Interbank Market and Macroprudential Tools in a DSGE Model

César Carrera and Hugo Vega
Subgerencia de Investigación Económica
Banco Central de Reserva del Perú

Main idea

- Recent efforts for modeling an interbank market
- Interbank funding can be a source of rigidity
- Return of money into a DSGE model
- Use of Macroprudential tools

BGG (1999)

- The financial accelerator of Bernanke, Gertler and Gilchrist (BGG, 1999) usually amplifies, spreads, and gives more persistence to different types of shocks in the economy.
- After the financial crisis of 2007 - 2008, BGG (1999) became a stepping stone for valid extensions of the original model.
- One of those extensions is the inclusion of an interbank market.

Literature review

- Gerali, Neri, Sessa, and Signoretti (JMCB, 2010): Credit and Banking in a DSGE Model of the Euro Area.
- Dib (Bank of Canada, 2010): Banks, Credit Market Frictions, and Business Cycles.
- Hilberg and Hollmayr (UCB, 2011): Asset Prices, Collateral and Unconventional Monetary Policy in a DSGE Model.

Gerali et al. (2010)

- The banking sector is composed of many banks in which each bank is composed of two parts:
  - Two "retail" branches: The first branch is responsible for giving out differentiated loans to households and entrepreneurs, the second for raising deposits.
  - One "wholesale" unit. Management of the capital position of the bank.

Dib (2010)

- Introduces the distinction between banks that only raise deposits and banks that only give out credit.
- Sets up them as interbank market in which the first group of banks borrows from the second group.

Hilberg and Hollmayr (2011)

- Separate the interbank market in two types of banks: commercial banks and investment banks.
- Only a few banks actually interact with the central bank, and then fund the rest of the banking system.

Discusion

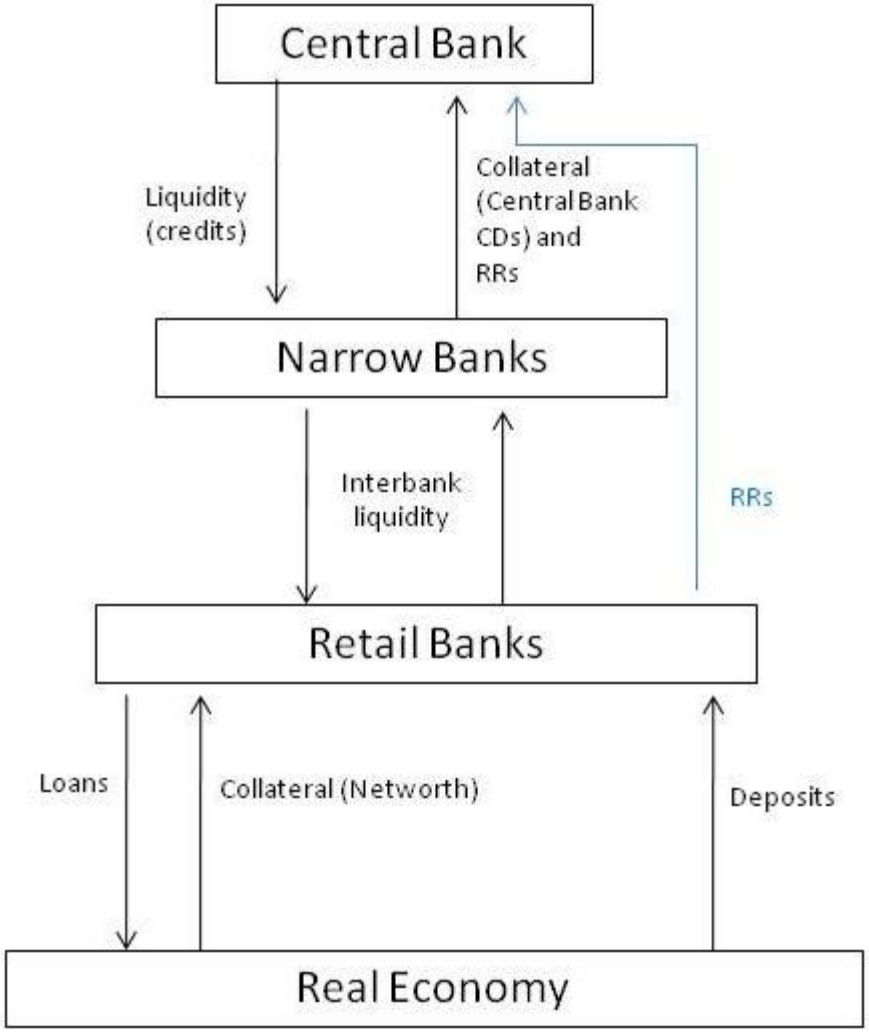
- The capital of the banks plays an important role in Gerali et al. (2010) and Dib (2010).
- For Hilberg and Hollmayr (2011) it is the structure of the market and collateral that matters the most.
- However the banking system in Hilberg and Hollmayr is not consistent when the balance sheet of the bank is considered.

