# Banking Regulation in Theory and Practice (2)

*Jin Cao*
(*Norges Bank Research, Oslo & CESifo, Munich*)

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Universitetet i Oslo

# Outline

1. Foundations of Banking Regulation
   - Risk management and leverage cycles
   - Capital regulation

# Disclaimer

*(If they care about what I say,) the views expressed in this manuscript are those of the author's and should not be attributed to Norges Bank.*

# Risk management at work: model setup

- Consider an economy of 2 periods: agents invest in risky projects at $t = 0$, and will get paid at $t = 1$. No private information;
  - Assumption 1: There are a *fixed* number of identical risky projects. Each
    - Needs 1 unit of initial investment to start at $t = 0$, while the gross payoff $R$
    - Only gets revealed at $t = 1$, perfectly correlated across projects;
    - $R$ is uniformly distributed over $\left[\overline{R} - z, \overline{R} + z\right]$, with $\overline{R} > 1$, $z > 0$. Therefore

$$E_0 [R] = \overline{R}, \text{ and } var [R] = \frac{z^2}{3}.$$

  - Besides risky projects, agents may also hold cash which is risk free.

# Risk management at work: model setup (cont'd)

- There are many *risk averse* consumers, each of them
  - Is endowed with wealth $e$ at $t = 0$;
    - Can deposit the wealth in the bank *and* invest directly on risky projects;
    - Gets utility from consumption at $t = 1$, or, proceeds from investment. Her expected utility at $t = 0$ is

$$u(c) = E[c] - \frac{1}{2\tau} var[c].$$

*Consumers are risk averse because they do not like volatility. Parameter $\tau$ is parameter for risk tolerance: the higher it is, the more risk consumers can tolerate. Assume $\tau$ is constant across consumers.*

# Risk management at work: model setup (cont'd)

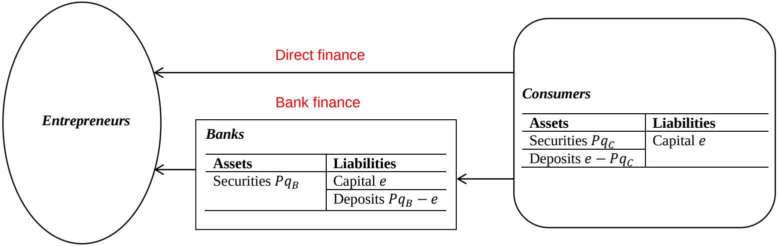
- There are many *risk neutral* banks, or *leveraged investors*, each of them
  - Invests only on risky projects, and can borrow from consumers (that's why banks are "*leveraged*");
    - Manages balance sheet using $VaR$ ("**V**alue-**a**t-**R**isk");

**Definition**

The $VaR$ of a portfolio at confidence level $\alpha$ means that the event that the realized loss $L$ exceeds $VaR$ happens at a probability no higher than $1-\alpha$, i.e., $Prob\,(L > VaR) \leq 1-\alpha$, or equivalently, $Prob\,(L < VaR) \geq \alpha$.

# Market for security and asset price

- Entrepreneurs fund their projects via issuing securities;
  - Security market opens at $t = 0$, each unit sold at price $P$.




*Financial intermediation emerges as a result of heterogeneity in preferences: those who are risk neutral become natural bankers, and those risk averse become depositors. In addition, $Pq_B - e$ is not required to be equal to $e - Pq_C$ here, since banks may raise funds from elsewhere.*

# Consumers' decision problem

- At $t = 0$, a consumer ("*non-leveraged investor*") chooses how much to invest on risky securities to maximize expected utility, i.e.

$$\max_{q_C} u(c) = E[Rq_C + e - Pq_C] - \frac{1}{2\tau} var[Rq_C + e - Pq_C] = \overline{R}q_C + e - Pq_C - \frac{1}{2\tau}\frac{z^2}{3}q_C^2.$$

*Remember for random variable* $x$, *if* $var[x] = \sigma^2$, $var[Ax] = A^2\sigma^2$ *given* $A$ *is a constant number.*

