Banking Regulation in Theory and Practice

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Outline

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.

Prelude

“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)

Why regulation?

Banking, as other industries, needs regulation on issues where free market cannot discipline itself, to

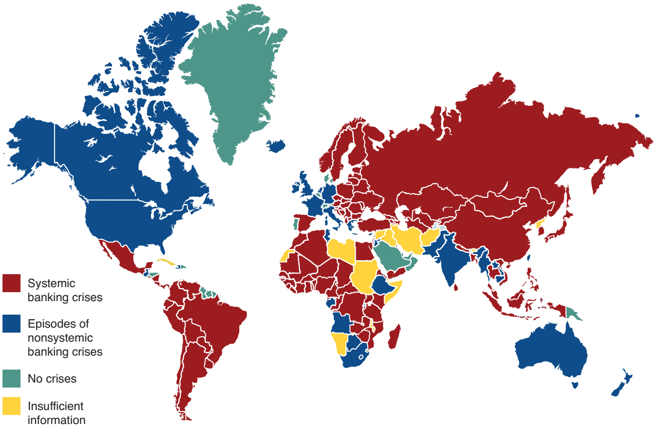
- Create and enforce *rules of the game*;
- Restrict *market power* and keep market competitive;
- Correct *externalities* or other *market failures* due to moral hazard and adverse selection;
- Protect the interests of *taxpayers*.

What make banking regulation special?

Banking regulation is special, comparing 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*".

Banking crises since 1970



Cost of bank bailout since 1980

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

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
    - **I**nternal **R**ating-**B**ased (IRB) approach – opportunities to *arbitrage*;
    - Generates more volatilities through *procyclical* rules;
  - **Basel III** (in progress).

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.

What's new in macroprudential regulation?

The macro- and microprudential perspectives compared

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

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 descipline 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 competion in deposit market $\rightarrow$ zero profit;
  - **Entrepreneurs**: borrow from banks, produce, and repay loans.
- No asymmetric information.

Technology

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 γR_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 γR_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.

Timing

At $t = 0$

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

Assets	**Liabilities**
α on safe projects	Deposits
$1-\alpha$ on risky projects	

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:

			Early Projects	Late Projects
$t = 0$		$t = 1/2$	$t = 1$	$t = 2$
Investors deposit;				
Bank	α	Type 1 projects →	$\boldsymbol{R_1}$	
chooses	$1 - \alpha$	Type 2 projects →	$\boldsymbol{R_2}$	$\boldsymbol{R_2}$

Debt roll-over and liquidity

- At $t = 1$ banks have
  - Collected return from early projects, $\gamma\left[\alpha R_1 + (1-\alpha)\, pR_2\right]$;
  - Loans to the postponed projects, $\gamma\,(1-\alpha)\,(1-p)\,R_2$;
- Early entrepreneurs have $(1-\gamma)\left[\alpha R_1 + (1-\alpha)\, pR_2\right]$;
- To maximize deposit repayment to depositors, banks may borrow from early entrepreneurs, using postponed projects as collateral.

Debt roll-over and liquidity (cont'd)

- Bank's balance sheet after $t = 1$

Assets	Liabilities
Late risky projects	Debt to early entrepreneurs

Maturity transformation and liquidity risk

- Bank's optimal strategy boils down to its choice on α, 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 $d_0 = \gamma\left[\alpha R_1 + (1-\alpha) R_2\right] = \alpha R_1 + (1-\alpha) p R_2 = E\left[R\right] > \gamma R_1$;
  - 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)

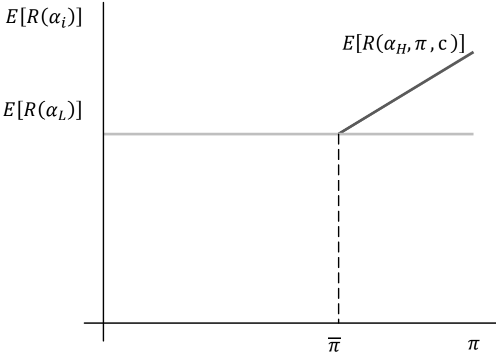
- Bank's liquidity risk comes from two sources
  - **Market liquidity**: on the *assets* side, the liquid assets that can be converted to cash without much discount ("haircut") when necessary — value of bank assets in this model;
  - **Funding liquidity**: on the *liabilities* side, the funding that 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 π;
- 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 π goes down from 1, following α_H
  - Depositor's return is $E[R_H]$ with probability π and c with $1-\pi$;
  - Bank sticks to α_H as long as $\pi E[R_H] + (1-\pi)c > E[R_L]$.



