A Pigovian Approach to Liquidity Regulation

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Presentation presented at the 12th Jacques Polak Annual Research Conference
Hosted by the International Monetary Fund
Washington, DC─November 10–11, 2011

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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 $\rightarrow$ better banks want to expand more

  – Incentives to take risk $\rightarrow$ 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*

$$\pi_x > 0,\ \pi_\theta > 0,\ \pi_{xx} < 0,\ \pi_{x\theta} > 0$$

$\varepsilon(x, \theta)$: contribution to expected *crisis costs* due to individual (x, θ)

$$\varepsilon_x > 0,\ \varepsilon_\theta \leq 0,\ \varepsilon_{xx} \geq 0,\ \varepsilon_{x\theta} \leq 0$$

$c(X)$: contribution to *crisis costs* due to systemic risk X

$$c' > 0,\ c'' \geq 0$$

- Hence, net *marginal* benefit from ST funding x is
(i) decreasing in x
(ii) increasing in θ

- 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 θ

- Social welfare:

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

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

(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:*

$$\max_{\{x(\theta)\},X^*} \int_0^1 [\pi(x(\theta),\theta) - \varepsilon(x(\theta),\theta)c(X^*)] f(\theta) d\theta$$

$$\text{s.t.:} \quad X^* = \int_0^1 x(\theta) f(\theta) d\theta.$$

  If interior,

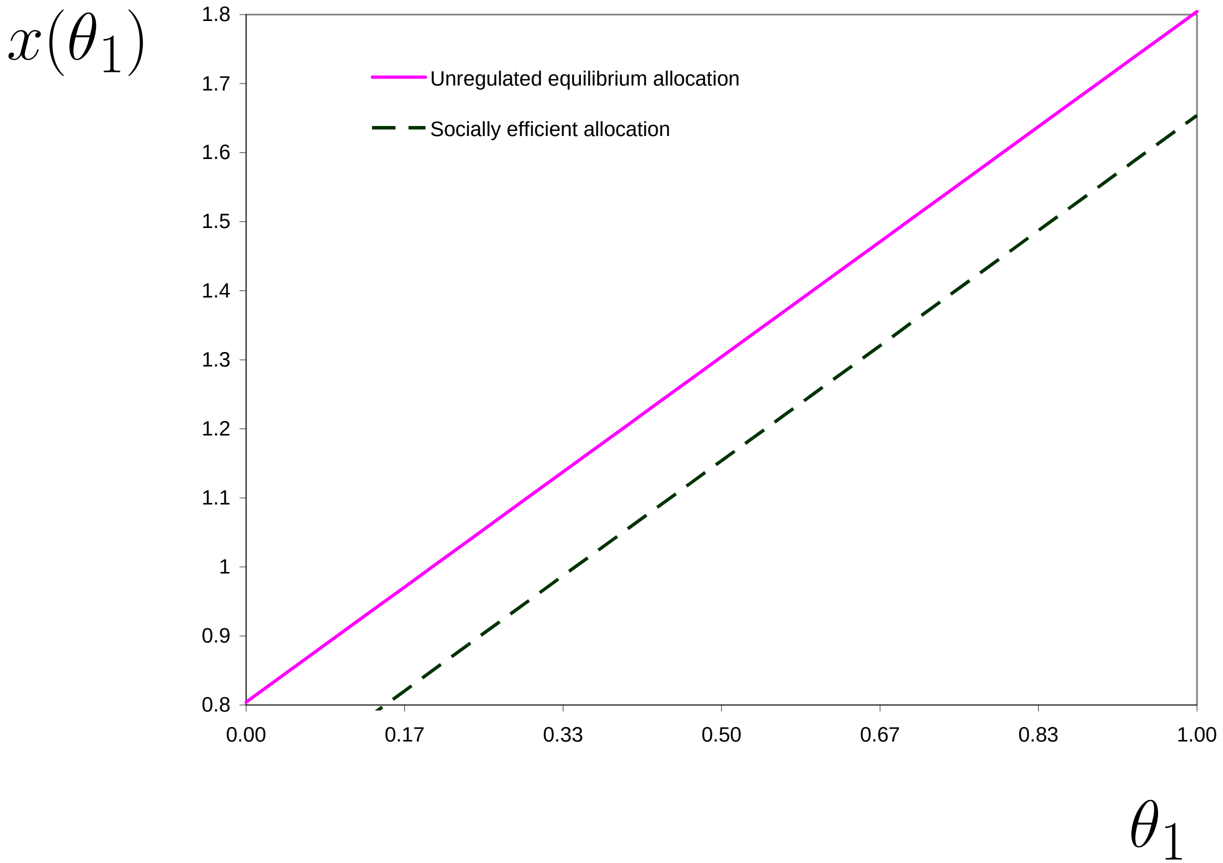
$$\pi_x(x^*(\theta),\theta) - \varepsilon_x(x^*(\theta),\theta)c(X^*) - E_z(\varepsilon(x^*(z),z))c'(X^*) = 0$$

