A Macroenonomic Model of Endogenous Systemic Risk Taking

David Martinez-Miera Javier Suarez

UC3M CEMFI

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"In the simplest terms, one can characterize the **macroprudential approach** to **capital regulation** as an effort to control the social costs associated with **excessive balance-sheet shrinkage** on the part of multiple financial institutions **hit with a common shock**."

S. Hanson, A. Kashyap, and J. Stein (2010)

"A Macroprudential Approach to Financial Regulation"

Journal of Economic Perspectives, forthcoming

Introduction

- Issue
  - What are the economic effects of banks' systemic risk taking decisions?
  - Can regulator reduce the (negative) externalities created by banks' decisions?
- Our setup
  - Macroeconomic model DSGE
    - Real economic effects (no partial equilibrium)
  - Banks decide their investment (loan granting) strategy
    - Being exposed to systemic shocks or not
    - Banks' decisions affects the consequences of the systemic shock
    - Crisis is endogenous
- Analyze the level of capital requirements that maximizes welfare

Exposure to systemic risk

- Systemic risk → exposure to an (infrequent) undiversifiable source of risk
- Firms (productive technology)
  - Need a loan for their funding
  - They can be systemic or not
    - Unobservable by regulator
  - Systemic firms:
    - If shock hits → All firms default
    - If no shock → Fraction $p1$ default (i.i.d)
  - Non systemic:
    - Always $p0$ ($> p1$) default (i.i.d)
    - Socially efficient firms
- Banks choose which firms they fund ⟶Risk shifting Incentives

Banks equity

- Face flat capital requirement γ
- Bank equity
  - Internally generated
    - "Retained earnings"
  - **Can NOT raise external equity**
    - If systemic + shock occurs equity is wiped out
    - Last bank standing effect (Perroti and Suarez 2002)
    - Reduces the systemic risk taking incentives
- Bank equity is the state variable of the model

Systemic risk taking equilibrium

- The fraction of systemic banks in the economy x is defined by the marginal bank being indifferent between being systemic or not

$$\underbrace{\left[(1-\varepsilon)v(e_{t+1}^{1-\varepsilon})+\varepsilon v(e_{t+1}^{\varepsilon})\right]R_{0t+1}}_{\textit{Non Systemic}} = \underbrace{(1-\varepsilon)v(e_{t+1}^{1-\varepsilon})R_{1t+1}^{1-\varepsilon}}_{\textit{Systemic}}$$

- Tradeoff
  - $R_{0t+1} < R_{0t+1}$ vs $\varepsilon v(e_{t+1}^{\varepsilon})$
  - where $v(e_{t+1}^{\varepsilon})$ is the value of bank equity if shock occurs
- Bankers can reallocate their wealth between the banks
  - x fraction of total bank equity devoted to systemic banks

Main Intuition of the capital requirements mechanism

- Increasing capital requirements $\uparrow \gamma$
  - $\downarrow$ amount of loans $\longrightarrow \downarrow$ output of the economy
  - Welfare decreases
- Increasing capital requirements $\uparrow \gamma$
  - $\downarrow$ amount of loans a bank can give
  - $\uparrow$ return of bank equity (scarce factor)
    - Specially true in "crisis" periods $\uparrow v(e^{\varepsilon}_{t+1})$
    - Increase charter value of the bank (more when shock hits)
  - Lower fraction of banks are systemic
  - Impact of a shock is smaller
  - Welfare increases
- Non trivial trade off GDP loss in "normal times" vs higher impact of systemic crisis

Some further intuitions

- Systemic risk is a latent factor
  - Only banks decision make it important
  - If no banks decided to be systemic then there would be no impact of the shock
- There are bank defaults in equilibrium
  - This means that bank equity (state variable) is not constant
  - Not a fixed steady state
    - Stochastic steady state
    - Probabilistic distribution of states
  - The characteristics of the stochastic steady state is affected by capital regulation
    - Welfare is affected by capital requirements

