Optimal Dynamic Capital Requirements
(Optimal Sectoral Capital Requirements?)

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Introduction

- Bank capital requirements (CRs) are still at the core of micro and macroprudential policies
- After the GFC adopting a macroprudential perspective has become compulsory
- Developing GE models that help understand the channels of tramission of macroprudential policies is a top research priority

Within this research program, our paper focuses on **two issues**:

- Policy rules that mimic closely current Basel regulations (optimal level + default-sensitivity of sectoral CRs)
- Agent heterogeneity & redistributive impact of prudential policies

The setup

Bank fragility is key to bank-related transmission channels

- Key distortions:
  - Limited liability & safety net guarantees (bank debt partly insured)
  - Pricing of uninsured bank debt based on systemwide risk-taking
  - Net worth channel a la BGG, also for banks
- Main policy conclusions:
  - CRs must keep risk of bank failure low
  - Increasing CRs is Pareto-improving up to a point
  - CRs on corporate & mortgages loans should be higher...
    but less time-varying than implied by IRB formulas with PIT PDs

Related literature (growing)

- DSGE+banking: Curdia-Woodford'10, Gertler-Kiyotaki'10, Gerali-et-al'10), Meh-Moran'10, Gertler-Kiyotaki-Queralto'12)

  [we add normative assessment of CRs]

- GE+bank fragility: Angeloni-Faia'13, Kashyap-Vardoulakis-Tsomocos'14, Aoki-Nikolov'15, Boissay-Collard-Smets'16, Martinez-Miera-Suarez'14, Clerc-et-al'15

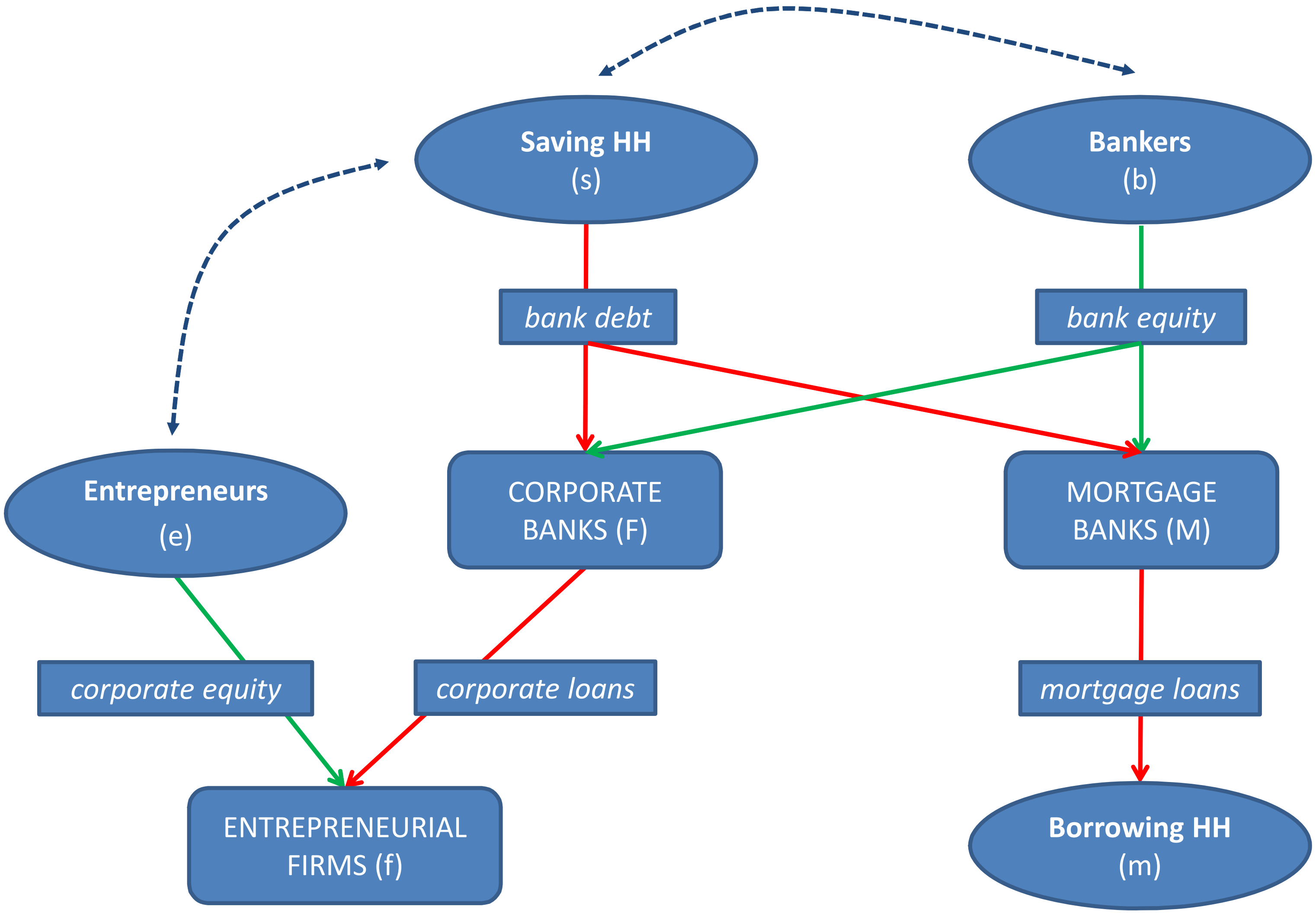
- We build on Clerc-et-al'15, with significant improvements:

  1. Model: bankers/entrepreneurs integration in saving dynasty; insured/uninsured bank debt; bank/non-bank funding
  2. Policy rules: CR levels + PD-sensitivity for sector loans
  3. Calibration: 1st+2nd moments of EA macro & banking data
  4. Welfare: fully stochastic economy+2nd order methods

Plan for the talk

1. Sketch of the model
2. Determinants of bank lending standards
3. Calibration
4. Policy results
5. Understanding the results

Model structure



[Banks are centerpiece of credit allocation system]

Model overview

- Model with three interconnected networth channels (m, e, b)
  - Connection between leverage & default as in BGG (1999) but with non-contingent debt
  - Bank debt partly insured; bank leverage determined by capital regulation
- Households
  - Patient dynasty (*savers* s):
    - supply (partly insured) debt to banks
    - receive dividends from entrepreneurs, bankers & other firms
  - Impatient dynasty (*borrowers* m):
    - borrow to buy houses
    - default if house is worth less than mortgage debt

- *Entrepreneurs* (e), ∞-lived members of patient dynasty
  - Max. value of net worth returned to dynasty at retirement
  - Provide inside equity to firms (f) that buy&rent physical capital
  - Firms default if assets are worth less than loan repayments

- *Bankers* (b), ∞-lived members of patient dynasty
  - Max. value of net worth returned to dynasty at retirement
  - Provide inside equity to banks
  - Banks $(j = M, F)$
    - default if value of loan portfolio $<$ deposit obligations
    - enjoy deposit insurance ($\simeq$ subsidy linked to default risk)
    - are subject to regulatory capital requirements

- *Production sector* [standard; no financial frictions]
  - Perfectly competitive firms owned by saving households
  - Consumption good firms: combine capital rented from entrepreneurs with labor supplied by households
  - Capital / housing producing firms: optimize intertemporally subject to investment adjustment costs
- Key imperfections to deal with:
  - Limited liability & safety net guarantees (bank debt partly insured)
  - Pricing of uninsured bank debt based on systemwide risk-taking
  - Net worth channel a la BGG, also for banks

Some details on savers*

- Budget constraint:

$$c_{s,t}+q_{h,t}\,(h_{s,t}-(1-\delta_{h,t})h_{s,t-1})+(q_{k,t}+s_t)\,k_{s,t}+d_t \leq (r_{k,t}+(1-\delta_{k,t})\,q_{k,t})\,k_{s,t-1}+w_t l_{s,t} + \widetilde{R}^d_t d_{t-1}+T_{s,t}+\Pi_{s,t}+\Xi_{s,t}$$

where

d_{t-1}: bank debt with (risky) gross return $\widetilde{R}^d_t$

$T_{s,t}$: lump-sum tax used to ex-post balance the DIA's budget

$\Pi_{s,t}$: net transfers of earnings from entrepreneurs and bankers

$\Xi_{s,t}$: profits from firms managing $k_{s,t}$

- Importantly,

$$\widetilde{R}^d_t = R^d_{t-1} - (1-\kappa)\Omega_t$$

with $R_{d,t-1}$: promised repayment (partly insured)

