Assessing Capital Regulation in a Macroeconomic Model with Three Layers of Defaults

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Introduction

- Collective effort under the auspices of MaRS (Macro-Prudential Research Network), launched in 2010 by the ESCB

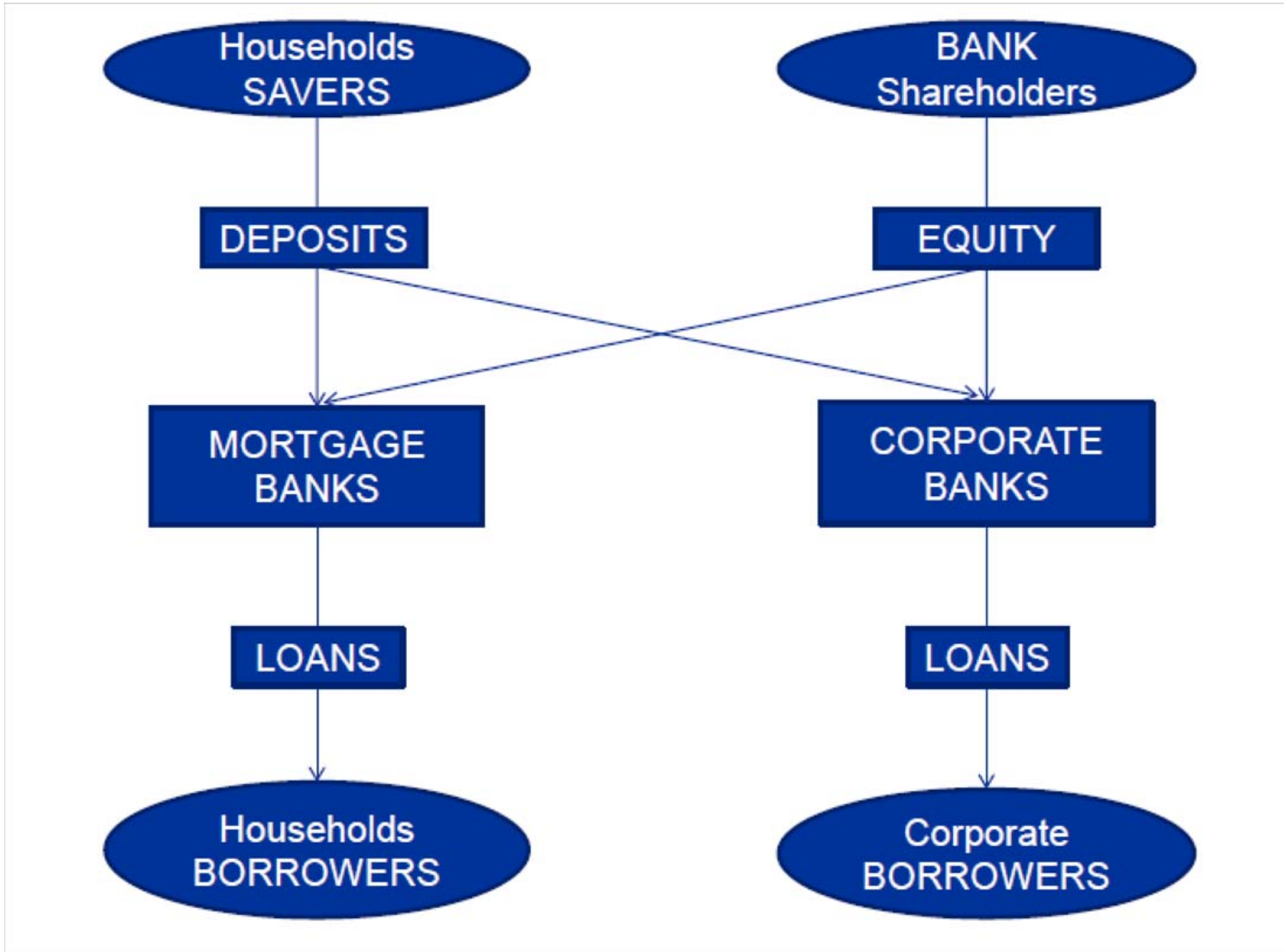
  [Project in WS1 — Macro-financial models linking financial stability & economic performance]

- Aim: Build a decision-support tool to provide analytical feedback to policymakers

- Main features: DSGE, default (three layers ⇒ 3D model), distortions associated with financial instability, explicit welfare analysis

- Specific focus: Capital requirements (CRs)

Structure of the 3D model



[Banks are centerpiece of credit allocaton system]

Mechanisms at play

1. Borrowing by households, corporations, and banks features default risk due to the combination of idiosyncratic and aggregate factors. Default causes bankruptcy costs

2. Deposit insurance (DI). Deposits are formally insured, providing an implicit subsidy to lending made by risky banks

3. Bank funding cost channel
   - Despite DI, depositors suffer transaction costs when banks fail
   - Depositors charge banks for the perceived risk of bank failure

4. Bank capital channel (+ other net worth channels)
   - Equity funding required to satisfy CRs is exclusively provided by bankers whose wealth comes from retained earnings
   - Aggregate shocks that destroy bankers net worth cause amplification and propagation

Net impact:

- We are agnostic about the relative importance of each mechanism
- The model may feature over- or under-investment
- Current parameterization is an illustration of what the model may deliver

Overview of the results

1. Steady state
   - Large gains from rising CRs when bank risk of failure is significant
   - Rather limited losses from making CRs too large
2. IRFs
   - Bank-related amplification channels are strong then bank risk of failure is large
   - CRs are effective in shutting them down
3. Countercyclical adjustments
   - Mitigate the impact of shocks with high CRs (or low bank risk)
   - Counterproductive otherwise

[Qualifications: rough parameterization, standard solution methods, bankers recover their wealth far *too* quickly]

Related literature*

- Bank capital channel in models without bank default: Gertler & Kiyotaki (2010), Meh & Moran (2010), Gertler & Karadi (2011), Brunnermeier & Sannikov (2014) [no focus on capital requirements]
- Models emphasizing 'fire sale' or investment externalities: Bianchi & Mendoza (2011), Gersbach & Rochet (2012), Korinek & Jeanne (2012) [quantitatively small effects on welfare]
- Policy-oriented assessments of capital requirements: Admati & Hellwig (2013), Miles, Yang & Marcheggliano (2012), MAG's Final Report (2010) [either no dynamics or poor microfoundations]
- Martinez-Miera & Suarez (2012): effect of capital requirements on banks' temptation to lend to systemic borrowers
- Parallel efforts: Benes, Kumhof & Laxton (2014), Nguyên (2014) [related insights]

Outline

1. The 3D model
2. Parameterization
3. Steady-state effect of CRs
4. Shock propagation and CRs
5. Counter-cyclically adjusted CRs
6. Conclusions

The 3D model

Agents

- Households
  - Borrowing households (impatient):
    - borrow to buy houses
    - default if house is worth less than mortgage repayment
  - Saving households (patient): supply deposits to banks

- Entrepreneurs (corporate borrowers)
  - 2-period OLG with net worth transmitted through bequests
  - Provide inside equity to firms that maintain the capital stock
  - Their firms default if assets are worth less than loan repayments

- Bankers
  - 2-period OLG with net worth transmitted through bequests
  - Provide inside equity to banks
  - Their banks:
    - default if loan portfolio is worth less than deposit repayments
    - enjoy deposit insurance
    - are subject to regulatory capital requirements

Production sector [standard]*

- Consumption goods
  - Perfectly competitive sector made up of firms owned by saving households
  - Combine capital rented from entrepreneurs with labor supplied by households

- Capital goods / Housing goods
  - Perfectly competitive sector made up of firms owned by saving households
  - Firms optimize intertemporally in response to changes in price of capital / housing
  - Face investment adjustment costs

[These sectors do not directly face financial frictions]

Macroprudential tools

- Steady state capital requirements
- Counter-cyclical capital buffers
- Risk weights

Households

- Two distinct dynasties that differ in their discount factors:
  - patient saving households ($j = s$) $\rightarrow \beta^s$
  - impatient borrowing households ($j = m$) $\rightarrow \beta^m < \beta^s$
- Dynasties provide risk-sharing to their members:

$$\max E_t \left[\sum_{i=0}^{\infty} \left(\beta^j\right)^{t+i} \left[\log\left(c_{t+i}^j\right) + v_{t+i}^j \log\left(h_{t+i}^j\right) - \frac{\varrho_{t+i}^j}{1+\eta} \left(l_{t+i}^j\right)^{1+\eta} \right] \right]$$

where

c_t^j: storable *consumption* good
h_t^j: durable *housing* good
l_t^j: hours worked

Saving households

- Dynamic budget constraint

$$c_t^s + q_t^H h_t^s + d_t \leq w_t l_t^s + \left(1 - \delta^H\right) q_t^H h_{t-1}^s + \widetilde{R}_t^D d_{t-1} - T_t^s + \Pi_t$$

where

d_{t-1}: deposits with (risky) gross return $\widetilde{R}_t^D$
T_t^s: lump-sum tax used to ex-post balance the DIA's budget
Π_t : profits from the standard production sector

