Banking Regulation in Theory and Practice

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Introduction

Why do we regulate banks?
Banking regulation in theory and practice

Foundations of Banking Regulation

Unstable banking
Macro-finance linkages
Systemic risks

Banking Regulation Toolbox

Objectives and tools
Liquidity and the Lender of Last Resort
Pillars in Basel III
(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.
“Now it is true that banks are very unpopular at the moment, but this (banking regulation) seems very much like a case of robbing Peter to pay Paul.” (The Economist, 20th July, 2011)
Banking, as other industries, needs regulation on issues where free market cannot discipline itself, to

- Create and enforce *rules of the game*;
- Restrict *market power* and keep market competitive;
- Correct *externalities* or other *market failures* due to moral hazard and adverse selection;
- Protect the interests of *taxpayers*. 
What make banking regulation special?

Banking regulation is special, compared with others like telecommunications:

- Focuses more on “safety” and less on “price”;
- *Taxpayer* protection, rather than consumer protection, is more important motivation and benchmark in regulatory design;
- The outcome is a crucial *public good:* *financial stability*;
- It prevents the spillover to the real economy through *macro-finance linkages,* such as “*financial accelerator*”.
"Déjà Vu All Over Again"

In the banking crises in these different countries, history keeps repeating itself. The parallels between the banking crisis episodes in all these countries are remarkably similar, creating a feeling of déjà vu. They all started with financial liberalization or innovation, with weak bank regulatory systems and a government safety net. Although financial liberalization is generally a good thing because it promotes competition and can make a financial system more efficient, it can lead to an increase in moral hazard, with more risk taking on the part of banks if there is lax regulation and supervision; the result can then be banking crises.4

However, the banking crisis episodes listed in Table 18.2 do differ in that deposit insurance has not played an important role in many of the countries experiencing banking crises. For example, the size of the Japanese equivalent of the FDIC, the Systemic banking crises

Episodes of
nonsystemic
banking crises

No crises
Insufficient
information

FIGURE 18.2
Banking Crises Throughout the World Since 1970


4A second Web appendix to this chapter, can be found on this book's Web site at www.pearsonhighered.com/mishkin_eakins, discusses in detail many of the episodes of banking crises listed in Table 18.2.
Cost of bank bailout since 1980

<table>
<thead>
<tr>
<th>Country</th>
<th>Date</th>
<th>Cost as Percentage of GDP</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1980–2007</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Indonesia</td>
<td>1997–2001</td>
<td>57</td>
</tr>
<tr>
<td>Argentina</td>
<td>1980–1982</td>
<td>55</td>
</tr>
<tr>
<td>Thailand</td>
<td>1997–2000</td>
<td>44</td>
</tr>
<tr>
<td>Chile</td>
<td>1981–1985</td>
<td>43</td>
</tr>
<tr>
<td>Turkey</td>
<td>2000–2001</td>
<td>32</td>
</tr>
<tr>
<td>South Korea</td>
<td>1997–1998</td>
<td>31</td>
</tr>
<tr>
<td>Israel</td>
<td>1977</td>
<td>30</td>
</tr>
<tr>
<td>Ecuador</td>
<td>1998–2002</td>
<td>22</td>
</tr>
<tr>
<td>Mexico</td>
<td>1994–1996</td>
<td>19</td>
</tr>
<tr>
<td>China</td>
<td>1998</td>
<td>18</td>
</tr>
<tr>
<td>Malaysia</td>
<td>1997–1999</td>
<td>16</td>
</tr>
<tr>
<td>Philippines</td>
<td>1997–2001</td>
<td>13</td>
</tr>
<tr>
<td>Brazil</td>
<td>1994–1998</td>
<td>13</td>
</tr>
<tr>
<td>Finland</td>
<td>1991–1995</td>
<td>13</td>
</tr>
<tr>
<td>Argentina</td>
<td>2001–2003</td>
<td>10</td>
</tr>
<tr>
<td>Jordan</td>
<td>1989–1991</td>
<td>10</td>
</tr>
<tr>
<td>Czech Republic</td>
<td>1996–2000</td>
<td>7</td>
</tr>
<tr>
<td>Sweden</td>
<td>1991–1995</td>
<td>4</td>
</tr>
<tr>
<td>United States</td>
<td>1988</td>
<td>4</td>
</tr>
<tr>
<td>Norway</td>
<td>1991–1993</td>
<td>3</td>
</tr>
<tr>
<td><strong>2007–2009</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Iceland</td>
<td>2007–2009</td>
<td>13</td>
</tr>
<tr>
<td>Ireland</td>
<td>2007–2009</td>
<td>8</td>
</tr>
<tr>
<td>Luxembourg</td>
<td>2007–2009</td>
<td>8</td>
</tr>
<tr>
<td>Netherlands</td>
<td>2007–2009</td>
<td>7</td>
</tr>
<tr>
<td>Belgium</td>
<td>2007–2009</td>
<td>5</td>
</tr>
<tr>
<td>United Kingdom</td>
<td>2007–2009</td>
<td>5</td>
</tr>
<tr>
<td>United States</td>
<td>2007–2009</td>
<td>4</td>
</tr>
<tr>
<td>Germany</td>
<td>2007–2009</td>
<td>1</td>
</tr>
</tbody>
</table>
Banking regulation: basic principles