κ: insured fraction of bank debt

Ω_t: debt value losses due to bank failures [$\rightarrow$ *bank funding cost* channel]

Some details on borrowers*

- Budget constraint (using typical BGG notation):

$$c_{m,t} + q_{h,t}h_{m,t} - b_{m,t} \leq w_t l_{m,t} + \underbrace{(1 - \Gamma_{m,t}(\overline{\omega}_{m,t}))R_t^H q_{h,t-1}h_{m,t-1}}_{\text{NET HOUSING EQUITY}} - T_{m,t}$$

- Participation constraint of the bank

$$E_t\Lambda_{b,t+1}[\underbrace{(1-\Gamma_{M,t+1}(\overline{\omega}_{M,t+1}))}_{\text{LEVERED RETURNS}}\underbrace{(\Gamma_{m,t+1}(\overline{\omega}_{m,t+1})-\mu_m G_{m,t+1}(\overline{\omega}_{m,t+1}))R_{t+1}^H}_{\text{NET RETURNS ON LOAN PORTFOLIO}}]q_{h,t}h_{m,t} \geq v_{b,t}\phi_{M,t}b_{m,t}$$

where $b_{m,t}$: non-contingent debt charging agreed gross rate R_t^M

$\bar{\omega}_{m,t+1}$, $\overline{\omega}_{M,t+1}$: borrowers/banks idiosyncratic-shock default threshold

$\Lambda_{b,t+1}$: bankers' stochastic discount factor

μ_m: repossession cost, $v_{b,t}$: shadow value of bankers' wealth

$\phi_{M,t}b_{m,t}$: bankers' equity involved in funding the loan

$\bar{\omega}_{m,t+1} = \frac{x_{m,t}}{R_{t+1}^H}$, $x_{m,t} \equiv \frac{R_t^M b_{m,t}}{q_{h,t}h_{m,t}}$, $R_{H,t} \equiv \frac{(1-\delta_{h,t})q_{h,t}}{q_{h,t-1}}$

Some details on entrepreneurs*

∞-lived, return net worth to patient dynasty at retirement. They solve:

$$v_{e,t}n_{e,t} = \max_{a_t, dv_{e,t}} \left\{ dv_{e,t} + E_t\Lambda_{t+1}\left[1-\theta_e+\theta_e\nu_{e,t+1}\right]n_{e,t+1}\right\}$$

Their firms maximize:

$$\max_{k_t, R_t^F} E_t\Lambda_{e,t+1}(1-\Gamma_{f,t+1}\left(\overline{\omega}_{f,t+1}\right))R_{t+1}^K q_{k,t}k_{f,t}$$

subject to the participation constraint of their bank

$$E_t\Lambda_{b,t+1}(1-\Gamma_{F,t+1}\left(\overline{\omega}_{F,t+1}\right))\widetilde{R}_{t+1}^F b_{f,t} \geq v_{b,t}\phi_{F,t}b_{f,t} \qquad (1)$$

where $k_{f,t}$: capital purchased with net worth a_t & loan $b_{e,t} = (q_{k,t}k_{f,t} – a_t)$

$b_{f,t}$: non-contingent debt charging agreed gross rate R_t^F

$\overline{\omega}_{F,t+1}$: F banks' idiosyncratic-shock default threshold

$\phi_{F,t}b_{f,t}$: bankers' equity involved in funding the loan

$\bar{\omega}_{f,t+1} \equiv \frac{x_{f,t}}{R_{t+1}^K}$, $x_{f,t} = \frac{R_t^F b_{f,t}}{q_{k,t}k_{f,t}}$, $R_{t+1}^K \equiv \frac{r_{k,t+1}+\left(1-\delta_{k,t+1}\right)q_{k,t+1}}{q_{k,t}}$

Some details on bankers*

∞-lived, return net worth to patient dynasty at retirement. They solve:

$$V_{b,t} = \max_{e_t^M, e_t^F, dv_{b,t}} \left\{ dv_{b,t} + E_t \Lambda_{t+1} \left[\left(1-\theta_b\right) n_{b,t+1} + \theta_b V_{b,t+1} \right] \right\}$$

$$e_{M,t} + e_{F,t} + dv_{b,t} = n_{b,t}$$

$$n_{b,t+1} = \int_0^\infty \rho_{M,t+1}\left(\omega\right) dF_{M,t+1}\left(\omega\right) e_{M,t} + \int_0^\infty \rho_{F,t+1}\left(\omega\right) dF_{F,t+1}\left(\omega\right) e_{F,t}$$

$$dv_{b,t} \geq 0$$

Interior equilibrium requires:

$$E_t[\Lambda_{b,t+1}\rho_{M,t+1}] = E_t[\Lambda_{b,t+1}\rho_{F,t+1}] = v_{b,t}$$

Resulting laws of motion of e & b net worth*

$$n_{e,t+1} = \theta_e \rho_{f,t+1} a_t + \iota_{e,t}$$

$$n_{b,t+1} = \theta_b(\rho_{F,t+1} e_{F,t} + \rho_{M,t+1} e_{M,t}) + \iota_{b,t}$$

Macroprudential policy

CRs applicable to each class of loans are determined by simple rules:

$$\phi_{M,t} = \phi_M + \tau_M (E_t \Psi_{m,t+1} - \Psi_m) \quad (2)$$

$$\phi_{F,t} = \phi_F + \tau_F (E_t \Psi_{f,t+1} - \Psi_f) \quad (3)$$

where: ϕ_j: steady-state level parameter

τ_j: PD-sensitivity parameter

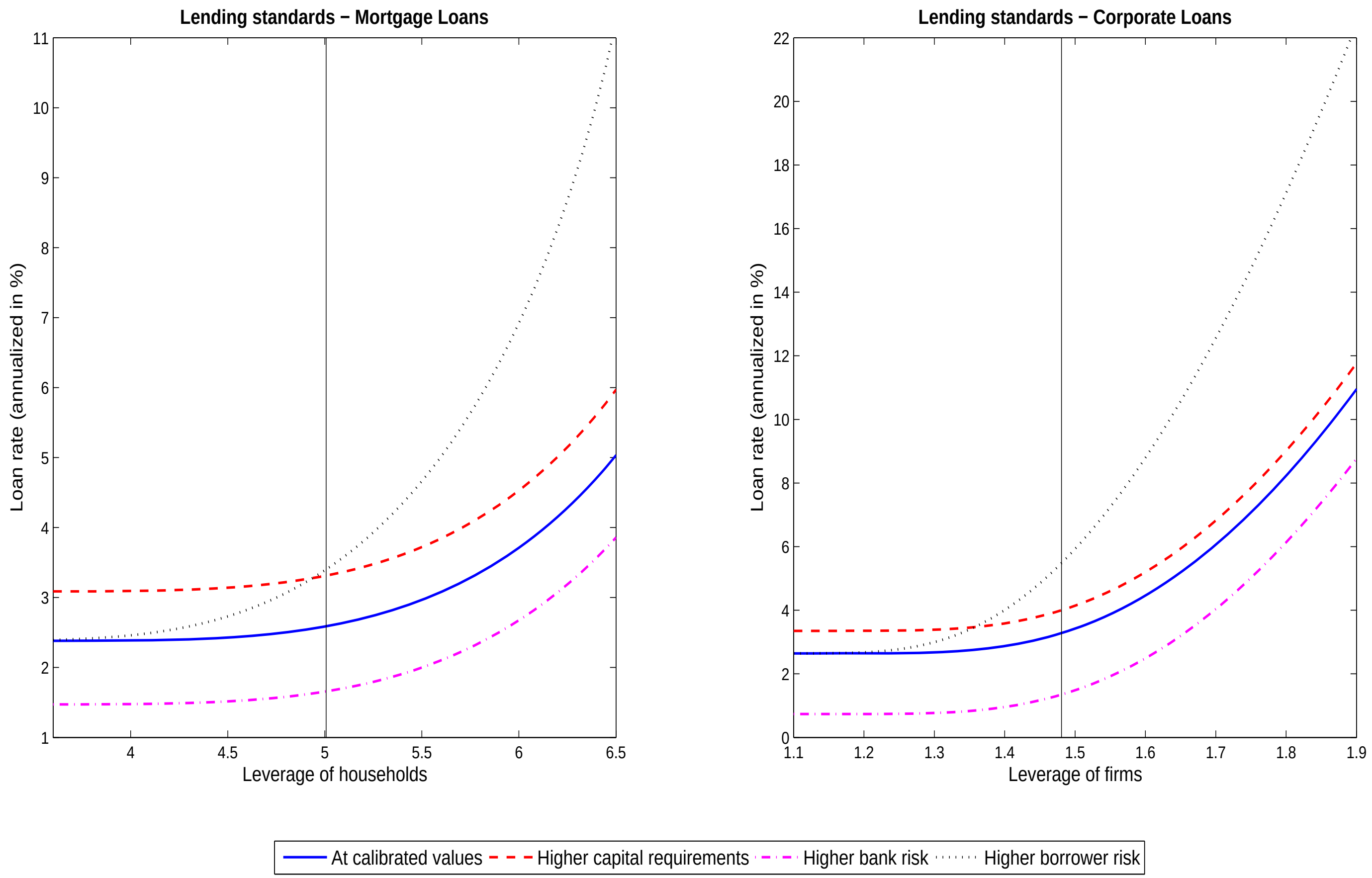
$E_t \Psi_{j,t+1}$: expected PD of loans of class j