  - First order condition leads to consumers' demand for security $q_C(P)$

$$\frac{\partial u}{\partial q_C} = \overline{R} - P - \frac{1}{\tau}\frac{z^2}{3}q_C = 0 \Rightarrow q_C(P) = \begin{cases} \frac{3\tau(\overline{R}-P)}{z^2}, & \overline{R} \geq P; \\ 0, & otherwise. \end{cases}$$

# Banks' decision problem

- At $t = 0$, a bank ("*leveraged investor*") chooses how much to invest on risky securities and how much to borrow ("*leverage ratio*") to maximize expected return, i.e.

$$\max_{q_B} E\left[Rq_B - (Pq_B - e)\right] = \left(\overline{R} - P\right) q_B + e \quad (1);$$

  - Assumption 2: Banks are subject to $VaR$ requirement such that they should stay solvent even in the worst case, i.e., be able to repay depositors even when the payoff from risky assets is the lowest

$$e \geq VaR \;\Rightarrow\; \left(\overline{R} - z\right) q_B \geq Pq_B - e \;\Rightarrow\; e \geq \left(P - \overline{R} + z\right) q_B = VaR \quad (2).$$

*Banks usually hold least possible equity (why?), or,* $e = \left(P - \overline{R} + z\right) q_B$*, implying banks' debt from deposits is* $pq_B - e = \left(\overline{R} - z\right) q_B$.

# Asset price in equilibrium

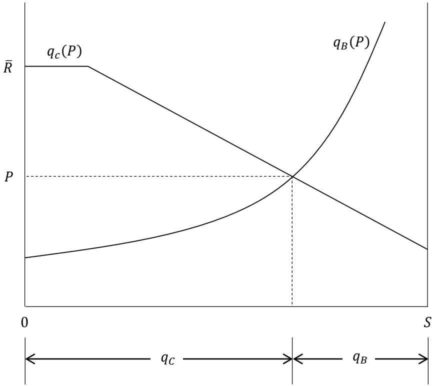
- Solving bank's problem defined by (1) and (2), we get bank's demand for security $q_B(P) = \frac{e}{P-\overline{R}+z}$;
  - Remember consumers' demand for security $q_C(P)$ is

$$q_C(P) = \begin{cases} \frac{3\tau\left(\overline{R}-P\right)}{z^2}, & \overline{R} \geq P; \\ 0, & otherwise; \end{cases}$$

  - Assumption 1 implies the aggregate supply of security is fixed, denote it by $S$. Depict $q_B(P)$ and $q_C(P)$ with fixed $S$, equilibrium $q_B$, $q_C$ and $P$ are determined simutaneously.

# Asset price in equilibrium (cont'd)

- Equilibrium bank's demand for security $q_B$, consumers' demand for security $q_C$ and security price $P$



# Asset price and leverage cycle: boom

- To capture the *feedback mechanism* between asset price and leverage in boom-bust cycle, suppose there is a shock to security return at $t = 0.5$, so that both banks and consumers have the chance to adjust their balance sheets;
  - At $t = 0.5$, it turns out that the distribution of security return is $\left[\overline{R'} - z, \overline{R'} + z\right]$, $\overline{R'} > \overline{R}$, or, the economy is in a *boom*
    - *Unleveraged investors* (consumers) will immediately respond with higher demand for security $q_C(P)$, leading to higher $q_C(P)$ curve and positive impact on $P$;

# Asset price and leverage cycle: boom (cont'd)

- (cont'd)
  - Suppose security price is now $\tilde{P} > P$. The direct impact is higher equity level ("*net worth*") in *leveraged investors'* (banks) balance sheet, given the debt (deposits) level remains the same as before;
    - Bank's $VaR$ constraint is relaxed, too: $\widetilde{e} = \tilde{P}q_B - \left(\overline{R} - z\right) q_B > e = VaR$, as shown in the figure

| Assets | Liabilities |
|---|---|
| Securities $Pq_B$ | Capital $e$ |
| | Deposits $(\overline{R} - z)q_B$ |

→

| Assets | Liabilities |
|---|---|
| Securities $\tilde{P}q_B$ | Capital $\tilde{e}$ |
| | Deposits $(\overline{R} - z)q_B$ |