- Banking regulation should be based on sound foundations
  - To address *well articulated problems*;
  - Using instruments working through well understood *mechanisms*;
- Banking regulation should target on *excessive* risk-taking while maintaining optimal *risk-sharing*;
- Regulatory policies should be *efficient*, or *incentive compatible*;
- Regulatory policies should be waterproof for *regulatory arbitrage*.
Financial crises and evolution of banking regulation

- Financial crisis is the most important driving force of banking regulation. The first greatest output was to create central banks worldwide;
- The second greatest output is to create global standards for banking regulation, namely, **Basel Accord** since 1988
  - **Basel I** (1988): on *credit risks* and *risk-weight* of assets;
  - **Basel II** (2004): more refinements, but failed miserably in the crisis
    - Internal Rating-Based (IRB) approach – opportunities to *arbitrage*;
    - Generates more volatilities through *procyclical* rules;
  - **Basel III** (2011) and **Basel IV** (?)
Reconstructing banking regulation

- Banking regulation needs to address **systemic risk**, 
  - The risk or probability of breakdowns in an *entire* system, as opposed to breakdowns in individual parts; 
  - Evidenced by *comovements* (*correlation*) among most or all the parts;

- Banking regulation needs to be **macroprudential** instead of microprudential, mitigating *systemic* risks instead of idiosyncratic risks;

- Banking regulation needs to be **countercyclical** instead of procyclical 
  - Building up buffers and cushions in the boom in order to 
  - Absorb shocks and losses in the bust.
Shades of grey are best appreciated when set against their two primitive components, black and white. Likewise, it is especially helpful to define the micro- and macroprudential perspectives in such a way as to sharpen the distinction between the two. So defined, by analogy with black and white, the macro- and microprudential souls would normally coexist in the more natural shades of grey of regulatory and supervisory arrangements.

As defined here, the macro and microprudential perspectives differ in terms of objectives and the model used to describe risk (Table 1).

<table>
<thead>
<tr>
<th></th>
<th>Macroprudential</th>
<th>Microprudential</th>
</tr>
</thead>
<tbody>
<tr>
<td>Proximate objective</td>
<td>limit financial system-wide distress</td>
<td>limit distress of individual institutions</td>
</tr>
<tr>
<td>Ultimate objective</td>
<td>avoid output (GDP) costs</td>
<td>consumer (investor/depositor) protection</td>
</tr>
<tr>
<td>Model of risk</td>
<td>(in part) endogenous</td>
<td>exogenous</td>
</tr>
<tr>
<td>Correlations and common</td>
<td>important</td>
<td>irrelevant</td>
</tr>
<tr>
<td>exposures across institutions</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Calibration of prudential</td>
<td>in terms of system-wide distress; top-down</td>
<td>in terms of risks of individual institutions;</td>
</tr>
<tr>
<td>controls</td>
<td></td>
<td>bottom-up</td>
</tr>
</tbody>
</table>

The objective of a macroprudential approach is to limit the risk of episodes of financial distress with significant losses in terms of the real output for the economy as a whole. That of the microprudential approach is to limit the risk of episodes of financial distress at individual institutions, regardless of their impact on the overall economy.

So defined, the objective of the macroprudential approach falls squarely within the macroeconomic tradition. That of its microprudential counterpart is best rationalised in terms of consumer (depositor or investor) protection.

To highlight the distinction between the two, it is useful to draw an analogy with a portfolio of securities. For the moment, think of these as the financial institutions in an economy. Assume, further, that there is a (monotonically) increasing relationship between the losses on this portfolio and the costs to the real economy. The macroprudential approach would then care about the tail losses on the portfolio as a whole; its microprudential counterpart would care equally about the tail losses on each of the component securities.

The implications for the setting of prudential controls are straightforward. The macroprudential approach is top-down. It first sets the relevant threshold of acceptable tail losses for the portfolio as a whole; the microprudential approach is bottom-up.

3 Previous statements of the distinction between the macro- and microprudential perspectives can be found in Crockett (2000a) and (2001a). Borio et al (2001) apply the distinction to the analysis of capital standards. Tsatsaronis (2002) provides a more in-depth, complementary analysis of these issues.