$\Psi_{j,}$: steady-state PD of loans of class j

Interpretation: Linear approximation to the result of implementing formulas such as those of IRB approach of Basel II & III, possibly with countercyclical corrections such as using TTC (instead of PIT) PDs

Determinants of bank lending standards (F1)

Banks' PCs $\longrightarrow$ loan pricing equation / lending standards



[Good PE summary of various forces acting in the model]

Calibration

- Stochastic steady state, explored through 2nd order approximate solution
- Based on linearly detrended quarterly data for EA (2001:1-2014:4)
- Reproduces salient features of the data (average ratios & volatilities of house prices, HH loans, NFC loans, spreads, write-offs)
- Implemented in two stages:
  1. Parameters tightly linked to one target or fixable by convention
  2. Rest of parameters found so as to match targeted moments

     [by minimizing equally weighted sum of distances between empirical & model-based moments]

Table 1. Calibration targets (1 of 2)

Description	Definition	Data	Model
A) Stochastic means			
Fraction of borrowers	x_m	0.437	0.437
Share of insured deposits	κ	0.54	0.54
Equity return of banks	$\rho * 400$	6.734	9.278
Borrowers housing wealth share	$x_m q_h h_m$	0.525	0.495
Housing investment to GDP	I_h/GDP	0.060	0.062
HH loans to GDP	$x_m b_m/GDP$	2.120	2.126
NFC loans to GDP	$x_e b_f/GDP$	1.770	1.746
Write-off HH loans	$\Upsilon_m * 400$	0.118	0.205
Write-off NFC loans	$\Upsilon_f * 400$	0.650	0.640
Spread HH loans	$(R^M - R^d) * 400$	0.821	0.450
Spread NFC loans	$(R^F - R^d) * 400$	1.080	1.148
Capital owned by savers	k_s/k	0.220	0.223

Interest rates, equity returns, write-offs and spreads reported in annualized percentage points

Table 1. Calibration targets (2 of 2)

Description	Definition	Data	Model
B) Standard deviations			
std(House prices)/std(GDP)	$\sigma(q_{h,t})/\sigma(GDP_t)$	2.668	2.420
std(HH loans)/std(GDP)	$\sigma(x_m b_{m,t})/\sigma(GDP_t)$	2.413	2.943
std(NFC loans)/std(GDP)	$\sigma(x_e b_{f,t})/\sigma(GDP_t)$	3.806	5.757
std(Write-offs HH)/std(GDP)	$\sigma(\Upsilon_{m,t})/\sigma(GDP_t)$	0.012	0.009
std(Write-offs NFC)/std(GDP)	$\sigma(\Upsilon_{f,t})/\sigma(GDP_t)$	0.050	0.027
std(Spread HH loans)/std(GDP)	$\sigma(R^M - R^d)/\sigma(GDP_t)$	0.056	0.069
std(Spread NFC loans)/std(GDP)	$\sigma(R^F - R^d)/\sigma(GDP_t)$	0.045	0.082
std(GDP)	$\sigma(GDP_t) * 100$	2.310	2.617

The standard deviation of GDP is in quarterly percentage points

- We calibrate the CR policy rules feeding the corresponding IRB formulas with the steady-state PDs of the loans

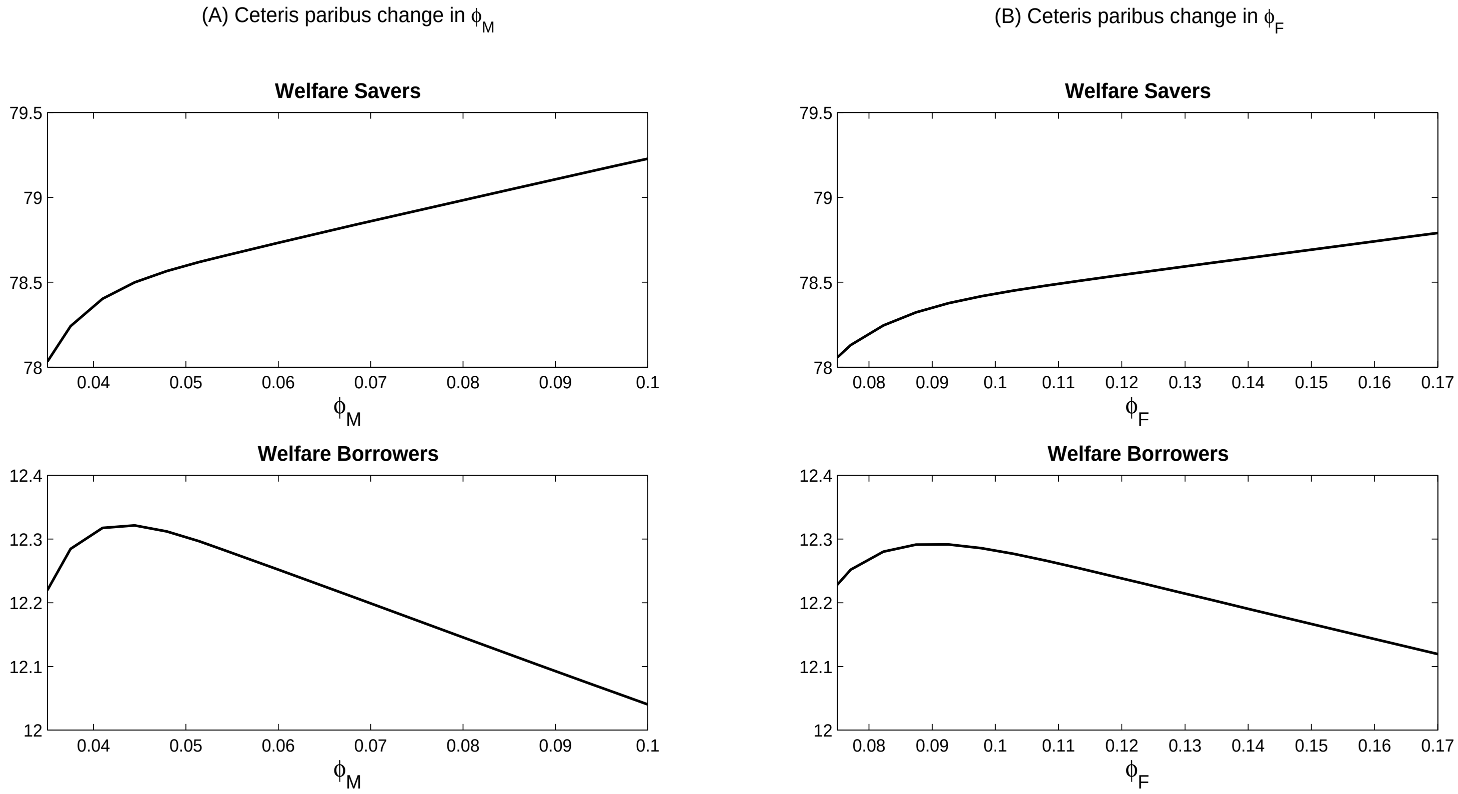
  $\Rightarrow \phi_M$=3.4%, ϕ_F =7.2% [Implied bank failure probability: 1.53%]