# Asset price and leverage cycle: boom (cont'd)

- (cont'd)
  - The bank thus has incentive to take more debt, buy more security (increase $q_B$), expand balance sheet, and make $VaR$ constraint binding again. This implies

$$\tilde{e} = \tilde{P}\tilde{q}_B - \underbrace{\left(\overline{R'} - z\right)\tilde{q}_B}_{\textit{new debt level}} = \widetilde{VaR};$$

| Assets | Liabilities |
|---|---|
| Securities $\tilde{P}q_B$ | Capital $\tilde{e}$ |
| | Deposits $(\overline{R} - z)q_B$ |

→

| Assets | Liabilities |
|---|---|
| Securities $\tilde{P}\tilde{q}_B$ | Capital $\tilde{e}$ |
| | Deposits $\left(\overline{R'} - z\right)\tilde{q}_B$ |

# Asset price and leverage cycle: boom (cont'd)

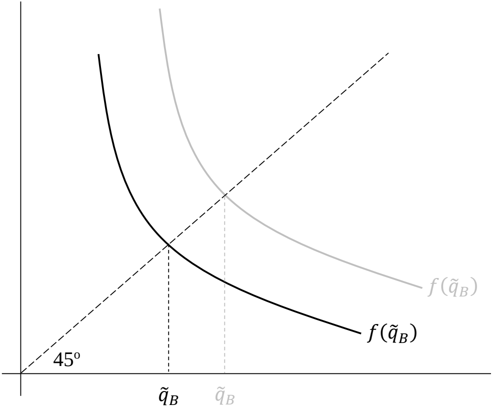
- (cont'd)
  - Express $\widetilde{q}_B$ with $q_B$ by combining two expressions for $\widetilde{e}$: $\widetilde{q}_B = \frac{\tilde{P}+z-\overline{R}}{\tilde{P}+z-\overline{R'}} q_B$;
    - The consumers' demand for security is now $\widetilde{q}_C = \frac{3\tau}{z^2}\left(\overline{R'} - \tilde{P}\right) = S - \widetilde{q}_B$. Analytical solution of $\widetilde{q}_B$ is derived by eliminating $\tilde{P}$

$$\widetilde{q}_B = \left[1 + \frac{\overline{R'} - \overline{R}}{z + \left(\widetilde{q}_B - S\right)\frac{z^2}{3\tau}}\right] q_B = f\left(\widetilde{q}_B\right);$$

  - Comparative statics: The impact of shocks to security return on $\widetilde{q}_B$ can be easily seen graphically.

# Asset price and leverage cycle: boom (cont'd)

- Comparative statics (cont'd): Higher $\overline{R'}$ shifts $f\left(\widetilde{q}_B\right)$ to the right, leading to bank's higher demand for security

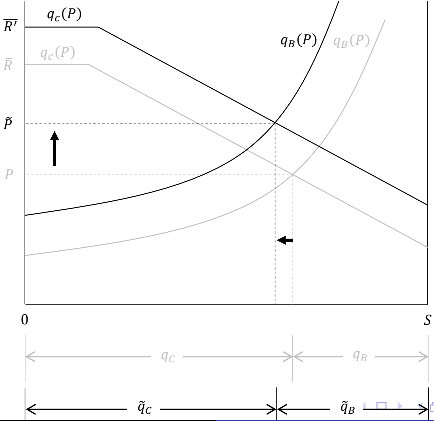


# Asset price and leverage cycle: boom (cont'd)

- Comparative statics (cont'd): $\tilde{q}_B$ is more *sensitive* to return shock when $z$ is smaller
  - Smaller $z$ implies lower risk in security return, therefore
    - Lower $VaR$, and lower capital ratio is needed. However
    - The bank is more leveraged, so that the impact of return shock is more amplified through leverage, leading to higher volatilities in demand for security and asset price.
  - To sum up: in the boom, positive shock to asset return eases $VaR$ constraint, inducing banks to *lever up* and expand balance sheet, leading to higher asset price and demand, which feeds to further expansion through $VaR$...

