Capital Requirements in the Short and in the Long Run

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Contribution

- Several macro-banking papers analyze effects (and socially optimal level) of CRs from long-run perspective

  [Van Den Heuvel’08; Gertler-Kiyotaki-Queralto’12; Martinez-Miera-Suarez’14; Nguyen’14; Clerc-et-al’15; Begenau’16; Christiano-Ikeda’17; Mendicino-et-al’18]

- Other papers consider interaction between macroprudential policy & monetary policy with focus on stabilization (typically w/o clear microprudential rationale for CRs)

  [De Paoli-Paustian’13; Lambertini-et-al’13; Kiley-Sim’15; Leduc-Natal’16; Collard-et-al’17; Carrillo-et-al’17; Gersbach-et-al’18]

- In this paper, we consider the transitional effects of capital reforms (and their interaction w/ monetary policy)
How?

- Macro-banking model à la Mendicino-Nikolov-Suarez-Supera (JMCB, 2018) w/ added Neo-Keynesian features

1. **Funding is subject to costly state verification frictions** Both firms and banks are subject to limited liability and default on their nominal uncontingent debt when their debt obligations exceed the value of their assets

2. **Participation in equity market is limited** Available (inside) equity funding to firms & banks is limited by the endogenously evolving wealth of entrepreneurs (e) & bankers (b)

3. **Bank debt risk is not priced at the margin** Insured deposits priced as riskless debt; uninsured debt priced based on expected average default losses

- Calibration to Euro Area matches key macro & financial data
Main findings

- In the long run (LR), rising CRs reduces excessive bank leverage, bank & firm defaults, and their social/fiscal costs.

- In the short run (SR), rising CRs tightens credit supply to bank-dependent borrowers; reduces agg. demand, introducing deflationary pressure.
  - Accommodative monetary policy reduces short-run costs.
  - Less accommodative monetary policy (perhaps due to a ZLB) can make the short-run costs exceed the long-run benefits.
  - With higher bank riskiness, long-run benefits increase & transition costs fall.
Plan for the talk

1. Model structure and overview
2. Calibration
3. Long-run effects of capital requirements
4. Transitional effects
5. Optimal capital requirements in view of transitional costs
Model structure

Households → Bankers b

Deposits

Entrepreneurs e

b-equity

Loans

Entrepreneurial firms

Physical K

Rest of the economy is standard Neo-Keynesian DSGE:

Intermediate good producing firms operating under monopolistic competition

Net worth endowments & dividends
Model overview

- Agents: households, several classes of firms, banks, policy authorities

- Households supply labor, save & provide consumption insurance to their members, which include:
  - Entrepreneurs, who provide equity to e-firms until retirement
  - Bankers, who provide equity to banks until retirement

- Banks issue equity among bankers & debt among households to provide loans to continuum of identical e-firms

- Authorities fix CR ($\phi_t$) & conduct monetary policy ($R_t$) using Taylor rule
Households maximize

\[
E_t \left\{ \sum_{\tau=0}^{\infty} \beta^{t+\tau} \left[ \log (C_{t+\tau}) - \frac{\varphi}{1 + \eta} (L_{t+\tau})^{1+\eta} \right] \right\}
\]

subject to the budget constraint:

\[
P_tC_t + (Q_t + P_{ts}t)K_{s,t} + D_t + B_t \leq [P_t r_{k,t} + (1-\delta_t) Q_t] K_{s,t-1} + W_t L_t + \tilde{R}_d^d D_{t-1} + R_{t-1} B_{t-1} - P_t T_{s,t} + P_t \Pi_t + P_t \Xi_t
\]

where:

- \(D_t\): portfolio of deposits
- \(\tilde{R}_t^d\): realized gross return on deposits
- \(Q_t\): nominal capital price
- \(K_{s,t}\): capital held by households (s.t. cost \(s_t\))
- \(R_t\): risk free rate
- \(B_t\): risk free asset (in zero net supply)
- \(P_t\): price of consumption good
- \(T_t\): lump-sum tax used to finance DGS
- \(C_t\): consumption
- \(\Pi_t\): net transfers from e’s & b’s
- \(\Xi_t\): dividends from K-management firms

and fraction \(1-\kappa\) of bank deposits are risky, so

\[
\tilde{R}_t^d = R_{t-1}^d - (1 - \kappa) \Omega_t \quad (\Omega_t: \text{default losses})
\]
**Entrepreneurs** Problem of an entrepreneur with net worth $N_{e,t}$ is

$$V_{e,t} = \max_{A_t, dv_{e,t}} \left\{ dv_{e,t} + \mathbb{E} \frac{\Lambda_{t+1}}{\pi_{t+1}} \left[ (1 - \theta_e) N_{e,t+1} + \theta_e V_{e,t+1} \right] \right\}$$

