Money and Banking in a New Keynesian Model

Monika Piazzesi
Stanford

Ciaran Rogers
Stanford

Martin Schneider
Stanford

Bank of Canada Annual Conference 2020

Motivation

- Standard New Keynesian model
  - central bank controls short rate in household stochastic discount factor
  - short rate = return on savings & investment
- This talk: New Keynesian model with banking sector
  - central bank controls <u>interest rate on interbank loans or reserves</u>
  - households do not hold these assets directly
  - banks like to hold these assets to back inside money

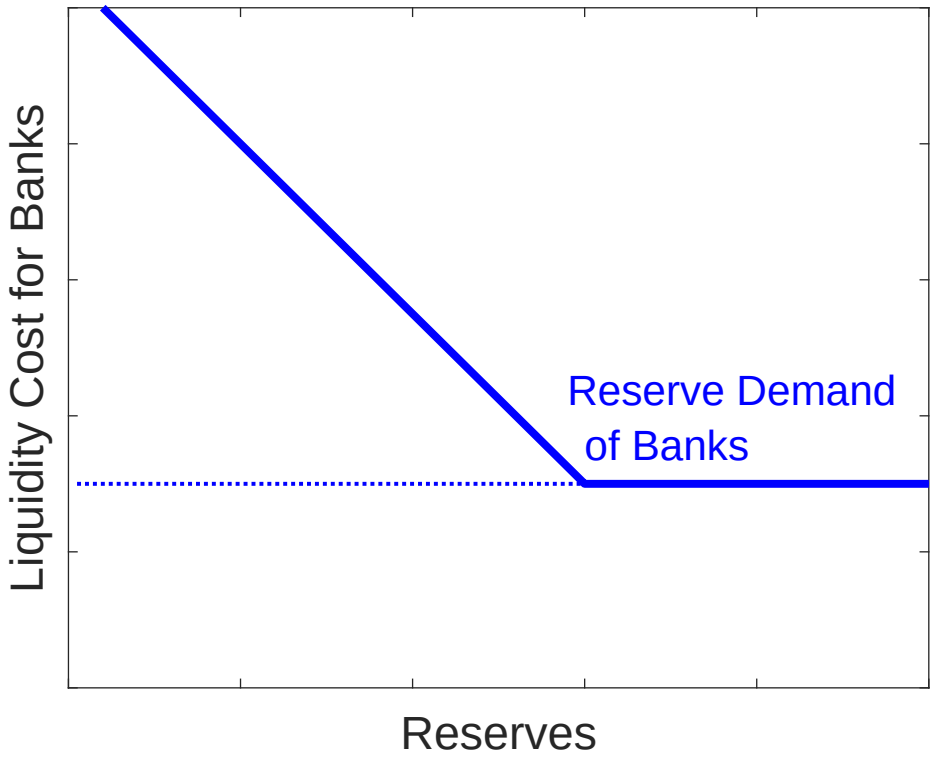
  $\rightarrow$ disconnect between policy rate & short rate
- Matters for transmission
  - short rate = policy rate + <u>convenience yield</u>
  - higher policy rate with sticky prices is contractionary
  - lower spending/inside money reduces convenience yield

  $\rightarrow$ convenience yield is counteracting force

Quantitatively important?

- Depends on regime for reserve supply
  - ample reserves: yes, convenience yield is strong counteracting force
  - scarce reserves: weaker, but still matters quantitatively
- Intuition:
  - does tighter policy increase the cost of liquidity for banks?

