation:

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

where

\[ \hat{i}^{avg}_t \equiv \pi_b \hat{i}_t^b + \pi_s \hat{i}_t^d \]
\[ \hat{\Omega}_t \equiv \hat{\lambda}_t^b - \hat{\lambda}_t^s \]
\[ g_t \equiv \text{composite exogenous disturbance to expenditure} \]
\[ \bar{\sigma} \equiv \pi_b s_b \sigma_b + \pi_s s_s \sigma_s > 0 \]
\[ s_{\Omega} \equiv \pi_b \pi_s \frac{s_b \sigma_b - s_s \sigma_s}{\bar{\sigma}} \]
Determination of the marginal utility gap:

\[ \hat{\Omega}_t = \hat{\omega}_t + \delta E_t \hat{\Omega}_{t+1} \]

where

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

\[ \hat{\delta} < 1 \]
Financial intermediation technology:

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

where \( \Xi_t(b_t) \) is positive and convex
Model: Financial intermediation

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- Competitive banking sector would imply equilibrium credit spread
  \[ \omega_t (b_t) = \Xi_{bt} (b_t) \]
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Competitive banking sector would imply equilibrium credit spread

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

More generally,

\[ 1 + \omega_t (b_t) = \mu_t^b (b_t) (1 + \Xi_{bt} (b_t)) \]

where \( \mu_t^b \) is markup in banking sector.
Monetary policy:

CB can effectively control deposit rate, $i^d_t$.
Model: Interest rates

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Lending rate determined by spread $\omega_t (b_t)$:

$$\hat{i}_t^b = \hat{i}_t^d + \hat{\omega}_t$$
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  \[
  \hat{i}_t^b = \hat{i}_t^d + \hat{\omega}_t
  \]

- Rate that matters for the IS relation:
  \[
  \hat{i}_t^{avg} = \hat{i}_t^d + \pi_b \hat{\omega}_t
  \]
Model: Supply side

- Same as in basic NK model
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- Dixit-Stiglitz monopolistic competition
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- Calvo staggering of adjustment of individual prices
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- Only difference: labor supply depends on both MUI: \( \lambda^b_t \) and \( \lambda^s_t \)
Model: AS relation

- Log-linear AS generalizes NK Phillips curve:

\[
\pi_t = \beta E_t \pi_{t+1} + \kappa (\hat{Y}_t - \hat{Y}_t^n) + u_t + \xi (s_\Omega + \pi_b - \gamma_b) \hat{\Omega}_t - \xi \bar{\sigma}^{-1} \hat{\Xi}_t
\]

where

- \( \hat{Y}_t^n, u_t, \kappa, \xi \) defined exactly as in basic NK

- \( \bar{\sigma} \) is average of elasticity of two types

- \( \gamma_b \equiv \pi_b \left( \bar{\lambda}^b / \bar{\lambda} \right)^{1/\nu} \), with \( \bar{\lambda} \) an average of MUI of two types
A simple special case:

- credit spread $\omega_t$ evolves exogenously
- intermediation uses no resources (i.e., spread is pure markup)
What difference do frictions make?

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  - $\hat{\omega}_t$ exogenous $\Rightarrow \hat{\Omega}_t$ exogenous
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- Usual 3-equation model suffices to determine paths of $\{\hat{Y}_t, \pi_t, i_{avg}^t\}$
  - AS relation
  - IS relation
  - MP relation (written in terms of $i_{avg}^t$, given exogenous spread)
What difference do frictions make?

- Difference made by credit frictions:
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  (under a given monetary policy rule, e.g. Taylor rule)
  - identical to those predicted by basic NK model
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- Responses to **financial shocks** equivalent to responses to 3 shocks in simultaneous:
  - monetary policy shock
  - "cost-push" shock
  - shift in natural rate of interest
What difference do frictions make?

- General case
  - $\Xi_t$ and/or $\omega_t$ depend on volume of lending $b_t$
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- Resort to numerical solution of calibrated examples
  - see how much difference the credit frictions make
Preferences heterogeneity:

- assume equal probability of two types, \( \pi_b = \pi_s = 0.5 \)
- \( \delta = 0.975 \) (average time that type persists = 10 years)
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Assume $C^b / C^s = 3.67$ in steady state

- given $s_c = 0.7$, this implies $s_b = 1.1$ and $s_s = 0.3$
- implied steady-state debt: $\bar{b} / \bar{Y} \approx 0.65$
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Assume $\sigma_b / \sigma_s = 5$
- implies credit contracts in response to monetary policy tightening (consistent with VAR evidence)
Financial frictions:

- Resource costs: $\Xi_t(b) = \tilde{\Xi}_t b_t^n$
- Exogenous markup: $\mu_t^b$ (no steady state markup: $\bar{\mu}^b = 1$)
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- Resource costs: $\Xi_t(b) = \Xi_t b_t^\eta$
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Resource costs imply

- steady-state credit spread $\bar{\omega} = 2.0$ percent per annum (median spread between FRB C&I loan rate and FF rate)
- $\bar{\lambda}^b / \bar{\lambda}^s = 1.22$
Calibration