I. The Model

Model Structure

- Consumers:
  - Households
  - Entrepreneurs
- Banks
  - Retail bank
  - Narrow bank
  - Central bank
- Firms
  - Wholesaler
  - Capital producer
  - Retailer

Financial market structure



Households

$$\sum_{t=0}^{\infty} \beta^t E_t \left[\frac{(C_t - bC_{t-1})^{1-\sigma^{-1}}}{1-\sigma^{-1}} - \chi_H \frac{H_t^{1+\varphi^{-1}}}{1+\varphi^{-1}} \right]$$

s.t.

$$C_t + T_t + D_t = \frac{W_t}{P_t} H_t + R_{t-1}^D D_{t-1} \frac{P_{t-1}}{P_t} + \Pi_t^R + \Pi_t^K + \Pi_t^{NB} + \Pi_t^{RB}$$

From F.O.C.:

$$(C_t - bC_{t-1})^{\frac{-1}{\sigma}} - \beta b E_t \left[(C_{t+1} - bC_t)^{\frac{-1}{\sigma}} \right] =$$
$$R_t^D E_t \left[\frac{P_t}{P_{t+1}} \left\{ (C_{t+1} - bC_t)^{\frac{-1}{\sigma}} - \beta b (C_{t+2} - bC_{t+1})^{\frac{-1}{\sigma}} \right\} \right]$$

$$\frac{W_t}{P_t} = E_t \left[\frac{\chi_H H_t^{\frac{1}{\varphi}}}{(C_t - bC_{t-1})^{\frac{-1}{\sigma}} - \beta b (C_{t+1} - bC_t)^{\frac{-1}{\sigma}}} \right]$$

Entrepreneur

Behaves as in BGG(1999): a fraction γ use their income to accumulate net worth (N), the rest consume it (C^E)

$$N_t = \gamma f(\overline{\omega_t}) R_t^e Q_{t-1} K_t \left(\frac{P_{t-1}}{P_t} \right) + \frac{W_t^E}{P_t}$$

Funding constraint: $$Q_t K_{t+1} = L_t + N_t$$

Return on capital: $$R_t^E = \frac{R_t^\omega K_t + (1-\delta) P_t Q_t K_t}{P_{t-1} Q_{t-1} K_t}$$

Cut-off: $$\overline{\omega} R_{t+1}^E P_t Q_t K_{t+1} = R_t^L P_t L_t$$

Entrepreneur (II)

Entrepreneurial consumption:

$$C_t^E = (1-\gamma) f(\overline{\omega}_t) R_t^E Q_{t-1} K_t \left(\frac{P_{t-1}}{P_t} \right)$$

Financial accelerator:

$$\frac{R_{t+1}^E}{R_t^{IB}} = \left[\frac{P_t Q_t K_t}{N_t} \right]^{\upsilon}$$

Wholesale producer

Production function: $Y_t^W = e^{a_t} (K_t)^{1-\psi-\varrho} (H_t)^{\psi} (H_t^E)^{\varrho}$

Profits function: $\Pi_t^W \equiv P_t^W Y_t^W - R_t^W K_t - W_t H_t - W_t^E H_t^E$

From F.O.C.:

$$R_t^W = (1-\psi-\varrho)\frac{P_t^W Y_t^W}{K_t}.$$

$$W_t = \psi \frac{P_t^W Y_t^W}{H_t}$$

$$W_t^E = \varrho \frac{P_t^W Y_t^W}{H_t^E}$$

Entrepreneurial labor is assumed to be fixed at unity.