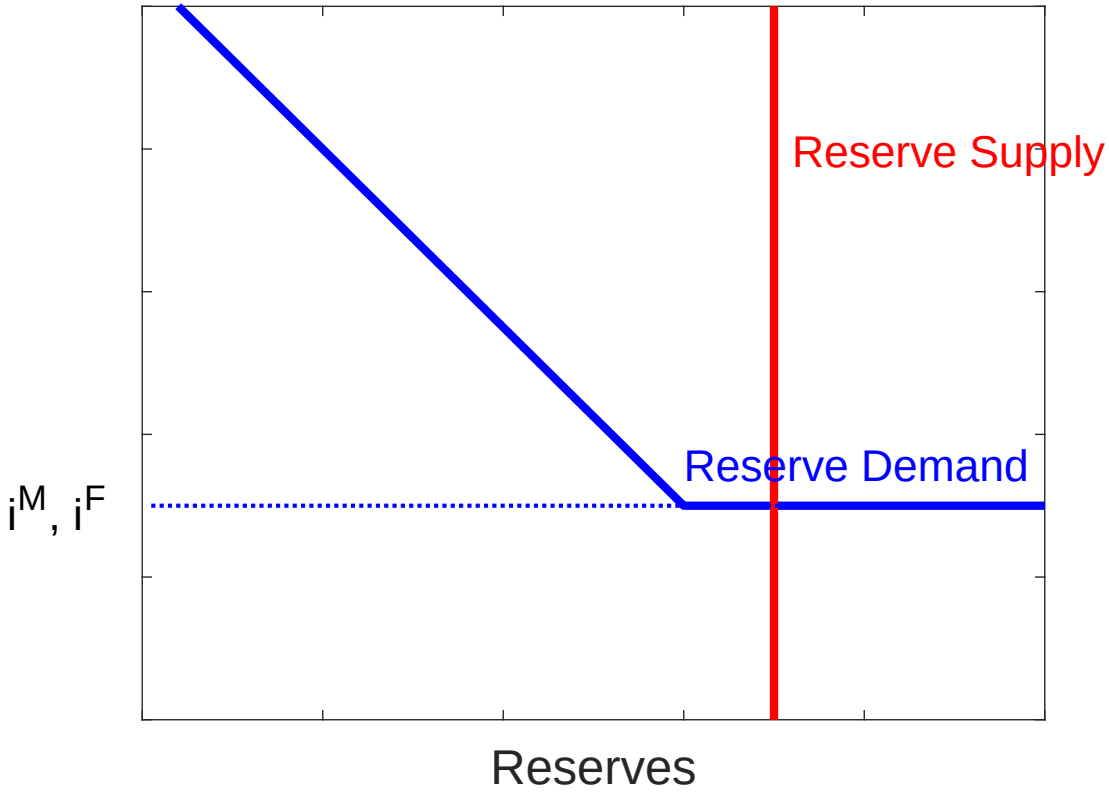
    if yes, banks produce less inside money, stabilizes convenience yield



