Monetary Policy Implementation in an Interbank Network: Effects on Systemic Risk

Marcel Bluhm*, Ester Faia**, Jan Krahnen***

*Xiamen University, CFS and SAFE, **Frankfurt University, CFS and SAFE, ***Frankfurt University, CFS, SAFE and CEPR

6-7 October 2014, ECB conference on "Non standard monetary policy measures"

Motivation

- Monetary policy and financial stability: effects of liquidity provision by central bank on risk and investment
- Traditionally measured through Taylor rule responding to financial variables
- Transmission mechanism shall be evaluated through interbank market micro-structure
- Effects on risk and liquidity depend upon network externalities

Monetary Policy Trade-offs

- Effects on individual banks:

1. Lender of last resort makes illiquid banks more resilient
2. Increases liquidity available for long term investment
3. Fall of interbank rates: induces asset substitution between interbank lending and investment in non liquid assets

Monetary Policy Trade-offs

- Effects of systemic risk:

1. By reducing the risk of illiquidity reduces probability of bank defaults
2. By reducing interbank borrowing it reduces the scope of interconnections
3. By increasing investment in long term assets it increases the scope of pecuniary externalities

Scope of Model

- Banks solve portfolio optimization choosing between bank lending/borrowing and long term investment
- Network in interbank market featuring both contagion through interconnection and pecuniary externalities
- Central bank injects liquidity to achieve a certain target rate
- Though plausible calibrated parameters asses the effects of liquidity injection on systemic risk

Scope of Model II

- Banks feature regulatory and liquidity constraints
- Assess effects of monetary policy for different regulatory requirements
- Optimal combination policy

Past Literature

- No model with monetary policy implemented through direct liquidity provision into networked interbank market
- Bartolini, Bertola and Prati 2002: model of the interbank money market with role for central bank intervention
- Literature on banking networks:

1. Random networks: Gai and Kapadia 2010
2. Contagion through interconnection and pecuniary externalities: Cifuentes, Ferrucci and Shin 2005
3. Contagion through learning: Caballero and Simsek 2014

Banks and Interbank Markets

- Endogenous dynamic network model:

1. Optimizing banks: choosing interbank lending/borrowing and non-liquid assets
2. Banks are heterogenous in their returns to investment
3. Endogenous price process (tatonnement): central Walrasian auctioneer (Duffie and Zhu 2010)

- Analyze evolution of systemic risk: Shapley values from non-cooperative game theory

The Model

- N banks: $N \in \{1, ..., n\}$ finite evolving set of banks (nodes)
- $g_{i,j} \neq 0$ link (directed network): cross borrowing and lending
- $n - \textit{square}$ adjacency matrix $\mathbf{G}^{(t)}$ describes the (endogenous) connections
- Banks objective function:

$$E(\pi^i) = l^i \cdot r^{rf} + \frac{r^i}{p} \cdot e^i - b^i \cdot r^{rf} \cdot \frac{1}{1 - \xi PD^i}$$

Banks' Constraints

$$c^i \geq \alpha \cdot d$$

$$er^i = \frac{c^i + p \cdot e^i + l^i - d^i - b^i}{\chi_1 \cdot p \cdot e^i + \chi_2 l^i} \geq \gamma + \tau$$

$$e^i \geq 0.$$

Tatonnement Interbank Market

- After banks' optimization, summing up all supplied and demanded funds: suppose $F^{demand} < F^{supply}$.
- Risk-free rate: $\underline{r}_0^{rf} \leq r_0^{rf} \leq \overline{r}_0^{rf}$. New lending rate: $r_1^{rf} = \frac{r_0^{rf} + \underline{r}_0^{rf}}{2}$
- Once price has been determined clearing of trading is done with 'closest matching partners
- PD^i, derived endogenously via iterative algorithm

Tatonnement Non Liquid Asset Markets

- Heterogenous returns but single price emerges
- Inverse demand function:

$$p = exp(-\varphi \sum_i s_i),$$

Systemic Risk

Ratio of assets from all defaulting banks subsequent to a shock to non-liquid assets:

$$\Phi = \frac{\sum_{def} assets_{def}}{\sum_{i} assets_{i}},$$

$def \in i$ indexes banks that are in default after the financial system has absorbed the shock

Shock Algorithm

- Shock: a loss in banks' non-liquid asset holdings. Eisenberg and Noe 2001
- If bank cannot fulfill its capital requirement, it sells non-liquid assets and could default on debt obligations
- Downward pressure on prices: further sales might lead to default
- Insolvent banks (negative equity-value) transmit shocks to their creditors

Parameter Values

α	χ_1	χ_2	γ	d	ς	e	r^i	Ψ
0.1	1	0.2	0.08	500	0.01	$N(65, 10)$	$U(0, 0.15)$	$N(\mu, \sigma^2, \rho))$

