Bank Regulation under Fire Sale Externalities

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Motivation and research question

- The recent crisis was characterized by severe liquidity problems and fire sales
- The crisis brought liquidity into the spotlight and provided the supervisory momentum to introduce harmonized liquidity regulations
  - Basel III includes liquidity requirements such as LCR and NSFR
  - Several countries have already adopted Basel III liquidity requirements
- We investigate the optimal design of and interaction between capital and liquidity regulations in the presence of fire sale externalities
- We propose an answer to Jean Tirole (2011)'s question:

  "Can we trust the institutions to properly manage their liquidity, once excessive risk taking has been controlled by the capital requirement?"

Key Results

- Banks' capital and liquidity ratios are inefficiently low in the competitive equilibrium in the presence of fire sale externalities
- Constrained efficiency can be achieved with the joint implementation of capital and liquidity regulations (complete regulation)
- When we regulate capital but not liquidity (partial regulation), banks undermine the regulation by reducing liquidity ratios
- The regulator tightens capital requirements to offset banks' lower liquidity ratios, leading to higher capital ratios and less liquidity compared with the second best

Related literature

Liquidity and its regulation
Bhattacharya and Gale (1987), Holmstrom and Tirole (1998), Allen and Gale (2004), Farhi, Golosov, and Tsyvinski (2009), Perotti and Suarez (2011), De Nicolo, Gamba and Lucchetta (2012), Adrian and Boyarchenko (2013), Covas and Driscoll (2014), Calomiris, Heider and Hoerova (2015), Donaldson, Piacentino, and Thakor (2015)

Jointly optimal design of liquidity and other bank regulations
Kashyap, Tsomocos and Vardoulakis (2014), Walther (2015), Van den Heuvel (2017)

Financial amplification and asset fire sales
Fisher (1933), Williamson (1988), Bernanke and Gertler (1989), Shleifer and Vishny (1992, 2011), Kiyotaki and Moore (1997), Allen and Gale (2005), Lorenzoni (2008), Stein (2012), Davila and Korinek (2017)

Efficiency under pecuniary externalities
Hart (1975), Stiglitz (1982), Geanakoplos and Polemarchakis (1986)

The model: Basic setup

Agents: A continuum of banks and consumers, each with a unit mass, and a financial regulator

Three dates: $t = 0, 1, 2$

Two goods:
- A consumption good (safe asset)
- An investment good (risky asset)

Consumers are endowed with ω units of consumption goods at $t = 0, 1, 2$

Consumers supply their endowments to banks inelastically at $t = 0$ and earn zero net expected interest

Banks can convert consumption goods into investment goods 1-to-1 at $t = 0$

Bank balance sheet

Assets	Liabilities
Risky (n_i)	Deposits (l_i)
Safe $(n_i\, b_i)$	Equity (e)

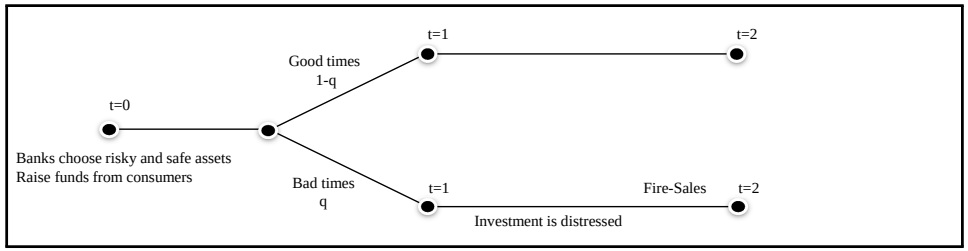
Banks choose risky asset level, n_i, and how many safe assets to hold per unity of risky assets, $b_i \in [0, 1]$

Banks are endowed with e units of fixed equity capital and raise $l_i = (1 + b_i)n_i - e$ units of consumption goods from consumers

The operational cost of a bank is $\Phi((1 + b_i)n_i)$, where Φ is increasing and convex