- Importantly,

$$\widetilde{R}_t^D = \left(1 - \gamma \Gamma_t^b\right) R_{t-1}^D$$

with R_{t-1}^D: promised repayment (insured)
γ: transaction cost incurred if the bank defaults
Γ_t^b: average bank failure rate [$\Rightarrow$ *funding cost* channel]

Borrowing households

- Dynamic budget constraint

$$c_t^m + q_t^H h_t^m - b_t^m \leq w_t l_t^m + \int_0^\infty \max\left\{\omega_t^m q_t^H \left(1 - \delta_t^H\right) h_{t-1}^m - R_{t-1}^m b_{t-1}^m, 0\right\} dF^m(\omega^m) - T_t^m$$

where b_t^m: standard (non-contingent) debt charging gross rate R_t^m

ω_t^m: idiosyncratic shock to housing value (mean=1)

- Default occurs when

$$\omega_t^m \left(1 - \delta_t^H\right) q_t^H h_{t-1}^m < R_{t-1}^m b_{t-1}^m \;\Leftrightarrow\; \omega_t^m \leq \overline{\omega}_t^m = x_{t-1}^m / R_t^H$$

where $R_t^H \equiv \left(1 - \delta_t^H\right) q_t^H / q_{t-1}^H$: realized gross return on housing

$x_t^m \equiv \frac{R_t^m b_t^m}{q_t^H h_t^m}$: household leverage

- Using the typical BGG notation, the budget constraint can be compactly written as

$$c_t^m + q_t^H h_t^m - b_t^m \leq w_t l_t^m + \left(1 - \Gamma^m\left(\overline{\omega}_t^m\right)\right) R_t^H q_{t-1}^H h_{t-1}^m - T_t^m$$

where

$$\Gamma^j(\overline{\omega}_t^j) = \int_0^{\overline{\omega}_t^k} \omega_t^j f(\omega_t^j) d\omega_t^j + \overline{\omega}_t^j \int_{\overline{\omega}_t^m}^{\infty} f(\omega_t^j) d\omega_t^j$$

[share of total returns of levered asset affected by shock ω_t^j (with mean=1) that accrues to lenders]

- Resulting gross return on mortgages for the lending bank:

$$\widetilde{R}_{t+1}^H b_t^m \equiv \left[\left(\Gamma^m\left(\overline{\omega}_{t+1}^m\right) - \mu^m G^m\left(\overline{\omega}_{t+1}^m\right)\right) q_{t+1}^H\right] h_t^m$$

where $\Gamma^m\left(\overline{\omega}_{t+1}^m\right)$: share of total return that accrues to bank

$G^m\left(\overline{\omega}_{t+1}^m\right)$: fraction of defaulting mortgages

μ^m: cost of repossessing houses from defaulted borrowers

[Default rates depend on aggregate variables because debt involves non-contingent promised repayments]

Credit supply to borrowing households

- The bank specialized in lending to households supplies loans b_t^m using deposit funding d_t^H & equity funding e_t^H as long as

$$E_t(\widetilde{\rho}_{t+1}^H) \equiv E_t\left[\max\left[\omega_{t+1}^H \widetilde{R}_{t+1}^H b_t^m - R_t^D d_t^H, 0\right]\right] \geq \rho_t e_t^H$$

where:

– the bank's balance sheet constraint imposes $b_t^m = d_t^H + e_t^H$
– the regulatory capital requirement imposes $e_t^H \geq \phi_t^H b_t^m$ (CR^H)

and ω_{t+1}^H: bank-specific loan quality shock (iid across H banks, mean=1)
ρ_t: market required expected return on bank equity

- Under binding CR, the bank participation constraint becomes

$$E_t\left[(1-\Gamma^H(\overline{\omega}_{t+1}^H))\widetilde{R}_{t+1}^H\right] \geq \rho_t \phi_t^H, \qquad (\mathrm{PC}^M)$$

with $\overline{\omega}_{t+1}^H = (1-\phi_t^H)R_t^D/\widetilde{R}_{t+1}^H$: bank default threshold

Constraints in the borrowing households' problem*

- The constraints faced by the borrowing households are then
  - the dynasty's budget constraint, and
  - the bank participation constraint (PC^H)
- (PC^H)
  - plays the role of competitive mortgage pricing equation
  - incorporates the implicit subsidy due to DI
- Ceteris paribus, changing the capital requirement ϕ_t^H
  - forces banks to make larger use of (more expensive) equity funding
  - reduces bank leverage & default risk, and, hence, the DI subsidy

$\Rightarrow$ makes household borrowing more expensive

Entrepreneurs

- OLG-founded version of BGG net worth dynamics: 2-period lived entrepreneurs transmit net worth through (warm glow) bequests
- Entrepreneurs' second stage problem

$$\max_{c^e_{t+1},n^e_{t+1}} U^e_{t+1} = (c^e_{t+1})^{\chi^e}(n^e_{t+1})^{1-\chi^e} \tag{1}$$

subject to:

$$c^e_{t+1} + n^e_{t+1} \leq W^e_{t+1}$$

where c^e_{t+1}: consumption
n^e_{t+1}: net worth left to next cohort of entrepreneurs
W^e_{t+1}: wealth resulting from activity in the first stage

$$\Rightarrow \begin{array}{l} c^e_{t+1} = \chi^e W^e_{t+1} \\ n^e_{t+1} = (1-\chi^e)W^e_{t+1} \end{array} \quad \Rightarrow U^e_{t+1} = W^e_{t+1}$$

- Entrepreneurs' first stage problem

$$\max_{k_t, b_t^e, R_t^F} \; E_t(W_{t+1}^e)$$

s.t. $\quad q_t^K k_t - b_t^e = n_t^e$

$$E_t(\tilde{\rho}_{t+1}^F) \geq \rho_t \quad \text{[Participation constraint of } F \text{ bank]}$$

where

$$W_{t+1}^e = \max\left\{\omega_{t+1}^e \left[r_{t+1}^k + (1 - \delta_{t+1})\, q_{t+1}^K\right] k_t - R_t^F b_t^e - T_{t+1}^e, 0\right\}$$

k_t : stock of physical capital in which entrepreneurs invest at t

$[r_{t+1}^k + (1 - \delta_{t+1})\, q_{t+1}^K] k_t$: unlevered average gross returns from k_t

ω_{t+1}^e: idiosyncratic shock to physical capital value (mean=1)

R_t^F: contractual gross interest rate on loans

b_t^e: amount borrowed from bank at t ("corporate loans")

T_{t+1}^e: possible lump-sum tax used to balance DIA's budget

- Resulting gross return on corporate lending for the lending bank:*

$$\widetilde{R}^F_{t+1} b^e_t = \left[\left(\Gamma^e \left(\overline{\omega}^e_{t+1} \right) - \mu^e G^e \left(\overline{\omega}^e_{t+1} \right) \right) R^K_{t+1} \right] q^K_t k_t$$

where $R^K_{t+1} = \frac{[r^k_{t+1} + (1-\delta) q^K_{t+1}]}{q^K_t}$: gross rate of return per unit of k_t

$\overline{\omega}^e_{t+1} = \frac{x^e_t}{R^K_{t+1}}$: entrepreneurs' default threshold

$x^e_t = \frac{R^e_t b^e_t}{q^K_t k_t}$: entrepreneurs' "leverage ratio"

$\Gamma^e \left(\overline{\omega}^e_{t+1} \right)$: share of total returns that accrue to bank

$G^e \left(\overline{\omega}^e_{t+1} \right)$: fraction of defaulting entrepreneurs

μ^e: cost of repossessing capital from defaulted entrepreneurs

Credit supply to corporate borrowers*

- The bank specialized in lending to entrepreneurs supplies loans b_t^e using deposit funding d_t^F & equity funding e_t^F as long as

$$E_t(\widetilde{\rho}_{t+1}^F) \equiv E_t\left[\max\left[\omega_{t+1}^F \widetilde{R}_{t+1}^F b_t^e - R_t^D d_t^F, 0\right]\right] \geq \rho_t e_t^F$$

where:

– the bank's balance sheet constraint imposes $b_t^e = d_t^F + e_t^F$

– the regulatory capital requirement imposes $e_t^F \geq \phi_t^F b_t^e$ (CR^F)

and ω_{t+1}^F: bank-specific loan quality shock (iid across F banks, mean=1)

ρ_t: market required expected return on bank equity

- Under binding CR, bank participation constraint becomes

$$E_t\left[(1 - \Gamma^F(\overline{\omega}_{t+1}^F))\widetilde{R}_{t+1}^F\right] \geq \rho_t \phi_t^F, \qquad (\mathrm{PC}^F)$$

with $\overline{\omega}_{t+1}^F = (1 - \phi_t^F) R_t^D / \widetilde{R}_{t+1}^F$: bank default threshold

