Efficient Risk and Bank Regulation

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Motivation

- The recent crisis has revived concerns that banks may take **too much risk**
- The standard model that can account for too much risk taking is based on
    - **inefficient risk** (on average, the risky technology pays less than the safe one)
    - **risk shifting** (typically due to limited liability and deposit insurance)
- **Charter value** mitigates but does not overturn the result
- However, empirical evidence is consistent with **efficient risk**: "*countries that have experienced financial crises have, on average, grown faster than countries with stable financial conditions*" (Rancière, Tornell, and Westermann, 2008)
- So what are the positive and normative implications of **efficient risk**?

Contribution

- We show that, when risk is efficient, banks may take not only too much risk, but also **too little risk** (without owner/manager agency problems)
- We build a model with
  - **limited liability** and **deposit insurance**
  - **charter value** arising from illiquid long-term assets
- We depart from the literature by making two key assumptions:
  - **efficient risk** (necessary to get too little risk taking)
  - **risk aversion** (necessary to get too much risk taking when risk is efficient)
- **Too much risk** taking arises from limited liability and deposit insurance
- **Too little risk** taking arises from the charter value, which is lost to shareholders but not society in case of bank failure

Main results

1. Banks may take not only too much risk, but also **too little risk**
2. Capital requirements, however high they are, may be **unable to prevent crises**
3. Capital requirements may have **non-monotonous effects** on risk taking and welfare
4. Banks with the same observable characteristics may **behave differently** (due to a new last-bank-standing effect)

Outline of the presentation

1. Introduction
2. Environment
3. Equilibrium
4. Extension
5. Conclusion

Overview

- **Two periods**: 1, 2
- **Three agents**:
  - representative household H (depositor, shareholder, taxpayer)
  - ex ante identical banks $(\mathrm{B}_i)_{i \in [0,1]}$ owned by H
  - prudential authority P
- **Main sources of distortion**:
  - Bs' limited liability
  - deposit insurance (taken as institutional feature)
  - resolution policy (no compensation for shareholders in case of bank failure)
- **Risk aversion**: H's utility is $u(c) = \frac{c^{1-\gamma}-1}{1-\gamma}$ with $\gamma > 0$, where c is consumption in Period 2.

Technologies available in Period 1

- H has access to a safe **storage technology** (gross return 1)

- Bs have access to
  - a **safe technology** (gross return $R^x > 1$)
  - a **risky technology** (gross return θ)

- The shock θ takes the value (common across banks)
  - 0 with probability π
  - R^y with probability $1 - \pi$

- The risky technology pays more on average than the safe one ("**efficient risk**"):

$$(1 - \pi)R^y > R^x$$

Period 1

- H starts with endowment ω and decides how much to
  - deposit (d) at the safe gross return R^d
  - invest in the storage technology (h)

  to maximize $\mathbb{E}\{u(c)\}$ subject to its **budget constraint** $h + d \leq \omega$

- B_i starts with equity e and long-term assets z and decides how much to
  - issue deposits (d) at the safe gross return R^d
  - invest in the safe technology (x_i)
  - invest in the risky technology (y_i)

  to maximize $\mathbb{E}\{u'(c).dividends\}$ subject to
  - its **balance-sheet identity** $x_i + y_i + z = e + d$
  - the **capital requirement** (CR) $e \geq \kappa\,(x_i + y_i)$

- P chooses κ and imposes CR on each B_i (observing $x_i + y_i$ but not x_i nor y_i)

Period 2

1. Shock θ is realized
2. Deposits are redeemed to H by
   - non-failing banks (those with $R^x x_i + \theta y_i \geq R^d d_i$)
   - deposit-insurance fund (financed by lump-sum taxation on H)
3. Failing banks (those with $R^x x_i + \theta y_i < R^d d_i$) are closed and their long-term assets are "seized" by P
4. Long-term assets mature (safe gross return R^z) and are redistributed to H
   - as dividends by non-failing B$_i$s (together with $R^x x_i + \theta y_i - R^d d_i$)
   - in a lump-sum way by P (assets seized from failing Bs)
5. H consumes ($c = h + R^x \int_0^1 x_i di + \theta \int_0^1 y_i di + R^z z$)

