Macro and Micro Prudential Policies : Sweet and Lowdown in a Credit Network Agent Based Model

Ermanno Catullo, Mauro Gallegati and Federico Giri

Università Politecnica delle Marche

16th Payment and Settlement System Simulation Seminar

Systemic Risk and Macro-prudential policies: a credit network-based approach

- Aims: getting insights on micro and sectoral effects of Macro and Meso (network based) prudential policies (Angelini et al., 2012; Osinski et al., 2013) .
- Theoretical bases: Network based financial accelerator approach (Delli Gatti et al., 2010; Riccetti et al., 2014a)

Presentation outline:

1. Credit Network Agent Based Model
2. Macro prudential policy
3. Meso prudential (network based) policy
4. Concluding remarks

The Model

Heterogeneous firms and banks

- Agents are profit seeking with bounded rationality, i. e. they gradually adjusting behavior (Riccetti et al., 2014b; Caiani et al., 2016)
- Firms are hit by price idiosyncratic shocks (Greenwald and Stiglitz, 1993; Delli Gatti et al., 2008)

Endogenous credit network

- Both firms and banks can have multiple credit relationships
- Firms choose their credit demand according to production choices
- Banks choose their supply according to credit demand and subjected to capital requirements

Banks

- Loan supply is gradually adjusted to match demand subjected to capital requirement
- interest rate:
  1) bank specific leverage (following Gerali et al. (2010); Delli Gatti et al. (2010)):

$$R_{bt} = \begin{cases} \eta r_t^d - k \left(E_{bt}/L_{bt}^S - \nu \right) \left(E_{bt} L_{bt}^S \right)^2 \text{ if } E_{bt}/L_{bt}^S < \nu \\ \eta r_t^d \text{ if } E_{bt}/L_{bt}^S \geq \nu \end{cases} \quad (1)$$

  2) firm specific premium (i.e., depending on firm's leverage (K_{it}^d/E_{it})

$$r_{ibt} = \bar{r} \left(\frac{E_{it}}{K_{it}^d} \right)^{-\beta} + R_{bt} \quad (2)$$

- Loan providing probability $P(L)$:

$$P(L) = \iota e^{-(L_{it}^D/E_{it})} \quad (3)$$

Banks

bank profit (π_{bt}): interest charged on the loans allocated to firms J minus bad debt (BD_{bt}) and deposit costs.

$$\pi_{bt} = \sum_{j}^{J} r_{jbt} L_{jbt} - BD_{bt} - r_d D_{bt} - F \qquad (4)$$

$$E_{b,t+1} = E_{bt} + \pi_{bt}^{\gamma} \qquad (5)$$

with $0 < \gamma < 1$.

Firms

Firms use capital (K_{it}) to produce output through a linear production function:

$$Y_{it} = \phi K_{it} \tag{6}$$

The firm's balance sheet is:

$$K_{it} = L_{it} + E_{it} \tag{7}$$

Idiosyncratic price shock

$$p_{it} \sim U[0, 2] \tag{8}$$

$$\pi_{it} = p_{it}\phi K_{it} - r_{it}L_{it} - cK_{it} - F \tag{9}$$

if $K_{it} > E_{it}$:

$$E(\pi_{it}) = E(p)\phi K_{it} - \left(\bar{r}\frac{K_{it}}{E_{it}}^{\beta} + E(R_{bt})\right)(K_{it} - E_{it}) - cK_{it} - F \tag{10}$$

Firms

assuming that $E(R_{bt}) = R_{b,t-1}$:

$$K^*_{it} = \begin{cases} \frac{1}{(1+\beta)\bar{r}} \left(E(p)\rho - c - R_{b,t-1} + \bar{r}\right)^{\frac{1}{\beta}} E_{it}, & \text{if } K_{it} > E_{it} \\ E_{it}, & \text{if } K_{it} \leq E_{it} \end{cases} \tag{11}$$

$$K^D_{it} = \begin{cases} max(K^*_{it}, K^D_{i,t-1}(1-\delta) \text{ if } K^D_{it} > K^*_{it} \\ min(K^*_{it}, K^D_{i,t-1}(1+\delta) \text{ if } K^D_{it} \leq K^*_{it} \end{cases} \tag{12}$$

Net-worth is accumulated according to:

$$E_{i,t+1} = E_{it} + \pi^{\gamma}_{it} \tag{13}$$

with $0 < \gamma < 1$.