The corporate borrowers' problem*

- Entrepreneurs' decision problem at t can be compactly rewritten as choosing capital (k_t) and leverage (x_t^e) to maximize:

$$\max_{x_t^e, k_t} E_t \left[\left(1 - \Gamma^e \left(\overline{\omega}_{t+1}^e\right)\right) R_{t+1}^K q_t^K k_t \right]$$

subject to (PC^F), which

– plays the role of competitive pricing equation for corporate loans

– incorporates the implicit subsidy due to DI

- Ceteris paribus, changing the capital requirement ϕ_t^F

– forces banks to make larger use of (more expensive) equity funding

– reduces bank leverage & default risk, and, hence, the DI subsidy

$\Rightarrow$ makes corporate borrowing more expensive

Bankers and the banks

Bankers

OLG structure like that of entrepreneurs, implying:

- Stage 2: Retiring bankers value consumption c^b_{t+1} & bequests n^b_{t+1}. Their resulting utility is linear in terminal wealth W^b_{t+1}
- Stage 1: New bankers allocate their net worth (=received bequest) as equity of the two classes of banks, e^H_t & e^F_t

Banks

As already described above, one-period entities in which bankers invest their wealth as equity

- Complement their funding with insured deposits
- Specialize in either mortgages ($j{=}H$) or corporate loans ($j{=}F$)

Bankers' optimization and net worth dynamics

- New bankers inherit $n_t^b = (1-\chi^b)W_t^b$ and solve

$$\begin{array}{ll} \max_{e_t^H, e_t^F} & E_t(W_{t+1}^b) = E_t(\widetilde{\rho}_{t+1}^H e_t^H + \widetilde{\rho}_{t+1}^F e_t^F) \\ \text{s.t.:} & e_t^H + e_t^F = n_t^b \end{array}$$

where $\widetilde{\rho}_{t+1}^j$: *ex post* return on bank-j equity [$=\frac{(1-\Gamma^j(\overline{\omega}_{t+1}^j))\tilde{R}_{t+1}^j}{\phi_t^j}$]

- Interior solutions require:

$$E_t(\widetilde{\rho}_{t+1}^F) = E_t(\widetilde{\rho}_{t+1}^H) \equiv \rho_t$$

where ρ_t : *required* expected return on bank equity

- Eventually:

$$n_{t+1}^b = (1-\chi^b)[\widetilde{\rho}_{t+1}^H e_t^H + \widetilde{\rho}_{t+1}^F (n_t^b - e_t^H)] \quad [\Rightarrow \ \rho_{SS} = \frac{1}{1-\chi^b}]$$

Capital production firms (/ Housing production firms)*

- New capital $I_t = k_t - (1-\delta)\, k_{t-1}$ is produced by firms...
  - owned by the saving households
  - that require resources $[1 + g\,(I_t/I_{t-1})]\, I_t$ to produce I_t

[$g(I_t/I_{t-1})$: investment adjustment cost function]

- These firms solve

$$\max_{\{I_\tau\}} E_t \left[\sum_{\tau=t}^{\infty} \varphi_{t,\tau}^{s} \left[q_\tau^K I_\tau - (1 + g\,(I_t/I_{t-1}))I_\tau \right] \right]$$

[$\varphi_{t,\tau}^{s}$: saving households' stochastic discount factor]

- Their FOC implies

$$q_t^K = 1 + g\left(\frac{I_t}{I_{t-1}}\right) + \frac{I_t}{I_{t-1}} g'\left(\frac{I_t}{I_{t-1}}\right) - E_t \varphi_{t,t+1}^{s} \left(\frac{I_{t+1}}{I_t}\right)^2 g'\left(\frac{I_{t+1}}{I_t}\right)$$

Market clearing conditions*

- Bank capital market:

$$(1-\chi^b)W_t^b = \phi_t^H \left(\frac{q_t^H h_t^m x_t^m}{R_t^m}\right) + \phi_t^F \left[q_t^K k_t - (1-\chi^e)W_t^e\right]$$

- Deposit market:

$$d_t = (1-\phi_t^H)\left(\frac{q_t^H h_t^m x_t^m}{R_t^m}\right) + (1-\phi_t^F)\left[q_t^K k_t - (1-\chi^e)W_t^e\right]$$

- Labor market: $(1-\alpha)\frac{y_t}{w_t} = l_t^s + l_t^m$

- Physical capital market: $q_t^K k_t = n_t^e + b_t^e$
  (available capital = entrepreneurs' demand)

- Housing market: $H_t = H_t^s + H_t^m$

- Goods market: long and ugly expression

Parameterization

- Baseline capital requirements: $(\phi^H, \phi^F) = (0.04, 0.08)$
- Default rates (annualized):
  - Banks: 2%
  - Entrepreneurs: 3%
  - Households: 0.35%
- Leverage of households & entrepreneurs: 70%-75%
- Standard choices for other conventional parameters
- Illustrative choices for unconventional ones

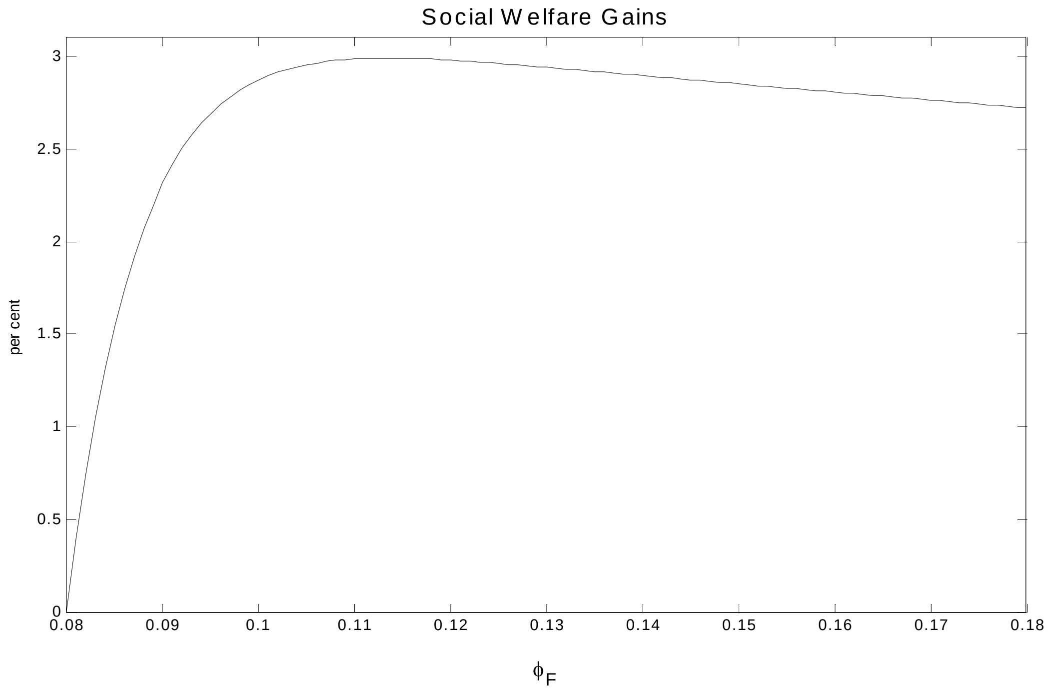
  [more adecuate for crisis times than for normal times?]

$\Rightarrow$ Table 1

Steady state effects of capital requirements

- Higher CRs:
  - Reduce bank leverage and the risk of bank failure
  - Reduce intensity of the bank funding cost channel
  - Reduce implicit DI subsidies
  - Increase the banks weighted average cost of funding (except at very low levels)
  - Tighten credit supply and reduce borrowers' leverage
- Caveats:
  - Transitional costs not taken into account: analysis neglects the credit crunch periods needed for bankers to accumulate wealth
  - Current analysis is based on non-stochastic steady state (= aggregate uncertainty shut down)

