Optimal Bank Capital Requirements: An Asymmetric Information Perspective

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Introduction

Aim:

Identify the regulatory framework (leverage ratio or risk weighted asset) that improves the stability of the financial system.

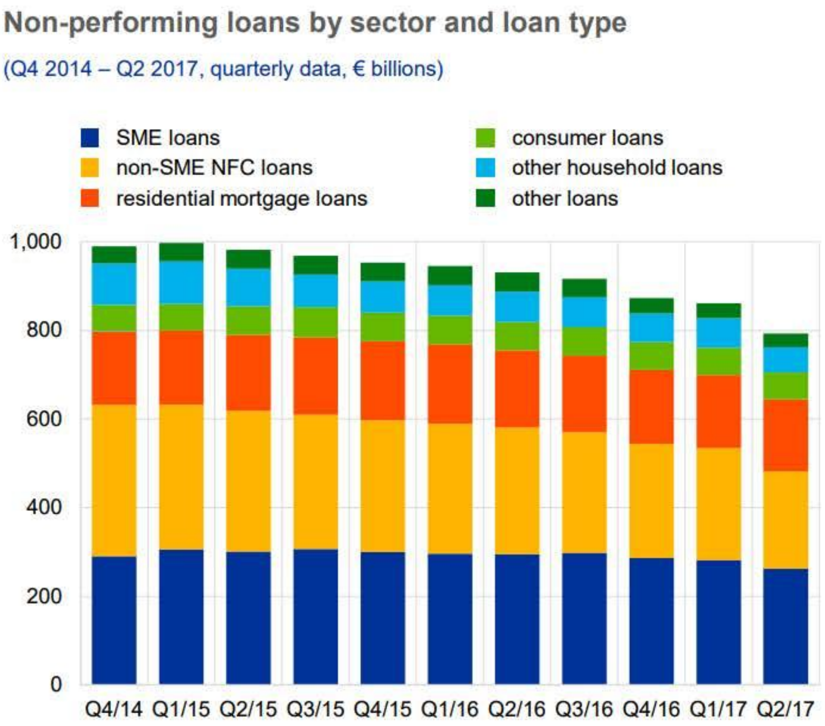
Question:

What is the socially optimal amount of capital that banks should be required to hold on their balance sheet?

Key risks to euro area financial stability

- The improvement of the financial sector is needed to make this sector, and especially the banking sector, less vulnerable to crises (Bénassy - Qéré, 2018).
- There is still a high persistent liquidity risk in the non-bank financial sector with potential spillovers to the broader financial system (FSR, Nov. 2017).
- Adverse feedback loop between weak bank profitability and low nominal growth, amid structural challenges in the euro area banking sector (FSR, Nov. 2017).

Key risks to euro area banking system



Source: FSR, 2017 - Q2.

- Improved asset quality, but still elevated NPL levels
- Pivotal nature of asset quality problems

Risks and vulnerabilities in the EU banking sector, environmental factors

Bank risk	Risk drivers	Level	Expected Trend
Regulatory and legal environment	Risk weighted assets, regulatory arbitrage		
Fragmentation	Asset quality, profitability		
Sovereign risk	Political risk, debt overhang		

Level	High	Medium	Low
Trend	Increasing	Stable	Decreasing

Source: EBA, 2016 - Q4.

Motivations

- Development of the financial sector is a key ingredient of economic growth, catalyst to increase firm productivity and a way to foster entrepreneurship
- Notwithstanding the improvements granted by the financial regulation, the banking system shows a high level of financial fragility
- Need of reviewing the regulatory framework
  - European Level: macroprudential framework and revision of the Capital Requirements Regulation (CRR) and Directive (CRD);
  - International Level: finalisation of the Basel III framework
- Recently, most of the papers focus on the adverse selection problem (Wu and Zhao, 2016; Blum, 2008)
- Banks have better information about their activities than regulator (adverse selection) and incentives to direct resources away from normal operation (moral hazard) (Gianmarino, Lewis and Sappington, 1993)