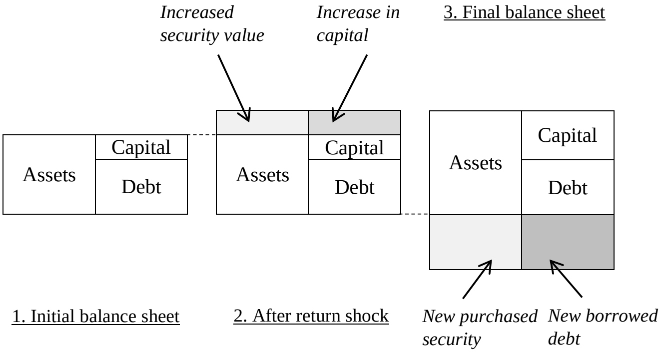
# Asset price and leverage cycle: boom (cont'd)

*We made the entire analysis in steps in order to better understand how economic boom gets amplified through leverage, while actually the equilibrium* $\widetilde{q}_B$, $\widetilde{q}_C$ *and* $\tilde{P}$ *can be simutaneously determined graphically following a positive shock in security return*



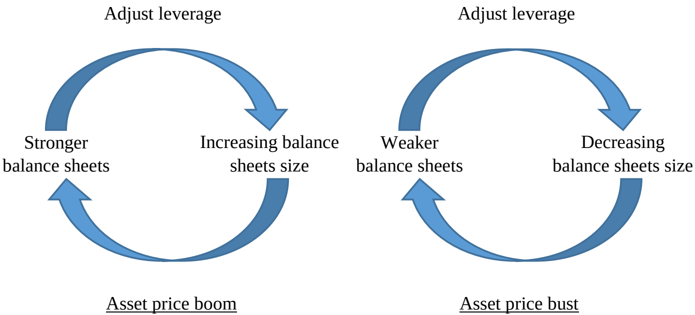
# Asset price and leverage cycle: boom (cont'd)

- The **balance sheet channel** of propagating macro shocks in the boom is summarized in the figure



# Feedback mechanism in leverage cycle

- Characterizing the **balance sheet channel** of propagating macro shocks in the bust is left as your exercise.
  - Initial macro shock triggers a *feedback loop* through *balance sheet adjustments*, amplifying initial shock: "*procyclicality*"



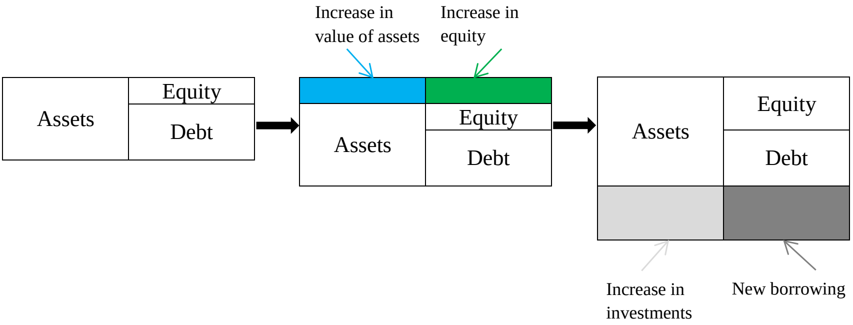
# Capital adquacy requirement

- Capital requirement is one of the best examples on how to design proper rules in financial regulation;
- Capital requirement is a good instrument
  - Provides *cushion* to absorb losses and avoid contagious spillover to the rest of the system;
  - Align with incentives: more "*skin-in the game*", encourage monitoring and avoid excess risk-taking;
  - Can reflect the risk in banks' assets: more risk, higher capital ratio;
  - Easy to understand and implement.

# Capital adquacy in design

- Capital requirement should be higher for *SIFI*s;
- Should be high enough to weather unanticipated systemic events;
- It should be waterproof for *regulatory arbitrage*
  - Should focus on *tier-1 capital* (common equity);
  - Should be less flexible in calculating *risk weights* of assets;
- Capital requirement rules should avoid **procyclicality**
  - Need to put a brake on banks' credit supply in the boom, while
  - Provide more room to cushion banks' losses in the bust.