Capital goods producer

Aggregate stock of new capital: $K_t = (1-\delta)K_{t-1} + \Phi(X_t, X_{t-1})X_t$

Investment adjustment cost: $\Phi(X_t, X_{t-1}) = \left[1 - 0.5\frac{\kappa(\frac{X}{X_{t-1}} - 1)^2}{\frac{X_t}{X_{t-1}}}\right]$

Expected discounted value of profits:

$$\sum_{t=0}^{\infty} E_t \left\{ M_t^H P_t (Q_t K_{t+1} - (1-\delta)\overline{Q}_t K_t) - \Phi(X_t, X_{t-1})X_t \right\}$$

Capital goods producer (II)

Tobin's Q and investment:

$$Q_t \left[\left(1 - 0.5\kappa \frac{(\frac{X_t}{X_{t-1}} - 1)^2}{\frac{X_t}{X_{t-1}}} \right) + (-0.5)\kappa \frac{[(\frac{X_t}{X_{t-1}})^2 - 1]}{(\frac{X_t}{X_{t-1}})^2} \frac{X_t}{X_{t-1}} \right] =$$

$$1 + \beta E_t \{ \left[\frac{(C_{t+1} - bC_t)^{\frac{-1}{\sigma}} - \beta b (C_{t+2} - bC_{t+1})^{\frac{-1}{\sigma}}}{(C_t - bC_{t-1})^{\frac{-1}{\sigma}} - \beta b (C_{t+1} - bC_t)^{\frac{-1}{\sigma}}} \right] \left[\frac{-0.5\kappa[(\frac{X_t}{X_{t-1}})^2 - 1]}{\left(\frac{X_t}{X_{t-1}}\right)^2} \right] \left(\frac{X_t}{X_{t-1}} \right)^2 Q_{t+1} \}$$

Retailer

Profits: $$\Pi^R = P_t Y_t - (1 - \tau^R) P_t^W Y_t^W$$

Aggregate CPI: $$P_t = [\alpha P_{t-1}^{1-\theta} + (1 - \alpha)(P_t^z)^{1-\theta}]^{\frac{1}{1-\theta}}$$

Retail bank

Table 1: Balance Sheet of Retail Banks

Assets	Liabilities
Loans (L_t)	Deposits (D_t)
Reserves (RR_tD_t)	Interbank loans (IB_t)

Balance sheet identity:

$$L_t = (1 - RR_t)D_t + IB_t$$

Retail bank (II)

Benefits:

$$E_t\left[\Pi_{t+1}^{RB}\right] = \left[\int_{\overline{\omega}}^{\infty} R_t^L L_t dF(\omega) + (1-\mu)\int_0^{\overline{\omega}} \omega R_{t+1}^E Q_t K_{t+1} dF(\omega) + R_t^{RR} RR_t D_t(i) - R_t^D(i) D_t(i) - \frac{\kappa^D}{2}\left(\frac{R_t^D(i)}{R_{t-1}^D(i)} - 1\right)^2 R_t^D D_t - R_t^{IB} IB_t\right]\frac{P_t}{P_{t+1}}$$

From F.O.C.:

$$\kappa^d\left(\frac{R_t^D}{R_{t-1}^D} - 1\right)\frac{R_t^D}{R_{t-1}^D}\frac{P_t}{P_{t+1}} = \left(-1 - \epsilon + \epsilon\frac{R_t^{IB}(1-RR_t) + R_t^{RR} RR_t}{R_t^D}\right)\frac{P_t}{P_{t+1}} + SDF\left(\frac{D_{t+1}}{D_t}\right)\kappa^d\left(\frac{R_{t+1}^D}{R_t^D} - 1\right)\left(\frac{R_{t+1}^D}{R_t^D}\right)^2\frac{P_{t+1}}{P_{t+2}}$$

Narrow bank

Table 2: Balance Sheet of Narrow Banks

Asset	Liabilities
Central Bank CDs (CD_t) Interbank Loans (IB_t)	Central bank credit (L_t^{CB})