Risk weighted capital ratio of bank is e/n_i

Timing of the model and the liquidity shock at $t = 1$



Good state: no shocks

- Bank's assets yield $Rn_i + n_i b_i$ units of consumption goods at $t = 2$

Bad state: a restructuring shock

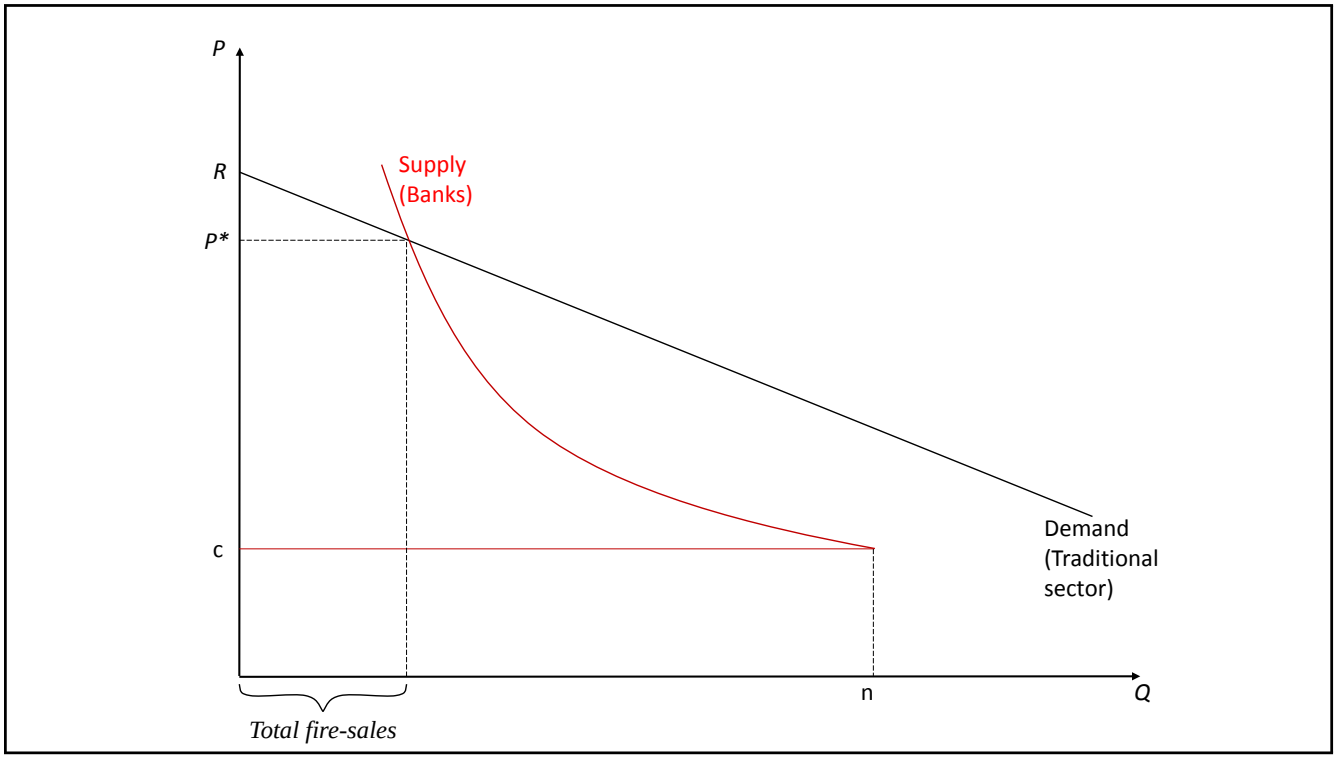
- Investment distressed, has to be restructured by incurring c units per risky asset to remain productive

- Banks can use safe assets $n_i b_i$ to carry out the restructuring

- A combination of limited-commitment and debt-overhang problems prevents banks from raising external finance

- Banks sell risky assets to firms in the traditional sector (owned by consumers) to raise liquidity (fire sales)