Discussion of assumptions

- The resolution policy amounts to **bank nationalization** and implies no compensation for shareholders
- What matters for the too-little-risk result, though, is merely that shareholders of an illiquid bank lose more than taxpayers (as under **Bagehotian lending of last resort**)
- Some other assumptions are not necessary for most of the results:
  - **complete illiquidity** of long-term assets
  - **absence of an interbank market** during a crisis
- These assumptions are relaxed later in the extension

Constrained planner's allocation

- **Problem**: choose x and y to maximize $\mathbb{E}\{u(c)\} = \mathbb{E}\left\{u\left(h + R^x x + \theta y + R^z z\right)\right\}$ subject to the resource constraint $x + y \leq \Omega \equiv (\omega - h) + (e - z)$

- **First-order condition** (FOC): $\mathbb{E}\{u'(c)\theta\} = \mathbb{E}\{u'(c)R^x\}$

- **Interior solution**:

$$\begin{aligned} x &= \frac{R^y}{\Psi^* R^x + R^y}\left[\Omega + \frac{h + R^z z}{R^x}\right] - \frac{h + R^z z}{R^x} \\ y &= \frac{\Psi^* R^x}{\Psi^* R^x + R^y}\left[\Omega + \frac{h + R^z z}{R^x}\right] \end{aligned}$$

where $\Psi^* \equiv \left[\frac{(1-\pi)(R^y - R^x)}{\pi R^x}\right]^{\frac{1}{\gamma}} - 1 > 0$

- **Corner solution**: $x = 0$ and $y = \Omega$

Interpretation

- **Rewritten problem**: choose
  - $\widetilde{x} \equiv x + \frac{h+R^z z}{R^x}$: quantity of goods obtained **certainly**, divided by R^x
  - y: quantity of goods obtained **possibly**, divided by R^y

  to maximize $\mathbb{E}\{u(c)\} = \mathbb{E}\{u(R^x\widetilde{x} + \theta y)\}$ subject to $\widetilde{x} + y = \Omega + \frac{h+R^z z}{R^x}$

- **Interior solution**:
  - $\widetilde{x} = \phi_x \left(\Omega + \frac{h+R^z z}{R^x}\right)$, where $\phi_x \equiv \frac{R^y}{\Psi^* R^x + R^y}$ increases with risk aversion γ
  - $y = \phi_y \left(\Omega + \frac{h+R^z z}{R^x}\right)$, where $\phi_y \equiv \frac{\Psi^* R^x}{\Psi^* R^x + R^y}$ decreases with risk aversion γ

- Unconstrained planner's allocation: $h = 0$

Candidate equilibria I

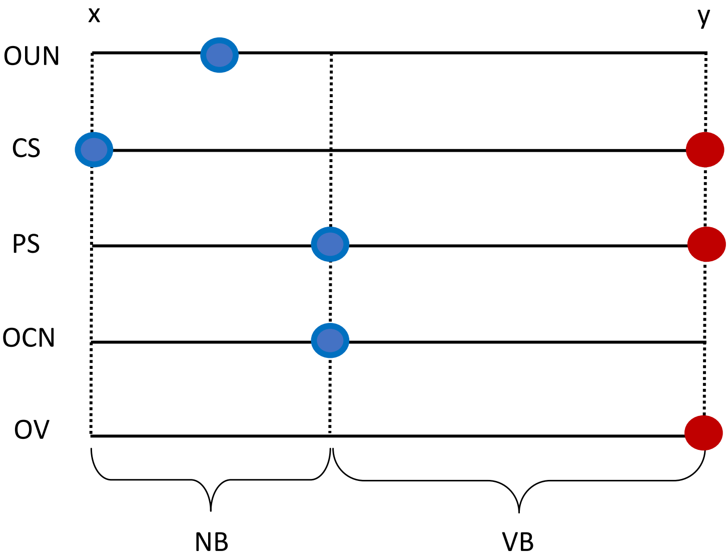
- "**Vulnerable/non-vulnerable bank**" (VB/NB) $\equiv$ bank that fails/does not fail when $\theta = 0$