Balance sheet identity:

$$CD_t + IB_t = L_t^{CB}$$

Narrow bank (II)

Benefits: $$\Pi_t^{NB} = [R_t^{IB} IB_t + R_t^{CD} CD_t - R_t^{REPO} L_t^{CB} - \Xi(IB_t)] \frac{P_t}{P_{t-1}}$$

Zero profit condition:

$$\left(R^{IB} - \frac{1}{HC} \left(\theta^{REPO} - (1 - HC)\theta^{CD} \right) R^P \right) = \Xi' \left(IB \right)$$

Central bank

Table 3: Balance Sheet of the Central Bank

Asset	Liabilities
Central bank credit (L_t^{CB})	Excess reserves (ER_t) Central Bank CDs (CD_t)

Balance sheet identity:

$$L_t^{CB} = ER_t + CD_t$$

Taylor Rule:

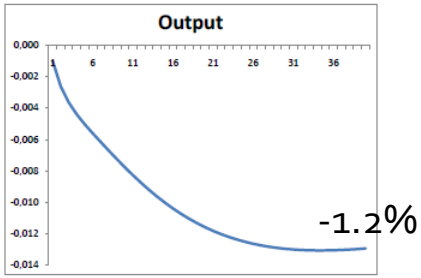
$$\left(\frac{R_t}{\bar{R}}\right) = \left(\frac{R_{t-1}}{\bar{R}}\right)^{\rho_R} \left[\left(\frac{P_{t+1}}{P_t}\right)^{\phi_\pi} \left(\frac{Y_t}{\bar{Y}}\right)^{\phi_y}\right]^{1-\rho_R} e^{\varepsilon_t^R}$$

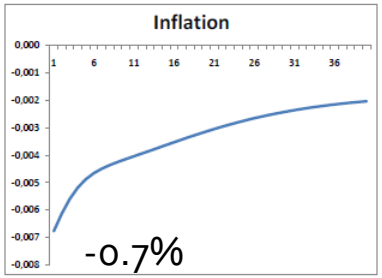
Resource constraint

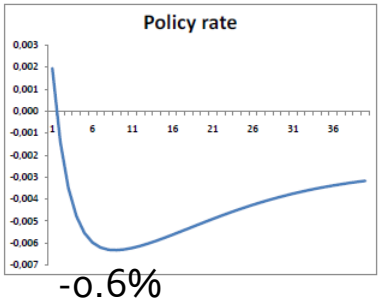
$$P_t Y_t = P_t C_t + P_t C_t^E + P_t X_t + P_t G_t - (1 - f(\omega) - g(\omega)) R_t^E P_{t-1} Q_{t-1} K_t + \Xi(IB_t)$$