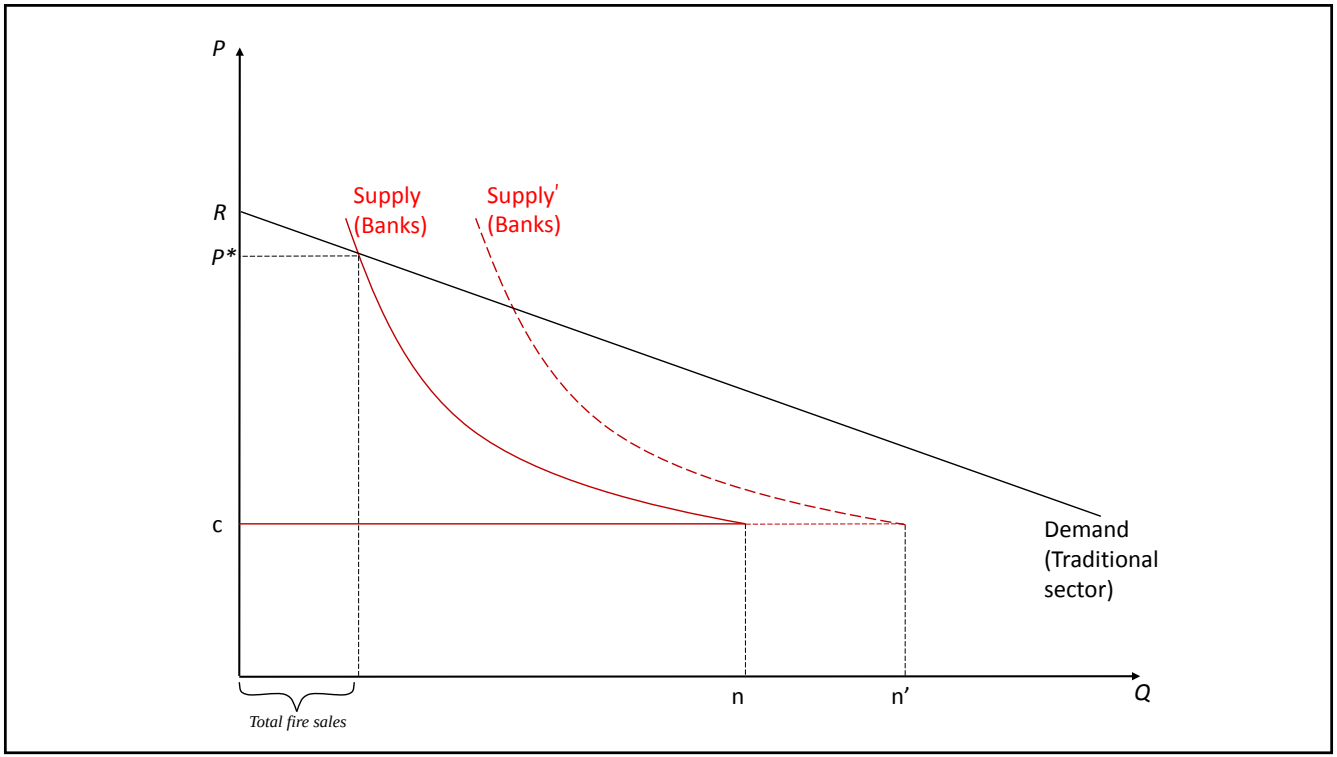
Asset market equilibrium at t=1



Downward Sloping Demand: Traditional sector has a concave technology and is less efficient than banks

Downward Sloping Supply: Banks need certain amount of liquidity. If the price is lower, they need to sell more assets

Asset market equilibrium: Comparative statics



Atomistic banks ignore the effects of their choices (n_i, b_i) on the equilibrium price, $P(n, b)$

Lemma: A higher initial risky investment (n) or a lower liquidity ratio (b) leads to lower asset prices and more fire sales: $\frac{\partial P}{\partial n} < 0$ and $\frac{\partial P}{\partial b} > 0$

What we do next

We will compare and contrast:

- Competitive Equilibrium: No regulation (n, b)
- Constrained Planner's Problem (Second Best): (n^{**}, b^{**})

How can we implement second-best allocations?

- Complete Regulation: Both capital ratio (e/n_i) and liquidity ratio (b_i) are regulated, as in Basel III
- Partial Regulation: Only capital ratio (e/n_i) is regulated, i.e. pre-Basel III regulation
- Optimal single linear rules that combine capital and liquidity requirements

Full insurance is not optimal

Lemma

It is optimal for both banks in the unregulated competitive equilibrium and the constrained social planner to take fire sale risk; that is, to set $b_i < c$

- The amount (c) and frequency (q) of the aggregate liquidity shock are exogenous in the model, but whether and to what extent a fire sale takes place are endogenously determined
- In principle, it is possible to insure banks perfectly against the liquidity shock by setting $b_i = c$
- However, liquidity has an opportunity cost in terms of forgone investment in the risky asset, which has a higher expected return

Competitive equilibrium vs second-best allocations

Proposition

Competitive equilibrium is constrained inefficient and features:
$n > n^{**}$
$b < b^{**}$

- Banks overinvest in the risky asset and underinvest in liquidity in the unregulated competitive equilibrium
- The inefficiency is created by the fire sale externality
- The second-best allocations can be implemented using both
  - A minimum risk weighted capital ratio requirement: $e/n_i \geq e/n^{**} \Leftrightarrow n_i \leq n^{**}$
  - A minimum liquidity ratio requirement: $b_i \geq b^{**}$