4 This view of prudential policy is formalised in Dewatripont and Tirole (1993).
Why is banking so unstable?

- Instability arising from bank runs has been presented in Diamond & Dybvig (1983)
  - **Maturity transformation:** one of the most important features in banking;
  - However, runs there are easily eliminated by deposit insurance, while
  - In reality banking is generally unstable — history shows that insurance did not make the system more stable;

- Why is banking still so unstable?
  - Moral hazard problem prevents full insurance;
  - Fragility may be necessary to discipline banks.
Fragility and instability: a model

A simple model based on Diamond & Rajan (2001) and Cao & Illing (2011)

Consider an economy extending over 3 periods, $t = 0, 1, 2$, with the following risk-neutral agents:

- **Depositors**: born with unit endowment at $t = 0$, deposit in banks; at $t = 1$ withdraw, consume and die;
- **Banks**: Bertrand competition in deposit market $\rightarrow$ zero profit;
- **Entrepreneurs**: borrow from banks, produce, and repay loans.

- No asymmetric information.
Two types of entrepreneurs, distinguished by the types of their projects:

- **Safe projects**: start at \( t = 0 \), return \( R_1 > 1 \) with certainty at \( t = 1 \);
- **Risky projects**: start at \( t = 0 \), return \( R_2 > R_1 \), however
  - With probability \( p \), realize at \( t = 1 \), and \( 1 < pR_2 < R_1 \);
  - With probability \( 1 - p \), return postponed to \( t = 2 \).

Banks would love to support only risky projects, while depositors prefer safe ones: maturity mismatch.
Incomplete contract and desire for fragility

- Entrepreneurs have expertise on operating projects ("inalienable human capital"), while bankers only get $\gamma R_i$ ($\gamma > p$) if they operate themselves
  - Entrepreneurs would walk away if the return demanded by bankers is too high: a *credible* threat;
  - In equilibrium bankers collect $\gamma R_i$ from projects’ return;

- However, depositors do not have such collection skills
  - Bankers have the power to renegotiate with depositors at $t = 1$;
  - Depositors exercise bank run as *commitment device*, preventing renegotiation: desire for fragility.
At $t = 0$

- Banks decide their investment plan: share $\alpha$ on safe projects and $1 - \alpha$ on risky projects, and offer deposit contracts promising the return $d_0 > 1$ to depositors;

<table>
<thead>
<tr>
<th>Assets</th>
<th>Liabilities</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\alpha$ on safe projects</td>
<td>Deposits</td>
</tr>
<tr>
<td>$1 - \alpha$ on risky projects</td>
<td></td>
</tr>
</tbody>
</table>
Timing (cont’d)

- At $t = \frac{1}{2}$
  - If depositors have doubt on bank’s return, they can run on the bank — all projects have to be liquidated, with poor return $c < 1$;

- At $t = 1$
  - Banks collect early returns, and depositors withdraw $d_0$;
  - Banks may borrow from early entrepreneurs (those with safe projects and risky projects that return early) using collateral;

- At $t = 2$
  - Banks collect returns from late projects and repay early entrepreneurs.
### Timing (cont’d)

**Timing of the model:**

<table>
<thead>
<tr>
<th>$t = 0$</th>
<th>$t = 1/2$</th>
<th>$t = 1$</th>
<th>$t = 2$</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Investors</strong> deposit; <strong>Bank</strong> chooses</td>
<td><strong>Early Projects</strong></td>
<td><strong>Late Projects</strong></td>
<td></td>
</tr>
<tr>
<td>$\alpha$</td>
<td>Type 1 projects $\rightarrow$</td>
<td>$R_1$</td>
<td>$R_2$</td>
</tr>
<tr>
<td>$1 - \alpha$</td>
<td>Type 2 projects $\rightarrow$</td>
<td></td>
<td>$R_2$</td>
</tr>
</tbody>
</table>

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**Fig. 1.** Timing and payoff structure, when banks are liquid.

**Fig. 2.** Timing and payoff structure, when banks are illiquid.

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2.3 The central planner’s constrained efficient solution

We first analyze the problem of a central planner maximizing the investors’ payoff. This provides the reference point for the market equilibrium with banks as financial intermediaries characterized in the next section. Investors being impatient, the central planner would choose the share invested in illiquid projects so as to maximize the resources available to investors at period 1. Since $p_s < R_2 < R_1$, in the absence of hold up problems, he would invest only in liquid type 1 projects, this way maximizing resources available at period 1. But due to the hold-up problem caused by entrepreneurs, the central planner can implement only a constrained efficient solution. If the central planner had unlimited taxation authority, he could eliminate the hold-up problem completely by taxing the entrepreneurs’ rent and redistributing the resources to the investors. Again, all resources would be invested only in liquid type 1 projects, and the entrepreneurs’ rents would be transferred to...
Debt roll-over and liquidity