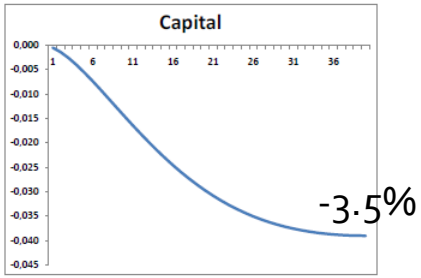
II. Results

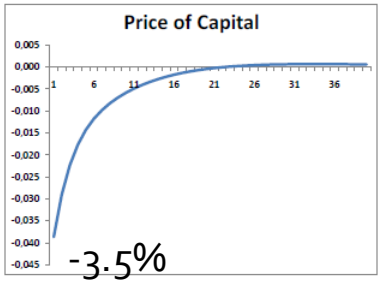
Monetary policy shock

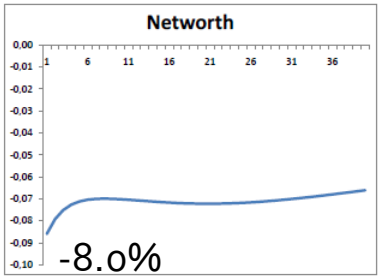


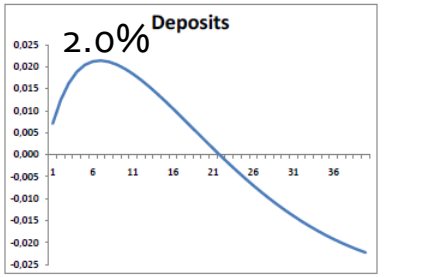


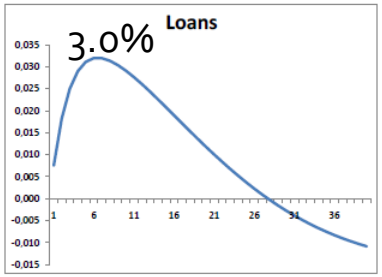


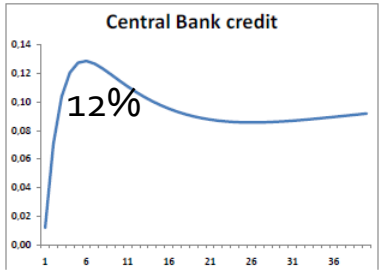




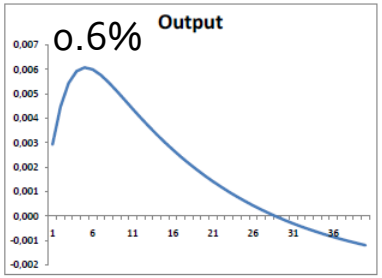


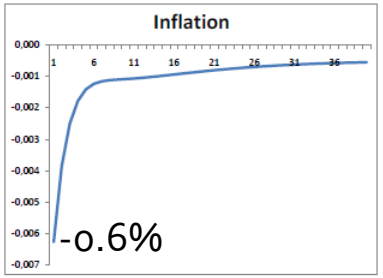


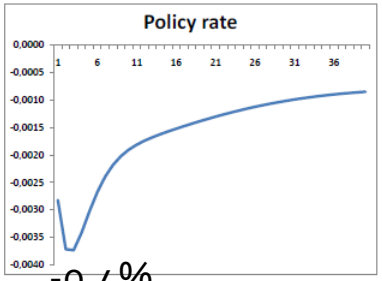


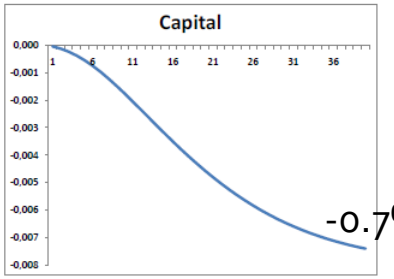


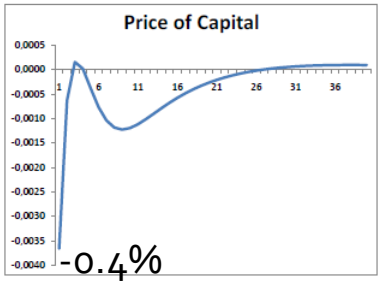
Productivity shock

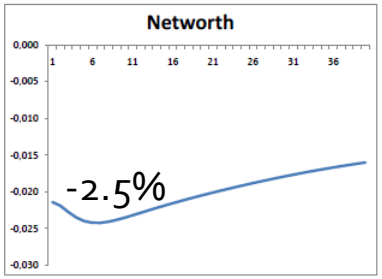


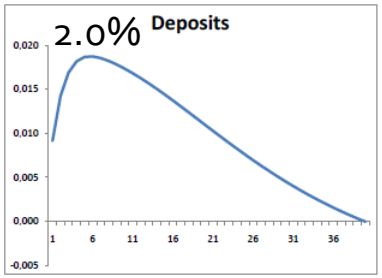


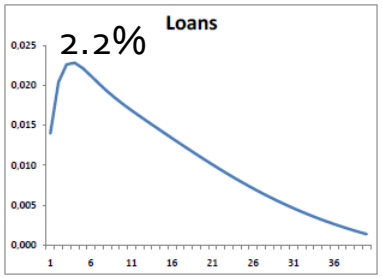


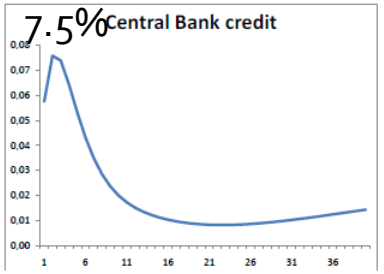




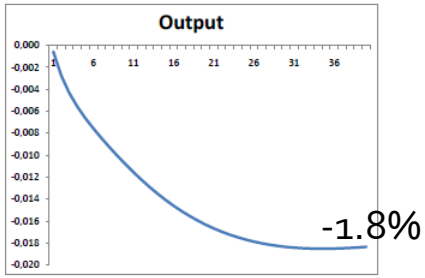


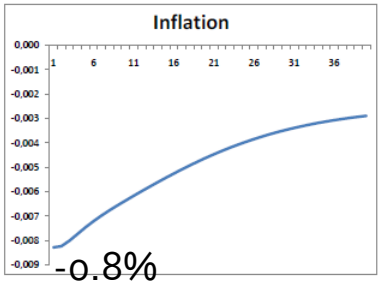


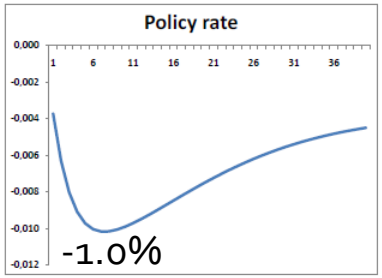