- For each value of (ω, e, z, κ), there are five alternative **candidate equilibria**:
  - only non-vulnerable banks
    - unconstrained (OUN)
    - constrained (OCN)
  - both non-vulnerable banks and vulnerable banks
    - complete specialization (CS)
    - partial specialization (PS)
  - only vulnerable banks (OV)

- In this presentation, I focus on the case $h > 0$, which implies that
  - $R^d = 1$ (indifference of H between storage and deposits)
  - CR is binding (finite demand of deposits by Bs at the price $R^d = 1$)

  (while the alternative case $h = 0$ implies that $R^d \in \{R^x, R^y\}$ and CR is lax)

Candidate equilibria II



Only unconstrained non-vulnerable banks I

- **Problem** of NB: choose d, x, and y to maximize

$$\mathbb{E}\left\{u'(c)\left[R^x x + \theta y - d + R^z z\right]\right\}$$

subject to $e \geq \kappa (x + y)$ and $e = x + y + z - d$

- **FOC**: $\mathbb{E}\{u'(c)\theta\} = \mathbb{E}\{u'(c)R^x\}$ as in the constrained-planner problem

- So the solution coincides with the constrained-planner allocation:

$$y = \frac{\Psi_{oun} R^x}{\Psi_{oun} R^x + R^y}\left[\Omega + \frac{h + R^z z}{R^x}\right] \quad \text{where} \quad \Psi_{oun} = \Psi^* \quad \text{and} \quad \Omega = \frac{e}{\kappa}$$

Only unconstrained non-vulnerable banks II

- So, at this equilibrium, there is **the optimal amount of risk**:
  - limited liability plays no role when there are only NBs
  - shareholders' interests coincide with taxpayers' interests
  - Bs have the same risk-taking incentives as the constrained planner
- Condition for **no deviation** from NB to VB to be profitable:

$$d < R^z z$$

(when $\theta = 0$, the deviating bank saves d but loses its charter value $R^z z$)

Complete specialization I

- Now consider the **candidate equilibrium** with NB(x) and VB(y)
- The condition for **indifference** between NB and VB gives

$$\int_0^1 y_i di = \frac{\Psi_{cs} R^x}{\Psi_{cs} R^x + R^y}\left[\Omega + \frac{h + R^z z}{R^x}\right]$$

$$\text{where} \quad \Psi_{cs} \equiv \left[\frac{(1-\pi)\left(R^y - R^x\right)}{\pi\left(R^x - \alpha_{cs}\right)}\right]^{\frac{1}{\gamma}} - 1$$

$$\alpha_{cs} \equiv \frac{\kappa}{e}\left[\frac{1-\kappa}{\kappa}e + z - R^z z\right] = \frac{d - R^z z}{\Omega}$$

$$\Omega = \frac{e}{\kappa}$$

Complete specialization II

- Condition for **no deviation** from NB(x) to NB(x,y) to be profitable:

$$\mathbb{E}\{u'(c)\theta\} < \mathbb{E}\{u'(c)R^x\} \iff \Psi_{cs} > \Psi^* \iff \alpha_{cs} > 0 \iff d > R^z z$$

- So, at this equilibrium, there is **too much risk**:
  - VBs take too much risk as they do not internalize the cost for taxpayers
  - in response, NBs best serve their shareholders' interests by holding only x
  - the number of NBs (or equivalently of VBs) adjusts so that, for the shareholders of an individual bank, the gain of moving from VB to NB (due to $\mathbb{E}\{u'(c)\theta\} < \mathbb{E}\{u'(c)R^x\}$) exactly offsets the loss (due to $d > R^z z$)

Complete specialization III

- Aggregate risk and risk aversion introduce **strategic substitutability** into banks' risk-taking decisions
- This creates a **last-bank-standing effect**, based on preferences, not market structure (Perotti and Suarez, 2002) nor technology (Martinez-Miera and Suarez, 2013)
- Thus, in our model the equilibrium may be asymmetric across banks even though banks are ex ante identical

Partial specialization I

- Now consider the **candidate equilibrium** with NB(x,y) and VB(y)
- At this equilibrium, **the non-vulnerability constraint is binding** for NBs:

$$R^x x = d \text{ for each NB} \quad \text{and} \quad \mathbb{E}\{u'(c)\theta\} > \mathbb{E}\{u'(c)R^x\}$$