Literature Review: Leverage and risk weighted asset

- Haldane (2015). "Multi-Polar Regulation." *International Journal of Central Banking*
  - Leverage is a "safeguard against the funding liquidity risk and a bulwark against the gaming of risk weights", but it might produce risk-shifting for bank with low risk tolerance
- Dermine (2015). "Basel III leverage ratio requirement and the probability of bank runs." *Journal of Banking & Finance*
  - "Unweighted" leverage ratio is needed to limit the risk of bank run
- Wu and Zhao (2016). "Optimal Leverage Ratio and Capital Requirements with Limited Regulatory Power." *Review of Finance*
  - Leverage ratio might lead to corner solution, but risk weighted asset is not enough
  - Solution: Risk weighted asset with leverage on top (Blum, 2008)
- Laffont (1995). "Regulation, moral hazard and insurance of environmental risks." *Journal of Public Economics*

Model Design

The economy is populated by two risk neutral representative agents

- Regulator $\Rightarrow$ maximize the financial stability
  - Distortion: The regulator cannot observe the portfolio's composition of the bank needed to set the optimal amount of capital
- Bank $\Rightarrow$ maximize the profit
  - Distortion: Reporting the actual parameter is costly for the bank, because it can lower the regulatory hurdle.

Hypothesis: Notation

- Two regulatory framework can be implemented:
  - k_L leverage ratio;
  - k_{RW} risk weighted asset.
- Bank finances itself with capital k and deposit $(1-k)$
- The cost of capital is δ, where $\delta > 0$
- Full insurance deposit, insurance premium and interest rate equal to 0
- Two investment projects, y and $\tilde{y}$, where $E(\tilde{y}) \geq y$:
  - safe asset with return y
  - risky asset with return $\tilde{y} \begin{cases} Y & \text{with probability} \quad \theta_{e_2} \\ 0 & \text{with probability} \quad (1-\theta_{e_2}) \end{cases}$
- Screening effort: e_1 determines the portfolio's composition
- Revelation cost: $e_2 \begin{cases} 1 & \text{truthful revelation of asset quality} \\ 0 & \text{otherwise} \end{cases}$
- t monetary or not penalty in case of financial disarray

Bank's problem

The bank utility U_b:

$$U_b = \underbrace{ye_1 + \theta_{e_2} Y(1 - e_1)}_{\text{Gross revenue}} - \overbrace{\delta k}^{\text{Cost of capital}} - \underbrace{t(1 - \theta_{e_2})(1 - e_1)}_{\text{Penalty}} - \overbrace{\psi(e_1, e_2)}^{\text{Disutility of efforts}}$$

where $\psi(e_1, e_2) = \frac{e_1^2 m}{2} + e_2$, the disutiliy of effort with $\psi(0) = 0$, $\psi'(e_1, e_2) > 0$ and $\psi''(e_1, e_2) > 0$

Regulator's Problem

The social welfare function V is:

Financial stability

maintenance stability and surveillance costs

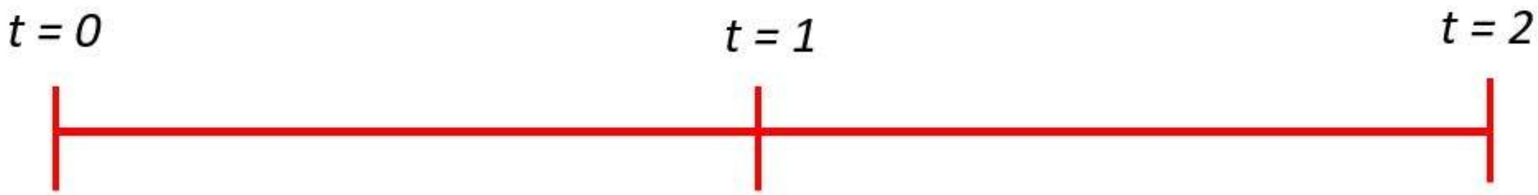
$$V = S - (1-\theta_{e_2})B - (1+\lambda)\left(C - t(1-\theta_{e_2})(1-e_1) + \frac{(1-e_1)^2}{2}\right) + U_b$$

Financial Disarray cost

Bank utility

where $C = \beta - e_1$ is the cost of maintaining stability; $\frac{(1-e_1)^2}{2}$ the surveillance cost; B the Bankruptcy/Financial Disarray cost for society, and S the social value of financial stability.