- We set $\tau_M = \tau_F = 0$, as if using strict TTC PDs

Table 2. Parameter values

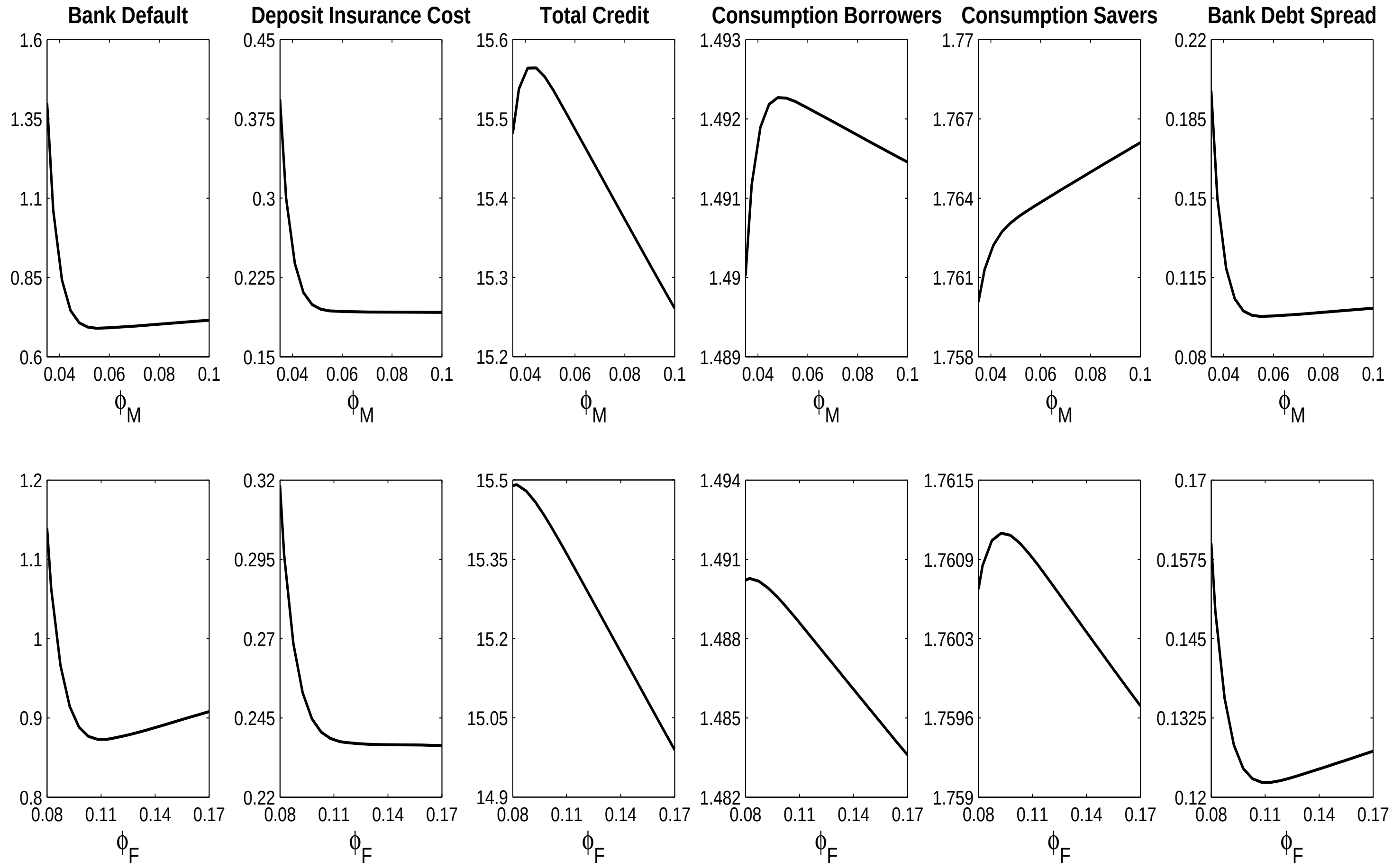
Description	Par.	Value	Description	Par.	Value
Housing weight in s utility	υ_s	0.1	HH bankruptcy cost	μ_m	0.3
Disutility of labor ($\varkappa$=s, m)	$\varphi_\varkappa$	1	NFC bankruptcy cost	μ_f	0.3
Frisch elasticity of labor	η	1	Bank M bankruptcy cost	μ_M	0.3
Capital share in production	α	0.3	Bank F bankruptcy cost	μ_F	0.3
Capital depreciation	δ_k	0.03	Survival rate entrepreneurs	θ_e	0.975
Shocks persistence (all ϱ)	ρ_ϱ	0.9	Survival rate bankers	θ_b	0.975
Fraction of borrowers	x_m	0.437	Share of insured deposits	κ	0.54
Discount factor savers	β_s	0.995	Entrepreneurs' endowment	χ_e	0.3666
Discount factor borrowers	β_m	0.971	Bankers' endowment	χ_b	0.1032
Housing weight in m utility	υ_m	0.202	Capital managerial cost	ξ	0.0014
Housing adjustment cost	ψ_h	2.422	Capital adjustment cost	ψ_k	4.567
Housing depreciation	δ_h	0.012	Std. housing pref. shock ($\varkappa$=s, m)	$\sigma_{\upsilon_\varkappa}$	0.061
Std. productivity shock	σ_z	0.0316	Std. housing depr. shock	σ_{δ_h}	0.002
Mean std of iid HH shocks	$\bar{\sigma}_{\omega_m}$	0.069	Std. capital depr. shock	σ_{δ_k}	0.002
Mean std of iid NFC shocks	$\bar{\sigma}_{\omega_f}$	0.399	Std. HH risk shock	σ_m	0.001
Mean std of iid M bank shocks	$\bar{\sigma}_{\omega_M}$	0.012	Std. NFC risk shock	σ_f	0.039
Mean std of iid F bank shocks	$\bar{\sigma}_{\omega_F}$	0.027	Std. banks' risk shock ($j = M, F$)	σ_j	0.059

Welfare impact of changes in CR levels (F2)



[Welfare=Expected lifetime utility of savers s & borrowers m]

Impact of CR levels on key variables (F3)