- The condition for **indifference** between NB and VB gives

$$\int_0^1 y_i di = \frac{\Psi_{ps} R^x}{\Psi_{ps} R^x + R^y} \left[\Omega + \frac{h + R^z z}{R^x} \right]$$

$$\begin{aligned} \text{where} \quad \Psi_{ps} &\equiv \left[\frac{(1-\pi)(R^y - R^x)\, \alpha_{ps}}{\pi R^x} \right]^{\frac{1}{\gamma}} - 1 \\ \alpha_{ps} &\equiv \frac{\frac{1-\kappa}{\kappa} e + z}{R^z z} = \frac{d}{R^z z} \\ \Omega &= \frac{e}{\kappa} \end{aligned}$$

Partial specialization II

- Condition for the **non-vulnerability constraint to be binding** for NBs:

$$\mathbb{E}\{u'(c)\theta\} > \mathbb{E}\{u'(c)R^x\} \Longleftrightarrow \Psi_{ps} < \Psi^* \Longleftrightarrow \alpha_{ps} < 1 \Longleftrightarrow d < R^z z$$

- So, at this equilibrium, there is **too little risk**:
  - Bs take too little risk as they internalize the loss $R^z z - d > 0$ for VBs' shareholders when $\theta = 0$ but not the corresponding taxpayers' gain
  - in response to excessively low aggregate risk, NBs hold as much y as they can
  - the number of NBs (or equivalently of VBs) adjusts so that, for the shareholders of an individual bank, the gain of moving from VB to NB (due to $d < R^z z$) exactly offsets the loss (due to $\mathbb{E}\{u'(c)\theta\} > \mathbb{E}\{u'(c)R^x\}$)

Only constrained non-vulnerable banks

- The condition for the **non-vulnerability constraint to be binding** for NBs

$$R^x x = d \quad \text{and} \quad \mathbb{E}\{u'(c)\theta\} > \mathbb{E}\{u'(c)R^x\}$$

implies that $\Psi_{ocn} < \Psi^*$, where Ψ_{ocn} is implicitly defined by

$$\int_0^1 y_i di = \frac{\Psi_{ocn} R^x}{\Psi_{ocn} R^x + R^y}\left[\Omega + \frac{h + R^z z}{R^x}\right]$$

- So, at this equilibrium, there is **too little risk**, for the same reason as in the PS case

- Unlike in the PS case, a condition for **no deviation** from NB to VB to be profitable has to be satisfied

Only vulnerable banks

- The condition for all Bs to be vulnerable

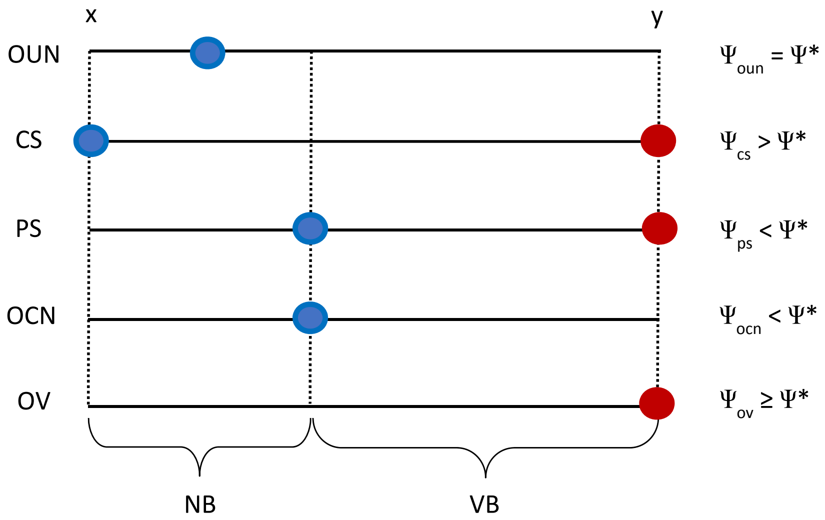
$$x = 0$$

allows for $\Psi_{ov} \geq \Psi^*$, where Ψ_{ov} is implicitly defined by

$$\int_0^1 y_i di = \frac{\Psi_{ov} R^x}{\Psi_{ov} R^x + R^y} \left[\Omega + \frac{h + R^z z}{R^x} \right]$$