The timing of the model



t = 0: Nature decides the parameter β

t = 1: Bank reveals the risky parameters of its credit portfolio;
Regulator imposes the capital regulation according to which effort max the social welfare

t = 2: Bank chooses the level of effort e_1 and Regulator observes the cost C

Results under complete information

- Under complete information the regulator knows β and e_1, and $e_2 = 1$ $(\theta_{e_2} = \theta)$
- The problem of improving financial stability is: $\max_{e1}$ social welfare s.t. the participation of the bank

Proposition 1:
The bank is better off, in terms of lower marginal disutility, under leverage ratio requirement

(Brief) Proof 1:

- The optimal marginal disutility is:
  $\psi'(e_1, e_2) = 1 + (1 - e_1) + \frac{dU(R, e_1)}{de_1}$, that is:
  - $\psi'(e_1, e_2)_L = 1 + (1 - e_1) + y - \theta Y + (1 - \theta)t - e_1 m$
  - $\psi'(e_1, e_2)_{RW} = 1 + (1 - e_1) + y - \theta Y + (1 - \theta)t - e_1 m + \delta y$

◂ Proof

Definition of the effort

Proposition 2:
If capital is costly, risk-weighted capital requirements incentivize banks to increase the amount of safe assets (i.e. to exert more screening effort) more than they would under a leverage ratio regime.

(Brief) Proof 2: Bank maximizes under the two regulatory schemes, i.e. $k = \{k_L; k_{RW}\}$, the utility function:

Leverage Ratio

$$k = k_L$$

$$e^*_{LR} = \frac{y - \theta Y}{m} + \frac{(1-\theta)t}{m}$$

$$\Downarrow$$

$$\underline{e}_1$$

Risk Weighted Asset

$$k = K_{RW} = 1 - e_1 y$$

$$e^*_{RW} = e^*_{LR} + \frac{\delta y}{m}$$

$$\Downarrow$$

$$\bar{e}_1$$

◂ Computational Details

Incentive Problem: Results

- The regulator wants to implement ($e_2 = 1$) and to know β.
- The efficiency can be $\bar{\beta}$ or $\underline{\beta}$, with $\bar{\beta} > \underline{\beta}$ and $v = Prob\{\beta = \bar{\beta}\}$.

Proposition 3:
Under incomplete information, the risk weighted asset implies always the lowest marginal disutility for the bank.

(Brief) Proof 3:

- The optimal marginal disutility is:
  - $\psi'(\underline{e}_1 + 1) = 1 + (1 - \underline{e}_1) + y - \theta_{e_2} Y + (1 - \theta_{e_2})t - \underline{e}_1 m$
  - $\psi'(\bar{e}_1 + 1) =$
    $1 + (1 - \bar{e}_1) + y - \theta_{e_2} Y + (1 - \theta_{e_2})t - \bar{e}_1 m + \delta y - \frac{\lambda v}{(1+\lambda)(1-v)} \frac{dU(\underline{\beta}, \bar{\beta}, 1)}{d\bar{e}_1}$
- $\psi'(\bar{e}_1 + 1) < \psi'(\underline{e}_1 + 1)$

Proof

Revelation Problem

What incentive does a bank have to report the true risks of its assets? Without adequate supervision and appropriate penalties, the answer is, "Not much" (Prescott, 2004, p.47)

In financial disarray — Extra payment

$$\underline{t}^{c} - \underline{t}^{nc} \geq \frac{\psi(\underline{e}_1 + 1) - \psi(\underline{e}_1)}{(1 - \underline{e}_1)(\theta_1 - \theta_0)}$$

$$\bar{t}^{c} - \bar{t}^{nc} \geq \frac{\psi(\bar{e}_1 + 1) - \psi(\bar{e}_1)}{(1 - \bar{e}_1)(\theta_1 - \theta_0)}$$

$$\bar{t}^{c} - \underline{t}^{c} \geq \theta_1(1 - \underline{e}_1)(\underline{t}^{nc} - \underline{t}^{c}) - \theta_0(1 - \bar{e}_1)(\bar{t}^{nc} - \bar{t}^{c}) + \psi(\underline{e}_1 + 1) - \psi(\bar{e}_1 - \Delta\beta) + a$$

$$\underline{t}^{c} - \bar{t}^{c} \geq \theta_1(1 - \bar{e}_1)(\bar{t}^{nc} - \bar{t}^{c}) - \theta_0(1 - \underline{e}_1)(\underline{t}^{nc} - \underline{t}^{c}) + \psi(\bar{e}_1 + 1) - \psi(\underline{e}_1 + \Delta\beta) + b$$