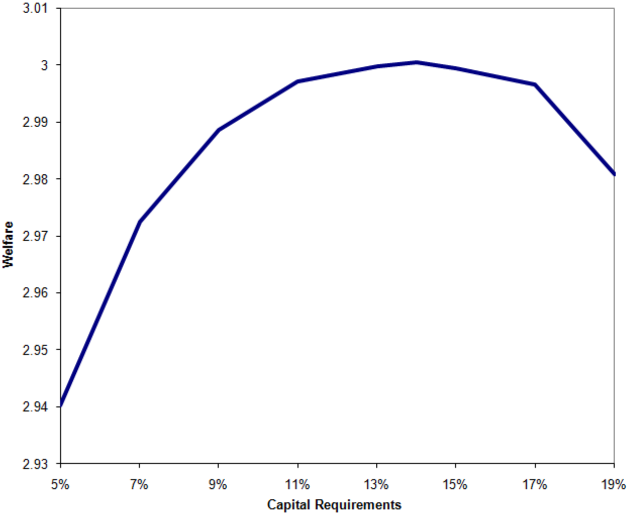
Road map

1. No time for model (In the paper)
2. Graphical Results
3. Calibration and Quantitative analysis
4. Conclusions

Qualitative results

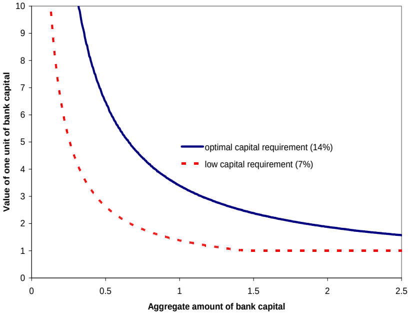
- Value function iteration on $v(e)$ + other equilibrium conditions
- Sometimes, equilibria without full reinvestment (off relevant range)
- No problems of inexistence or multiplicity detected

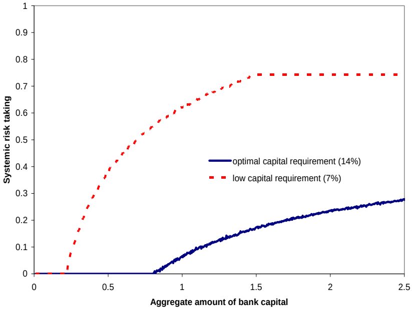
Social welfare as a function of Cap Req



[We compare γ^*=14% with γ=7%]

V and x under low and optimal Cap Requirement

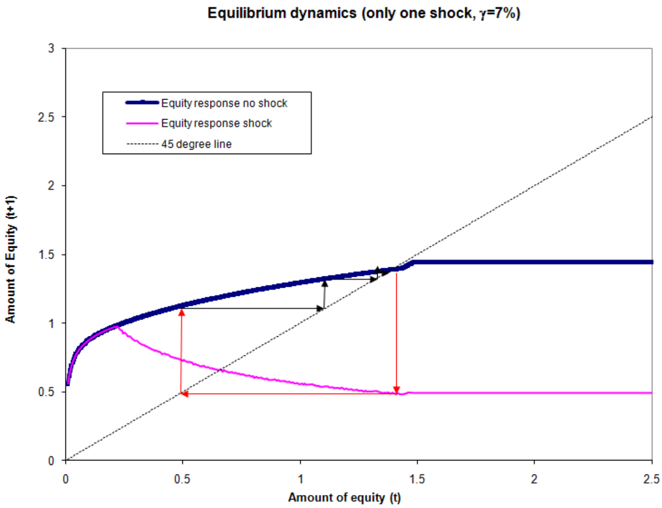




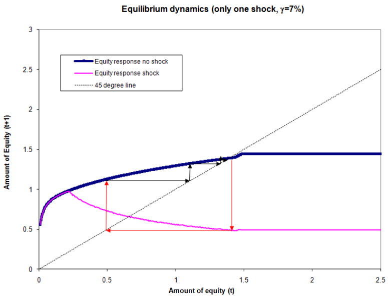
Comments on Fig. 2

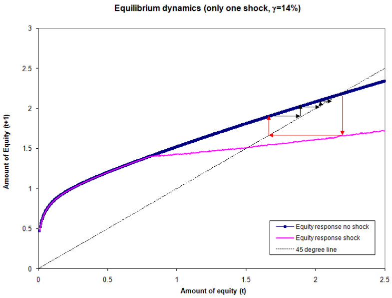
- Greater scarcity of e due to higher γ implies larger $v(e)$
- Systemic risk-taking (increasing in e) is lower when γ is higher
- Why?
  - γ affects position and slope of $v(e)$
  - Gives greater incentives to preserve e after systemic shock
- Further intuition (esp. on welfare trade-offs) requires looking at (endogenous) dynamics of e