- So, at this equilibrium, there may be
  - **too much risk**, for the same reason as in the CS case
  - **the (constrained) optimal amount of risk**, when z and h are large enough

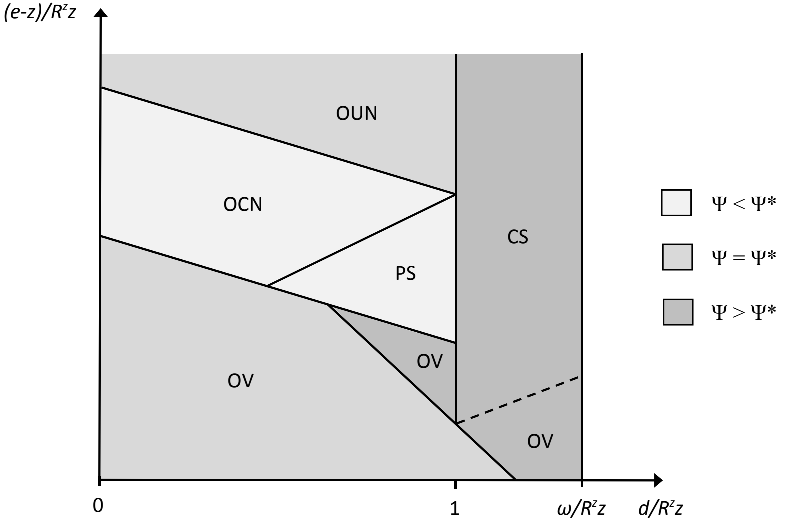
Taking stock



Values of (ω, e, z, κ) for which each equilibrium exists

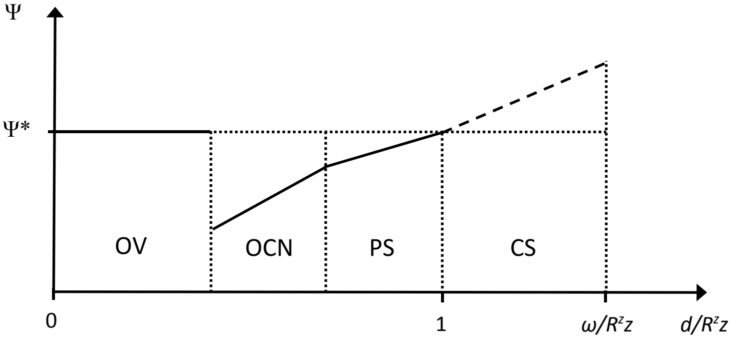
- The conditions on (ω, e, z, κ) for existence of each equilibrium involve only $\frac{d}{R^z z} = \frac{1}{R^z z}\left[\frac{e}{\kappa} - (e-z)\right]$, $\frac{e-z}{R^z z}$, and $\frac{\omega}{R^z z}$
- So the set of values of (ω, e, z, κ) for which each equilibrium exists can be represented as an area of the $\left(\frac{d}{R^z z}, \frac{e-z}{R^z z}\right)$ plane, with the borderlines between areas depending only on $\frac{\omega}{R^z z}$
- In the **generic case** $\gamma \neq 1$, some of the equations characterizing these borderlines are linear, but the others cannot be easily studied analytically
- In the **specific case** $\gamma = 1$, these equations are either linear or quadratic

A simple example with $\gamma = 1$



Non-monotonous effect of capital req. on risk and welfare

- For a range of values of $\frac{e-z}{R^z z}$, the function $\Psi(\frac{d}{R^z z})$ looks like this:



so that capital requirements have a non-monotonous effect on risk

- Since welfare depends continuously on $\Psi(\frac{d}{R^z z})$ and $h = \omega - d$, capital requirements have a non-monotonous effect on welfare too