Optimal dynamic CRs: Welfare metrics

- Social welfare function

$$\tilde{V}_t \equiv \left[\zeta V_{s,t} + (1-\zeta) V_{m,t}\right]$$

where: $V_{\varkappa,t}$: expected lifetime utility of savers s & borrowers m

$\zeta \in [0,1]$: weight on savers' welfare

- We explore the whole Pareto frontier; for each ζ, we solve

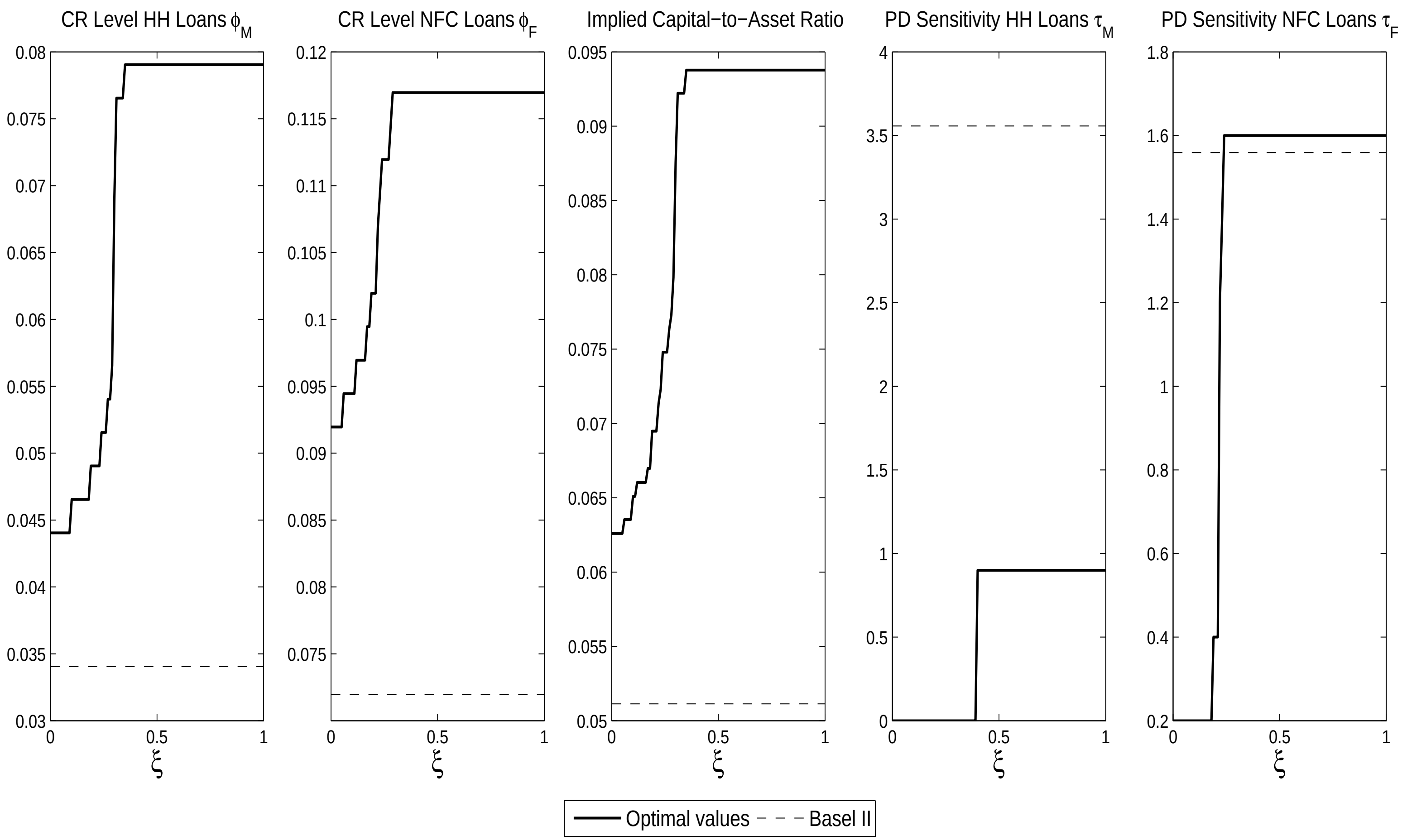
$$\max_{\{\phi_j,\tau_j\}_j} \tilde{V}_t$$

s.t.: $V_{s,t} \geq \bar{V}_{s,t}$, $V_{m,t} \geq \bar{V}_{m,t}$ (Pareto-improvement const.)

($\bar{V}_{\varkappa,t}$: expected lifetime utility under *calibrated CR rule*)

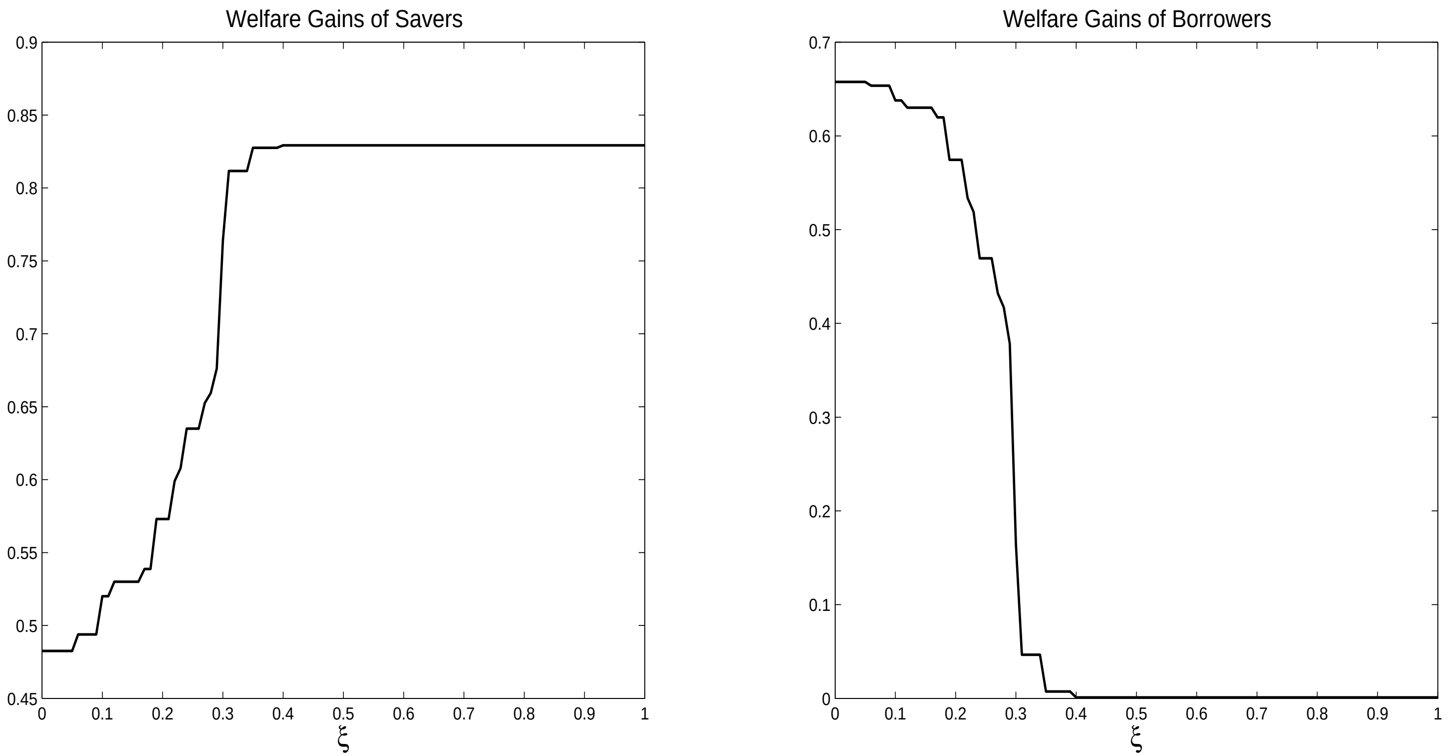
- Explored grid: $\phi_M \in [0.02, 0.2]$, $\phi_F \in [0.05, 0.2]$, $\tau_j \in [0, 5]$

Optimal dynamic CRs (F4)