Ample reserves: strong convenience yield channel

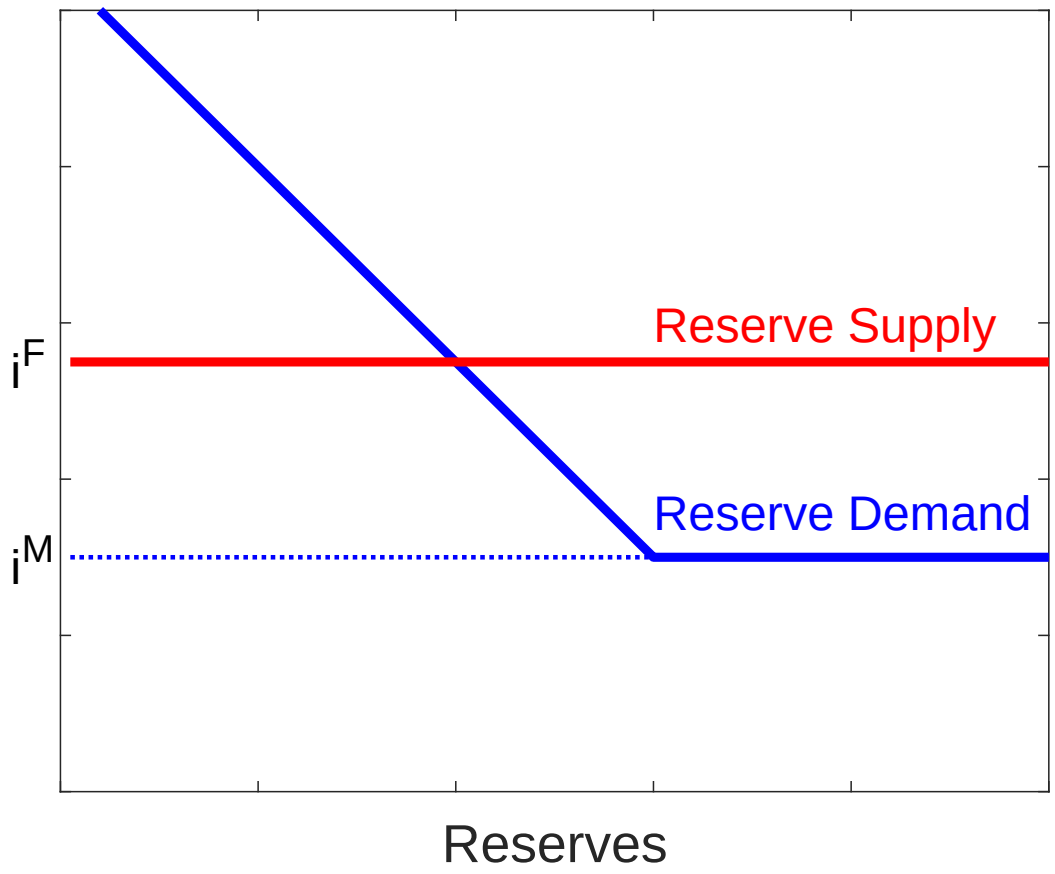
- monetary policy sets reserve rate i^M and quantity of reserves
- reserve rate provides a floor ("floor system")
- no liquidity cost for banks, remains zero if central bank tightens

  $\rightarrow$ banks keep inside money constant, large drop in spending/inside money



Scarce reserves: weaker convenience yield channel

- policy targets interbank rate, sets reserve rate ("corridor system")
- trading desk supplies reserves elastically to meet target
- positive liquidity cost for banks, rises if central bank tightens
  - $\rightarrow$ banks reduce inside money, smaller drop in spending/inside money



Implications

- Standard NK model
  - interest rate is all that matters, plumbing & quantities not important
- Banking & short rate disconnect: plumbing & quantities matter
  - ample reserves:
    - higher reserve rate reduces cost of producing inside money,
      lower cost of liquidity for *households*, but not banks - weakens policy
    - quantity of reserves is independent policy tool
  - scarce reserves:
    - higher interbank rate increases liquidity cost for banks, stronger policy
    - supply of reserves perfectly elastic (not indep. tool),
      higher elasticity of inside money, depends on banking system!
  - both regimes
    - less scope for multiple equilibria
    - features of banks matter, e.g. market power, health of bank assets

Literature

- NK models with financial frictions & banking
  Bernanke-Gertler-Gilchrist 99, Cúrdia-Woodford 10, Gertler-Karadi 11, Gertler-Kiyotaki-Queralto 11, Christiano-Motto-Rostagno 12, Del Negro-Eggertson-Ferrero-Kiyotaki 17, Diba-Loisel 17, Arce-Nuño-Thaler-Thomas 19
- Convenience yields on bonds Patinkin 56, Tobin 61, Bansal-Coleman 96, Krishnamurthy-Vissing-Jorgensen 12, Andolfatto-Williamson 14, Nagel 15, Hagedorn 18, Michaillat-Saez 19
- Convenience yield on assets that back medium of exchange
  Kiyotaki-Moore 05, Williamson 12, Venkateswaran-Wright 13, Lenel-Piazzesi-Schneider 19
- Bank competition Yankov 12, Driscoll-Judson 13, Brunnermeier-Sannikov 14, Duffie-Krishnamurthy 16, Bianchi-Bigio 17, Egan, Hortacsu-Matvos 17, Drechsler-Savov-Schnabl 17, DiTella-Kurlat 17
- Recent work on dynamics of the New Keynesian model at ZLB
  information frictions, bounded rationality, fiscal theory, incomplete markets