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-finace linkages* missed the building-up of financial imbalances.

Macro-finance: the missing link (cont'd)

- 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*.

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 $\left[\overline{R} - z, \overline{R} + z\right]$, with $\overline{R} > 1$, $z > 0$. Therefore

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

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

Leverage cycle: 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 τ is parameter for risk tolerance: the higher it is, the more risk consumers can tolerate. Assume τ is constant across consumers.

Leverage cycle: model setup (cont'd)

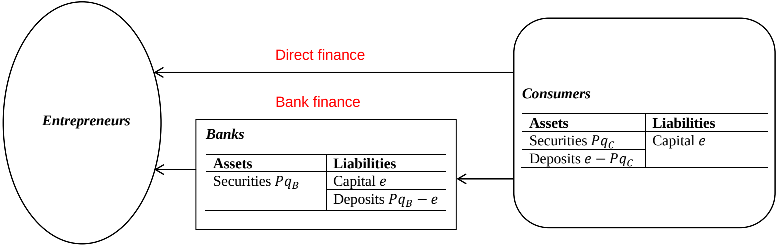
- There are many *risk neutral* banks, or *leveraged investors*, each of them
  - Invests only on risky projects, and can borrow from consumers (that's why banks are "*leveraged*");
    - Manages balance sheet using VaR ("**V**alue-**a**t-**R**isk");

Definition

The VaR of a portfolio at confidence level α 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

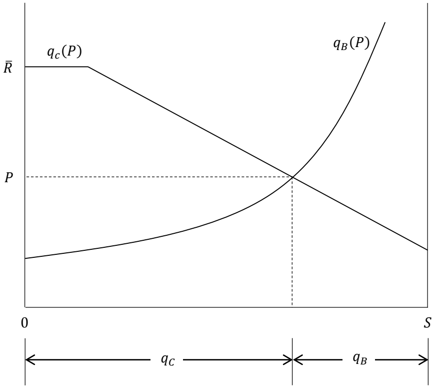
- Solving bank's problem defined by (1) and (2), we get bank's demand for security $q_B(P) = \frac{e}{P-\overline{R}+z}$;
  - Remember consumers' demand for security $q_C(P)$ is

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

  - 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: $\tilde{e} = \tilde{P} q_B - \left(\overline{R} - z\right) q_B > e = VaR$, as shown in the figure

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

→

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

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

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

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)

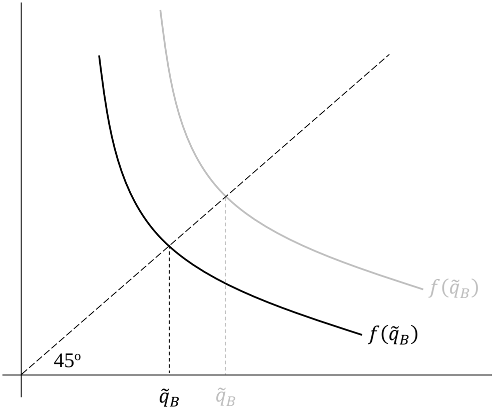
- (cont'd)
  - Express $\widetilde{q}_B$ with q_B by combining two expressions for $\widetilde{e}$: $\widetilde{q}_B = \frac{\tilde{P}+z-\overline{R}}{\tilde{P}+z-\overline{R'}} q_B$;
    - The consumers' demand for security is now $\widetilde{q}_C = \frac{3\tau}{z^2}\left(\overline{R'} - \tilde{P}\right) = S - \widetilde{q}_B$. 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 $f(\tilde{q}_B)$ to the right, leading to bank's higher demand for security

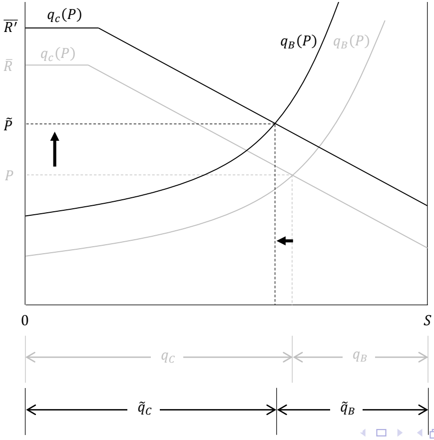


Asset price and leverage cycle: boom (cont'd)

- 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...