- At $t = 1$ banks have
  - Collected return from early projects, $\gamma [\alpha R_1 + (1 - \alpha) \rho R_2]$;
  - Loans to the postponed projects, $\gamma (1 - \alpha) (1 - \rho) R_2$;
- Early entrepreneurs have $(1 - \gamma) [\alpha R_1 + (1 - \alpha) \rho R_2]$;
- To maximize deposit repayment to depositors, banks may borrow from early entrepreneurs, using postponed projects as collateral.
Bank’s balance sheet after $t = 1$

<table>
<thead>
<tr>
<th>Assets</th>
<th>Liabilities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Late risky projects</td>
<td>Debt to early entrepreneurs</td>
</tr>
</tbody>
</table>
Bank’s optimal strategy boils down to its choice on $\alpha$, which leads to “just enough” collateral for debt roll-over:

$$\alpha = \frac{\gamma - p}{\gamma - p + (1 - \gamma) \frac{R_1}{R_2}};$$

Depositor’s return $d_0 = \gamma [\alpha R_1 + (1 - \alpha) R_2] = \alpha R_1 + (1 - \alpha) pR_2 = E[R] > \gamma R_1$;

- Maturity transformation is *welfare improving*;
- However, if there is anything wrong in debt roll-over, banks are exposed to *liquidity risk*. 
Maturity transformation and liquidity risk (cont’d)

- Bank’s liquidity risk comes from two sources
  - Market liquidity: on the assets side, the liquid assets that can be converted to cash without much discount (“haircut”) when necessary — value of bank assets in this model;
  - Funding liquidity: on the liabilities side, the funding that a bank can raise without too high cost when it needs to roll over its debt — debt to the entrepreneurs in this model;

- A bank’s liquidity changes over time: a liquid balance sheet can easily becomes illiquid under market stress.
Liquidity risk under aggregate shock

- Now suppose there is uncertainty on $p$
  - $p$ can take two values, $0 < p_L < p_H < \gamma$;
  - $p$ is unknown at $t = 0$, and revealed at $t = \frac{1}{2}$. Probability of being $p_H$ is $\pi$;

- Consider two extreme cases
  - $\pi \to 1$, $\alpha_H = \frac{\gamma - p_H}{\gamma - p_H + (1 - \gamma) \frac{R_1}{R_2}}$ and
    \[ d_0 = \alpha R_1 + (1 - \alpha) p_H R_2 = E[R_H]; \]
  - $\pi \to 0$, $\alpha_L = \frac{\gamma - p_L}{\gamma - p_L + (1 - \gamma) \frac{R_1}{R_2}} > \alpha_H$ and
    \[ d_0 = \alpha R_1 + (1 - \alpha) p_L R_2 = E[R_L]; \]
  - What happens in between?
Liquidity risk under aggregate shock (cont’d)

- Suppose $\pi$ goes down from 1, following $\alpha_H$
  - Depositor’s return is $E[R_H]$ with probability $\pi$ and $c$ with $1 - \pi$;
  - Bank sticks to $\alpha_H$ as long as $\pi E[R_H] + (1 - \pi) c > E[R_L]$. 

\[ E[R(\alpha_i)] \quad E[R(\alpha_H, \pi, c)] \]

\[ E[R(\alpha_L)] \quad \pi \]

Suppose $\pi$ goes down from 1, following $\alpha_H$

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\[ E[R(\alpha_i)] \quad E[R(\alpha_H, \pi, c)] \]

\[ E[R(\alpha_L)] \quad \pi \]
Macro-finance: the missing link

- Dynamic stochastic general equilibrium models were so successful that they dominated central banks’ monetary policy analysis before the crisis. However
  - It was assumed that monetary policy could perfectly reach real economy: banking sector is a *black box* that always does the job (which was proved to be wrong);
  - Even in those models with financial frictions, banks were passive “financial accelerator” instead of *trouble makers*;
- It has been mostly agreed that, before the crisis, monetary policy with ignorance of *macro-finance linkages* missed the building-up of financial imbalances.
One biggest challenge in central banking research and practice is to address macro-finance linkages, including

- *Business-driven credit cycles*, in which macro shocks are amplified by banking sector. Often addressed by financial accelerator models;
- *Credit-driven business cycles*, in which shocks are generated from inside banking sector and spill over to real economy. Poorly understood;

We focus on two types of financial frictions with strong macro impacts

- *Lender- (Bank-) side frictions*: macro shocks affect banks’ balance sheet, then get amplified by balance sheet adjustments ⇒ *leverage cycle*;
- *Borrower-side frictions*: macro shocks affect borrowers’ collateral value & credit demand ⇒ *financial accelerator*. 