New Keynesian Model with Banks

- Nonfinancial private sector
  - Representative household; utility over consumption & money
  - Standard NK Firms with Calvo price setting

  $\rightarrow$ NK Phillips curve and Euler equation

- Banks provide money

Assets		Liabilities	
M	Reserves	Money	D
F^+	Fed funds lending	Fed funds borrowing	F^-
A	Other assets	Equity	

  - Liquidity shocks $\tilde{\lambda} D$, with continuous cdf $G(\tilde{\lambda})$ on $[-\bar{\lambda}, \bar{\lambda}]$
  - Leverage constraint: $F^- + D\left(1 - \tilde{\lambda}\right) \leq \ell\left(M + \rho_F F^+ + \rho_A A\right)$
  - Shareholder value maximization; costless adjustment of equity

Key new equation: interest-rate pass-through

- combine households' money demand with banks' optimization
- i_t^P = policy rate, r^P in zero-inflation steady state
  i_t^S = rate on household savings, δ in steady state

$$i_t^S - \delta = \underbrace{i_t^P - r^P}_{\text{policy rate}} + \underbrace{\frac{\delta - r^P}{\eta}\left(\hat{p}_t + \hat{y}_t - \hat{d}_t\right)}_{\text{convenience yield, increasing in velocity = spending / money}}$$

- convenience yield weakens policy
  - lower policy rate leads to higher output, increases convenience yield
  - how much depends on response of real balances $\hat{d}_t - \hat{p}_t$
- convenience yield helps to establish generalized Taylor principle:
  - higher inflation expectations lower real rate & increase output

  $\rightarrow$ increases convenience yield, pushes up real rate
  - LR reaction of i_t^S rate on savings to inflation > 1

How do banks provide money in corridor system?

- interest-rate pass-through equation
  - consider reserve-less limit $\bar{\lambda} \to 0$, fixed corridor $i^F - i^M$

$$i_t^S - \delta = i_t^F - r_t^F + \frac{\delta - r^F}{\eta + \epsilon} \left(\hat{y}_t - \hat{a}_t \right)$$

  - i_t^F is interbank lending rate, $\hat{a}_t$ are real bank assets
  - convenience yield channel more important when
    - interest-rate elasticity η of money demand by households is low
    - elasticity of deposit supply ϵ by banks is low
    - $\epsilon \to \infty$: standard new Keynesian model