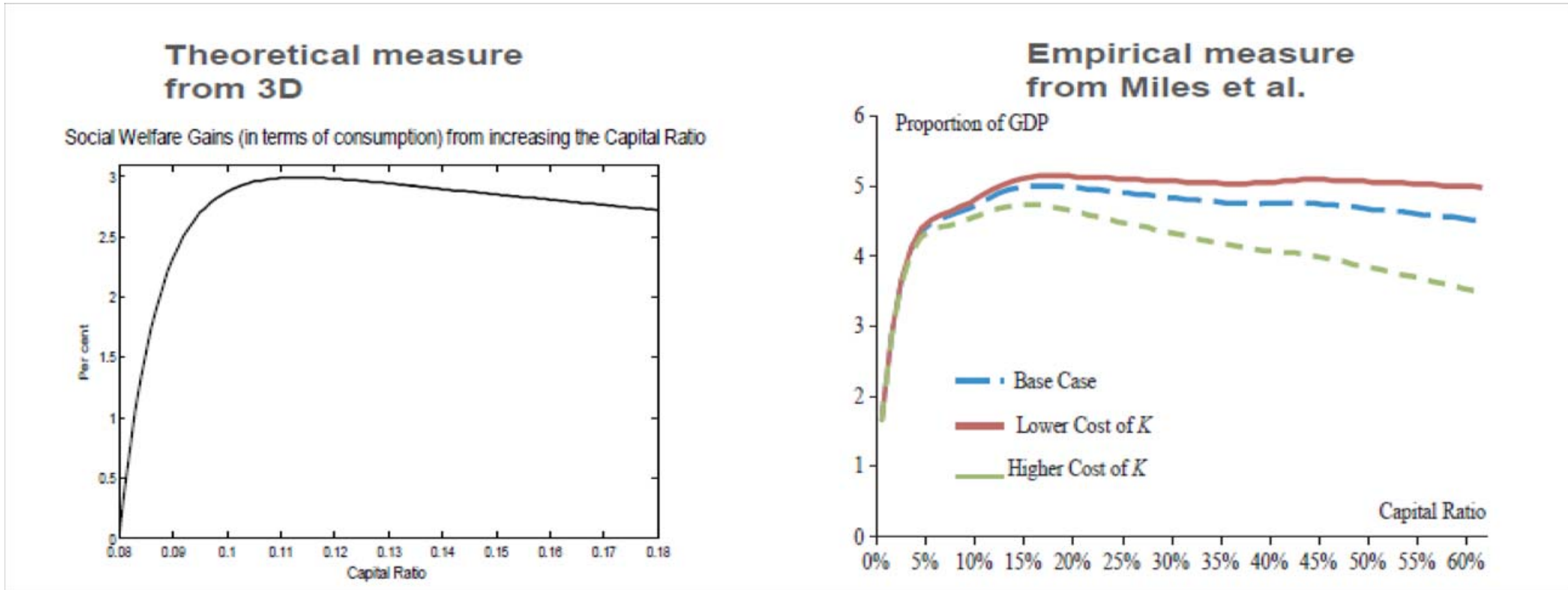
Social welfare (i)



- Individual welfare=conditional expectation of lifetime utility
- Individual welfare gains=consumption-equivalent measure
  [% increase in SS consumption that would make welfare under the baseline policy equal to welfare under alternative policy]
- Social welfare gains= individual gains weighted by consumption shares

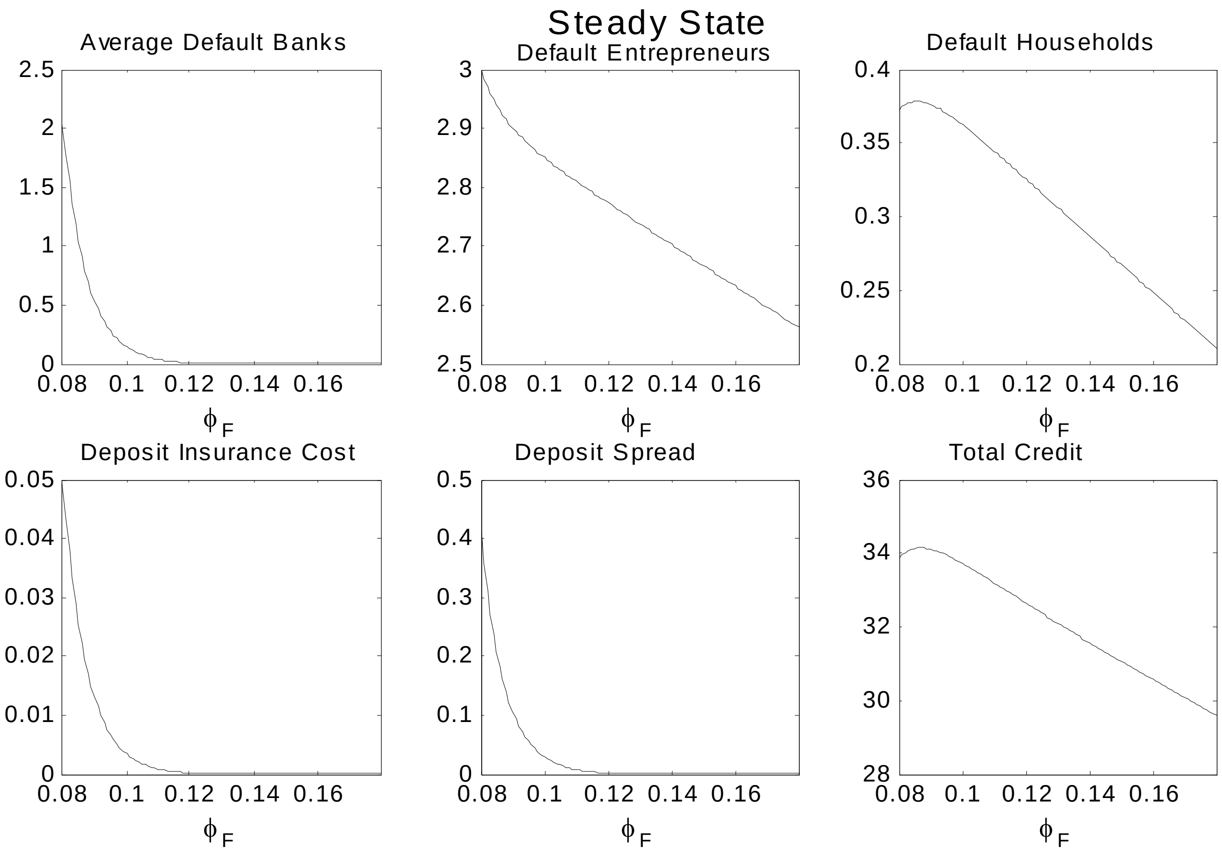
Social welfare (ii)

- We find:
  - Sizable social benefits from increasing the requirements from low levels
  - Limited social costs to keeping increasing them
- Quantitatively similar results to those in Miles et al. (2013, EJ)...



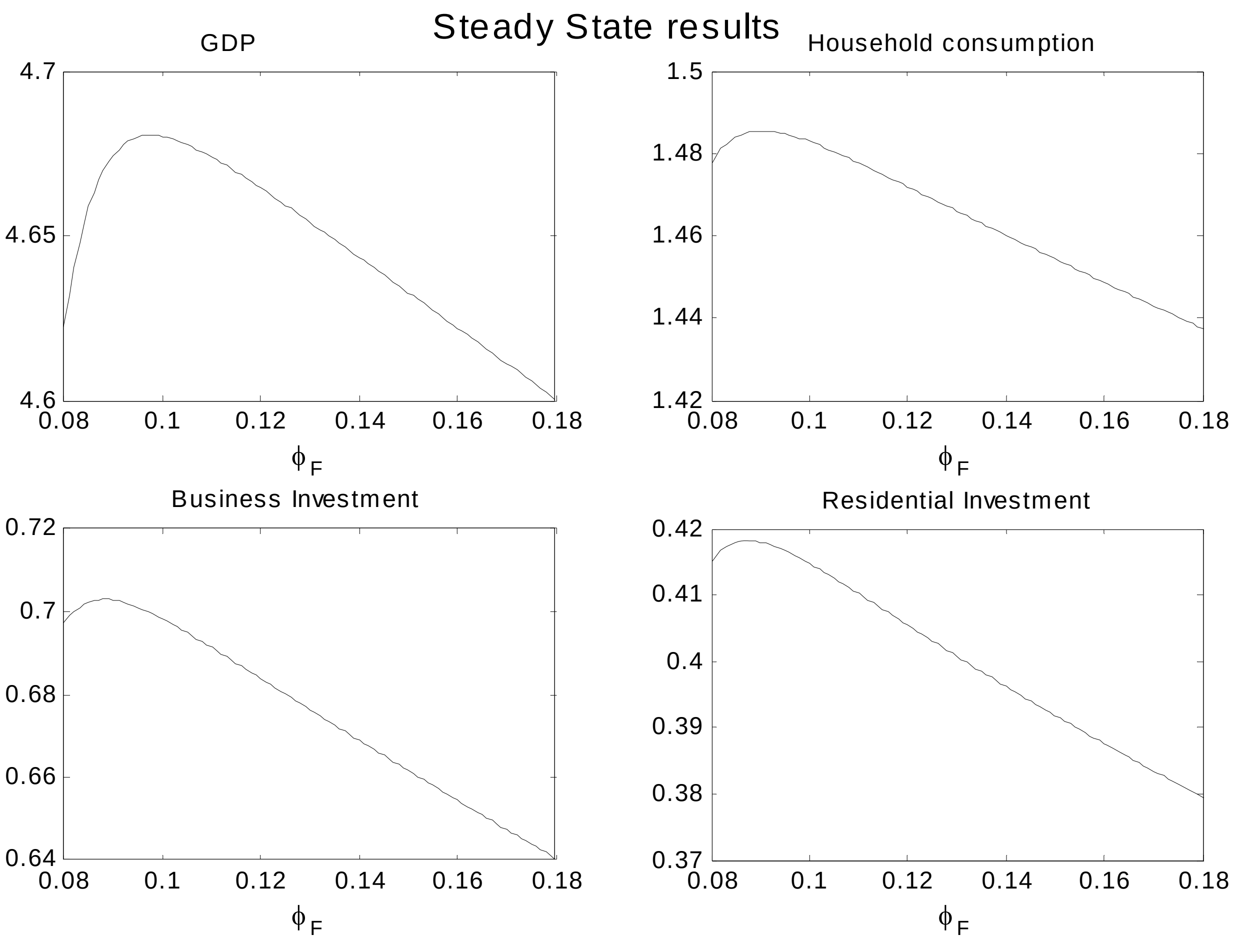
... but, of course, the exact quantitative details depend on the parameters!