- Financial frictions:
  - Resource costs: \( \Xi_t(b) = \Xi_t b_t^\eta \)
  - Exogenous markup: \( \mu^b_t \) (no steady state markup: \( \bar{\mu}^b = 1 \))

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  - \( \bar{\lambda}^b / \bar{\lambda}^s = 1.22 \)

- Calibrate \( \eta \)
  - 1% increase in credit raises spread by 0.10% (per annum) (relative VAR responses of credit, spread)
  - requires \( \eta = 6.06 \)
Monetary policy rule:

\[ \hat{i}_t^d = \phi_\pi \pi_t + \phi_y \hat{Y}_t + \epsilon_m^t \]

with \( \phi_\pi = 2 \) and \( \phi_y = 0.75/4 \)
Numerical results: Taylor rule

- **Monetary policy rule:**
  \[ \hat{i}_t^d = \phi_{\pi} \pi_t + \phi_y \hat{Y}_t + \varepsilon_t^m \]
  with \( \phi_{\pi} = 2 \) and \( \phi_y = 0.75/4 \)

- **Compare 3 model specifications:**
  - **FF model:** model with heterogeneity and credit frictions
  - **No FF model:** same heterogeneity, but \( \omega_t = \Xi_t = 0, \forall t \)
  - **RepHH model:** representative household w/ intertemporal elasticity \( \bar{\sigma} \)
Numerical results: Taylor rule

Responses to monetary policy shock
Numerical results: Taylor rule

Responses to technology shock
Numerical results: Taylor rule

Responses to wage markup shock
Numerical results: Taylor rule

Responses to shock to government purchases
Numerical results: Taylor rule

Responses to shock to government debt
Numerical results: Taylor rule

Responses to shock to demand of savers
Optimal policy

Natural objective for stabilization policy: average expected utility

\[ E_0 \sum_{t=0}^{\infty} \beta U \left( Y_t, \lambda^b_t, \lambda^s_t, \Delta_t; \zeta_t \right) \]

where

\[ U \left( Y_t, \lambda^b_t, \lambda^s_t, \Delta_t; \zeta_t \right) \equiv \pi_b u^b \left( c^b \left( \lambda^b_t; \zeta_t \right); \zeta_t \right) + \pi_s u^s \left( c^s \left( \lambda^s_t; \zeta_t \right); \zeta_t \right) \]

\[ - \frac{1}{1 + \nu} \left( \frac{\lambda_t}{\tilde{\Lambda}_t} \right)^{-\frac{1+\nu}{\nu}} \tilde{H}_t^{-\nu} \left( \frac{Y_t}{A_t} \right)^{1+\omega_y} \Delta_t \]

and

- \( \tilde{\lambda}_t / \tilde{\Lambda}_t \) is decreasing function of \( \lambda^b_t / \lambda^s_t \)
- total disutility of producing is increasing function of MU gap
Optimal policy: LQ approximation

- Compute a quadratic approximation to welfare measure in the case of small fluctuations around optimal steady state.
Optimal policy: LQ approximation

- Compute a quadratic approximation to welfare measure in the case of small fluctuations around 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: \( \ddot{\omega} = \ddot{\Xi} = \ddot{\Xi}_b = 0 \)
    - Allow for shocks to the size of credit frictions
Approximate objective for the special case:

\[
\begin{align*}
\text{max expected utility} & \iff \min \text{quadratic loss function} \\
& \text{(to 2\textsuperscript{nd} order)}
\end{align*}
\]
Optimal policy: LQ approximation

- Approximate objective for the special case:
  - $\max$ expected utility $\iff \min$ quadratic loss function (to $2^{nd}$ order)

  $$\sum_{t=0}^{\infty} \beta^t \left[ \pi_t^2 + \lambda_y (\hat{Y}_t - \hat{Y}_t^n)^2 + \lambda_\Omega \hat{\Omega}_t^2 + \lambda_\Xi \hat{\Xi}_b \hat{b}_t \right]$$

  - $\lambda_y > 0$ and $\hat{Y}_t^n$ same as in basic NK model
  - New weights: $\lambda_\Omega, \lambda_\Xi > 0$
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- 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 $\mu_t^b$ exogenous
Optimal policy: LQ approximation

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Result:

- Optimal policy characterized by same target criterion as in basic NK model

\[
\pi_t + \frac{\lambda_y}{\kappa} (x_t - x_{t-1}) = 0
\]

"flexible inflation targeting"
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"Flexible inflation targeting"

But, state-contingent path of policy rate required to implement target criterion not the same
Implementing optimal policy: Interest rate rule

- Instrument rule to implement the above target criterion:
  - Given
    - lagged variables
    - current exogenous shocks
    - observed current expectations of future inflation and output
  - solve AS and IS relations for target $i^d_t$
    s.t. $\{\pi_t, x_t\}$ satisfy target relation

What Evans-Honkapohja (2003) call “expectations-based” rule for implementation of optimal policy