subject to:

$$A_t + dv_{e,t} = N_{e,t}$$

$$N_{e,t+1} = \int_0^\infty \rho_{f,t+1}(\omega) dF_f(\omega) A_t$$

$$dv_{e,t} \geq 0$$

where

$$\Lambda_{t+1} = \beta \lambda_{t+1}/\lambda_t: \text{ stochastic discount factor}$$

$$\pi_{t+1} = P_{t+1}/P_t: \text{ inflation rate; } \theta_e: \text{ e's continuation rate}$$

$$A_t: \text{ investment in equity of entrepreneurial firms}$$

$$dv_{e,t} \geq 0: \text{ dividend paid to household}$$

$$\rho_{f,t+1}(\omega): \text{ gross return on equity invested in firm with idiosyncratic shock } \omega$$

$$\omega: \text{ idiosyncratic shock to asset return (log-normal, mean one, STD } \sigma_f)$$

⇒ Guess $V_{e,t} = v_{e,t} N_{e,t}$ & verify $v_{e,t} > 1$ so that $dv_{e,t} = 0$
Entrepreneurial firms

\[
\max_{K_{f,t}, B_{f,t}, R^b_t} \mathbb{E} \left[ \Lambda_{c,t+1} (1 - \Gamma_f (\overline{\omega}_{f,t+1})) R_{K,t+1} \right] K_{f,t}
\]
e’s levered returns

subject to the budget constraint

\[
Q_t K_{f,t} = B_{f,t} + A_t
\]

and the bank’s participation constraint

\[
\mathbb{E} \left[ \Lambda_{b,t+1} (1 - \Gamma_b (\overline{\omega}_{b,t+1}))(\Gamma_f (\overline{\omega}_{f,t+1}) - \mu_f G_f (\overline{\omega}_{f,t+1})) R_{K,t+1} K_{f,t} \right] \geq v_{b,t} \phi_t B_{f,t}
\]

where

\[
R_{K,t+1} = (1 - \delta_{t+1}) Q_{t+1} + P_{t+1} r_{k,t+1}
\]

\[
\overline{\omega}_{j,t+1}: \text{default threshold for borrower } j = f, b
\]

\[
\Gamma_j (\overline{\omega}_{j,t+1}): \text{share of total returns of levered asset accruing to } j\text{'s lenders}
\]

\[
G_j (\overline{\omega}_{j,t+1}): \text{share of borrowers of class } j \text{ that default}
\]

\[
\mu_j: \text{cost of repossessing assets of borrower } j
\]
Bankers Problem of a banker with net worth $N_{b,t}$ is

$$V_{e,t} = \max_{E_{b,t},dve_{t}} \left\{ dv_{b,t} + \mathbb{E}^{\Lambda_{t+1}} \frac{\pi_{t+1}}{\pi_{t+1}} [(1 - \theta_b) N_{b,t+1} + \theta_b V_{b,t+1}] \right\}$$

subject to:

$$E_{b,t} + dv_{b,t} = N_{b,t}$$

$$N_{b,t+1} = \int_{0}^{\infty} \rho_{b,t+1}(\omega) dF_b(\omega) A_t$$

$$dv_{b,t} \geq 0$$

where

$\theta_b$: $b$'s continuation rate
$E_{b,t}$: investment in bank equity
$dv_{e,t} \geq 0$: dividend paid to household
$\rho_{b,t+1}(\omega)$: gross return on equity invested in bank with idiosyncratic shock $\omega$
$\omega$: idiosyncratic shock to asset return (log-normal, mean one, STD $\sigma_b$)

$\Rightarrow$ Guess $V_{b,t} = v_{b,t} N_{b,t}$ & verify $v_{b,t} > 1$ so that $dv_{b,t}=0$
**Banks** supply loans $B_{f,t}$ using deposits $D_t$ & equity $E_{b,t}$

$$\max_{B_{f,t}, D_t, E_{b,t}} E_t \left[ \Lambda_{b,t+1} \max \left( \omega \tilde{R}^b_{t+1} B_{f,t} - R^d_t D_t, 0 \right) \right] - v_{b,t} E_{b,t}$$

subject to:  
$B_{f,t} = D_t + E_{b,t}$ \hspace{1cm} balance sheet constraint  
$E_{b,t} \geq \phi_t B_{f,t}$ \hspace{1cm} regulatory capital constraint

where

$$\Lambda_{b,t+1} = \Lambda_{t+1} (1 - \theta_b + \theta_b v_{b,t+1})$$: $b$’s stochastic discount factor  
$v_{b,t}$: opportunity cost of $b$’s equity  
$\tilde{R}^b_{t+1}$: realized return on diversified loan portfolio