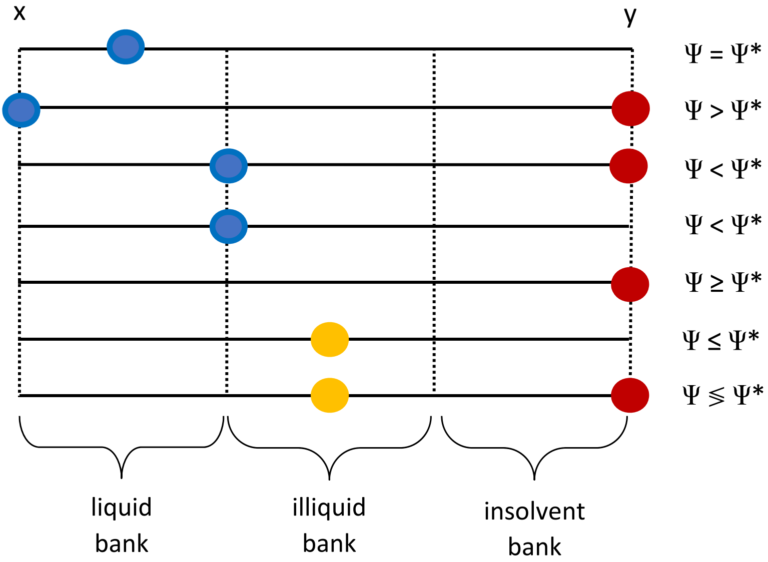
Some alternative assumptions...

- So far, long-term assets have been assumed to be completely illiquid
- Assume now that they can be liquidated at cost $0 < \delta < 1$: a fraction δ of liquidated assets is lost
- This gives rise to three possible kinds of banks:
  - **liquid banks** can redeem deposits when $\theta = 0$ without liquidating assets
  - **illiquid banks** can redeem deposits when $\theta = 0$ only by liquidating assets
  - **insolvent banks** cannot redeem deposits when $\theta = 0$, even by liq. assets
- In terms of resolution policy, assume that P leaves banks liquidate assets and closes insolvent banks when $\theta = 0$

...and their implications

- Define Ψ^{**} as the value of Ψ that would be chosen by a planner constrained to
  - invest as many goods in the storage technology as in equilibrium (h)
  - throw away as many goods when $\theta = 0$ as are lost in eq. because of liquidation
- We still get that banks may take **too little or too much risk** (in the weaker sense that $\Psi \lesseqgtr \Psi^{**}$), whether there is or is not an interbank market when $\theta = 0$
- The presence of an **interbank market** when $\theta = 0$ provides an additional source of strategic substitutability (as the gross interbank rate may be higher than one)

Equilibria in the absence of an interbank market



Summary

- We investigate the consequences of **efficient risk** in a risk-shifting model
- We obtain that
  - banks may take not only too much risk, but also **too little risk**
  - capital requirements, however high they are, may be **unable to prevent crises**
  - capital requirements may have **non-monotonous effects** on risk and welfare
  - banks with the same observable characteristics may **behave differently**

Towards risk cycles

- For a range of values of (ω, z, κ), we have
  - $\Psi > \Psi^*$ for relatively high values of e
  - $\Psi < \Psi^*$ for relatively low values of e
- This result suggests that, in a dynamic setting, we could get
  - **too much risk in "good times"** (high values of e)
  - **too little risk in "bad times"** (low values of e)

  under constant capital requirements (as in Basel II)
- This would provide a new justification for the "**countercyclical capital buffer**" of Basel III, based on **risk cycles**, not credit cycles (as in Gersbach and Rochet, 2013)

Towards optimal-policy analysis

- **Policy objective**: representative agent's ex ante utility $\mathbb{E}\{u(c)\}$
- **Policy instruments**: capital requirement κ and lending of last resort (LLR)
- **Policy trade-offs**: in areas with $\Psi > \Psi^*$,
  - the higher κ, the lower Ψ $(+)$ and the higher h $(-)$
  - the more LLR, the lower liquidation costs $(+)$ and the higher Ψ $(-)$

  ($+$: positive effect on welfare; $-$: negative effect on welfare)
- So the unconstrained-planner allocation may or may not be implementable depending on (ω, e, z)