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**J. C.**

**Banking Regulation in Theory and Practice**
Leverage cycle: 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 $[\bar{R} - z, \bar{R} + z]$, with $\bar{R} > 1$, $z > 0$. Therefore

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

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

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

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.
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 (“Value-at-Risk”);

**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., $\text{Prob}(L > VaR) \leq 1 - \alpha$, or equivalently, $\text{Prob}(L < VaR) \geq \alpha$. 
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.

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

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

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

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

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

- 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

$$e \geq VaR \Rightarrow (\bar{R} - z) q_B \geq Pq_B - e \Rightarrow e \geq (P - \bar{R} + z) q_B = VaR \ (2).$$

Banks usually hold least possible equity (why?), or,

$$e = (P - \bar{R} + z) q_B, \text{ implying banks’ debt from deposits is}$$

$$pq_B - e = (\bar{R} - z) q_B.$$
Solving bank’s problem defined by (1) and (2), we get bank’s demand for security $q_B(P) = \frac{e}{P-\bar{R}+z}$;

Remember consumers’ demand for security $q_C(P)$ is

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

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 simultaneously.
Asset price in equilibrium (cont’d)

- Equilibrium bank’s demand for security $q_B$, consumers’ demand for security $q_C$ and security price $P$
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 $[\bar{R}' - z, \bar{R}' + z]$, $\bar{R}' > \bar{R}$, 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)

(1) 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;

(2) Bank’s VaR constraint is relaxed, too:

$$\tilde{e} = \tilde{P} q_B - (\tilde{R} - z) q_B > e = \text{VaR},$$

as shown in the figure.

<table>
<thead>
<tr>
<th>Assets</th>
<th>Liabilities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Securities $P q_B$</td>
<td>Capital $e$</td>
</tr>
<tr>
<td>Deposits $(\tilde{R} - z) q_B$</td>
<td></td>
</tr>
</tbody>
</table>

<table>
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<td>Securities $\tilde{P} q_B$</td>
<td>Capital $\tilde{e}$</td>
</tr>
<tr>
<td>Deposits $(\tilde{R} - z) q_B$</td>
<td></td>
</tr>
</tbody>
</table>
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

$$\tilde{e} = \tilde{P}\tilde{q}_B - (\tilde{R}' - z)\tilde{q}_B = \tilde{VaR};$$

\textit{new debt level}
Asset price and leverage cycle: boom (cont’d)

(Cont’d)

Express \( \tilde{q}_B \) with \( q_B \) by combining two expressions for \( \tilde{e} \):

\[
\tilde{q}_B = \frac{\tilde{P} + z - \bar{R}}{\tilde{P} + z - \bar{R}'} q_B;
\]

The consumers’ demand for security is now

\[
\tilde{q}_c = \frac{3\tau}{z^2} \left( \bar{R}' - \tilde{P} \right) = S - \tilde{q}_B.
\]

Analytical solution of \( \tilde{q}_B \) is derived by eliminating \( \tilde{P} \):

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

Comparative statics: The impact of shocks to security return on \( \tilde{q}_B \) can be easily seen graphically.
Comparative statics (cont’d): Higher $\overline{R}'$ shifts $f(\widetilde{q}_B)$ to the right, leading to bank’s higher demand for security.
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 $\tilde{q}_B$, $\tilde{q}_C$ and $\bar{P}$ can be simultaneously determined graphically following a positive shock in security return.
The **balance sheet channel** of propagating macro shocks in the boom is summarized in the figure.

1. Initial balance sheet
2. After return shock
3. Final balance sheet

- **Increased security value**
- **Increase in capital**
- **New purchased security**
- **New borrowed debt**
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”

Adjust leverage

Stronger balance sheets
Increasing balance sheets size
Asset price boom

Weaker balance sheets
Decreasing balance sheets size
Asset price bust
Consider the baseline case: economy with perfect financial market, a production sector (firms) deploying single input $x$;

- **Assumption 1**: Firms’ technology $f(x)$ is *neoclassical* such that $f'(x) > 0$ and $f''(x) < 0$;
- A representative firm has small initial wealth $W$, and borrows $L$ (at gross interest rate $R$) on top of $W$ from the banking sector for input, i.e., $x = W + L$. Its decision is

$$
\max_L f(L + W) - RL;
$$

- The optimal borrowing comes from the first order condition, $f'(L + W) = R$, marginal product equals marginal cost of borrowing.
Suppose now financial market is imperfect. Firms are not guaranteed to behave properly: during production, entrepreneurs may walk away with private benefit, leaving nothing in the firms;

- A firm owns some *pledgeable* assets $K$, which can serve as *collateral* and be sold at price $P$;
  - Banks should not lend more than $PK$ to the firm;
- The firm’s problem is now

\[
\max_{L^C} f (L^C + W) - RL^C, \quad \text{s.t. } RL^C \leq PK;
\]

