A Pigovian Approach to Liquidity Regulation

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INTRODUCTION

• Paper studies effectiveness of different approaches to regulation of banks’ refinancing risk

• Short-term (ST) funding helps banks expand their credit activity but makes them more vulnerable to systemic liquidity problems

  Because of fire sales or counterparty risk externalities...

  – Each bank’s individual funding decision has an impact on the vulnerability of other banks

  – In the absence of regulation, banks rely excessively on ST funding

• We provide a theoretical assessment of the performance of

  – Pigovian taxes: levies on banks’ short-term funding

  – Quantity regulations: ratios introduced by Basel III
• The analysis stresses bank heterogeneity & potential constraints to making regulation contingent on the relevant bank characteristics:

Depending on the dominant source of heterogeneity, the socially efficient solution may be attained with Pigovian taxes, quantity regulations or a combination of both

• Two main sources of heterogeneity:

  – Credit ability/quality of investment opportunities → better banks want to expand more

  – Incentives to take risk → overconfident managers & less capitalized banks want to “gamble” more
    (e.g. because they shift downside risk to the safety net)

[We first analyze each of them separately, then jointly]
• Key findings:

1. Strong case for simple Pigovian tax when banks differ in credit ability/quality of investment opportunities

2. Strong case for quantity regulation (net stable funding ratio) if banks differ in risk-shifting incentives

3. Skepticism about effectiveness and efficiency of a liquidity coverage ratio (in both scenarios)

4. Potential optimality of a mixed approach if the two sources of heterogeneity are important
Outline

1. Baseline case: heterogeneity in credit ability
2. Equilibrium vs. social optimum
3. The simple Pigovian solution
4. Quantity-based alternatives
5. Case for quantity regulation: heterogeneity in gambling incentives
6. Other issues
1. Baseline case: heterogeneity in credit ability

- Simple one-period model in which agents are risk neutral
  - Single round of ST funding decisions
  - Relevant trade-off are captured by reduced-form payoff functions
    [Compatible with broad set of structural models]

- Measure-one continuum of banks characterized by type $\theta \in [0, 1]$, distributed with density $f(\theta)$ across banks

- Bank owners:
  - Make a ST funding decision $x \in [0, \infty)$
  - Maximize bank value (NPV of their claims)

- Other investors: (i) could invest at some exogenous market rates
  (ii) provide funding at competitive terms
Without regulation, bank value is
\[ v(x, X, \theta) = \pi(x, \theta) - \varepsilon(x, \theta)c(X) \]
where:
\( \pi(x, \theta) \): value generated in the absence of systemic crisis risk
\[ \pi_x > 0, \quad \pi_{\theta} > 0, \quad \pi_{xx} < 0, \quad \pi_{x\theta} > 0 \]
\( \varepsilon(x, \theta) \): contribution to expected crisis costs due to individual \((x, \theta)\)
\[ \varepsilon_x > 0, \quad \varepsilon_{\theta} \leq 0, \quad \varepsilon_{xx} \geq 0, \quad \varepsilon_{x\theta} \leq 0 \]
\( c(X) \): contribution to crisis costs due to systemic risk \(X\)
\[ c' > 0, \quad c'' \geq 0 \]

Hence, net marginal benefit from ST funding \(x\) is
(i) decreasing in \(x\)
(ii) increasing in \(\theta\)
• $X$ is determined by the ST funding decisions of all banks.

  For simplicity, we assume

  $$X = \int_0^1 x(\theta) f(\theta) d\theta,$$

  where $x(\theta)$ is the decision made by each bank of type $\theta$

• Social welfare:

  If other investors obtain zero NPV from the banks, a natural measure of social welfare is just

  $$W = \int_0^1 v(x(\theta), X, \theta) f(\theta) d\theta = \int_0^1 \left[ \pi(x(\theta), \theta) - \varepsilon(x(\theta), \theta) c(X) \right] f(\theta) d\theta$$

  (The total NPV of cash flows received by bank owners)
2. Equilibrium vs. social optimum

- **Unregulated equilibrium:**
  1. \( x_e(\theta) = \arg\max_x \{ \pi(x, \theta) - \varepsilon(x, \theta)c(X_e) \} \) for all \( \theta \in [0, 1] \),
  2. \( X_e = \int_0^1 x_e(\theta) f(\theta) d\theta \).

    If interior, FOCs imply:
    \[
    \pi_x(x_e(\theta), \theta) - \varepsilon_x(x_e(\theta), \theta)c(X_e) = 0
    \]

- **Socially optimal allocation:**
  \[
  \max_{\{x(\theta)\}, X^*} \int_0^1 \left[ \pi(x(\theta), \theta) - \varepsilon(x(\theta), \theta)c(X^*) \right] f(\theta) d\theta
  \]
  s.t.: \( X^* = \int_0^1 x(\theta) f(\theta) d\theta \).