Credit Matching

The matching process follows three steps:

1. firms ask for loans to the banks with which they where linked
2. if firms do not receive enough credit they ask for loans to banks that have supply that where not allocated in the first step
3. firms may choose to cut a credit agreement in favor of a banks that has excess credit demand and offer better credit conditions

Credit Matching

Following Delli Gatti et al. (2010) and Riccetti et al. (2014a), each firm will change a randomly chosen linked bank with a given probability (Ps)

$$Ps = max[Ps(r), Ps(L)] \tag{14}$$

Where $Ps(r)$ and $Ps(L)$ are given by:

$$Ps(r) = \begin{cases} 1 - e^{(r_{new} - r_{old})/r_{new}} \text{ if } r_{new} < r_{old} \\ 0 \text{ othewise} \end{cases} \tag{15}$$

$$Ps(L) = \begin{cases} 1 - e^{(L^s_{old} - L^s_{new})/L^s_{new}} \text{ if } L^s_{new} > L^s_{old} \\ 0 \text{ otherwise} \end{cases} \tag{16}$$

Exit and Enter

- The number of agents is fixed
- Firms and bank with net-worth lower than zero exit
- The net-worth of the new enter firm (E_{it}):

$$E_{it} = max[E(F)_t^{med}, E(F)^{min}] \tag{17}$$

  where $E(F)_t^{med}$ is the median firm net-worth and $E(F)^{min}$ a given minimum firm net-worth level.
- The net-worth of the new enter bank (E_{bt}):

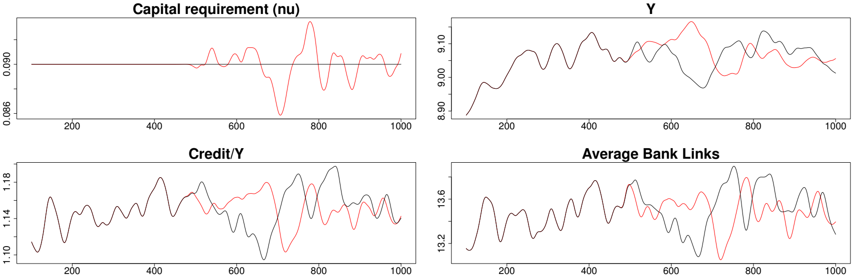
$$E_{bt} = max[E(B)_t^{med}, E(B)^{min}] \tag{18}$$

  where $E(B)_t^{med}$ is the median bank net-worth and $E(B)^{min}$ a given minimum bank net-worth level.

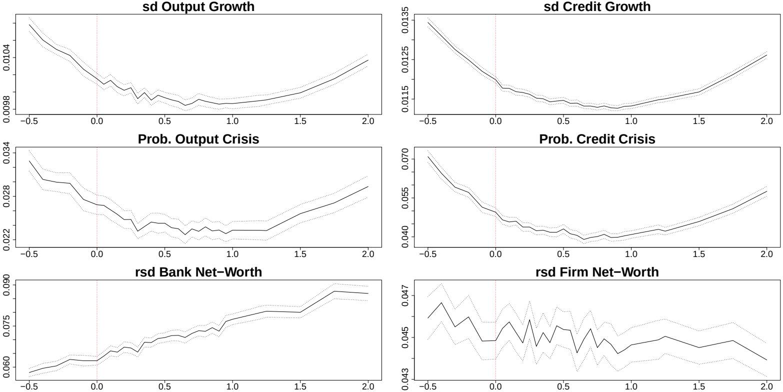
Simulations with Macro Prudential Policy (ν)

following (Angelini et al., 2012), capital requirement (ν_t) evolves according:

$$\nu_t = (1-\rho)\bar{\nu} + (1-\rho)(\chi((\Delta L_t)/L_{t-1})) + \rho\nu_{t-1} \tag{19}$$