- **Assumption 2**: Suppose $K$ is small so that the borrowing constraint is always binding.
Set up Lagrangian for the optimization problem

\[ \mathcal{L} = f (L^C + W) - RL^C - \lambda (RL^C - PK), \]

And first order condition leads to

\[ f' (x^C) = R + \lambda \text{ with } RL^C = PK \text{ and } \lambda > 0; \]

Comparing with the case of perfect financial market, \( x^C < x \) since \( f' (x^C) = R + \lambda > f' (x) = R \), and \( f (x^C) < f (x) \). Lower feasible credit and output.
The impact of such credit constraint becomes more pronounced in a *dynamic, general equilibrium* setup (Bernanke & Gertler, 1989). After an initial macro shock, say, increase in firms’ productivity:

- Consumers earn more wage from firms, hence higher demand for firms’ product;
  - Firms get higher profit, increasing firms’ value, and more *collateral* available for borrowing;
  - Then more borrowing from firms, leading to even higher output for the next period;
- Initial boom increases firms’ collateral value, allowing for more borrowing, then even higher output: “*financial accelerator*”.
The root of evils

- Principal-agent problems and limited liability that encourage banks to take excessive risks, e.g., biased incentives from OPM (Other People’s Money) instead of MOM (My Own Money);
- Externalities that lead to inferior allocation of resources and risks
  - Positive externalities – taking the full cost while generating benefit to others – reduce necessary buffers in banking system, e.g., liquid assets holdings;
  - Negative externalities – taking the full benefit while cost partially borned by others – lead to excess risk-taking, e.g., interbank borrowing.
Example: systemic liquidity shortages

- Banks need to hold some liquid assets – assets that can be easily converted to cash – in order to cushion demand shocks from depositors
  - There’s opportunity cost in holding liquid assets, while
  - It benefits stressed banks through interbank lending;
- Positive externality $\rightarrow$ systemic liquidity shortage among banks.
There has been a secular decline in liquid assets as a share of bank balance sheets over the last three decades. Figure 1 depicts the liquidity ratios of the banking systems in the United States and the United Kingdom during this period. While the average liquidity ratio for US banks was roughly constant at a level of 5–7% during the 1980s and early 1990s, it dropped to below 1% before the outbreak of the financial crisis in 2007. A similar picture arises for the UK, where the liquidity ratio was steady at a level of about 3% during the 1980s and early 1990s, dropping to a level of 1% and below in the 2000s.

**Figure 1:** Liquid assets as a share of banks’ balance sheet in percentage points for the US (left panel, 1980–2010) and the UK (right panel, 1980–2008). Note: The chart for the US shows obligations of the US Treasury held by FDIC-insured commercial banks as a proportion of total FDIC-insured commercial bank assets. Source: www2.fdic.gov/hsob, Commercial Bank reports. The chart for the UK shows the ‘broad’ liquidity ratio of UK banks reported in Bank of England Financial Stability Report (October, 2008), which shows cash, central bank balances, money at call, eligible bills and UK gilts held by the UK banking sector as a proportion of total UK banking sector assets. Source: www.bankofengland.co.uk.

Liquidity regulation plays a major role in recent proposals for financial reform. These proposals include the introduction of rules governing the composition of banks’ balance sheets envisaged under the Basel Committee on Banking Supervision’s proposed Liquidity Coverage Ratio (LCR) or Net Stable Funding Ratio (BCBS (2010)). Both regulatory tools seek to impose limits on the degree of liquidity mismatch on a bank’s balance sheet by, for example, imposing a lower bound on banks’ liquidity ratios. Liquidity regulation is also being considered for use as part of the macroprudential toolkit in the United Kingdom (Bank of England (2011)).

This paper studies optimal macroprudential regulation in an interconnected financial system subject to system-wide bank runs. To what extent would individual institutions self-insure against bank runs by holding liquidity buffers over and above those needed to meet expected...
Example: network externality

\[ A \rightarrow B \]
\[ D \rightarrow C \]

\[ A \rightarrow B \]
\[ D \rightarrow C \]

\[ A \rightarrow B \]
\[ D \rightarrow C \]

\[ A \rightarrow B \]
\[ D \rightarrow C \]
Example: network externality (cont’d)

- Interbank lending makes the banks a “web of claims”, or banking network;

- One bank’s failure leads to losses of connecting banks’; bank failure may further spread over the network – contagion or “domino effect”;

- In good time banks make profit with borrowed money from other banks, while in bad time the connecting banks suffer from losses, too – negative externality;

- Too much reliance on interbank lending – “too-interconnected-to-fail”.
Systemic risk indicators: the devil in the details

- Financial history suggests the following *lead indicators* for systemic events:
  - “Capital Flow Bonanzas”;
  - Waves of financial innovation;
  - Housing boom;
  - Financial liberalization;
  - After all, *credit growth* seems single best indicator for financial instability;