Equilibrium dynamics with low and optimal Cap Req



Equilibrium dynamics with low and optimal Cap Req

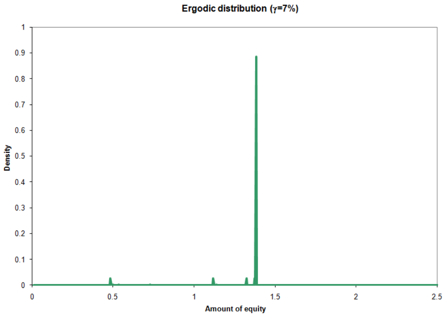


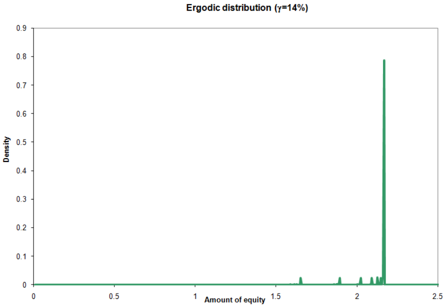


Comments

- Mappings from amount of e_t to amount of e_{t+1}
  - if the systemic shock does not occur $\longrightarrow$ solid line
  - if the shock occurs$\longrightarrow$ dashed line
- Vertical distance measures bank capital lost when the economy is hit by shock
- Abs. and relative loss is bigger for high e because systemic risk taking is higher
- Intersection of solid line with 45-degree line identifies *pseudo-steady state* (PSS)

Equilibrium dynamics with low and optimal Cap Req





Comments

- PSS:
  - Highest values of e and $x(e)$
  - Most devastating implications of a systemic shock
  - Economy only fully recovers prior e in a minimum of 5 periods
- Figures show frequencies with which values of e are visited along long histories
- Higher capital requirements concentrate those values on narrower (and higher) range

Quantitative results (summary)

- Optimal capital requirements: positive and large (14%)
- Comparison CR=7% ↔ CR=14%
  - Fraction of systemic loans: 72% ↔ 25%
  - PSS aggregates fall: bank credit (22%), GDP (7%), wages (9%)
  - Yet, difference in social welfare ≃ 0.9% permanent consumption:
- Fall in year-after-shock aggregates:
  - CR=7% → bank credit (65%), GDP (32%), wages (37%)
  - CR=14% → bank credit (24%), GDP (10%), wages (11%)

RESULTS

- **Calibration** (1 period = 1 year) 11 parameters

Baseline parameter values

Discount rate of the patient agents	r	0.02
Discount factor of the impatient agents	β	0.96
Total factor productivity	A	2
Physical capital elasticity	α	0.3
Depreciation rate in successful firms	δ	0.05
Depreciation rate in failed firms	λ	0.35
Idiosyncratic default rate of non-systemic firms	p_0	0.03
Idiosyncratic default rate of systemic firms	p_1	0.018
Probability of a systemic shock	ε	0.03
Bankers' exit rate	ψ	0.20
Fraction of wage income earned by bankers	ϕ	0.05

Why these values?

