Unconventional Monetary Policy and Funding Liquidity Risk

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Disclaimer: the views expressed are those of the authors and do not necessarily reflect those of the ECB.
Motivation

- Money markets are key to bank liquidity management
  - allows to mitigate funding shocks when holding illiquid assets

- Access to money markets may be impaired due to lack of collateral
  - associated with high risk premia and drop in asset prices

- Striking for shadow banks as they lack access to central bank liquidity
  - motivation for unconventional monetary policy (Bernanke, 2009)
This Paper

Research Question:

*How can funding liquidity risk affect asset prices? What can the central bank do about it in the presence of shadow banks?*
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Model:

We add liquidity management to an asset pricing model with heterogeneous banks

- Banks face idiosyncratic funding shocks while holding illiquid securities
- Banks trade in money markets subject to collateral constraints
- The central bank decides on the size and composition of its balance sheet
Results

- When bank capital is low, a vicious cycle between declining asset prices and funding risks arises.

- Liquidity injection policy help alleviate stresses in the traditional banking sector but fail to reach to the shadow banking sector.

- Asset purchase policy (LSAP) decreases the stock of funding risks through a general equilibrium effect and therefore has a larger reach.

*If the shadow banking sector is large, LSAP is necessary to stabilize asset prices.*
Contribution to the Literature

- **Macro-banking with fire-sales** (He, Kang, and Krishnamurthy, 2010; Brunnermeier and Sannikov, 2013; Gertler and Kiyotaki, 2015; Gertler, Kiyotaki, and Prestipino, 2017)

  → funding risk affects asset prices through the stochastic discount factor of intermediaries rather than aggregate cash flows

- **Macro-finance with monetary policy** (He and Krishnamurthy, 2013; Brunnermeier and Sannikov, 2014; Silva, 2017)

  → LSAP stabilize asset prices by decreasing aggregate funding risks rather than redistributing wealth to banks or risks to households.

- **Shadow banking**: (Vishny, 2013; Plantin, 2015; Moreira and Savov, 2017; Huang, 2018; Ordonez, 2018)

  → focus on lack of access to central bank liquidity instead of regulatory arbitrage
MODEL
Environment

Intermediary asset pricing
- random supply of Lucas Trees \( \frac{dS_t}{S_t} = \mu dt + \sigma dZ_t \) with dividend flow \( a \)
- limit to bank equity issuance \( \rightarrow \) incomplete markets for aggregate risk

Liquidity management
- idiosyncratic funding shocks
- collateralized money markets
- fire sale of securities at a cost \( \lambda \)

Shadow banks without access to central bank
Monetary Policy

The central bank has three policy tools \( \{ m_t, \phi_t, \nu_t \} \):

- **liquidity injection**: supply of reserves \( m_t \)
- **discount window**: provide lower haircuts \( \alpha_t \to \alpha_t + \phi_t \)
- **asset purchase**: purchase of securities \( \nu_t \) but lower expertise \( a < a \)

subject to the balance sheet constraint:

\[
\nu_t + b_t = m_t
\]

The central bank is not subject to funding liquidity risk.
STATIC RESULTS

▷ Analytical solution when dynamics are shut down ($\eta_t = \eta$ and $\bar{\eta}_t = \bar{\eta}$)

▷ Epstein-Zin utility functions with risk aversion $\gamma$, intertemporal elasticity of substitution $\zeta$, and time preference $\rho$
In the absence of any friction ($\lambda = 0, \eta + \eta = 1$), prices are given by:

$$q = \frac{a}{\rho - (1 - \zeta^{-1}) \begin{pmatrix} \mu - \frac{\gamma}{2} & \sigma^2 \end{pmatrix}}$$
In the absence of money market frictions \((\lambda = 0)\), prices are given by:

\[
q = \frac{a}{\rho - (1 - \zeta^{-1}) \left( \mu - \frac{\gamma}{2} \frac{1}{\eta + \bar{\eta}} \sigma^2 \right)}
\]
Benchmark without Liquidity Risk

In the absence of money market frictions \((\lambda = 0)\), prices are given by:

\[
q = \frac{a}{\rho - (1 - \zeta^{-1})\left(\mu - \frac{\gamma}{2} \frac{1}{\eta + \bar{\eta}} \sigma^2\right)}
\]

- Neutrality of Monetary Policy Instruments

In the absence of money market frictions \((\lambda = 0)\), any change in the monetary policy decision set \(\{m_t, \phi_t, \nu_t\}\) has no effect on any equilibrium variables.
In an economy without asset purchase $\nu = 0$, without reserves $m = 0$, and without discount window facility $\phi_t = 0$, prices are given by:

$$q = \frac{a}{\rho - (1 - \zeta^{-1}) \left( \mu - \frac{\gamma}{2} \frac{1}{\eta + \bar{\eta}} \left( \sigma^2 + \Theta^2 \right) \right)}$$

where

$$\Theta = \lambda (1 - \eta - \bar{\eta}) - \lambda \alpha$$
No Central Bank with Moderate and Large Amount of Funding Risk