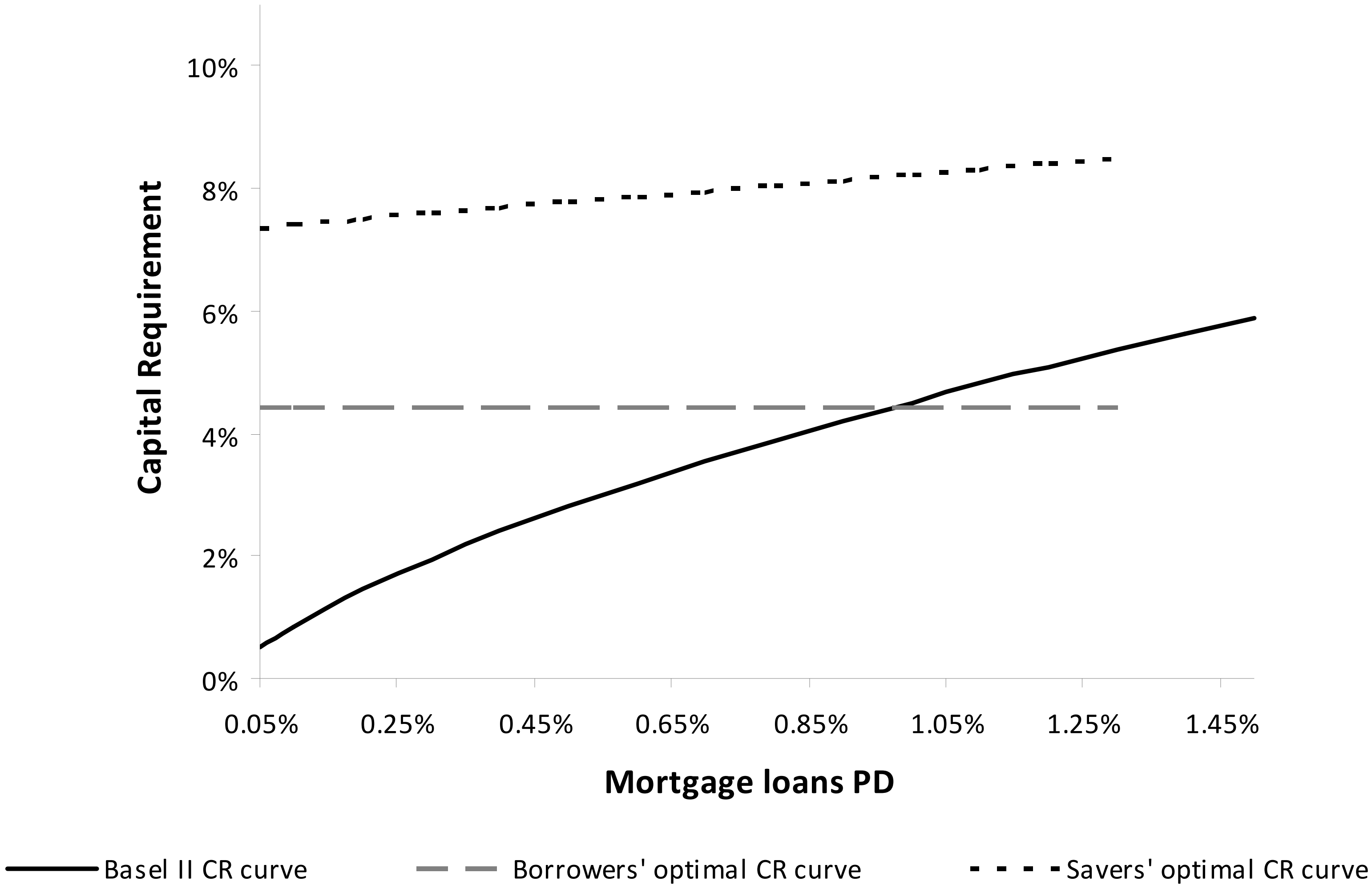
[ζ: weight on savers' welfare]

Welfare gains (F5)

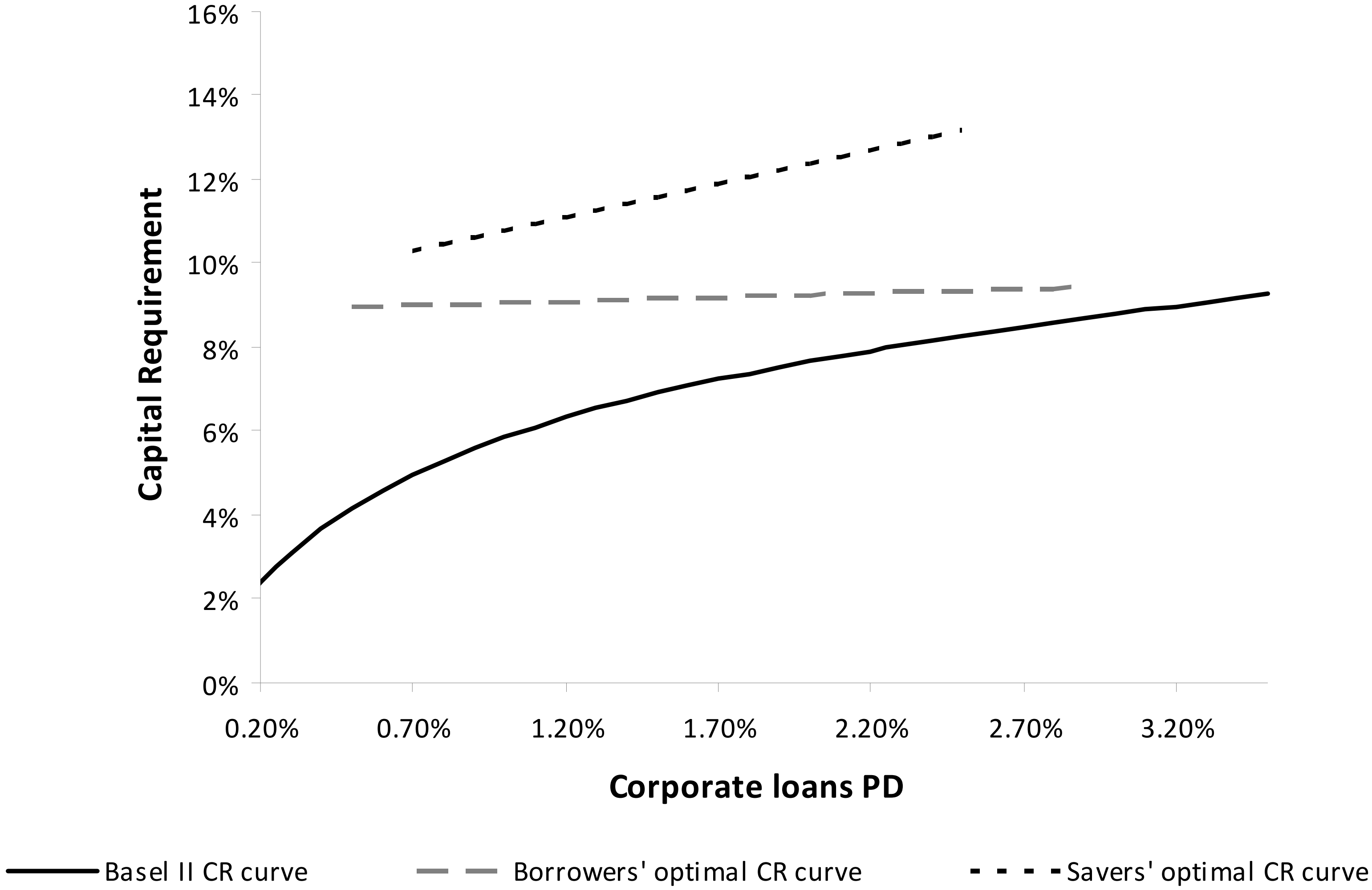


[ζ: weight on savers' welfare]