Implementing the second-best allocations

- Two regulatory tools are sufficient to implement the second-best:
  - capital adequacy ratios and liquidity ratio requirements
- What if only one of these tools is used?
  - For example, can we use only capital ratio requirement, similar to the pre-Basel III era?
- We call this case "Partial Regulation" because liquidity is not regulated
  - Regulator moves first and optimally chooses an upper limit on risky investment, n
  - Banks set $n_i = n$ and choose the liquidity ratio, b_i, freely to maximize their expected profits

Partial regulation

Proposition

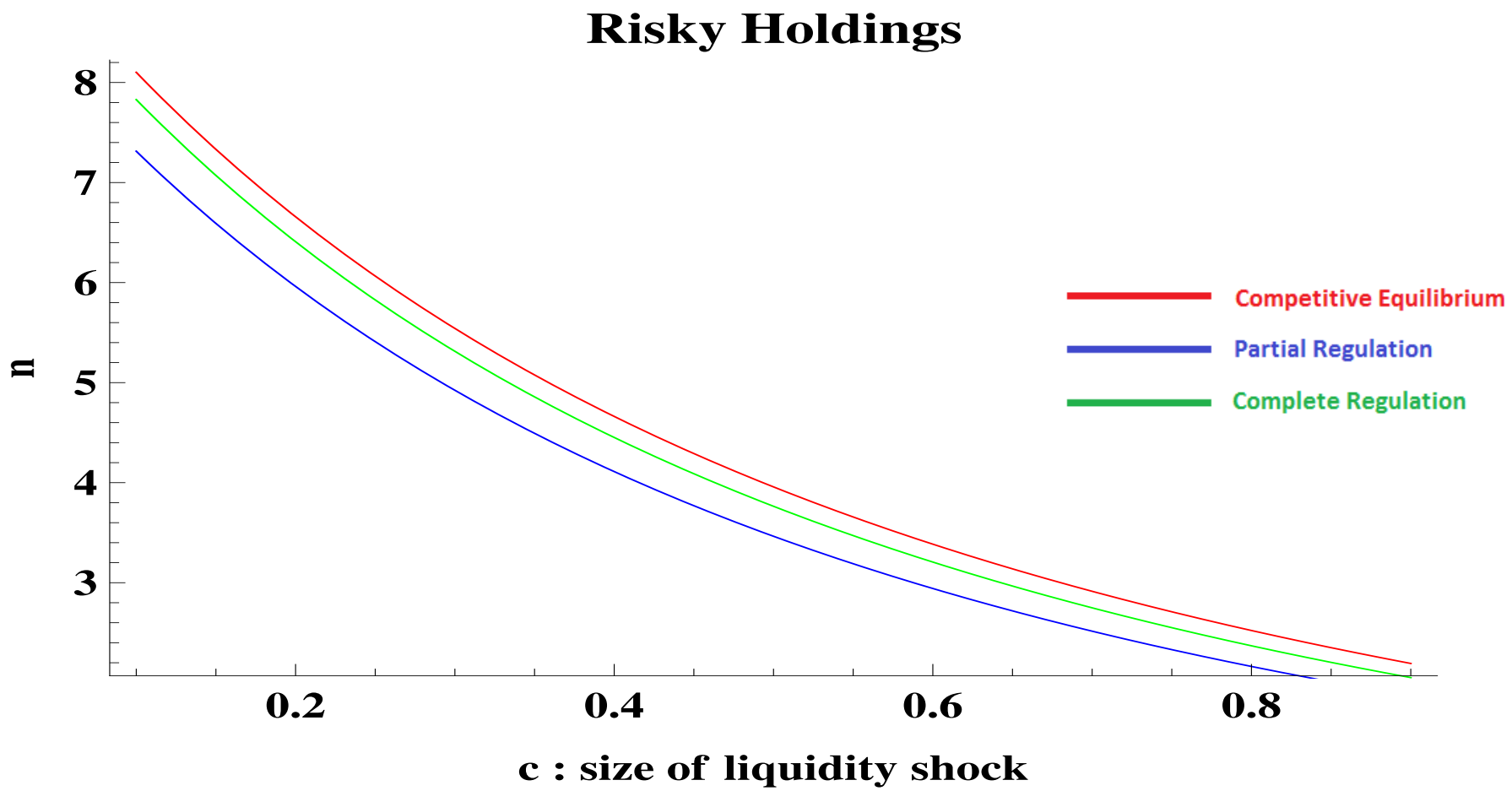
Banks decrease their liquidity ratio as the regulator tightens capital requirements, i.e. $b_i'(n) > 0$