In equilibrium, CR is binding and solution w/ $B_{f,t} > 0$ requires

$$E_t \left[ \Lambda_{b,t+1} (1 - \Gamma_b (\varpi_{b,t+1})) \tilde{R}^b_{t+1} \right] = v_{b,t} \phi_t$$

which justifies banks’ participation constraint in firms’ problem
Rest of the economy

- Intermediate goods $y(i)$ produced under monopolistic competition
- Prices revised a la Calvo (1983) (w. pr. $1-\xi$) give rise to New Keynesian Phillips curve:
  \[
  \log(\pi_t) = \beta (E_t \log(\pi_{t+1})) + \epsilon_\pi \log(m_{ct})
  \]
  where $\epsilon_\pi = \frac{(1 - \xi)(1 - \beta \xi)}{\xi}$ and $m_{ct}$: real marginal cost
- Perfectly competitive firms
  (i) produce consumption good combining intermediate goods,
  (ii) produce physical capital subject to adjustment costs,
  (iii) manage capital directly held by households under convex costs
- Authorities fix CR ($\phi_t$) & conduct monetary policy ($R_t$) using Taylor rule
  \[
  R_t = R_{t-1}^{\rho_R} \left[ \bar{R} \left( \frac{\pi_t}{\bar{\pi}} \right)^{\alpha_\pi} \left( \frac{GDP_t}{GDP_{t-1}} \right)^{\alpha_{GDP}} \right]^{1-\rho_R}
  \]
Calibration

- Based on quarterly data for the Euro area (1992:1-2016:4)
- Reproduces salient features of macro, financial & banking data
- Implemented in two stages:
  - Parameters fixable by convention
  - Rest of parameters found so as to match targeted moments (by minimizing equally weighted sum of distances between empirical model-based moments)
## Model fit

<table>
<thead>
<tr>
<th>Targets (steady state values)</th>
<th>Definition</th>
<th>Data</th>
<th>Model</th>
</tr>
</thead>
<tbody>
<tr>
<td>Real risk-free rate</td>
<td>$(\beta^{-1} - 1) \times 400$</td>
<td>2.32</td>
<td>2.32</td>
</tr>
<tr>
<td>Inflation</td>
<td>$(\pi - 1) \times 400$</td>
<td>1.77</td>
<td>1.77</td>
</tr>
<tr>
<td>Capital requirements</td>
<td>$\phi$</td>
<td>0.08</td>
<td>0.08</td>
</tr>
<tr>
<td>Share of insured deposits</td>
<td>$\kappa$</td>
<td>0.54</td>
<td>0.54</td>
</tr>
<tr>
<td>NFCs’ default</td>
<td>$F_f(\overline{\omega}_f) \times 400$</td>
<td>2.646</td>
<td>2.556</td>
</tr>
<tr>
<td>NFC loans to GDP</td>
<td>$B_f/GDP$</td>
<td>1.897</td>
<td>1.893</td>
</tr>
<tr>
<td>Spread NFC loans</td>
<td>$(R_f - R) \times 400$</td>
<td>1.244</td>
<td>1.295</td>
</tr>
<tr>
<td>Banks’ default</td>
<td>$F_b(\overline{\omega}_b) \times 400$</td>
<td>0.665</td>
<td>0.665</td>
</tr>
<tr>
<td>Real equity return of banks</td>
<td>$(\rho_b - 1) \times 400$</td>
<td>7.066</td>
<td>6.937</td>
</tr>
<tr>
<td>Banks price to book ratio</td>
<td>$v_b$</td>
<td>1.148</td>
<td>1.148</td>
</tr>
<tr>
<td>Capital share of households</td>
<td>$K_s/K$</td>
<td>0.22</td>
<td>0.219</td>
</tr>
</tbody>
</table>
## Parameters