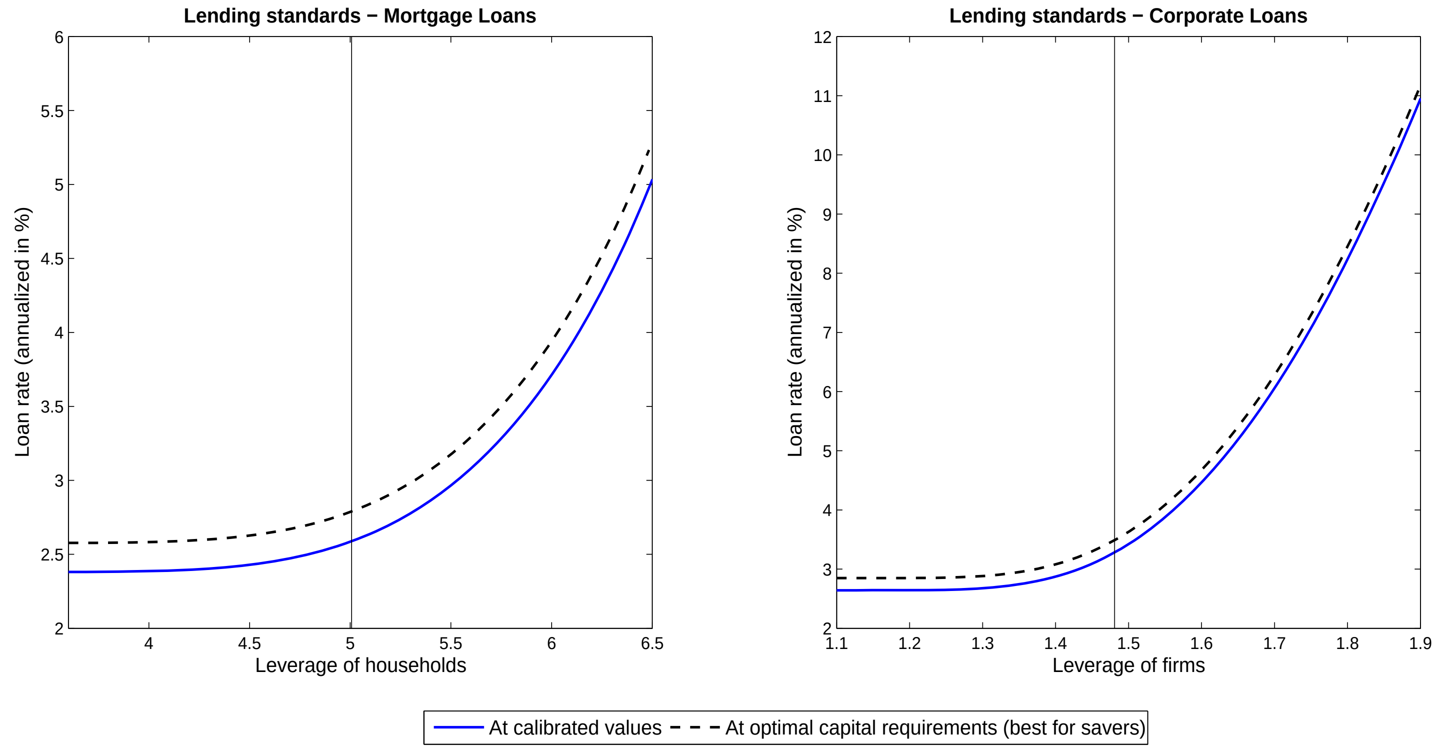
Basel vs. optimal CRs: mortgage loans (F6)



Basel vs. optimal CRs: corporate loans (F7)



Impact of optimal CRs on lending standards (F8)



- Focus: policy rule that implies equal (consumption equivalent) welfare gains for both groups
- PE effects + bank debt funding cost effects

Sources of the welfare gains*

Individual welfare gains when one or several aggregate shocks are shut down

Table 3. Welfare Gains

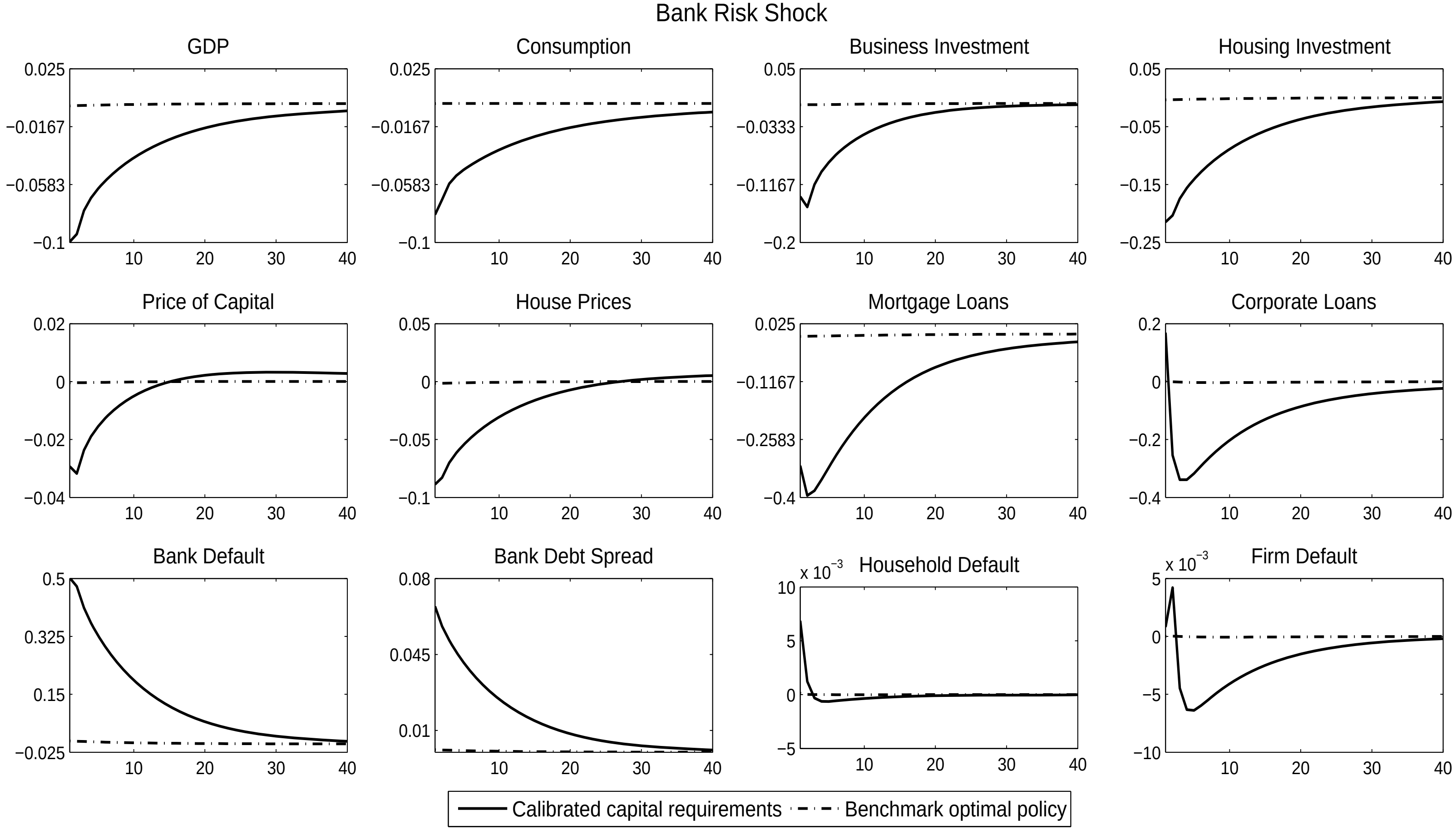
	Savers	Borrowers
(i) All shocks	0.60	0.60
(ii) No risk shocks	0.44	0.15
- No *bank risk* shocks	0.46	0.21
- No *housing return risk* shocks	0.60	0.60
- No *entrepreneurial capital return risk* shocks	0.59	0.51
(iii) No other shocks	0.60	0.57
(iv) No aggregate uncertainty	0.43	0.11

Welfare gains from benchmark optimized policy rule vs. calibrated policy rule

- Borrowers' welfare gains fall drastically in absence of risk shocks
- Risk shocks account for about 1/3 of savers' welfare gains