Table: Parameters

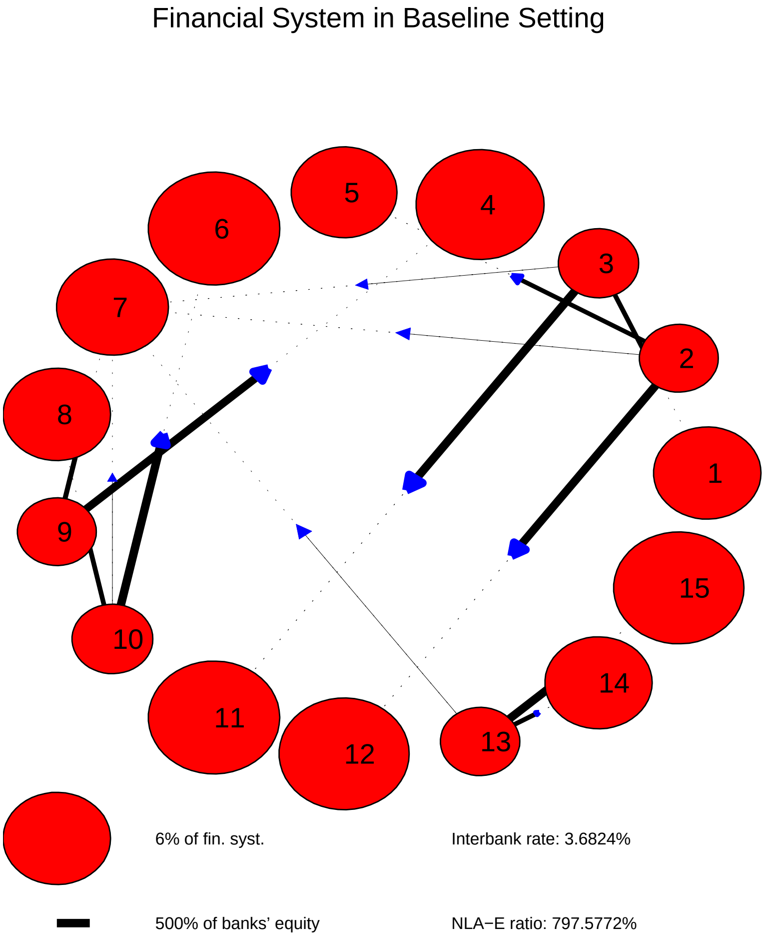

Figure 2: Financial System in Baseline Scenario

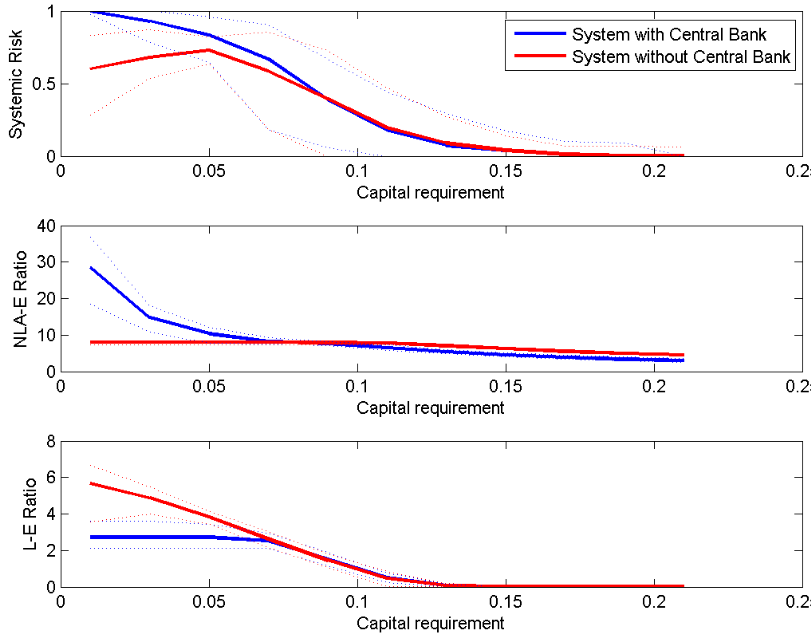

Figure 3: Evolution of systemic risk, ratio of non-liquid asset to equities and ratio of liquid assets to equities under different values of capital requirements and under two scenarios, with and without central bank intervention.

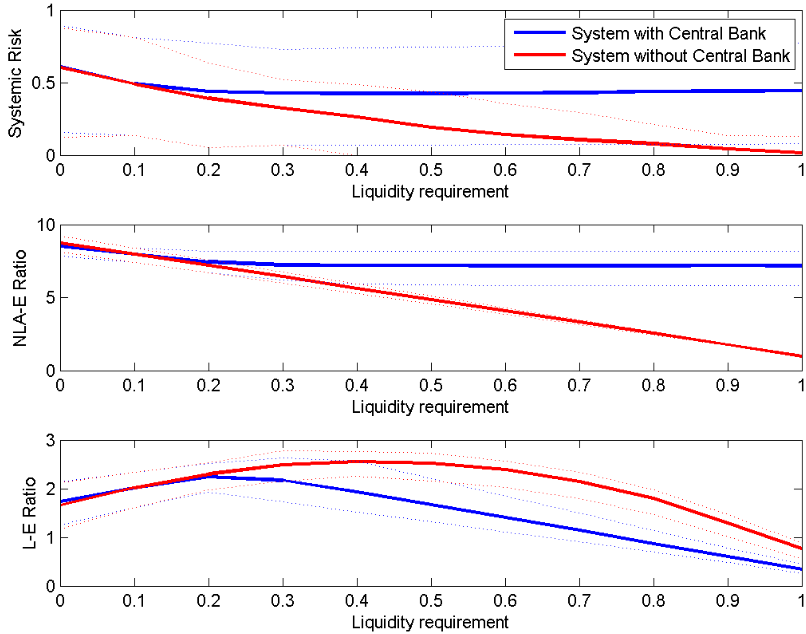

Figure 4: Evolution of systemic risk, ratio of non-liquid asset to equities and ratio of interbank loans to equities under different values of liquidity ratios and under two scenarios, with and without central bank interventions.

Conclusions

- Monetary policy transmission in interbank markets with network and pecuniary externalities
- Given parameters pecuniary externalities prevail and liquidity injections increases systemic risk
- systemic risk always decreases with higher capital ratios, it increases with central bank interventions and higher liquidity ratios