In dishonest — All possible earnings derived from lying

where $a = U(R, \bar{e}_1) - U(R, \underline{e}_1) + \bar{t}^{c}\bar{e}_1 - \underline{t}^{c}\underline{e}_1$, and $b = \underline{t}^{c}\underline{e}_1 - \bar{t}^{c}\bar{e}_1 + U(R, \underline{e}_1) - U(R, \bar{e}_1)$

Summarizing the structure of the penalty

- In case of no-financial disarray, the bank will not pay any penalty $t^{nc} = 0$.
- The highest the probability of financial disarray, the worst the bank's behavior, the highest the fine.
- In case of financial disarray, the banks will pay the opportunity cost plus the extra payment.

Advantage of the penalty: Provide incentive for accurate reporting and does not distort liquidity holding.

Revelation problem: Result

Proposition 4:
Financial stability can be improved and/or maintained if the regulator implements an optimal risk weighted asset capital requirements regulation scheme, with penalty set such that the bank will truthfully reveal the risky parameters of its credit portfolio.

(Brief) Proof 4:
Constraints on the penalty ensure that the bank will always reveal its efficiency type and that $e_2 = 1$

Conclusion

Advantages of the here proposed model:

- Risk-weighted asset solves simultaneously moral hazard and adverse selection
- Uni-polar regulation in the banking sector allows regulator to offset financial instability risk
- Internalizing the cost of financial disarray, the bank is incentivized to not game the risk parameter

Possible extension:

- Do we need a leverage ratio on top of risk weighted asset?
- Include the different bank business model

Appendix

Computational details on:

- Computing the effort level;
- Proposition 1 - 2 - 3 - 4;
- Constraints characterizing the revelation principle.

Computing the effort level

Under leverage ratio $k = k_L$ and utility of the bank is:

$$U_b = ye_1 + \theta Y(1 - e_1) - \delta k_L - (1-\theta)(1-e_1)(t) - \left(\frac{e_1^2 m}{2} + 1\right) \quad (1)$$

Deriving 1 with respect to e_1,

$$\frac{dU_b}{de_1} = y - Y\theta + (1-\theta)t - e_1 m \quad (2)$$

and posing it equal to zero, we obtain:

$$e_{LR}^* = \frac{y - \theta Y}{m} + \frac{(1-\theta)t}{m} \quad (3)$$

Under the risk-weighted capital requirement, $k_{RW} \leq 1 - e_1 y$, U_b is:

$$U_b = ye_1 + \theta Y(1 - e_1) - \delta(1 - e_1 y) - (1-\theta)(1-e_1)(t) - \left(\frac{e_1^2 m}{2} + 1\right) \quad (4)$$

Deriving (4) with respect to e_1:

$$\frac{dU_b}{de_1} = y - \theta Y + \delta y + (1-\theta)(-1)(-t) - e_1 m \quad (5)$$

and posing the derivative equal to zero, we obtain:

$$e_{RW}^* = \frac{\delta y}{m} + \frac{y - \theta Y}{m} + \frac{(1-\theta)t}{m} \quad (6)$$

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Complete Information, Computational Details

1. Rewrite V:

$$V = S - (1-\theta(e_2))B - (1+\lambda)(C - t(1-\theta(e_2))(1-e_1) + \tfrac{(1-e_1)^2}{2}) + U_b$$

$$= S - (1-\theta(e_2))B - (1+\lambda)(C - U(R,e_1) + \psi(e_1,e_2) + U_b + \tfrac{(1-e_1)^2}{2}) + U_b$$

2. Maximize w.r.t. e_1:

$$\frac{dV}{de_1} = (1+\lambda) + (1+\lambda)\frac{dU(R,e_1)}{de_1} - (1+\lambda)\psi'(e_1,e_2) + (1+\lambda)(1-e_1)$$

3. Calculate $\frac{dU(R,e_1)}{de_1}$, under both capital requirements and pose the derivative equal to zero

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Incomplete Information: Constraints

- The regulator wants to implement ($e_2 = 1$) and to know β.
- The efficiency can be $\bar{\beta}$ or $\underline{\beta}$, with $\bar{\beta} > \underline{\beta}$ and $v = Prob\{\beta = \bar{\beta}\}$.