[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 θ!

Proposition 2

With heterogeneity in investment opportunities, social efficiency of equilibrium can be restored by charging tax τ^* on banks' ST funding

4. Quantity-based alternatives

- Pure quantity regulation (prescribing $x^*(\theta)$ to each θ)...
  - Would require bank-level knowledge of $\pi_x(x,\theta)$ & $\varepsilon_x(x,\theta)$
  - Strong informational requirements $\Rightarrow$ 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:

$$\frac{\textit{Stable funding}}{\text{Non-liquid assets}} \geq \text{regulatory minimum}$$

[*Stable funding* = equity+customer deposits+other LT debt]

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

- Then, in an *equilibrium with a stable funding requirement* $\overline{x}$:

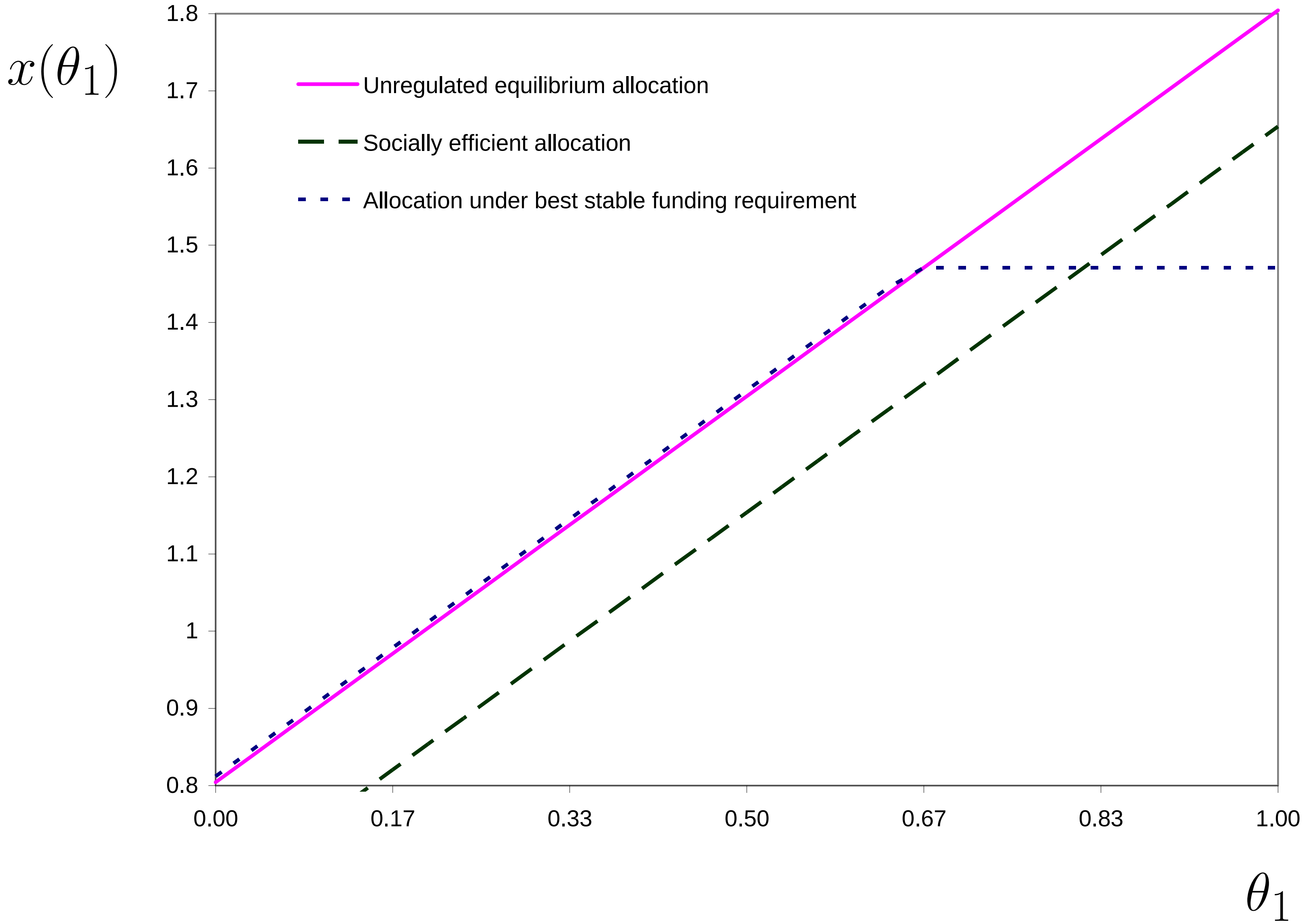
$$x^{\overline{x}}(\theta) = \arg\max_{x \leq \overline{x}} \{\pi(x,\theta) - \varepsilon(x,\theta)c(X^{\overline{x}})\}$$