- Regulators need watch the indicators, while design rules to target sources of systemic risks.
Objectives and related market failures

- Mitigate and prevent excessive credit growth
  - *Credit crunch externalities*: a sudden tightening of the conditions required to obtain a loan, resulting in a reduction of the availability of credit to the non-financial sector;
  - *Endogenous risk-taking*: incentives that during a boom generate excessive risk-taking and, in the case of banks, a deterioration of lending standards;
  - Risk illusion: collective *underestimation* of risk related to short-term memory and the infrequency of financial crises;
  - *Bank runs*: the withdrawal of wholesale or retail funding in case of actual or perceived insolvency;
  - *Network externalities*: contagious consequences of uncertainty about events at an institution or within a market.
Mitigate and prevent excessive *maturity mismatch* and *market illiquidity*

- *Fire sales externalities*: arise from the forced sale of assets due to excessive asset and liability mismatches. This may lead to a liquidity spiral whereby falling asset prices induce further sales and spillovers to financial institutions with similar asset classes;
- *Bank runs*;
- *Market illiquidity*: the drying-up of interbank or capital markets resulting from a general loss of confidence or very pessimistic expectations.
Objectives and related market failures (cont’d)

- Strengthen the resilience of financial infrastructures
  - Network externalities;
  - Fire sales externalities;
  - Compensation structures that provide incentives for risky behavior;

- Reducing moral hazard
  - Excessive risk-taking due to expectations of a bailout due to the perceived system relevance of an individual institution, or “too-big-to-fail”.

J. C. Banking Regulation in Theory and Practice
Banking regulation instruments

1. Mitigate and prevent excessive credit growth and leverage
   - Countercyclical capital buffer
   - Sectoral capital requirements (including intra-financial system)
   - Macro-prudential leverage ratio
   - Loan-to-value requirements (LTV)
   - Loan-to-income/debt (service)-to-income requirements (LTI)

2. Mitigate and prevent excessive maturity mismatch and market illiquidity
   - Macro-prudential adjustment to liquidity ratio (e.g. liquidity coverage ratio)
   - Macro-prudential restrictions on funding sources (e.g. net stable funding ratio)
   - Macro-prudential unweighted limit to less stable funding (e.g. loan-to-deposit ratio)
   - Margin and haircut requirements
3. **Limit direct and indirect exposure concentration**
   - Large exposure restrictions
   - CCP clearing requirement

4. **Limit the systemic impact of misaligned incentives with a view to reducing moral hazard**
   - SIFI capital surcharges

5. **Strengthen the resilience of financial infrastructures**
   - Margin and haircut requirements on CCP clearing
   - Increased disclosure
   - Structural systemic risk buffer
Central bank as the lender of last resort

- The classical doctrine (Thornton, 1802 and Bagehot, 1873): during market stress
  - Lend only against good collateral to solvent banks;
  - Lend at a penalty rate (to banks that are illiquid);
  - Credible policy: willing to lend without limits;

- However, it is generally hard to follow
  - Impossible to distinguish illiquidity and insolvency;
  - Creates moral hazard problem, e.g., too-big-to-fail;
  - Subject to political pressure and regulatory capture;

- Liquidity regulation is needed.
Central bank doesn’t create real value, but rather inject fiat money into banking system against good collateral (late projects)

<table>
<thead>
<tr>
<th>Depositors: nominal deposit contract $d_0$</th>
<th>Banker decides $\alpha$</th>
<th>1 $-\alpha$</th>
<th>Central Bank</th>
</tr>
</thead>
<tbody>
<tr>
<td>$t = 0$: $p$ unknown</td>
<td>$t = 0.5$: $p$ revealed</td>
<td>$t = 1$</td>
<td>$t = 2$</td>
</tr>
<tr>
<td>Run</td>
<td>$R_1$</td>
<td>$R_2$ with prob. $p$</td>
<td>$R_2$ with prob. $1 - p$</td>
</tr>
</tbody>
</table>
Lender of last resort and bank run

- Suppose $\pi$ is sufficiently high so that banks choose $\alpha_H$
  - Depositors get $d_0 = E[R_H]$ real return under $p_H$
- But when $p_L$ gets revealed, depositors have two choices
  - If they do not run, they get paid $d_0 = E[R_H]$ nominal return which allows them to buy $\alpha_H R_1 + (1 - \alpha_H) p_L R_2 > 1$ real goods;
  - If they run, they get real liquidation value $c < 1$.
- Of course they won’t run. With lender of last resort policy, depositors get higher real return than market solution:
  \[
  \pi E[R_H] + (1 - \pi) [\alpha_H R_1 + (1 - \alpha_H) p_L R_2] > \\ \pi E[R_H] + (1 - \pi) c.
  \]
Moral hazard and liquidity regulation

- Unfortunately, this cannot be the equilibrium outcome
  - Delayed (high return) projects are good collateral, allowing banks to borrow and promise higher *nominal* return to depositors: no need to hold liquid assets;
  - Competition makes all banks choose $\alpha = 0$;
  - Depositors get *nominal* return $d'_0 = \gamma R_2 > d_0$, while the *real* return is $\pi p_H R_2 + (1 - \pi) p_L R_2$, lower than $\pi E[R_H] + (1 - \pi) [\alpha_H R_1 + (1 - \alpha_H) p_L R_2]$;

- Moral hazard arising from central bank policy — depositors get *worse* off!