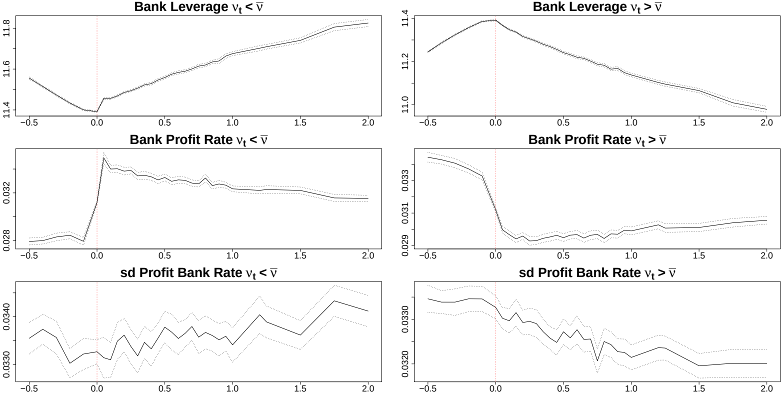


Simulations with Macro Prudential Policy



- Non-linear effect of sensitivity to credit variation (χ) on output volatility.
- Increasing volatility of the banking sector net-worth, augmenting financial fragility Albertazzi and Gambacorta (2009) and De Haan and Poghosyan (2012)

Simulations with Macro Prudential Policy



- Capital requirement above the average ($nu_t > \bar{\nu}$) reduces leverage, profit rate and profit rate volatility.
- Capital requirement above the average ($nu_t < \bar{\nu}$) increases leverage and profit rate.
- Therefore, variable capital requirements increase the volatility of bank net-worth

Simulations with Meso Prudential Policy

We measure Bank connectivity (NC_{bt}) as:

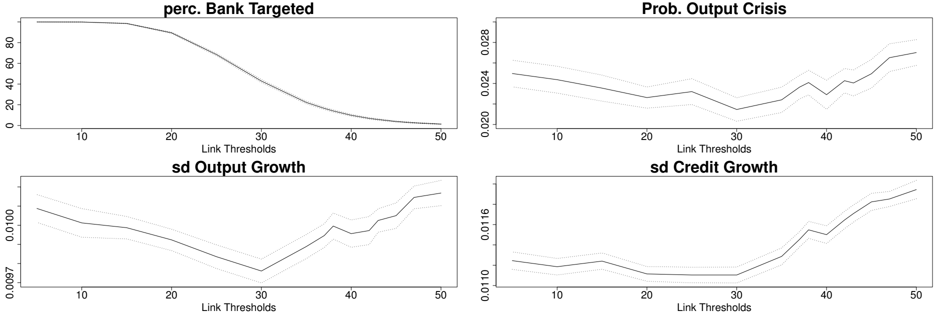
$$NC_{bt} = \sum_{j}^{NF_{bt}} NB_{jt}. \tag{20}$$

NF_{bt} is the number of firms j connected with the bank b at time t and NB_{jt} is the number of banks that provide credit to a firm j at time t

The meso prudential policy fixes higher capital requirement for banks that overcome a certain threshold of connectivity

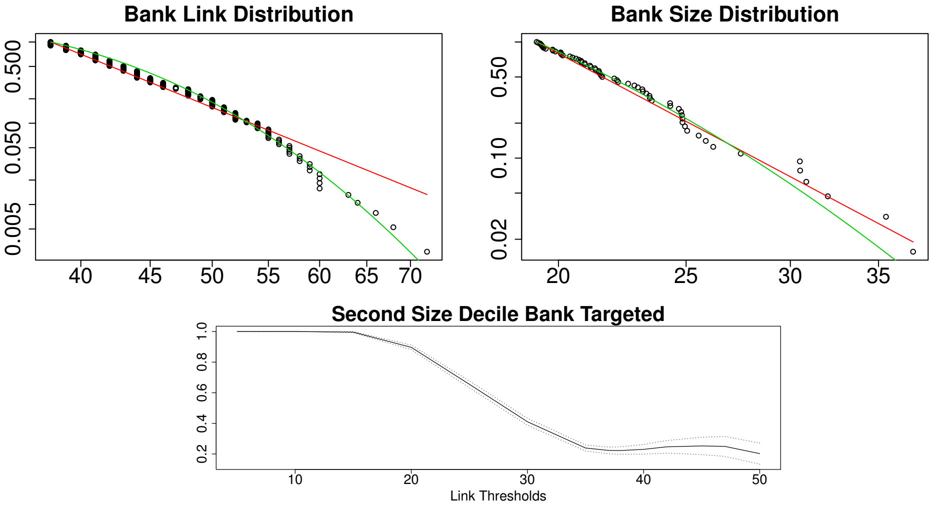
$$\nu_b = \begin{cases} \nu(1+\delta_\nu) \text{ if } NC_{bt} > TC \\ \nu \text{ if } NC_{bt} \leq TC. \end{cases} \tag{21}$$