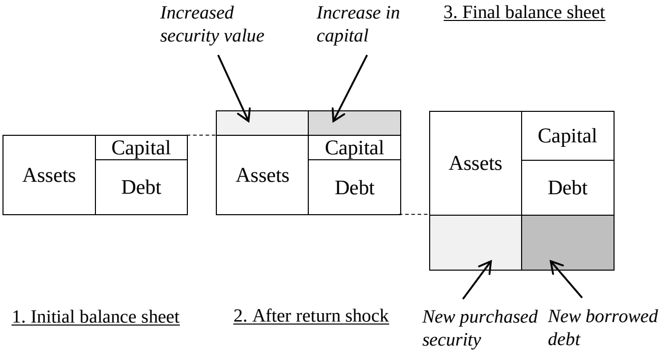
Asset price and leverage cycle: boom (cont'd)

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



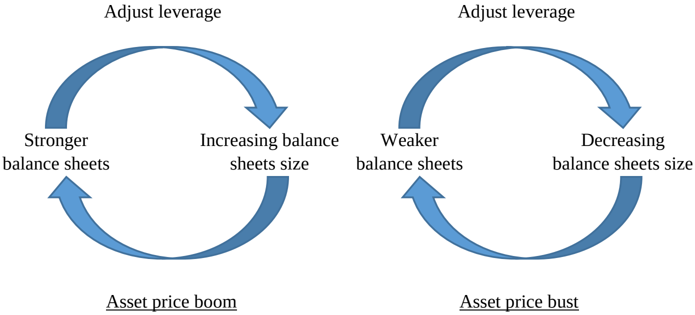
Asset price and leverage cycle: boom (cont'd)

- 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*"



Financia accelerator: the baseline

- 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 representiteve 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., $x = W + L$. It's 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.

Financial accelerator: imperfect market

- 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

$$\max_{L^C} f\left(L^C + W\right) - RL^C, \; s.t. \; RL^C \leq PK;$$

  - Assumption 2: Suppoe K is small so that the borrowing constraint is always binding.

Financial accelerator: imperfect market (cont'd)

- Set up Lagrangian for the optimization problem

$$\mathcal{L} = f\left(L^C + W\right) - RL^C - \lambda\left(RL^C - PK\right),$$

  - And first order condition leads to

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

  - Comparing with the case of perfect financial market, $x^C < x$ since $f'\left(x^C\right) = R + \lambda > f'(x) = R$, and $f\left(x^C\right) < f(x)$. Lower feasible credit and output.

Financial accelerator: credit channel & business cycle

- The impact of such credit constraint becomes more pronounced in a *dynamic*, *general equilibrium* setup (Bernanke & Gertler, 1989). After an intial 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

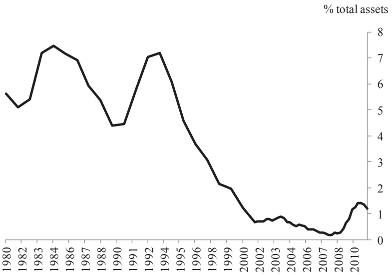
- *Principal-agent problems* and *limited liability* that encourage banks to take excessive risks, e.g., biased incentives from OPM (**O**ther **P**eople's **M**oney) instead of MOM (**M**y **O**wn **M**oney);
- *Externalities* that lead to inferior allocation of resources and risks
  - **Positive** 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.

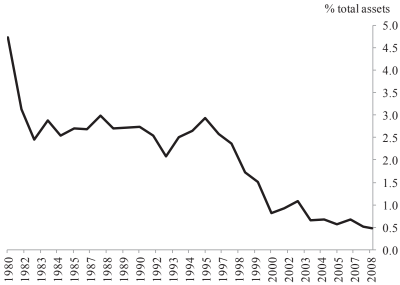
Example: systemic liquidity shortages

- 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* → *systemic liquidity shortage* among banks.

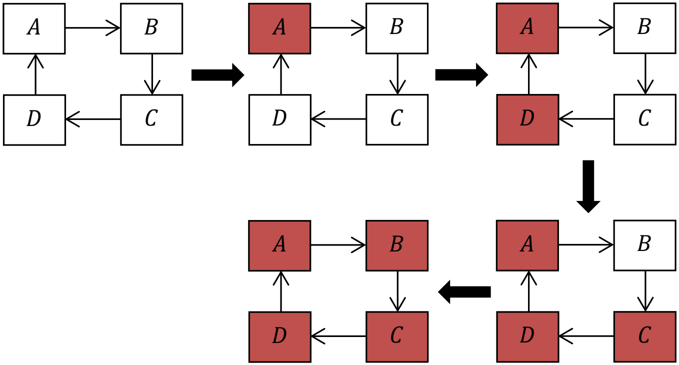
Example: systemic liquidity shortages (cont'd)

- Liquid assets as share of banks' balance sheets: US & UK





Example: network externality



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.