Default rates and credit supply



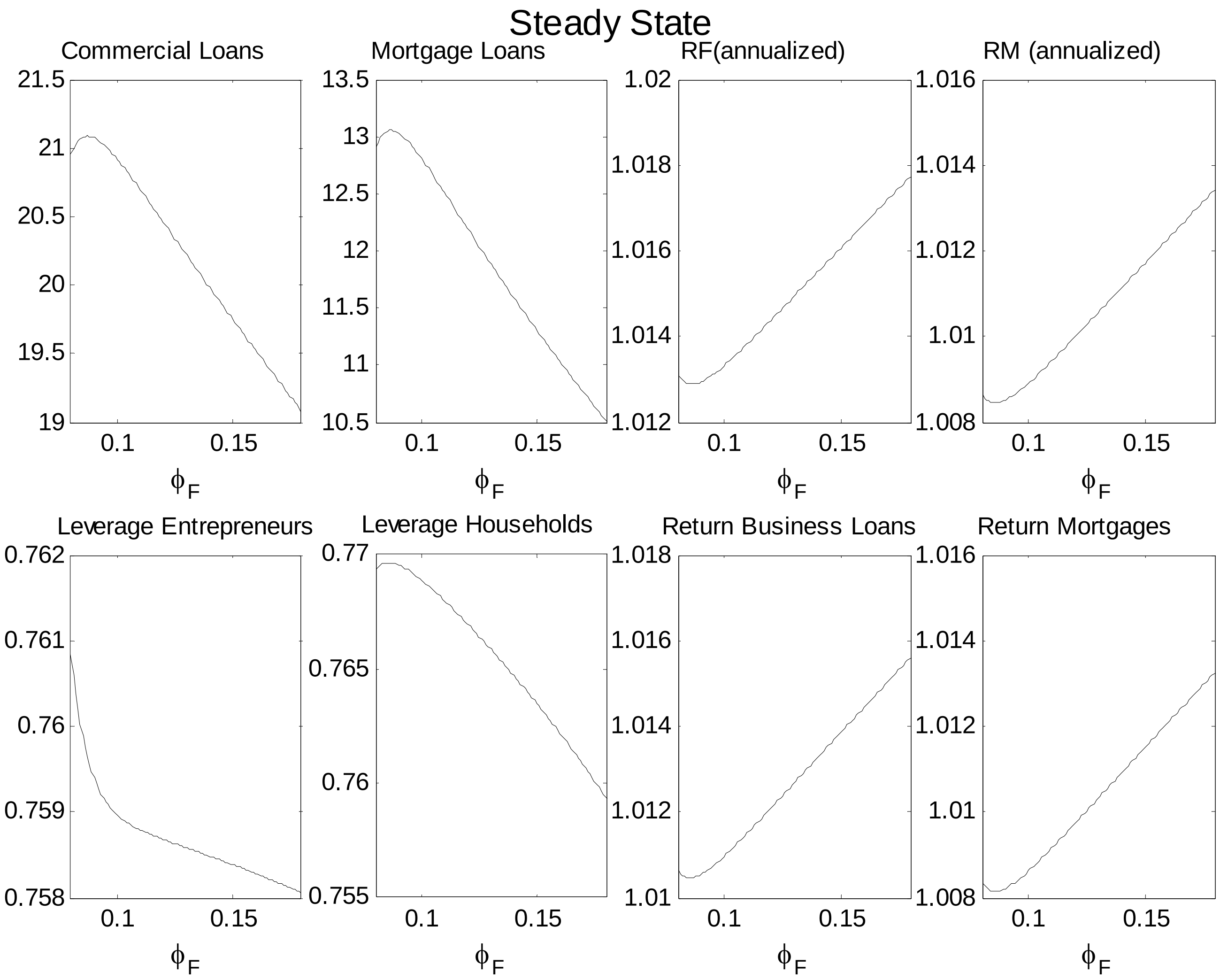
- (+) EFFECTS: ↓ borrowers default costs & ↓ funding costs for banks [dominates initially!]
- (-) EFFECTS: ↓ credit supply, ↑ loan rates [dominates when bank default→ 0!]

Real outcomes



- 1st, reduction in bank failure risk $\Rightarrow \downarrow$ bankruptcy & funding channels $\Rightarrow \uparrow$ consumption & investment
- Eventually, reduction in credit supply$\Longrightarrow \downarrow$ consumption & investment)

Credit market outcomes



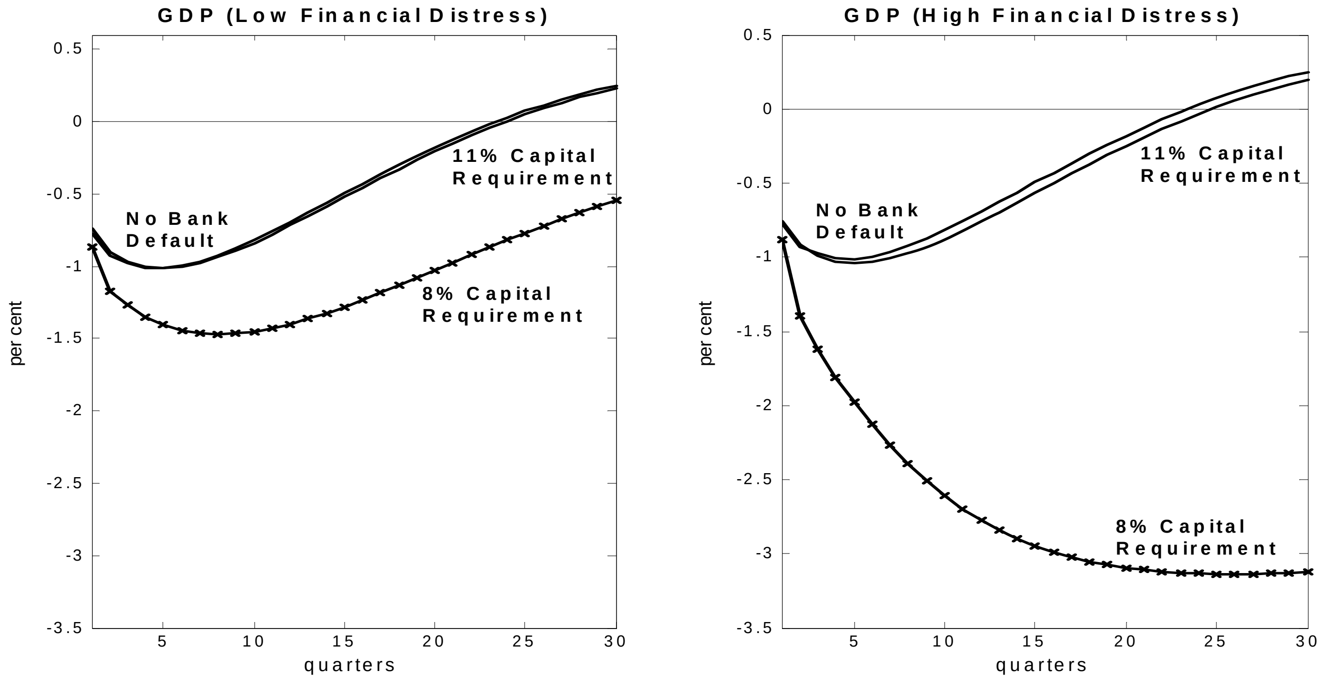
[Note: Initial increase in loans: funding cost channel]

Shock propagation and capital requirements

- Experiment: Hit the economy with one large shock
- Here: A persistent shock to capital depreciation that produces a collapse in asset prices ($\downarrow$ housing & business net worth)
- How do CRs (high vs low) affect the transmission of this shock?

[Paper also discusses shocks to productivity & bank performance]

IRF to a 0.2 pps depreciation shock (with 0.9 persistence)



- CRs higher than benchmark ($(\phi^H, \phi^F) = (0.07, 0.11)$)
  - A: mitigates the effects of a financial shock (large decline in asset prices)
  - B: mimics the dynamics of a no bank default economy ($\sigma_H = \sigma_F \approx 0$)
- High financial distress scenario (with 20% higher $\sigma_H \& \sigma_F$): exacerbates negative effect of the shock $\Longrightarrow$ substantial amplification due to bank instability!