- Three cases:
  - If $\overline{x} \geq x^e(1) \Rightarrow$ not binding for any θ, no effect
  - If $\overline{x} \leq x^e(0) \Rightarrow$ binding for all θ, very rough
  - If $\overline{x} \in (x^e(0), x^e(1)) \Rightarrow$ asymmetric & inefficient
    * Banks with largest θs: $x^{\overline{x}}(\theta) = \overline{x} < x^e(\theta)$
    * Paradoxically, other banks: $x^{\overline{x}}(\theta) > x^e(\theta)$ [since $X^{\overline{x}} < X^e$]

Proposition 3

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

[*Second best* $\overline{x}$ can be found]


$x(\theta_1)$
1.8
1.7
1.6
1.5
1.4
1.3
1.2
1.1
1
0.9
0.8
Unregulated equilibrium allocation
Socially efficient allocation
Allocation under best stable funding requirement
0.00
0.17
0.33
0.50
0.67
0.83
1.00
θ_1

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"

  $$\widehat{x} = x - m \quad \& \quad \widehat{X} = X - M$$

  – 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* ϕ :

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

  – Equivalent to equilibrium with tax $\tau(\theta) = \frac{\delta\phi}{1-\phi}$ on ST funding

  – But $\delta > 0$ implies social deadweight losses:

$$\mathit{DW}^{\phi} = -\delta \int_0^1 m^{\phi}(\theta) f(\theta) d\theta \equiv -\delta M^{\phi} = -\tau X^{\tau}$$

Proposition 4 ($\delta = 0$) [*normal times*?]

With $\delta = 0$, ϕ is innocuous, except because it generates artificial demand for liquid assets

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[Formally, $M^{\phi} = \frac{\phi}{1-\phi} E_{\theta}(x^{e}(\theta))$]

Proposition 5 ($\delta > 0$)

With $\delta > 0$, ϕ can be set so as to *seemingly* replicate any flat-tax τ on ST funding but at a deadweight cost $-\tau X^{\tau}$

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

Second best requirement ϕ^{SB} must move in response to fluctuations in δ, producing variability in M^{ϕ}

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 θ_2 of crisis losses [due to, say, diff. in governance, charter value, capitalization,...]

  – Fraction θ_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 $\theta_1 = \overline{\theta}_1$ for all banks

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

vs.

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

$$\Downarrow$$

Inefficiency of equilibrium :