<table>
<thead>
<tr>
<th>Preset parameters</th>
<th>Calibrated parameters</th>
</tr>
</thead>
<tbody>
<tr>
<td>Disutility of labor $\varphi$ 1</td>
<td>Discount factor of consumers $\beta$ 0.994</td>
</tr>
<tr>
<td>Frisch elasticity of labor $\eta$ 1</td>
<td>Capital requirement for banks $\phi$ 0.08</td>
</tr>
<tr>
<td>Capital share in production $\alpha$ 0.3</td>
<td>Share of insured deposits $\kappa$ 0.54</td>
</tr>
<tr>
<td>Depreciation rate of capital $\delta$ 0.03</td>
<td>Steady-state inflation $\bar{\pi}$ 1.004</td>
</tr>
<tr>
<td>Population of entrepreneurs $n_e$ 1</td>
<td>STD iid risk for entrepreneurs $\sigma_f$ 0.298</td>
</tr>
<tr>
<td>NFC bankruptcy cost $\mu_f$ 0.3</td>
<td>STD iid risk for banks $\sigma_b$ 0.029</td>
</tr>
<tr>
<td>Survival rate of entrepreneurs $\theta_e$ 0.975</td>
<td>Survival rate of bankers $\theta_b$ 0.873</td>
</tr>
<tr>
<td>Population of bankers $n_b$ 1</td>
<td>Transfer from HH to entrepreneurs $\chi_e$ 0.001</td>
</tr>
<tr>
<td>Banks bankruptcy cost $\mu_b$ 0.3</td>
<td>Transfer from HH to bankers $\chi_b$ 0.859</td>
</tr>
<tr>
<td>Capital adjustment cost parameter $\psi_k$ 4.567</td>
<td>Output growth response (Taylor rule) $\alpha_{GDP}$ 0.1</td>
</tr>
<tr>
<td>Price elasticity of demand $\theta$ 0.2</td>
<td>Inflation response (Taylor. rule) $\alpha_{\pi}$ 1.5</td>
</tr>
<tr>
<td>Calvo probability $\xi$ 0.75</td>
<td>Smoothing parameter (Taylor rule) $\rho_R$ 0.75</td>
</tr>
<tr>
<td>Population of entrepreneurs $n_e$ 1</td>
<td>$\text{Steady-state inflation} \bar{\pi}$ 1.004</td>
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<tr>
<td>Calibration parameters</td>
<td>$\text{Capital management cost} \varsigma$ 0.006</td>
</tr>
</tbody>
</table>
Long-run effects of higher CR: key drivers

• Higher CRs affect bank funding costs & credit supply in two offsetting ways:
  – Because of reduction in bank failure risk, uninsured debt funding becomes cheaper
  – More scarce/expensive equity funding is required

• In parallel, insured debt funding becomes less costly to taxpayers & society saves on deadweight default losses

∴ Net effect on credit supply (and welfare) reflects the balance between these drivers
Long-run effects of higher CR: results
1pp vs 2.5pp rise in the CR: experiment

Design of the experiment:

- t=1 economy at deterministic steady state
- t=2, 3, ... a permanent rise in CR, implemented gradually
- Perfect foresight:
  - Speed of implementation becomes known at beginning of t=2
  - Economy suffers no agg. shocks during the transition

Results:
Larger rise carries larger financial stability gains but also much higher transitional costs (akin to a negative demand shock)
1pp vs 2.5pp rise in the CR: results
Interaction with monetary policy: experiment

Design of the experiment:

- $t=1$ economy at deterministic steady state
- $t=2, 3, ...$ a permanent rise in CR, implemented gradually
- Perfect foresight
- Compare Taylor rules with different reactivity to inflation

Results:
Larger reactivity to inflation reduces the transition costs (akin to better accommodating negative demand shock)
Interaction with monetary policy: results
Impact of an effective lower bound (ELB): experiment

Design of the experiment:

- $t=1$ economy at deterministic steady state
- $t=2, 3, \ldots$ a permanent rise in CR, implemented gradually
- Perfect foresight

- Compare transitions w/ & w/o proximity to an ELB

Results:
Proximity to an ELB increases the transition costs (reducing the rise in the CR that maximizes social welfare)
Impact of an ELB: results
Transition costs under high bank fragility: experiment

Design of the experiment:

• $t=1$ economy at deterministic steady state
• $t=2, 3, \ldots$ a permanent rise in CR, implemented gradually
• Perfect foresight
• Compare \textit{economies w/ different levels of bank risk}

Results:
Larger bank fragility implies lower transitional costs (in addition to higher long-run gains)
Transition costs under high bank fragility: results
Optimal CR rise: experiment

Find the CR rise that maximizes social welfare (starting with the 8% of Basel I and II)

• Opposite to prior literature transitional costs are taken into account
• Welfare gains are measured in pp of permanent consumption
• We compare results across:
  – Different distances to the ELB
  – Different degrees of bank fragility

Results:

– Being close to the ELB reduces the optimal CR rise
– Increases in the CR are more beneficial when banks are more fragile (in line with microprudential logic)
Optimal CR: results

![Baseline bank risk graph](image1)

![Higher bank risk graph](image2)
Conclusions

• Transitional effects/costs are crucial to assessment of real & welfare effects of CR rises

• Higher CRs make banks less fragile & have positive impact on long-run welfare (as shown in previous papers)

• Transition carries short-run output costs due to the reduction in credit & impact on agg. demand

• Crucial elements for the overall cost/benefit balance are size of the CR rise, speed of implementation, conduct of monetary policy & bank risk

• Assessment of CR reforms neglecting short-run costs & interaction with monetary policy can produce misleading conclusions
THANK YOU!