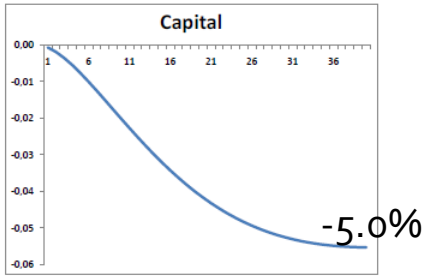


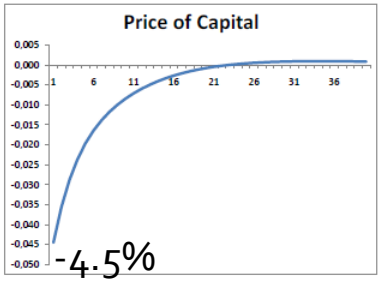
RRs shock

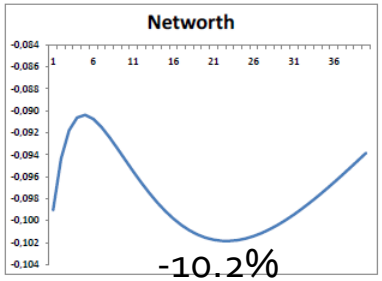

Output
-1.8%

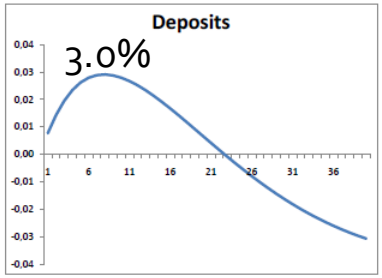

Inflation
-0.8%

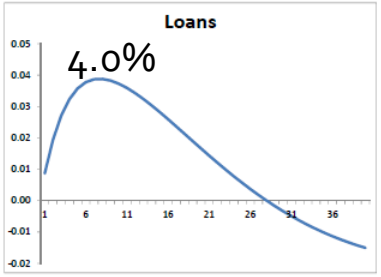

Policy rate
-1.0%

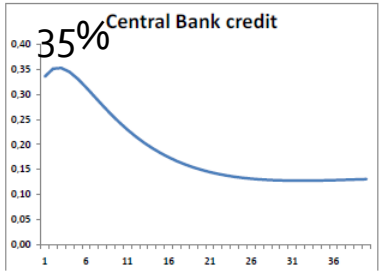

Capital
-5.0%


Price of Capital
-4.5%


Networth
-10.2%


Deposits
3.0%


Loans
4.0%


Central Bank credit
35%

III. Conclusions

- The introduction of an interbank market allows a better identification of the final effects of different type of shocks in the economy.
- Our results (prior) suggest that taking into account the interbank market dumps the BGG (1999) financial accelerator effect.
- Our result is similar to Dib (2010), even though his model works with capital requirements.

Thanks!!!