- Stricter limits on risky investment $\rightarrow$ lower liquidity ratios
- Banks are restricted to take risk on the investment side, they switch to the liquidity channel
- An unintended consequence of capital regulation: Making the system safer allows banks to take more risk on the liquidity side

Comparing risky investment levels (n)

Proposition

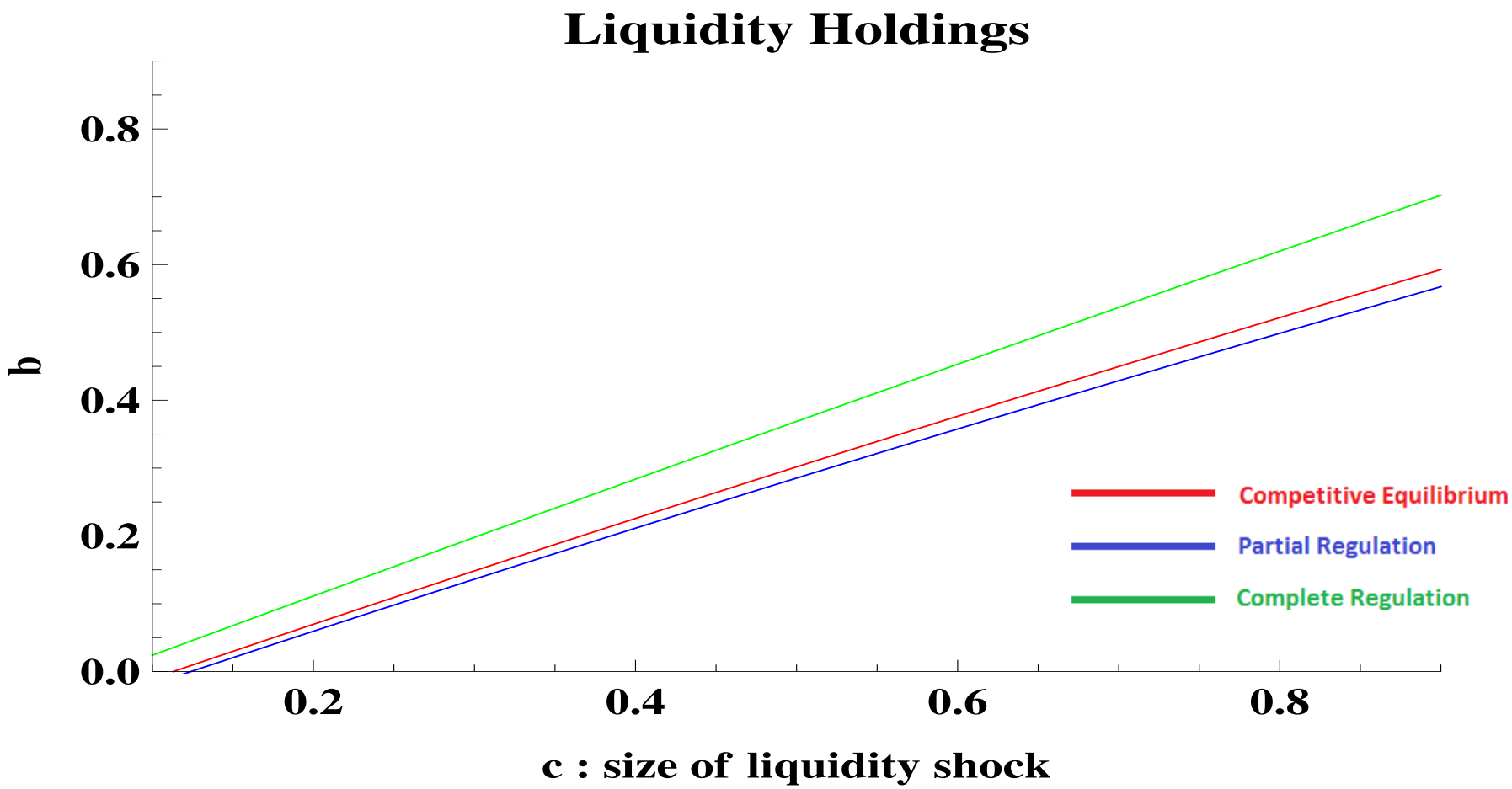
$n > n^{**} > n^{*}$



Comparing liquidity ratios (b)