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

- The efficient Pigovian tax schedule is now **dependent** on θ_2

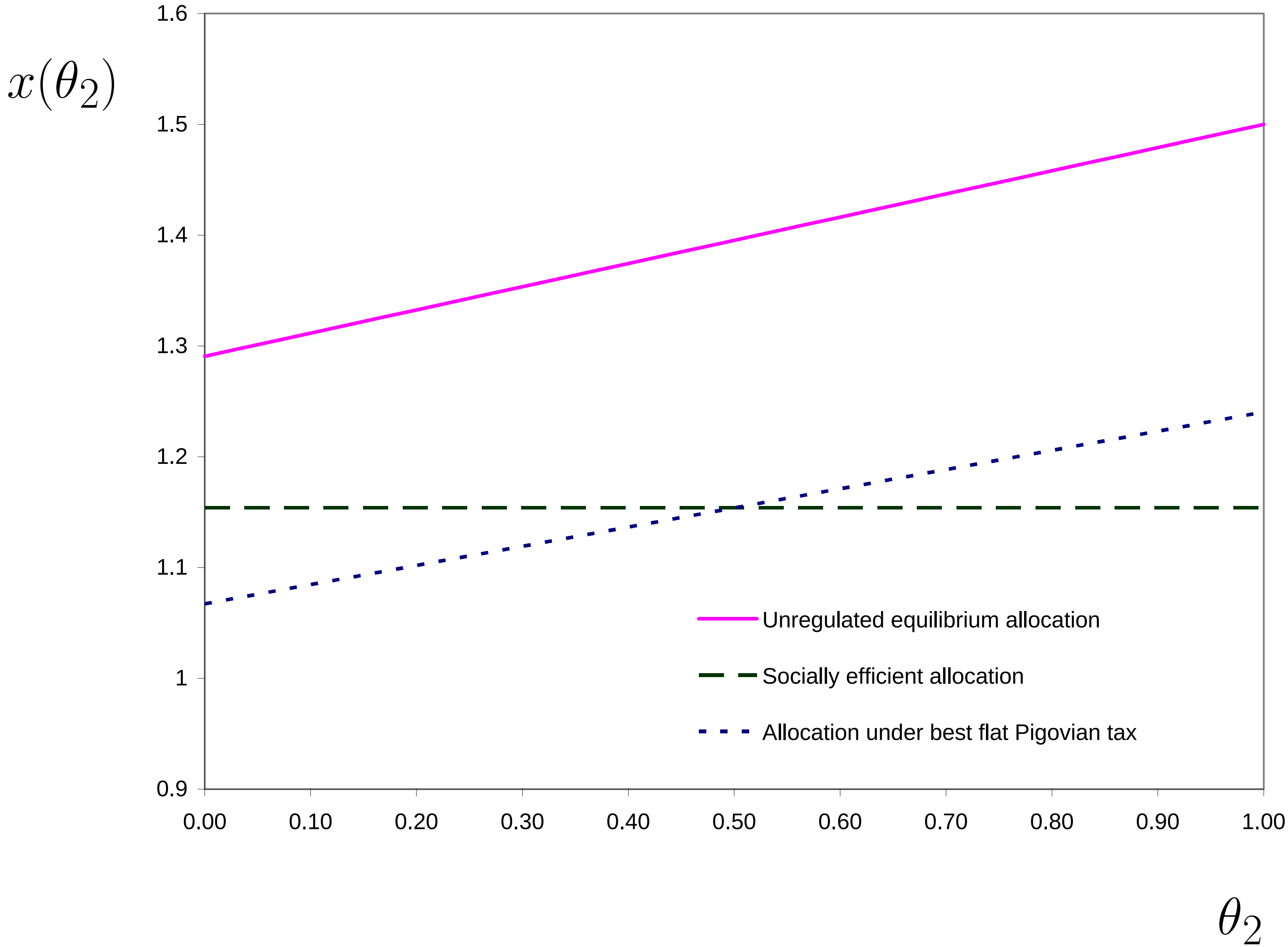
Proposition 7

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 $\overline{x} = \overline{x}^{**}$ can do it

[For liquidity requirements, same conclusions obtained above apply]


$x(\theta_2)$
1.6
1.5
1.4
1.3
1.2
1.1
1
0.9
0.00
0.10
0.20
0.30
0.40
0.50
0.60
0.70
0.80
0.90
1.00
Unregulated equilibrium allocation
Socially efficient allocation
Allocation under best flat Pigovian tax
θ_2

5.2 The general case

- Most likely, not clear-cut results:

  1st best is generally not attainable
  with instruments non-contingent on θ_1 or θ_2

- Second best performance:
  - Continuity argument:
    * If θ_1 is the dominant source of heterogeneity,

      Flat tax on ST funding $\succ$ Stable funding requirement

    * Vice versa if θ_2 is the dominant source of heterogeneity
  - More generally, a combination may be optimal

    [If stronger capital regulation, pushes θ_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]