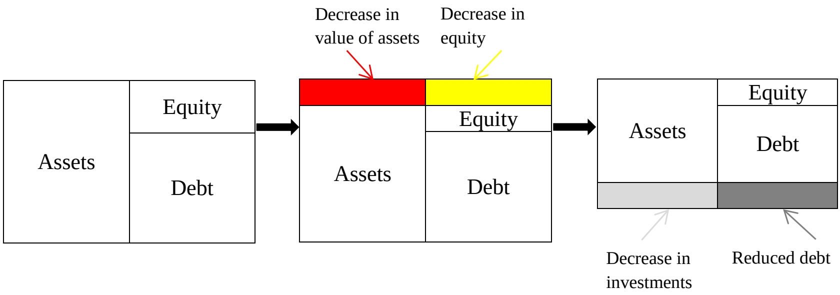
# Procyclicality: in the boom



# Procyclicality: in the boom (cont'd)

- Suppose capital ratio is required to be no less than 33%;
- In the boom, profit from each bank's assets makes equity ("*net worth*") doubled – now capital ratio becomes 50%;
- The capital requirement allows every bank to take in *more* debt for *more* investments, expanding its balance sheet by 50%;
- Demand for assets$\uparrow \rightarrow$ asset price$\uparrow \rightarrow$ banks' profit$\uparrow \rightarrow$ net worth$\uparrow \rightarrow$ debt$\uparrow$ & demand for assets$\uparrow$...
- Making banking sector *expand more in the boom*.

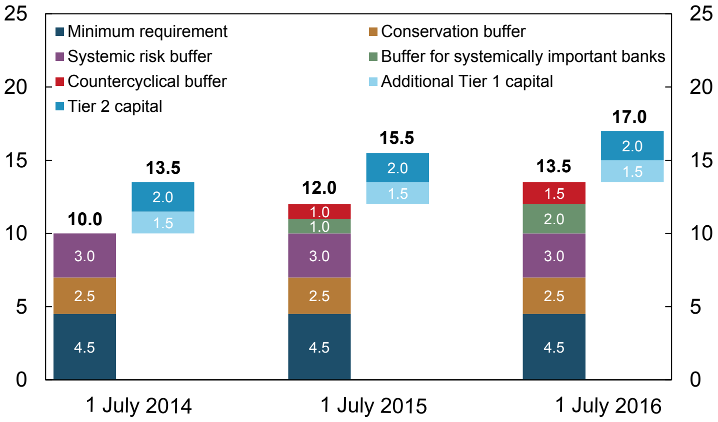
# Procyclicality: in the bust



# Procyclicality: in the bust (cont'd)

- Suppose capital ratio is required to be no less than 33%;
- In the bust, loss from each bank's assets makes equity halved – now capital ratio becomes 16.5%;
- The capital requirement forces every bank to cut off investments, contracting its balance sheet by 20%;
- Demand for assets$\downarrow$ $\rightarrow$ asset price$\downarrow$ $\rightarrow$ banks' loss$\uparrow$ $\rightarrow$ net worth$\downarrow$ $\rightarrow$ debt$\downarrow$ & demand for assets$\downarrow$...
- Making banking sector *contract more in the bust*.

# Countercyclical capital buffer in design (Norway)



# Countercyclical capital buffer in design (Norway)

- Minimum capital ratio increased to 4.5% from 2% (Basel II);
- Additional *conservation buffer* to cushion *idiosyncratic risks* and *systemic risk buffer* to weather *systemic events*;
- Addition buffer for identified *SIFI*s;
- Building up *countercyclical capital buffer* in the good time
  - To cool down booming credit supply, and
  - Allow banks to use the buffer for loss absorption during future downturn, subject to restrictions on executives' compensation.

# Countercyclical capital buffer in practice

- Challenges in implementing countercyclical capital buffer
  - How to properly measure indicators such as credit-to-GDP gap?
  - How to properly evaluate benefit and cost?
  - How to properly design the path of buffer building?
- Questions on the design of countercyclical capital buffer
  - Interaction with other regulatory requirements and monetary policy?
  - Banks' reaction to such requirements?
  - Is it really a good policy?