Proposition

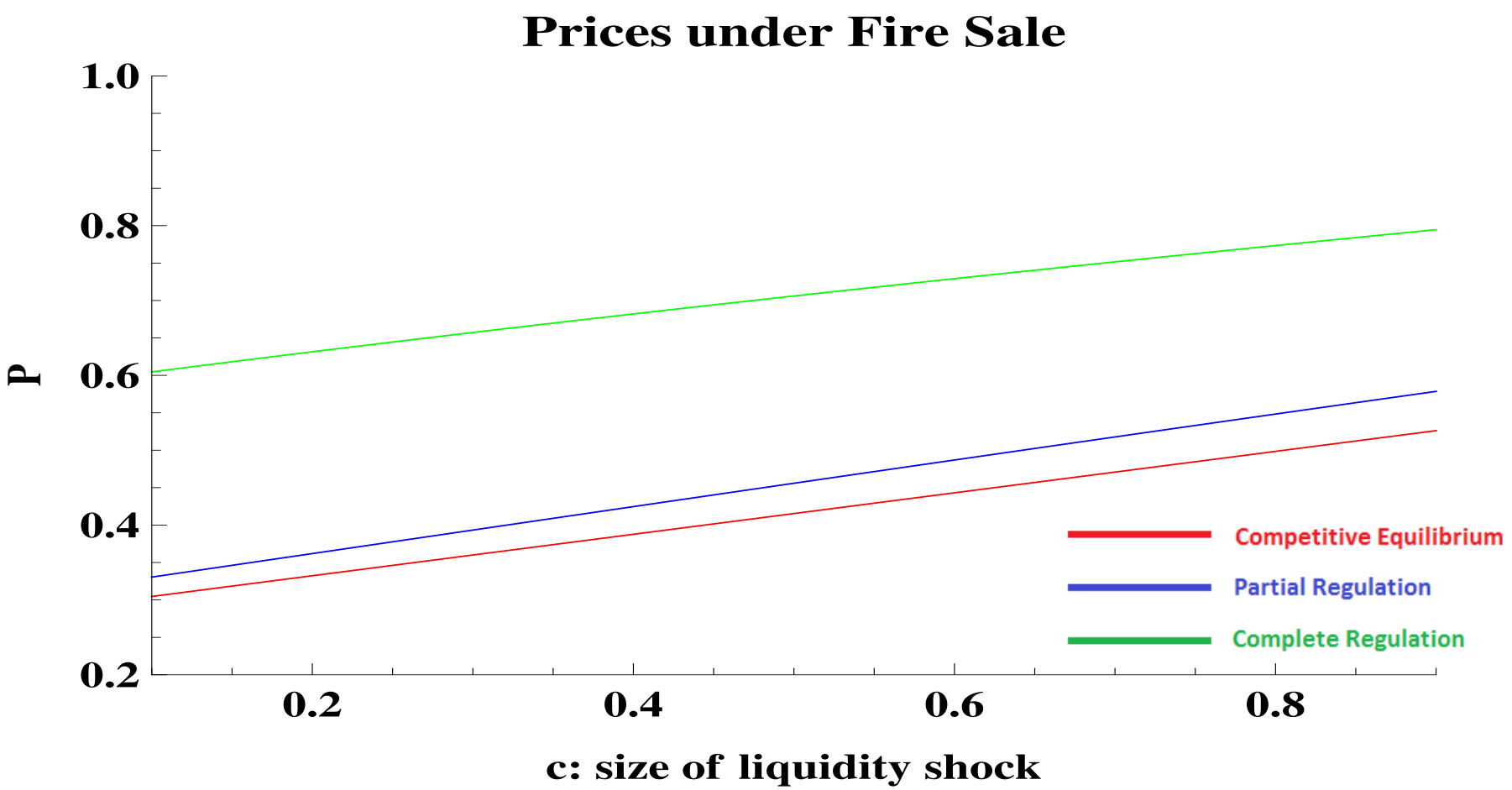
$b^{**} > b > b^{*}$



Fire sale price of risky asset (P)