Desirable properties:
- there are no REE other than those in which target criterion holds
- ensures determinacy of REE in this example, also implies “E-stability” of REE
- convergence of least-squares learning dynamics to REE
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    $\Rightarrow$ ensures determinacy of REE
  - in this example, also implies "E-stability" of REE
    $\Rightarrow$ convergence of least-squares learning dynamics to REE
Implementable rule:

\[
\hat{r}_t^d = \hat{r}_t^n + \phi_u u_t + (1 + \beta \phi_u) E_t \pi_{t+1} + \bar{\sigma}^{-1} E_t x_{t+1} - \phi_y x_{t-1}
\]

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

where

\[
\phi_u \equiv \frac{\kappa \bar{\sigma}^{-1}}{\lambda_y + \kappa^2}
\]

\[
\phi_y \equiv \frac{\lambda_y \bar{\sigma}^{-1}}{\lambda_y + \kappa^2}
\]
Implementing optimal policy: Interest rate rule

- Implementable rule:

\[
\hat{i}_t^d = \hat{r}_t^n + \phi_u u_t + (1 + \beta \phi_u) E_t \pi_{t+1} + \bar{\sigma}^{-1} E_t x_{t+1} - \phi_y x_{t-1} \\
- (\pi_b + \delta^{-1} s_\Omega) \hat{\omega}_t + ((\delta^{-1} - 1) + \phi_u \xi) s_\Omega \hat{\Omega}_t
\]

where

\[
\phi_u \equiv \frac{\kappa \bar{\sigma}^{-1}}{\lambda_y + \kappa^2}
\]

\[
\phi_y \equiv \frac{\lambda_y \bar{\sigma}^{-1}}{\lambda_y + \kappa^2}
\]

- This is a forward-looking Taylor rule, w/ adjustments proportional to
  - the credit spread
  - the marginal-utility gap
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- Note that if
  - \( s_b \sigma_b >> s_s \sigma_s \Rightarrow s_\Omega \approx \pi_s \)
  - \( \delta \approx 1 \)
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  - then rule becomes approximately

$$\hat{i}_t^d = ... - \hat{\omega}_t + \phi_\Omega \hat{\Omega}_t$$
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  ... except in case of very persistent fluctuations in credit spread
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- In this scenario
  - it is really only \( i_t^b \) that matters much to economy
  - simple intuition for spread adjustment is reasonably accurate
Implementing optimal policy: Interest rate rule

- For other parameterizations
  - 100 percent spread adjustment not optimal
Implementing optimal policy: Interest rate rule

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- For example
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- effectively an instrument rule in terms of $\hat{i}_t^{avg}$, rather than $\hat{i}_t^d$ or $\hat{i}_t^b$
Numerical results: Optimal policy

- General case

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Numerical results: Optimal policy

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  - target criterion no longer exact characterization of optimal policy
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  - target criterion no longer exact characterization of optimal policy

- Numerical results suggest
  - target criterion still fairly good approximation to optimal policy
Numerical results: Optimal policy

Responses to technology shock
Numerical results: Optimal policy

Responses to wage markup shock
Numerical results: Optimal policy

Responses to shock to government purchases
Numerical results: Optimal policy

Responses to shock to demand of savers
Numerical results: Optimal policy

Responses to financial shock
Rule of thumb suggested by various authors: 
(McCulley and Toloui, 2008; Taylor, 2008)

- adjust intercept of Taylor rule in proportion to changes in spreads

\[ \hat{i}_t^d = \phi_\pi \pi_t + \phi_y \hat{Y}_t - \phi_\omega \hat{\omega}_t \]
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- We allow for other possible values of \( \phi_\omega \)
Numerical results: Spread-adjusted Taylor rule

Responses to financial shock

Cúrdia and Woodford

Credit Frictions and Optimal Monetary Policy
Numerical results: Spread-adjusted Taylor rule

Responses to a shock to government debt
Numerical results: Spread-adjusted Taylor rule

Responses to a shock to the demand of savers
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Responses to a shock to government purchases

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Credit Frictions and Optimal Monetary Policy
Responses to a technology shock
It is often suggested that:

- credit frictions make it desirable for monetary policy to respond to variation in aggregate credit.
Responding to credit

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- Christiano et al. (2007) suggest modified Taylor rule

$$\tau^d_t = \phi_\pi \pi_t + \phi_y \hat{Y}_t + \phi_b \hat{b}_t$$

with $\phi_b > 0$
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We consider this family of rules, allowing also for $\phi_b < 0$
Numerical results: Responding to credit

Responses to financial shock
Numerical results: Responding to credit

Responses to a shock to government purchases
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Credit Frictions and Optimal Monetary Policy
Provisional Conclusions

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  - Quantitatively, basic NK model remains a good approximation
    - especially if little endogeneity of credit spreads
Recognizing importance of credit frictions does not require reconsideration of de-emphasis of monetary aggregates in NK models
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- Credit more important state variable than money
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Credit more important state variable than money

However, interest-rate spreads really what matter
  
  more than variations in quantity of credit
Provisional Conclusions

- Spread-adjusted Taylor rule can improve upon standard Taylor rule under some circumstances

Guideline for policy:
- Base policy decisions on 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.
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