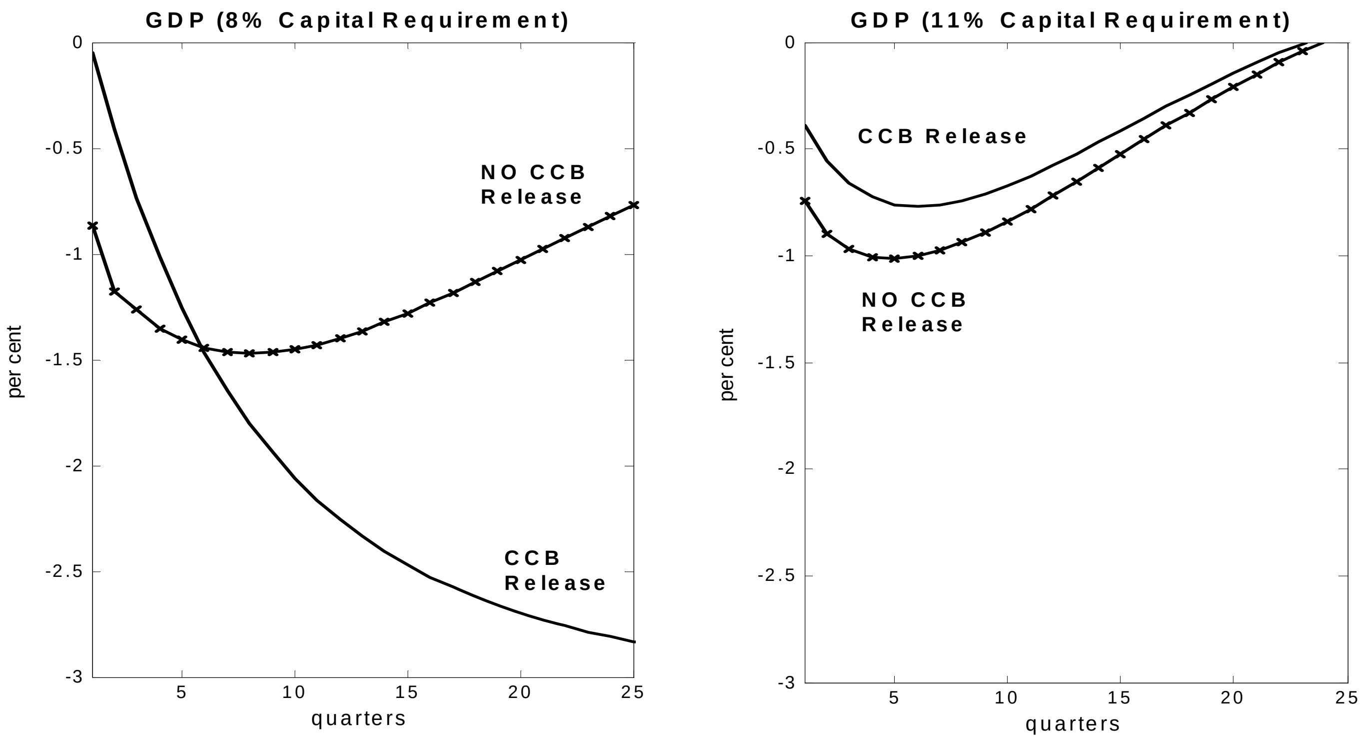
Counter-cyclically adjusted capital requirements (i)

- Experiment: Hit the economy with one (or more) large shocks

- Here: As before, persistent collapse in asset prices

- Does a reduction in the CRs after the bad shock help to maintain economic activity?

Counter-cyclically adjusted capital requirements (ii)



- High CR: Trade-off: (+) mitigates $\downarrow$ credit supply; (-) $\uparrow$ bank default & cost of funds
  $\Rightarrow$ Overall: margin for improvement!
- LOW CR: Shocks hit economy with poorly capitalized banks: small (+) effect in short run BUT large (-) effect in the medium/long run!

Summary

- We have developed a macroeconomic model in which banks and borrower default take center of stage
- Steady state effects of capital requirements
  - eliminate bank default and the limited liability subsidy
  - reduce dead-weight costs of default & bank funding channel
  - may constrain credit excessively
- Capital requirements and shock propagation
  - shock propagation & amplification are very large when bank failure risk is high (or CRs are low)
  - high capital requirements eliminate the extra shock propagation coming from bank defaults
- Countercyclical adjustment in CRs is only beneficial when CRs are high enough!

Conclusions

- We have developed a macroeconomic model targeted to inform the cost-benefits analysis of macroprudential policy
- Introduces several dimensions of financial instability in macro setup
- Contributes a hopefully useful analytical tool to policy makers
- Yet, it is a first step in a challenging field of research

Backup material

Baseline parameterization (i)

Household preference parameters

Description	Parameter	Value
Household Preferences		
Patient Household discount factor	β^s	0.995
Impatient Household discount factor	β^m	0.98
Patient Household utility weight on housing	v^s	0.25
Impatient Household utility weight on housing	v^m	0.25
Patient Household marginal disutility of labour	ϱ^s	1.0
Impatient Household marginal disutility of labour	ϱ^m	1.0
Habit persistence parameter	ψ	0.0
Variance of household idiosyncratic shocks	σ_m^2	0.2
Household bankruptcy cost	μ^m	0.3

Baseline parameterization (ii)

Entrepreneurial sector parameters

Description	Parameter	Value
Entrepreneurs		
Dividend payout ratio of entrepreneurs	χ^e	0.06
Variance of entrepreneurial idiosyncratic shocks	σ_e^2	0.15
Entrepreneur bankruptcy cost	μ^e	0.3

Baseline parameterization (iii)

Banking sector parameters

Description	Parameter	Value
Bankers		
Depositor cost of bank default	γ	0.20
Dividend payout ratio of bankers	χ^b	0.06
Variance of corporate bank idiosyncratic shocks	σ^2_F	0.035
Variance of mortgage bank idiosyncratic shocks	σ^2_H	0.016
Capital requirement for corporate loans	ϕ^F	0.08
Capital requirement for mortgages	ϕ^H	0.04
Corporate bank bankruptcy cost	μ^F	0.3
Mortgage bank bankruptcy cost	μ^H	0.3

Baseline parameterization (iv)

Production parameters

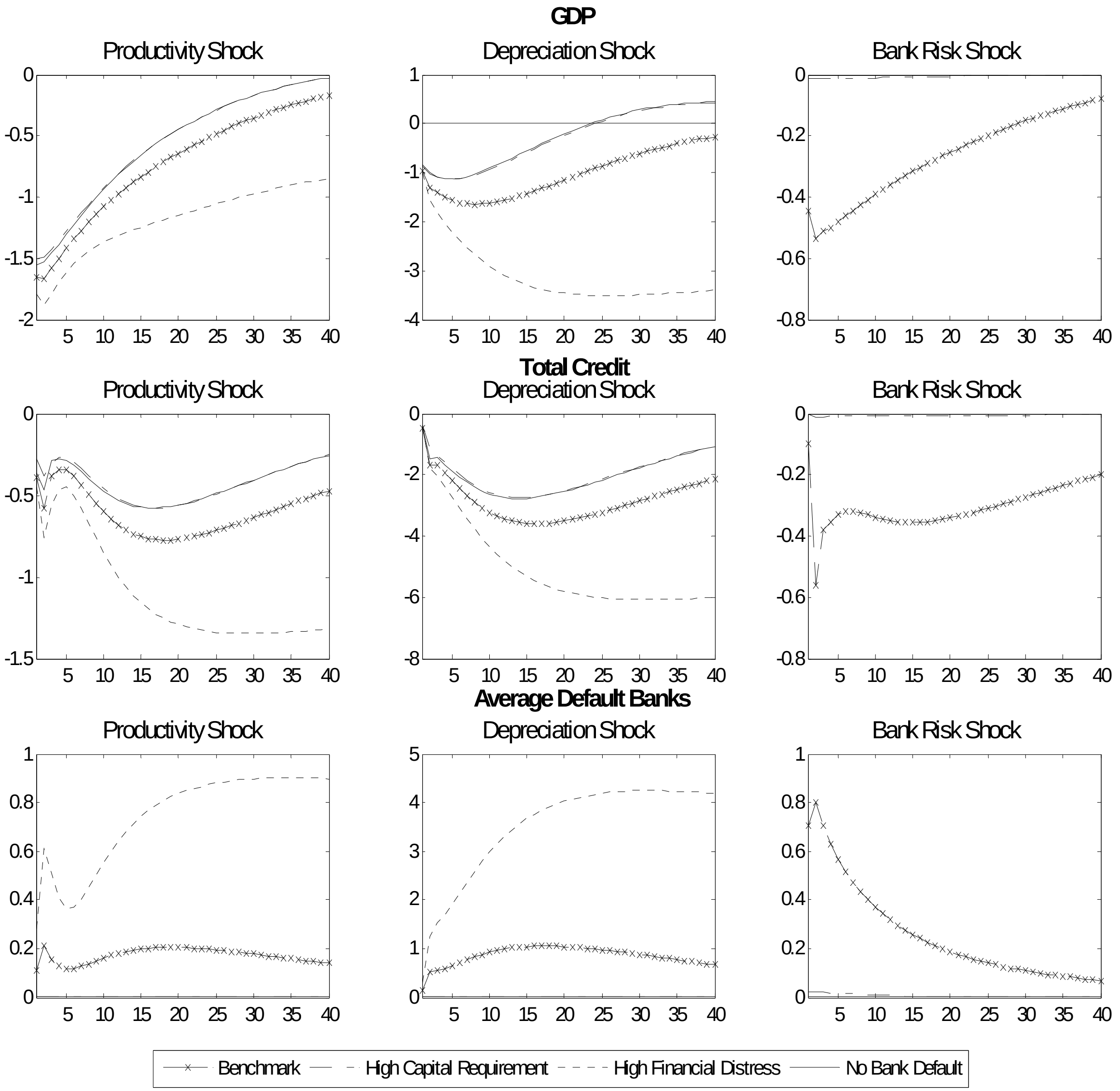
Description	Parameter	Value
Production parameters		
Capital share	α	0.30
Capital depreciation rate	δ^K	0.025
Capital adjustment cost parameter	ξ^K	2
Housing depreciation rate	δ^H	0.01
Housing adjustment cost parameter	ξ^H	2