Proposition

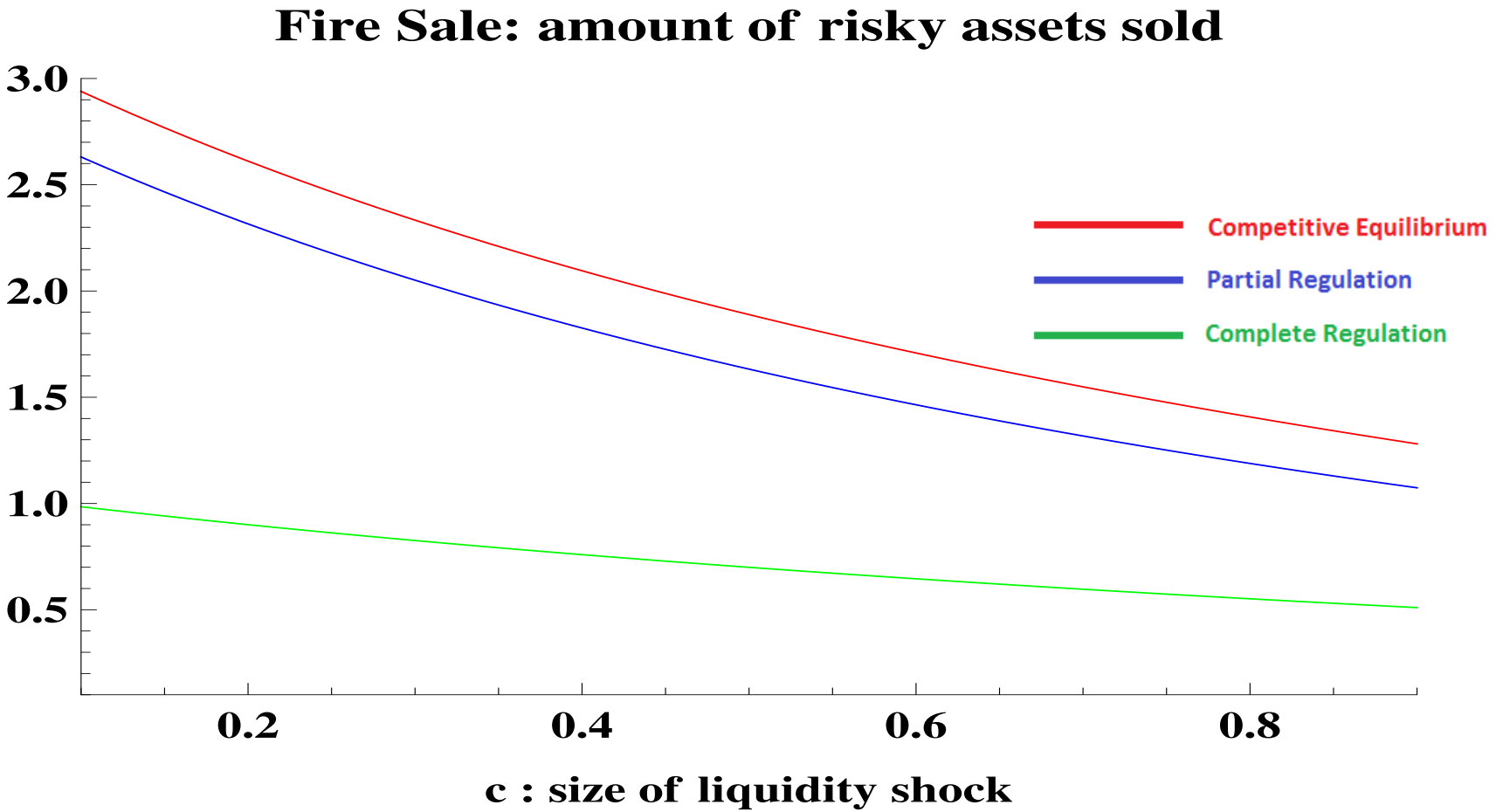
$P^{**} > P^{*} > P$



Severity of the crisis: Total amount of risky assets sold

Proposition 4 (c)