The rationality constraints are:

$$U_b(\underline{\beta}, \underline{\beta}, 1) \geq U_b(\underline{\beta}, \bar{\beta}, 1) \quad (7)$$

$$U_b(\underline{\beta}, \underline{\beta}, 1) \geq U_b(\underline{\beta}, \underline{\beta}, 0) \quad (8)$$

$$U_b(\underline{\beta}, \underline{\beta}, 1) \geq U_b(\underline{\beta}, \bar{\beta}, 0) \quad (9)$$

$$U_b(\bar{\beta}, \bar{\beta}, 1) \geq U_b(\bar{\beta}, \underline{\beta}, 1) \quad (10)$$

$$U_b(\bar{\beta}, \bar{\beta}, 1) \geq U_b(\bar{\beta}, \bar{\beta}, 0) \quad (11)$$

$$U_b(\bar{\beta}, \bar{\beta}, 1) \geq U_b(\bar{\beta}, \underline{\beta}, 0) \quad (12)$$

The participation constraints are:

$$U_b(\underline{\beta}, \underline{\beta}, 1) \geq 0 \quad (13)$$

$$U_b(\bar{\beta}, \bar{\beta}, 1) \geq 0 \quad (14)$$

Incentive Problem

- The problem of the regulator is to maximize its social welfare, under constraints 7, 10, 13, 14. The social welfare becomes:

$$V = v[S - (1-\theta(e_2))B - (1+\lambda)(\beta - \underline{e}_1 - U(R,\underline{e}_1) + \psi(\underline{e}_1, e_2) + \tfrac{(1-\underline{e}_1)^2}{2}) - \lambda \underline{U}_b] +$$

$$+(1-v)[S - (1-\theta(e_2))B - (1+\lambda)(\beta - \bar{e}_1 - U(R,\bar{e}_1) + \psi(\bar{e}_1, e_2) + \tfrac{(1-\bar{e}_1)^2}{2}) - \lambda \bar{U}_b]$$

- In the incentive problem, the binding constraints are 7 and 14, thus $U_b(\underline{\beta},\underline{\beta},1) = U_b(\underline{\beta},\bar{\beta},1), \quad U_b(\bar{\beta},\bar{\beta},1) = 0$ where $U(\beta,\tilde{\beta},e_2)$ is:

$$U(\beta,\tilde{\beta},e_2) = U(R,\tilde{e}_1) - \theta(e_2)t^{nc}(\tilde{\beta})(1-\tilde{e}_1) - (1-\theta(e_2))t^{c}(\tilde{\beta})(1-\tilde{e}_1) - \psi(\beta-\tilde{\beta}+\tilde{e}_1+e_2)$$

$$\Downarrow$$

$$\begin{aligned} \max_{e_1} \quad & V \\ s.t. \quad & U_b(\underline{\beta},\underline{\beta},1) = U_b(\underline{\beta},\bar{\beta},1) \\ & U_b(\bar{\beta},\bar{\beta},1) = 0 \end{aligned} \tag{15}$$

Incomplete Information: Computational details

To demonstrate that $\psi'(\underline{e}_1 + 1) > \psi'(\bar{e}_1 + 1)$, we equate the two disutility as:

$$-\underline{e}_1 - \underline{e}_1 m > -\bar{e}_1 - \bar{e}_1 m + \delta y - \frac{\lambda v}{(1+\lambda)(1-v)} \frac{dU(\underline{\beta}, \bar{\beta}, 1)}{d\bar{e}_1}$$

Reminding that $\underline{e}_1 = e_L^*$ and that $\bar{e}_1 = e_{RW}^* = e_L^* + \frac{\delta y}{m}$, we obtain:

$$-e_L - e_L m > -e_L - \frac{\delta y}{m} - e_L m - \frac{\delta y m}{m} + \delta y - \frac{\lambda v}{(1+\lambda)(1-v)} \frac{dU(\underline{\beta}, \bar{\beta}, 1)}{d\bar{e}_1}$$

Simplifying and rearranging we get the condition:

$$\frac{\delta y}{m} + \frac{\lambda v}{(1+\lambda)(1-v)} \frac{dU(\underline{\beta}, \bar{\beta}, 1)}{d\bar{e}_1} > 0$$

Since both terms on the left side of the equation are greater than zero, the condition is always satisfied.

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