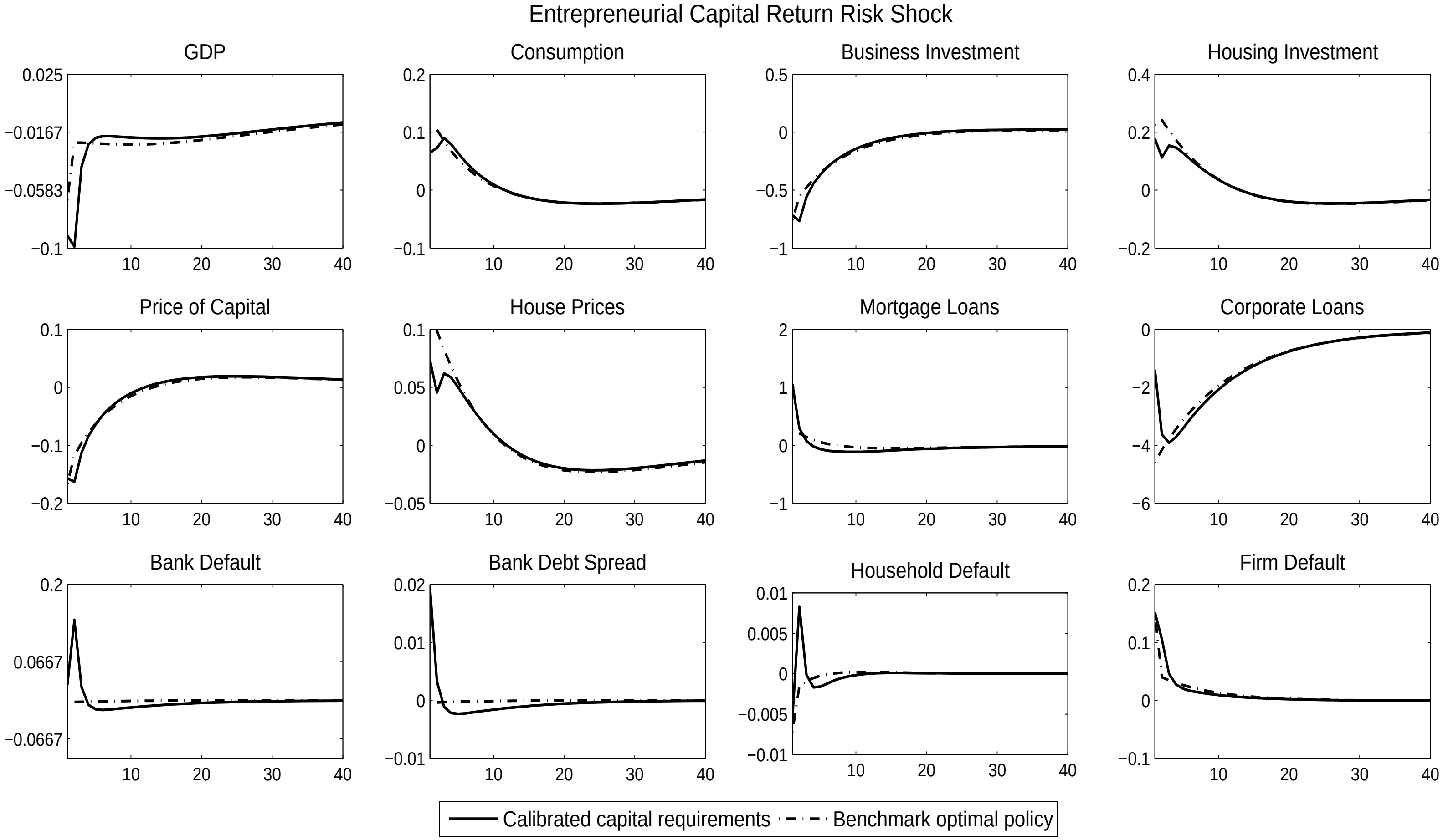
$\therefore$ Optimized policy brings both micro- & macro-prudential gains

Transmission of bank risk shocks (F9)



- The effects are completely offset by the optimized policy
- Bank default risk & bankers' net worth losses are close to zero, preventing contractionary impact of rise in bank funding costs

Transmission of entrepreneurial risk shocks (F10)*



- Fully offsetting the effects is not possible, since they have a non-bank root (entrepreneurs react by deleveraging ⇒ demand side effect)
- Role of policy: not to make things worse

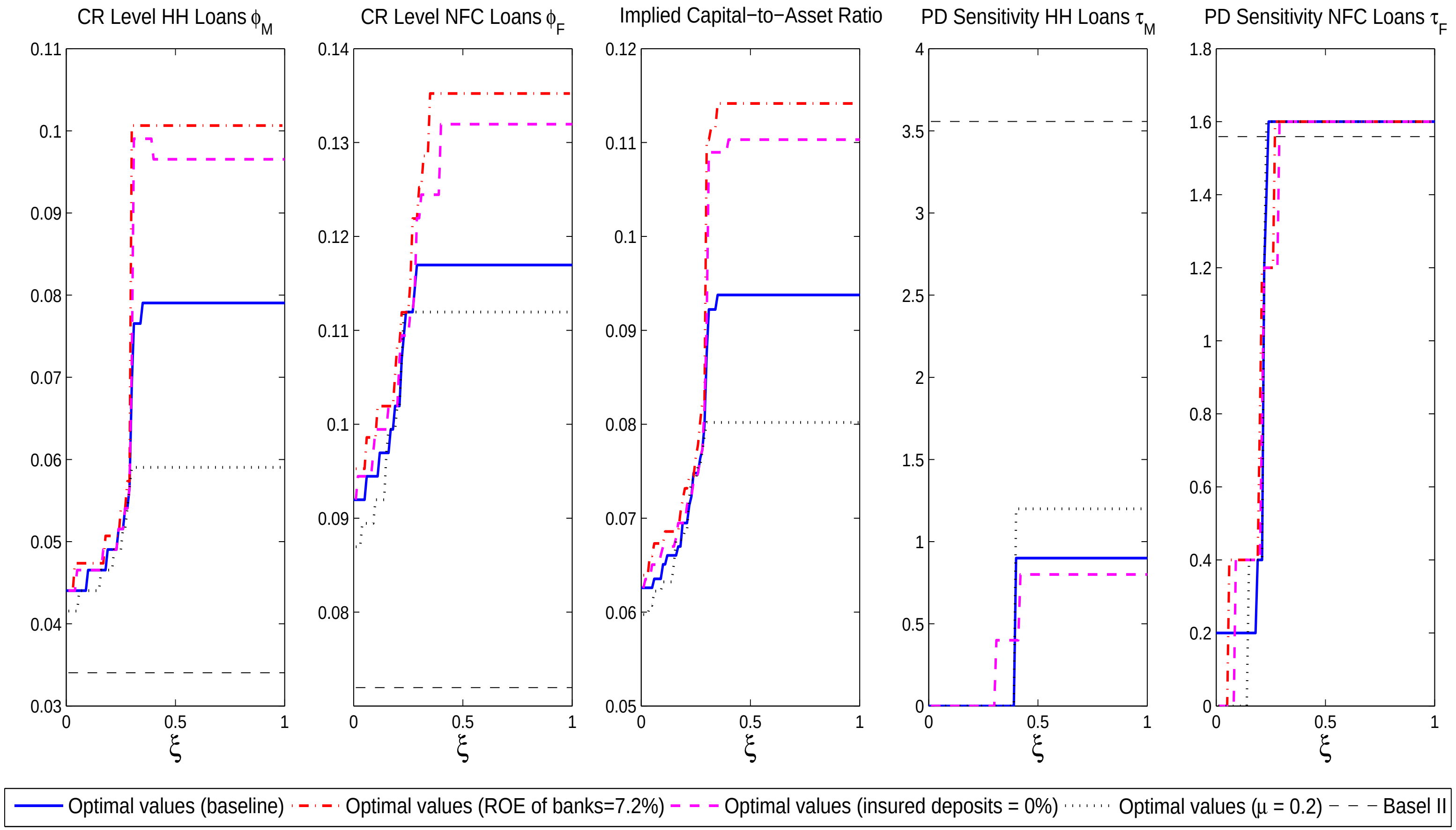
Conclusions

- We have calibrated an augmented version of the 3D model to EA data (2001-2014) and characterized optimal Basel-type dynamic capital requirement rules
- We have addressed up-front potential conflicts between savers and borrowers
- Starting from low levels, both groups benefit from higher CR levels, especially for mortgages
  - So as to keep risk of bank failure & bank-related channels of shock transmission under control
  - Above some point, opposite effects on savers & borrowers
- Borrowers and, to a lesser extent savers, also benefit from a lower PD-sensitivity than under a PIT implementation of the IRB formulas

THANK YOU!

COMPLEMENTARY MATERIALS

Sensitivity analysis: Optimal dynamic CRs (F11)*



Sensitivity analysis: Welfare gains (F12)*