    If interior,
    \[
    \pi_x(x^*(\theta), \theta) - \varepsilon_x(x^*(\theta), \theta)c(X^*) - E_z(\varepsilon(x^*(z), z))c'(X^*) = 0
    \]
    [3rd term = Mg External Costs of each \( x(\theta) \)]
Proposition 1:

- The equilibrium allocation is not socially efficient
- Systemic externalities imply $X^e > X^*$
3. The simple Pigovian solution

- As in textbook discussions on negative production externalities:
  - Efficiency can be restored by imposing a Pigovian tax:
    - Tax rate = Social MgC – Private MgC
- In our case:
  \[ \tau^* = E_z(\varepsilon(x^*(z), z))c'(X^*) \]
  Independent of \( \theta \)!

Proposition 2

With heterogeneity in investment opportunities, social efficiency of equilibrium can be restored by charging tax \( \tau^* \) on banks’ ST funding
4. Quantity-based alternatives

• Pure quantity regulation (prescribing $x^*(\theta)$ to each $\theta$)...
  
  – Would require bank-level knowledge of $\pi_x(x, \theta)$ & $\varepsilon_x(x, \theta)$
  
  – Strong informational requirements ⇒ not considered in practice

• Proposals considered in practice are ratio-based

  In Basel III:

  – Liquidity coverage ratio
  
  – Net stable funding ratio
4.1 Net stable funding requirement:

\[
\frac{\text{Stable funding}}{\text{Non-liquid assets}} \geq \text{regulatory minimum}
\]

\[
[\text{Stable funding} = \text{equity} + \text{customer deposits} + \text{other LT debt}]
\]

• If stable funding is given:
  
  – Requirement is equivalent to upper limit \( \bar{x} \) to ST funding
  
  – \( \bar{x} \) could be endogenized as a result of prior decisions
    
    [e.g. on asset maturity/liquidity or LT funding]
  
  – Assume implied \( \bar{x} \) is the same for all banks

• Then, in an equilibrium with a stable funding requirement \( \bar{x} \):

\[
x^\bar{x}(\theta) = \arg \max_{x \leq \bar{x}} \{ \pi(x, \theta) - \varepsilon(x, \theta)c(X^\bar{x}) \}
\]
• Three cases:

- If $\bar{x} \geq x^e(1) \Rightarrow$ not binding for any $\theta$, no effect
- If $\bar{x} \leq x^e(0) \Rightarrow$ binding for all $\theta$, very rough
- If $\bar{x} \in (x^e(0), x^e(1)) \Rightarrow$ asymmetric & inefficient

  ∗ Banks with largest $\theta$s: $\bar{x}^e(\theta) = \bar{x} < x^e(\theta)$

  ∗ Paradoxically, other banks: $\bar{x}^e(\theta) > x^e(\theta)$ [since $X\bar{x} < X^e$]

**Proposition 3**

A net stable funding requirement may reduce $X$, but at the cost of redistributing ST funding inefficiently across banks.

[Second best $\bar{x}$ can be found]
$x(\theta_1)$

- Unregulated equilibrium allocation
- Socially efficient allocation
- Allocation under best stable funding requirement
4.2 Liquidity coverage requirement:

ST funding $x$ must be backed with high-quality liquid assets $m$ [e.g. so as to confront one-month disruption in markets]

- How can it be captured in the model?
  Like fractional “reserve” requirement $m \geq \phi x$ with $\phi \leq 1$

- Two adaptations:
  - What matters for individual & systemic risk are “net positions”
    
    \[
    \hat{x} = x - m \quad \& \quad \hat{X} = X - M
    \]
  - But holding liquidity may have a cost $\delta = r_b - r_m \geq 0$ [source of a deadweight loss!]
• In an equilibrium with liquidity requirement $\phi$:

$$\hat{x}^\phi(\theta) = \arg \max_{\hat{x}} \{ \pi(\hat{x}, \theta) - \varepsilon(\hat{x}, \theta)c(\hat{X}^\phi) - \frac{\delta \phi}{1 - \phi} \hat{x} \}$$

- Equivalent to equilibrium with tax $\tau(\theta) = \frac{\delta \phi}{1 - \phi}$ on ST funding
- But $\delta > 0$ implies social deadweight losses:

$$DW^\phi = -\delta \int_0^1 m^\phi(\theta)f(\theta)d\theta \equiv -\delta M^\phi = -\tau X^\tau$$
Proposition 4 \((\delta = 0)\) [normal times?]