- Solution? Imposing $\alpha_H$ as *entry requirement* to complement!
Liquidity requirement: LCR

- Liquidity Coverage Ratio (LCR) in Basel III to address *market liquidity risk*
  - Sufficient liquid assets to withstand a 30-day stressed funding scenario;
  - Unencumbered, high quality liquid assets that can be converted to cash to meet liquidity demand;
  - \[ LCR = \frac{\text{Stock of high-quality assets}}{\text{Net cash outflows over 30 days}} \geq 100\%; \]

- In the similar vein, LCR can be captured by \( \alpha^* \) in our model
  - Banks should hold a share of liquid assets as *entry* condition;
  - To deter excessive engagement in liquidity risk and achieve constrained efficiency with monetary policy.
Liquidity requirement: NSFR

- Net Stable Funding Ratio (NSFR) in Basel III to address funding liquidity risk
  - NSFR measures the proportion of long-term assets which are funded by long-term, stable funding – such as customer deposits, long-term wholesale, equity, etc.;
  - NSFR is required to be no lower than 100%.
Liquidity regulation: facts and challenges

- From very limited experience of liquidity regulation in the Netherlands and UK
  - Banks tend to respond to regulation from liability side, reducing short-term funding;
  - Instead of reducing lending to certain sectors;
- However, still many potential problems, most of them not well understood, e.g.
  - Interaction between liquidity regulation and monetary policy?
  - Impact on systemic risk?
Capital adequacy 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 adequacy in design

- Capital requirement should be higher for SIFIs;
- 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

- Increase in value of assets
- Increase in equity
- Increase in investments
- New borrowing
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↑ → asset price↑ → banks’ profit↑ → net worth↑ → debt↑ & demand for assets↑...

Making banking sector expand more in the boom.
Procyclicality: in the bust

- Decrease in value of assets
- Decrease in equity
- Decrease in investments
- Reduced debt
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 ↓ → asset price ↓ → banks’ loss ↑ → net worth ↓ → debt ↓ & demand for assets ↓ ...
- Making banking sector *contract more in the bust*. 
Countercyclical capital buffer in design (Norway)

- Minimum requirement
- Systemic risk buffer
- Countercyclical buffer
- Tier 2 capital
- Conservation buffer
- Buffer for systemically important banks
- Additional Tier 1 capital

<table>
<thead>
<tr>
<th>Year</th>
<th>Minimum requirement</th>
<th>Systemic risk buffer</th>
<th>Countercyclical buffer</th>
<th>Tier 2 capital</th>
<th>Conservation buffer</th>
<th>Systemic risk buffer</th>
<th>Buffer for systemically important banks</th>
<th>Additional Tier 1 capital</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 July 2014</td>
<td>10.0</td>
<td>3.0</td>
<td>13.5</td>
<td>4.5</td>
<td>2.0</td>
<td>1.5</td>
<td>2.0</td>
<td>1.5</td>
</tr>
<tr>
<td>1 July 2015</td>
<td>12.0</td>
<td>3.0</td>
<td>15.5</td>
<td>4.5</td>
<td>2.0</td>
<td>1.5</td>
<td>2.0</td>
<td>1.5</td>
</tr>
<tr>
<td>1 July 2016</td>
<td>13.5</td>
<td>3.0</td>
<td>17.0</td>
<td>4.5</td>
<td>2.0</td>
<td>1.5</td>
<td>2.0</td>
<td>1.5</td>
</tr>
</tbody>
</table>
Countercyclical capital buffer in design (Norway)

- Minimum capital ratio increased to 4.5% from 2% (Basel II);
- Additional *conservation buffer* to cushion *idosyncratic risks* and *systemic risk buffer* to weather *systemic events*;
- Addition buffer for identified *SIFIs*;
- 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?
Conclusion

- Banking regulation is special:
  - More focus on “safety” than “price”;
  - Much greater macroeconomic consequences and implication for taxpayers’ interests;

- Banking regulation design must come from sound economic theories
  - Using instruments directly targeting on market failures, based on clear lead indicators;
  - Rules need to be macroprudential, countercyclical and arbitrage-proof.