Objectives and related market failures (cont'd)

- 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*".

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

Banking regulation instruments (cont'd)

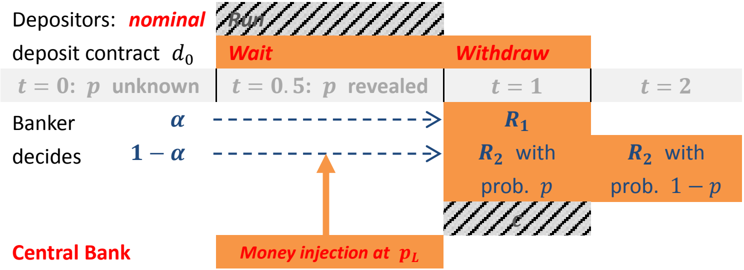
3. **Limit direct and indirect exposure concentration**
   - Large exposure restrictions
   - CCP clearing requirement
4. **Limit the systemic impact of misaligned incentives with a view to reducing moral hazard**
   - SIFI capital surcharges
5. **Strengthen the resilience of financial infrastructures**
   - 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.

Modelling central bank

Central bank doesn't create real value, but rather inject fiat money into banking system against good collateral (late projects)



Lender of last resort and bank run

- Suppose π is sufficiently high so that banks choose α_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 α_H as *entry requirement* to complement!

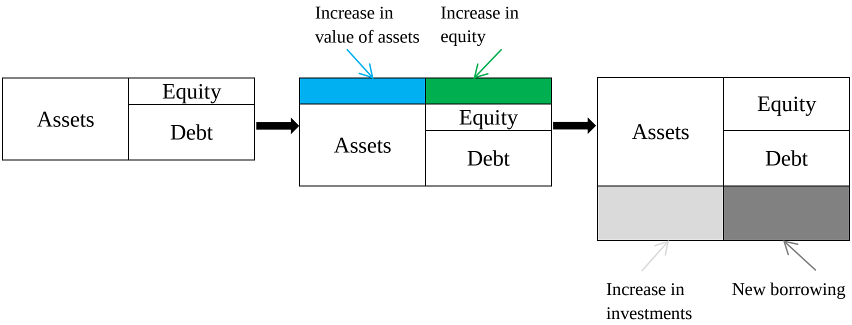
Capital adquacy requirement

- 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.

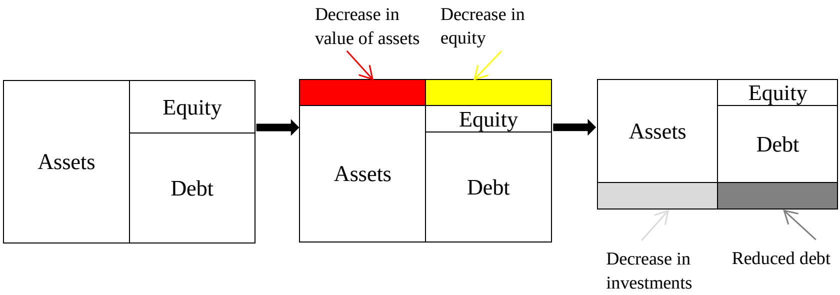
Procyclicality: in the boom



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*.

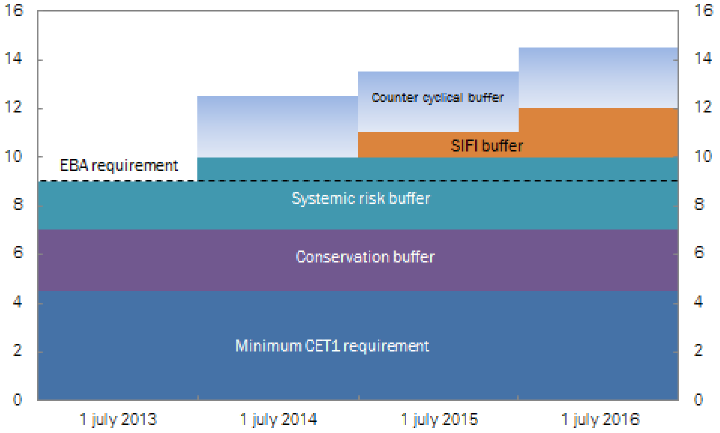
Procyclicality: in the bust



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.

Conclusion

- Banking regulation is special:
  - More focus on "*safety*" than "*price*";
  - Much greater *macroeconomic* consequences and implication for *taxpayers*' interests;
- Banking regualtion 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*.