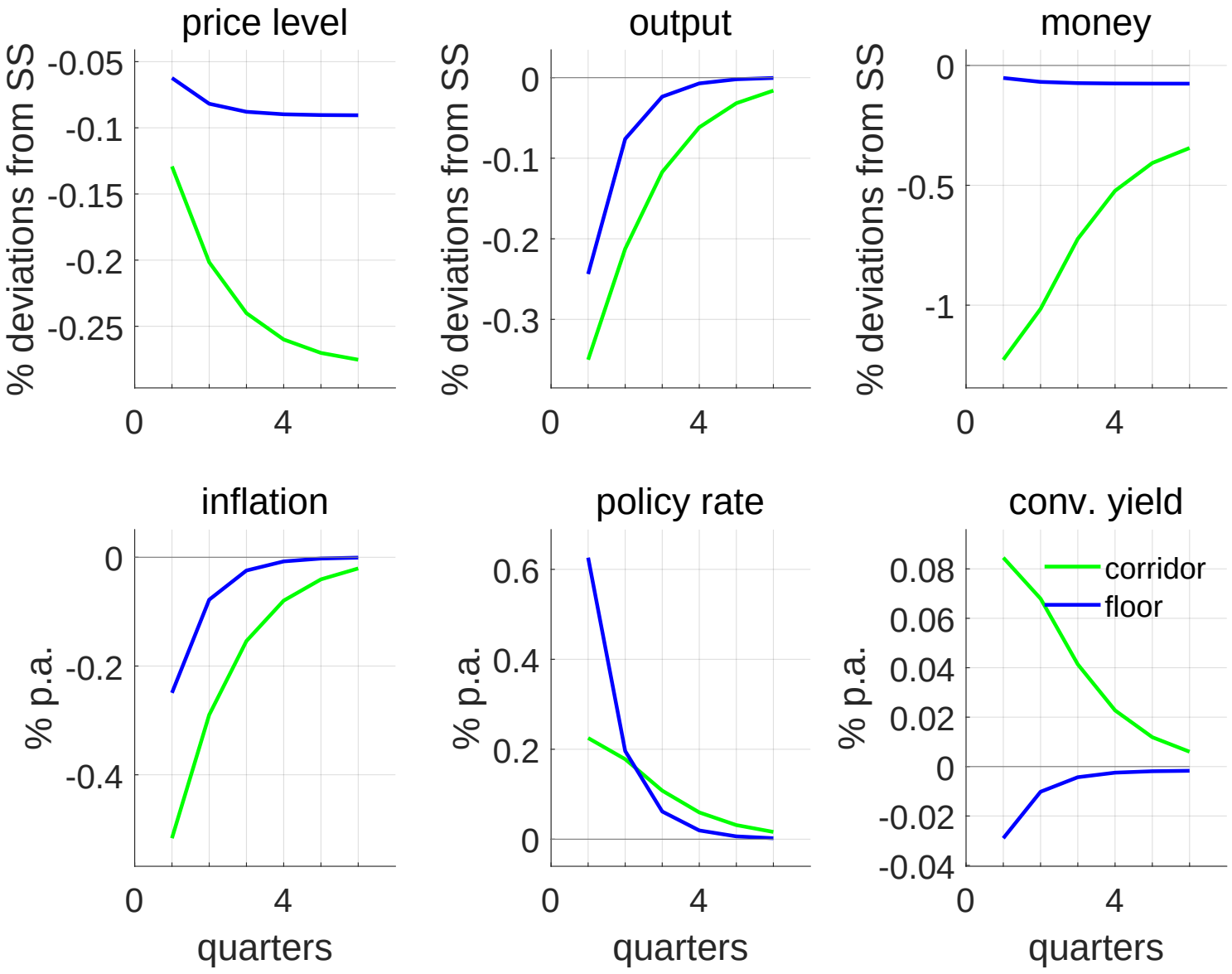
How do banks provide money in floor system?

- interest-rate pass-through equation

$$i_t^S - \delta = i_t^M - r_t^M + \frac{\delta - r^M}{\eta}\left(\hat{y}_t - \alpha_m(\hat{m}_t - \hat{p}_t) - (1-\alpha_m)\hat{a}_t\right)$$

  - i_t^M is reserve rate, $\hat{m}_t$ are reserves
  - convenience yield channel
    - depends on the policy rule for second instrument: reserves
    - suppose real reserves are fixed, moves with output
    - also depends on other bank assets $\hat{a}_t$, quantitative easing
    - interest rate elasticity of money demand η

25bp increase in policy rate: corridor vs floor systems



Conclusion

- Disconnect between policy rate and short rate
  - convenience yield is endogenous wedge, weakens transmission
  - less scope for multiple equilibria, even without Taylor principle
- Banks matter for transmission
  - market power in deposits, health of other bank assets, elasticity of deposit supply, liquidity management etc.
  - which details different from setups where banks are special for lending
- Ample vs scarce reserves
  - with cost channel, significant differences in IRFs
  - scare reserves is closer to standard model but still different