Simulations with Meso Prudential Policy



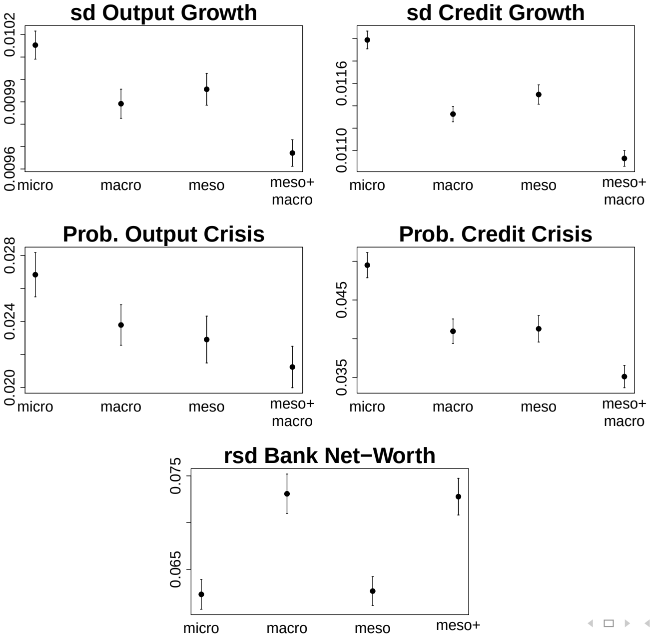
- Non-linear effect of Threshold Link as a trigger.
- Meso Policy based on network may reduce volatility

Simulations with Meso Prudential Policy



- Fat tail distribution of links and connection.
- Non perfect correspondence of connectivity and size

Comparing Micro Macro and Meso



Conclusions

- but macro prudential policy may increase the volatility of the banking sector
- meso (network based) prudential policy can reduce systemic risk without affecting the bank sector
- macro plus meso (network based) prudential policy can be effective in reducing systemic risk

Perspectives:

- diversify bank portfolio
- interbank market
- agent decisions and risk

Thank you

References

Albertazzi, U, Gambacorta, L, 2009. Bank profitability and the business cycle. Journal of Financial Stability 5, 393–409.

Angelini, P, Nicoletti-Altimari, S, Visco, I, 2012. Macroprudential, microprudential and monetary policies: conflicts, complementarities and trade-offs. Questioni di Economia e Finanza (Occasional Papers) 140, Bank of Italy, Economic Research and International Relations Area.

Caiani, A, Godin, A, Caverzasi, E, Gallegati, M, Kinsella, S, Stiglitz, J.E, 2016. Agent Based-Stock Flow Consistent macroeconomics: Towards a benchmark model. Journal of Economic Dynamics & Control 69, 375–408.

De Haan, J, Poghosyan, T, 2012. Bank size, market concentration, and bank earnings volatility in the US. Journal of International Financial Markets, Institutions and Money 22, 35–54.

Delli Gatti, D, Gaffeo, E, Gallegati, M, Giulioni, G, Palestrini, A, 2008. Emergent Macroeconomics: An Agent-Based Approach to Business Fluctuations: Springer.

Delli Gatti, D, Gallegati, M, Greenwald, B.C, Russo, A, Stiglitz, J.E, 2010. The financial accelerator in an evolving credit network. Journal of Economic Dynamics & Control 34, 1627–1650.

Gerali, A, Neri, S, Sessa, L, Signoretti, F, 2010. Credit and banking in a dsge model of the euro area. Journal of Money, Credit and Banking 42, 107–141.

Greenwald, B.C, Stiglitz, J.E, 1993. Financial market imperfections and business cycles. The Quarterly Journal of Economics 108, 77–114.

Osinski, J, Seal, K, Hoogduin, L, 2013. Macroprudential and Microprudential Policies; Toward Cohabitation. IMF Staff Discussion Notes 13/5, International Monetary Fund.

Riccetti, L, Russo, A, Gallegati, M, 2014a. An agent-based decentralized matching macroeconomic model. Journal of Economic Interaction and Coordination 3, –.

Riccetti, L, Russo, A, Gallegati, M, 2014b. An Agent Based Decentralized Matching Macroeconomic Model. Journal of Economic Interaction and Control. On-line version.