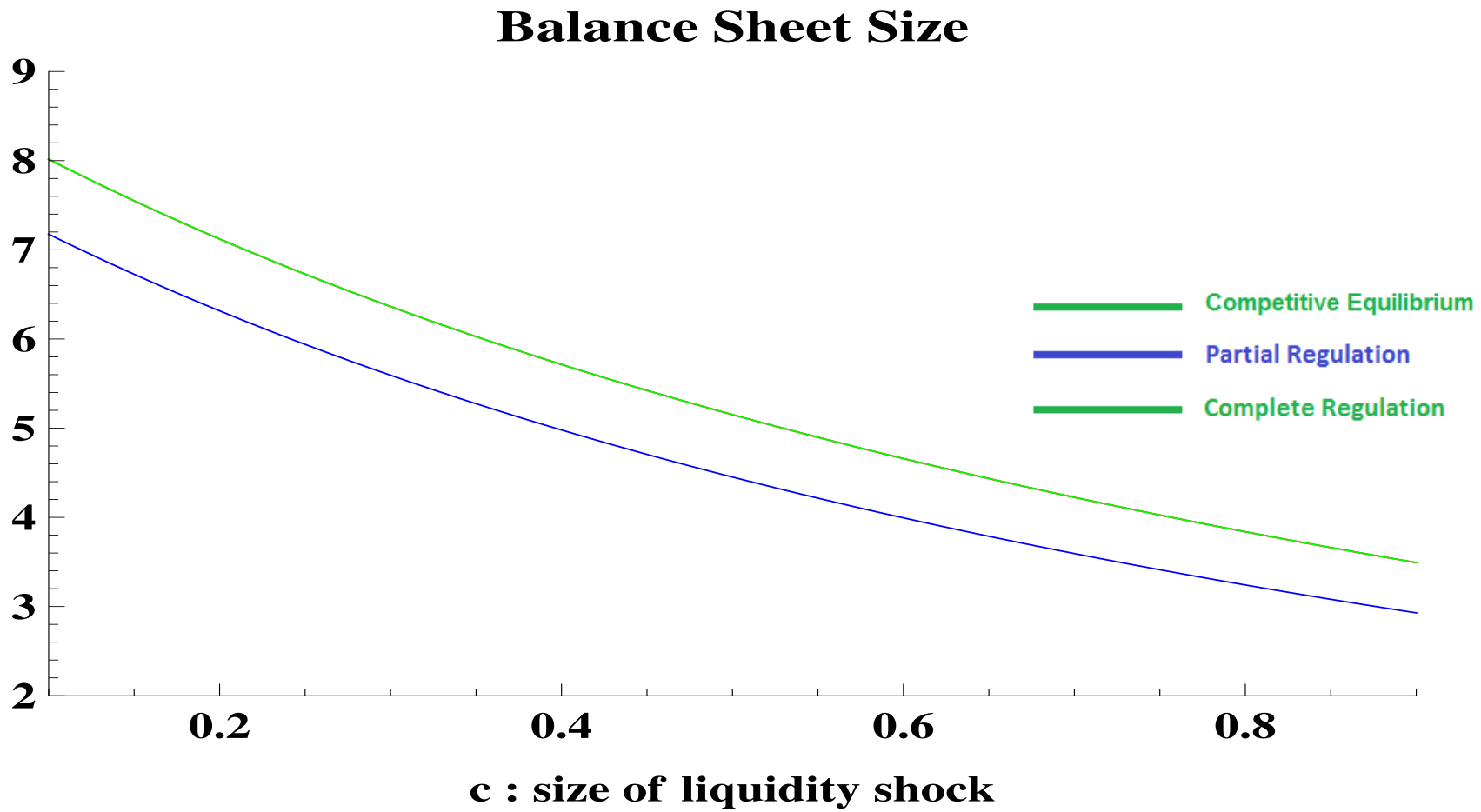
$$(1-\gamma)n > (1-\gamma^*)n^* > (1-\gamma^{**})n^{**}$$



Balance sheet size

Proposition

$$(1+b)n = (1+b^{**})n^{**} > (1+b^{*})n^{*}$$



Advantages of regulating both liquidity and capital

- More funds for high return projects: $n^{**} > n^{*}$
- More liquidity: $b^{**} > b^{*}$
- Less fire-sales:
  - Ratio: $1 - \gamma^{*} > 1 - \gamma^{**}$
  - Level: $(1 - \gamma^{*})n^{*} > (1 - \gamma^{**})n^{**}$
- Higher fire sale prices: $P^{**} > P^{*}$

Why not just regulate liquidity?

- Fire sales are triggered by a restructuring shock in the bad state. Banks are solvent otherwise
- Can the second-best be implemented using liquidity regulation alone?
- The answer is negative: $n_i(b^{**}) > n^{**}$
- Again, when one channel is restricted banks switch to another channel to take their privately optimal fire sale risk

Single linear rule

Can we instead implement the second-best allocations using more complex rules that combine capital and liquidity regulations?

Consider the following linear rule $\tau_n n + \tau_b b \leq k$

If we choose τ_n, τ_b properly the linear rule implements the optimal allocations

The optimal weights satisfy: $\tau_n > 0$ and $\tau_b < 0$.

The banks can satisfy the constraint by decreasing risk investment or increasing liquidity ratio

Conclusion

- Under fire sale externalities, banks overinvest in the risky asset and underinvest in the liquid asset in the unregulated competitive equilibrium
- When we regulate capital but not liquidity, banks undermine the regulation by taking more risk through the liquidity channel
- Pre-Basel III regulatory framework, with its reliance only on capital requirements, was ineffective in addressing systemic instability caused by fire sales
- Macroprudential liquidity regulations that complement capital requirements implement second-best allocations, improve financial stability and allow for a higher level of investment in risky assets