Baseline parameterization (v)

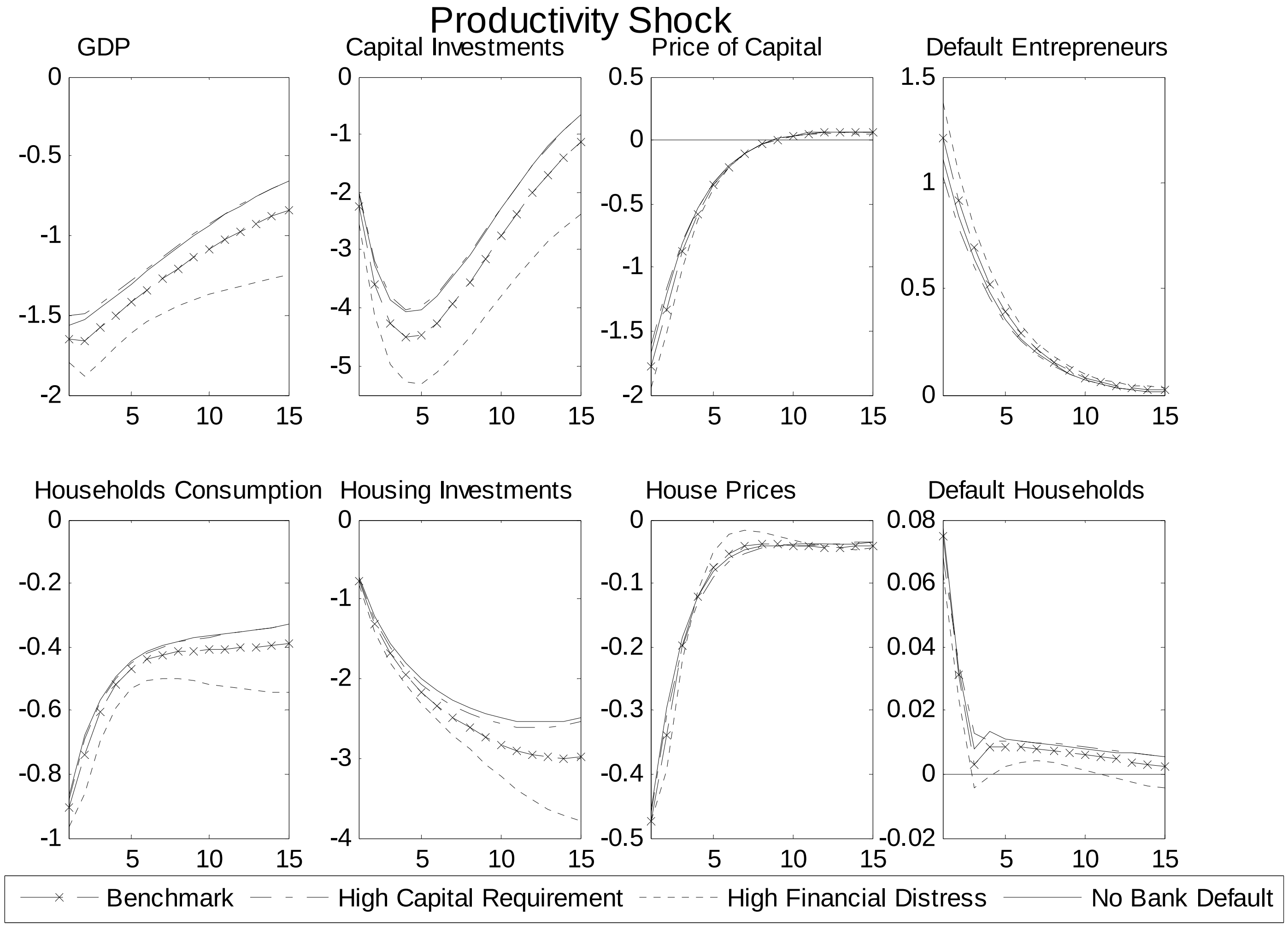
Shock processes

Description	Parameter	Value
Shock processes		
TFP shock persistence	ρ^A	0.9
Risk shock persistence	ρ^σ	0.9
Depreciation shock persistence	ρ^d	0.9
Housing demand persistence	ρ^D	0.9

IRFs to other shocks

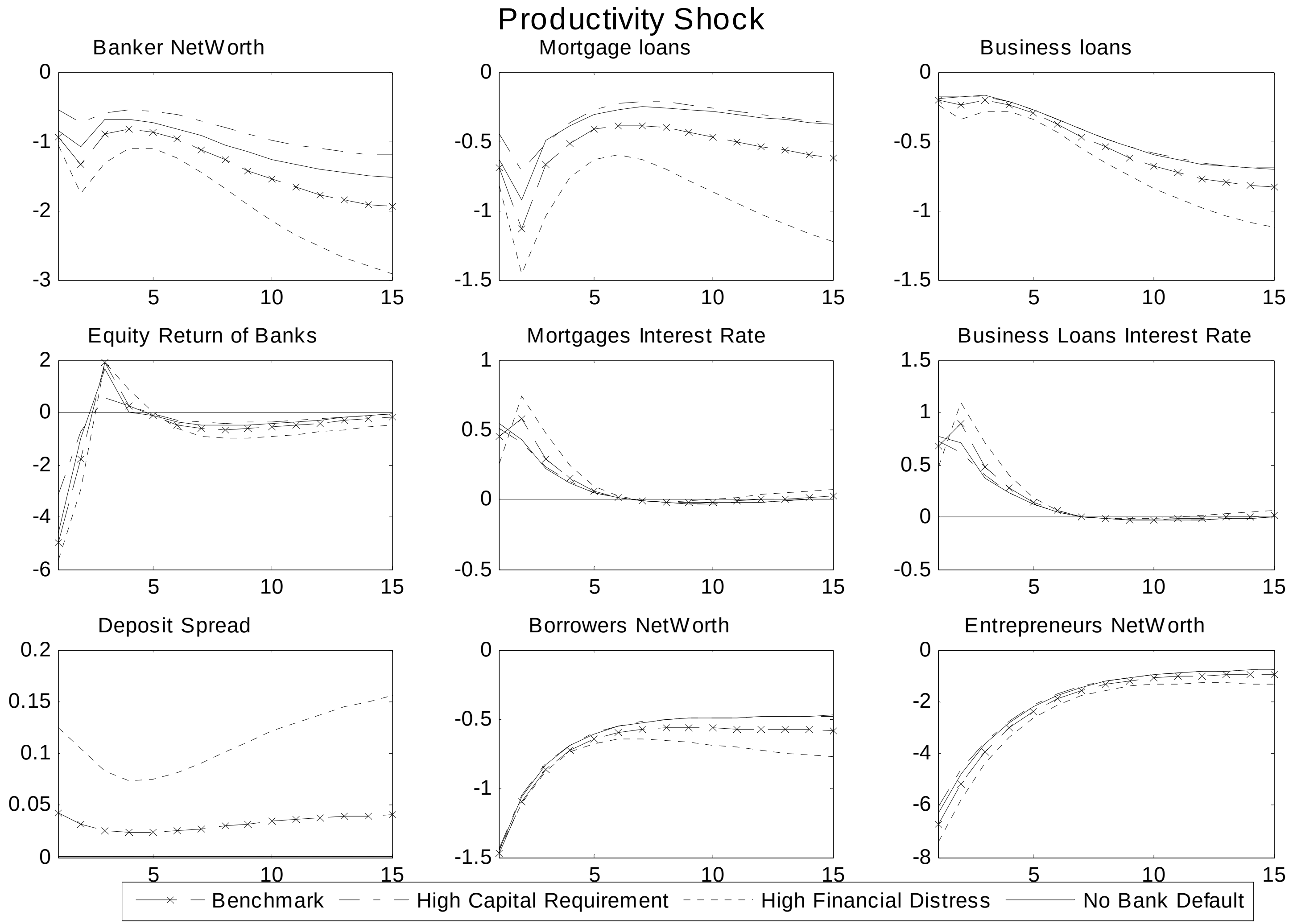


IRFs to productivity shock (i)