No funding liquidity risk in black ($\lambda = 0$), moderate amount of funding liquidity risk in red ($\lambda = 0.3$), large amount of funding liquidity risk in blue ($\lambda = 0.6$)
Prices with Positive Supply of Reserves $m$

In an economy without asset purchase $\nu = 0$ and without a discount window facility $\phi = 0$, prices are given by:

$$q = \frac{a}{\rho - (1 - \zeta^{-1}) \left( \mu - \frac{\gamma}{2 \eta + \bar{\eta}} (\sigma^2 + \Theta(m)^2 + \Omega(m)) \right)}$$

where

$$\Theta(m) = \lambda(1 - \eta - \bar{\eta} - m) - \lambda \alpha \quad \text{if } m \leq m^*$$

$$\Omega(m) = \frac{m^2(1 - \alpha)^2 \lambda^2}{\sigma^2 + (1 - \alpha)^2 \lambda^2 \bar{\eta}} \sigma^2 \bar{\eta}^2 \quad \text{if } m \leq m^*$$

where $m^*$ is the level of liquidity satiation for regular banks:

$$m^* = (1 - \eta - \bar{\eta} - \alpha) \frac{\sigma^2 + \lambda^2 (1 - \alpha)^2}{\sigma^2 + \lambda^2 (1 - \alpha)^2 + \sigma^2 \bar{\eta} \eta}$$
Supply of Reserves with Small and Large Shadow Banking Sector

No funding liquidity risk in black ($\alpha = 0$, $\eta = 0.05$, $\bar{\eta} = 0.05$); with small shadow banking sector in blue ($\alpha = 0.6$, $\eta = 0.08$, $\bar{\eta} = 0.02$); with large shadow banking sector in red ($\alpha = 0.6$, $\eta = 0.02$, $\bar{\eta} = 0.08$)
Prices with Large Scale Asset Purchases $\nu$

In an economy without a discount window facility $\phi = 0$ and $\nu = m > 0$, prices are given by:

$$q = \frac{a - \nu(a - a)}{\rho - (1 - \zeta^{-1}) \left( \mu - \frac{\gamma}{2(\eta + \bar{\eta})} \left( \sigma^2 + \Theta(\nu)^2 \right) \right)}$$

where

$$\Theta(\nu) = \lambda(1 - \eta - \bar{\eta} - \nu) - \lambda \alpha(1 - \nu) \quad \text{if} \quad \nu \leq 1 - \eta - \bar{\eta}$$

and $\Theta(\nu) = 0$ otherwise
No funding liquidity risk in black ($\lambda = 0$); without efficiency loss in blue ($\alpha = 0.6$, $a = a$); with efficiency loss in red ($\alpha = 0.8$, $a - a = 0.01$)
DYNAMIC RESULTS

▶ Numerical solution with dynamics in the state variables $\eta_t$ and $\bar{\eta}_t$

▶ Endogenous collateral constraint to pin down $\alpha(\eta_t, \bar{\eta}_t)$
Collateral Constraint $\alpha(\eta_t, \bar{\eta}_t)$

To borrow $1$, the required amount of collateral $\chi$ satisfies:

$$\mathbb{P} \left[ \chi_t \exp \left( \mu_t^s - (\sigma_t^s)^2 / 2 + \sigma_t^s (Z_{t+1} - Z_t) \right) \leq 1 \right] = p.$$ 

Thus, the proportion of available collateral $\alpha_t$ per unit of risky asset is given by

$$\alpha_t = \kappa^\chi \exp \left( \Phi^{-1} (p) \sigma_t^s + \mu_t^s - (\sigma_t^s)^2 / 2 \right)$$

where $\kappa^\chi$ is the fraction of securities that can be used as collateral.
Collateral Scarcity Spiral

\[ dZ_t < 0 \]

\[ (\eta_t + \bar{\eta}_t) \]

\[ (\mu_t^s - r_t^d) \]

\[ q_t \]

\[ \sigma_t^q \]

\[ \alpha_t \]
Collateral Scarcity Spiral

No amplification in blue ($\alpha_t = 1$) and endogenous collateral constraint in red

▷ Brunnermeier and Pedersen (2009) in general equilibrium
Conclusion

- When bank capital is low, an endogenous haircut spiral between declining asset prices and funding risks arises.

- Liquidity injection policy help alleviate stresses in the traditional banking sector but fail to reach the shadow banking sector.

- Asset purchase policy (LSAP) decreases the stock of funding risks through a general equilibrium effect and therefore has a larger reach.

*If large shadow banking sector, LSAP may be necessary to stabilize asset prices.*
INTRODUCTION

MODEL

STATIC

DYNAMIC

Deficit Bank
Surplus Bank

qS
D
N

qS
D
N

qS
D
N

qS
D
N

qS
D
N

qS
D
N

qS
D
N

qS
D
N

qS
D
N

Initial Position

Deposit Shock

Reserves Transfer

Money Market Trade

Discount Window

Securities Fire-Sale

Initial Position

Liquid Stage

Illiquid Stage

Liquid Stage