- Low real interest rates such as prior to the current crisis
- $A = 2$ is inconsequential (levels in 0 to 100 range)
- $\alpha = 0.30$ produces labor share $\simeq$ 70%
- δ and λ match $K/Y \simeq$ 3-4 & LGD$\simeq$ 45%
- p_0, p_1, and $\varepsilon \Rightarrow$ sufficient room of risk shifting
  - *expected* default rates 3%–4.7%; systemic shocks every 33y
- Bank capital dynamics (highly tentative):
  - ψ: bankers' expected active life = 5y
  - $\psi\phi$: capital brought in by new bankers = 1% of agg. labor income

Quantitative results

Statistic Expected	$\gamma = 7\%$	$\gamma = 14\%$	Δ
Certainty-equivalent consumption (CEC)	2.973	3.000	0.94%
GDP	4.404	4.116	-6.52%
Dep Insurance	-0.158	-0.037	-76.54%
Bank credit	19.243	15.254	-20.73%
Bank Equity	1.347	2.136	58.54%
Value Equity	1.107	1.786	61.31%
Systemic banks	0.706	0.244	-65.38%

Quantitative results

Statistic From "normal" to crisis period	$\gamma = 7\%$	$\gamma = 14\%$
Certainty-equivalent consumption (CEC)	-17.28%	-4.55%
GDP	-31.74%	-9.54%
Dep Insurance	.	.
Bank credit	-65.34%	-23.96%
Bank Equity	-65.34%	-23.96%
Value Equity	160.29%	25.79%
Systemic banks	-50.07%	-20.24%

Welfare Decomposition (Expected terms)

	Welfare	GDP	K Cons	Fin Adj Term
$\gamma = 7\%$	2.973	4.227	-1.623	0.368
$\gamma = 14\%$	3.000	3.952	-1.221	0.269
Difference	0.028	-0.276	0.403	-0.099
Total Effect	1.000	-9.854	14.396	-3.542

Comments on quantitative results

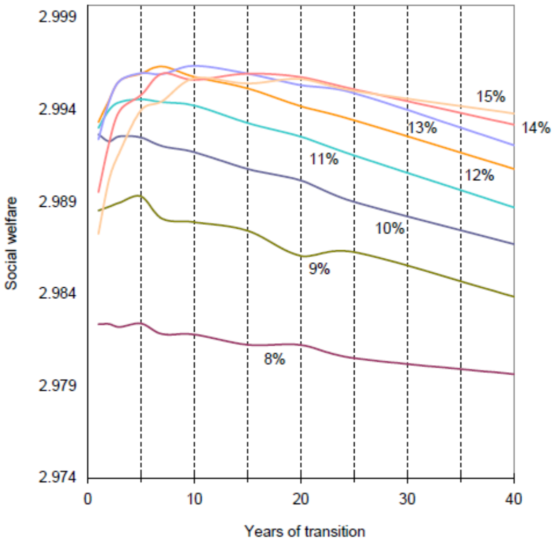
- Significant implications of capital requirements
- Setting them optimally requires economic risk-management view:
    - static element: inefficient systemic risk-taking
    - dynamic element: invisible threat to macroeconomic stability
- Standard macroeconomic variables in the PSS give bad indication of convenience of high γ

  [Capital requirements have "large costs" in these terms]
- Comparison $\gamma = 0.07 \leftrightarrow \gamma = 0.14$ suggests regulatory-based explanation for "financial exuberance" (e.g. bank credit to GDP)

WORK AHEAD

- Fine tuning the calibration, robustness checks
- Value (and limits to the value) of gradualism in rising γ
  - [Best: Moving from 7% to 13% in 11 years]
- Assessment of anti-cyclical capital requirements
  - Partially done (TENTATIVE)
- Assessment of "credit policy" and recapitalization programs
- Other macroprudential policies

Transition


2.999
2.994
2.989
2.984
2.979
2.974
Social welfare
0
10
20
30
40
Years of transition
15%
14%
13%
12%
11%
10%
9%
8%

CONCLUSIONS

- Dynamic GE model of endogenous systemic risk-taking
- The model embeds a meaningful definition of systemic risk
- Formal assessment of macroprudential policies (with an internally consistent welfare metrics)
- Preliminary results suggest significant effects of capital requirements on systemic risk-taking, standard macroeconomic and banking indicators, and welfare
  - Capital requirements have apparently large cost in terms of macro-aggregates in "normal times"...
  - But there is a unique socially optimal level of capital requirements and finding it out requires a carefully calibrated model
  - Social welfare at stake can be quite large