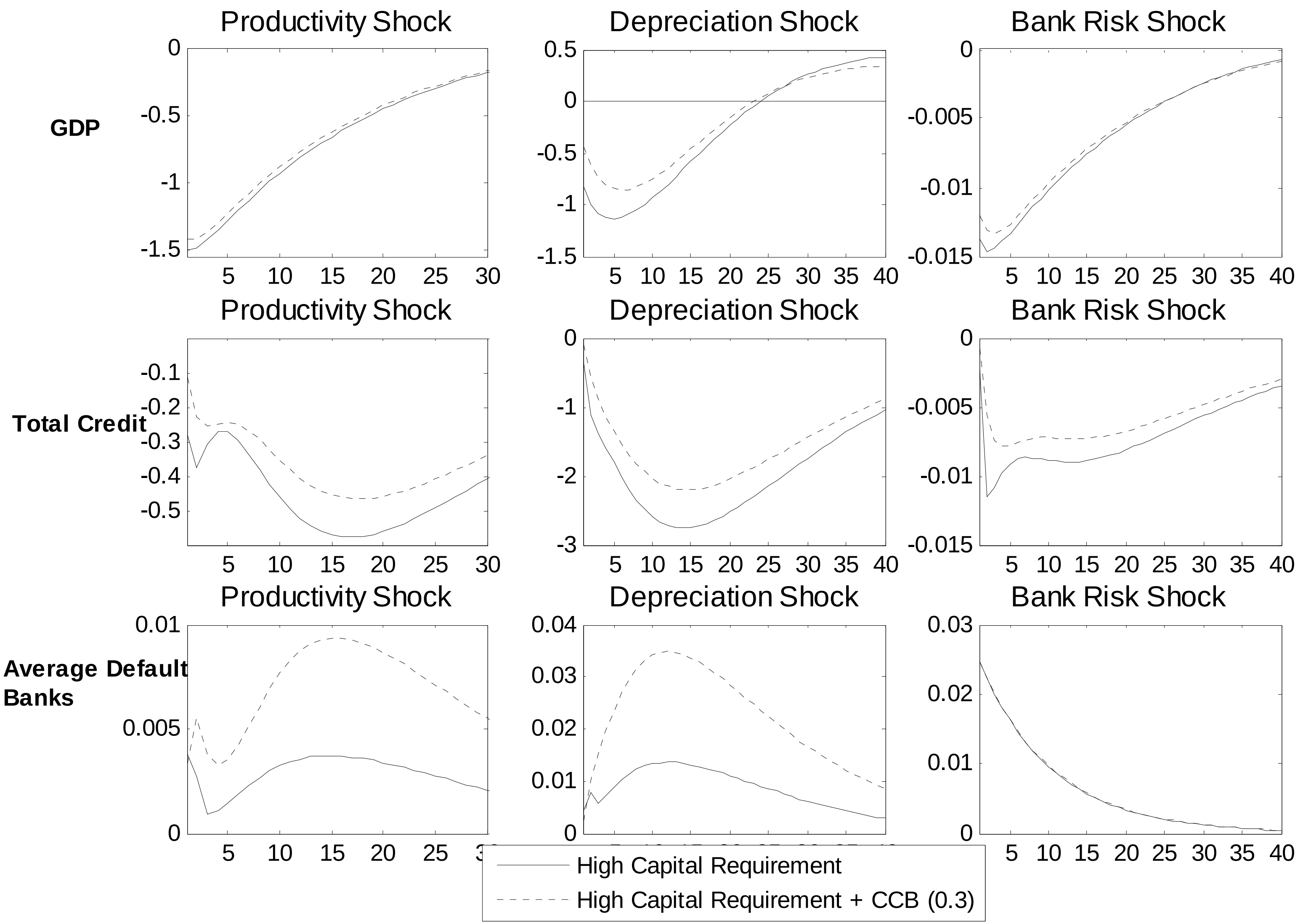


- Reduction in spending and production
- Reduction in asset prices$\Longrightarrow \uparrow$ borrowers default

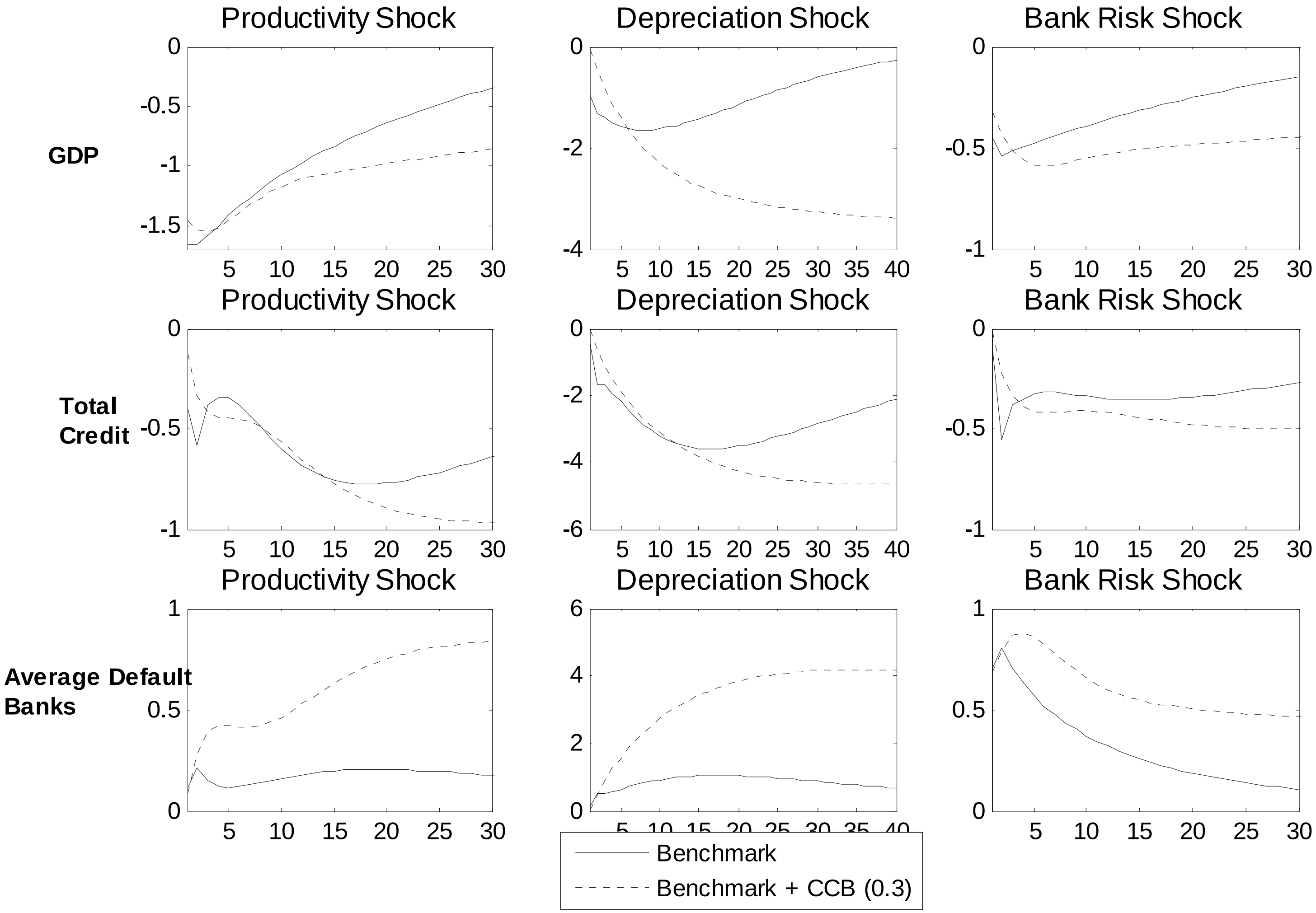
IRFs to productivity shock (ii)



Counter-cyclically adjusted CRs: high CRs



Counter-cyclically adjusted CRs: low CRs



[Release of the counter-cyclical buffers (CCBs) makes the economy more vulnerable to the persistent negative effects of shocks!]

PAPER	OPTIMAL CAPITAL RATIO	GENERAL FRAMEWORK	BENEFITS OF CAPITAL	COSTS OF CAPITAL
Admati and Hellwig (2013)	20+%	Qualitative reasoning based on Modigliani-Miller type partial equilibrium models and corporate finance literature	General discussion of banks' ability to absorb losses, limiting their risk taking, preventing debt overhangs and the associated social benefits	General discussion rejecting reasons why bank capital is costly (banks can raise equity relatively freely)
Miles, Yang and Marcheggiano (2012)	16-20%	Range of partial equilibrium and ad hoc empirical estimates or models of social benefits and costs of bank equity	Reduced probability of banking crises and therefore their expected output costs	Increased average cost of bank funding and hence borrowing costs for firms and households
Martinez-Miera and Suarez (2012)	14%	Macroeconomic general equilibrium model with moral hazard for banks, for low capital ratios they invest in "correlated/bad" projects	Reduced implicit subsidies associated with deposit insurance, systemic risk taking and bank failures, leading to higher consumption	Reduced credit supply and output (banks cannot raise outside equity)
MaRs 3D	11%	Macroeconomic general equilibrium model with moral hazard for banks, for low capital ratios they generally lend at too low interest rates and therefore too much to firms and households	Reduced implicit subsidies associated with deposit insurance, over-lending and bank failures, leading to higher consumption	Reduced credit supply and output (banks cannot raise outside equity yet – extension of the model ongoing)