With \(\delta = 0\), \(\phi\) is innocuous, except because it generates artificial demand for liquid assets.

\[
[M^\phi = \frac{\phi}{1-\phi} E^\theta(x^e(\theta))]
\]

Proposition 5 \((\delta > 0)\)

With \(\delta > 0\), \(\phi\) can be set so as to seemingly replicate any flat-tax \(\tau\) on ST funding but at a deadweight cost \(-\tau X^\tau\)

\textbf{Seemingly replicating efficient Pigovian tax} \(\tau^*\) is feasible, but generically not optimal in 1st or 2nd best sense (Prop. 6)

Second best requirement \(\phi^{SB}\) must move in response to fluctuations in \(\delta\), producing variability in \(M^\phi\)
5. Case for quantity regulation: heterogeneity in gambling incentives

• What if some “crazy,” risk-inclined banks are willing to pay the tax and “abuse” of ST funding?

Add a new dimension of heterogeneity:

– Assume bank owners do not internalize fraction $\theta_2$ of crisis losses [due to, say, diff. in governance, charter value, capitalization,...]

– Fraction $\theta_2$ is (uncompensatedly) passed to other stakeholders [e.g. the deposit insurer]

• Bank owners payoff function becomes:

$$v(x, X, \theta_1, \theta_2) = \pi(x, \theta_1) - (1 - \theta_2)\varepsilon(x, \theta_1)c(X)$$

• Social welfare $W$ must account for the “missed” losses

$$-\theta_2\varepsilon(x, \theta)c(X)$$
5.1 Gambling as the sole source of heterogeneity:

• Fix $\theta_1 = \bar{\theta}_1$ for all banks

\[
\pi_x(x^{ee}(\theta_2), \bar{\theta}_1) - (1 - \theta_2)\varepsilon_x(x^{ee}(\theta_2), \bar{\theta}_1)c(X^{ee}) = 0
\]

vs.

\[
\pi_x(x^{**}(\theta_2), \bar{\theta}_1) - \varepsilon_x(x^{**}(\theta_2), \bar{\theta}_1)c(X^{**}) - E_z(\varepsilon(x^{**}(z), \bar{\theta}_1))c'(X^{**}) = 0
\]

\[\downarrow\]

Inefficiency of equilibrium:

$x^{ee}(\theta_2)$ is increasing, while $x^{**}(\theta_2) = \bar{x}^{**}$ is constant

• The efficient Pigovian tax schedule is now dependent on $\theta_2$
Proposition 7

If gambling incentives constitute the only source of heterogeneity:

– A flat tax on ST funding does not implement the first best

– A stable funding requirement implying \( \bar{x} = \bar{x}^{**} \) can do it

[For liquidity requirements, same conclusions obtained above apply]
$x(\theta_2)$

- Unregulated equilibrium allocation
- Socially efficient allocation
- Allocation under best flat Pigovian tax
5.2 The general case

- Most likely, not clear-cut results:
  1st best is generally not attainable
  with instruments non-contingent on $\theta_1$ or $\theta_2$

- Second best performance:
  - Continuity argument:
    * If $\theta_1$ is the dominant source of heterogeneity,
      Flat tax on ST funding $\succ$ Stable funding requirement
    * Vice versa if $\theta_2$ is the dominant source of heterogeneity
  - More generally, a combination may be optimal
    [If stronger capital regulation, pushes $\theta_2$ towards zero, greater room for a tax on ST funding]
6. Other issues

- A straight Pigovian approach provides direct control on the externality correction mechanism (the tax rate)
  
  - Allows the response in quantities to be as smooth as the industry finds it optimal to pay for
  
  - No need for gradualism or long implementation calendars

- Quantity regulation faces a problem of “controllability” when the market or shadow price of the limiting quantity fluctuates
  
  - Potential source of procyclicality
  
  - With adjustment costs in the limiting quantity, tightening the requirements may produce “rationing”
• Institutionally, involving treasuries & parliaments is a nuisance

BUT:

– Liquidity risk levies will reinforce the commitment to act promptly in a systemic crisis
– May encourage explicit international arrangements for crisis resolution & burden sharing
CONCLUSIONS

• Addressing implications of liquidity risk for systemic risk is a key regulatory challenge

• Taxes on banks’ ST funding are a reasonable response
  – Perform better than quantity-based regulation if credit ability/quality of investment opportunities is key source of bank heterogeneity
  – Can be complementary to quantity regulation if heterogeneity in risk-shifting incentives is also large

• A net stable funding ratio limits ST funding too roughly, if credit ability is the main source of heterogeneity

• A liquidity coverage ratio is either ineffective or inefficient
  [With stronger capital requirements, a straightforward Pigovian approach is probably superior to relying on the Basel III liquidity ratios]