Sectoral Credit Allocation, Capital Requirements and Financial Stability

Maximiliano San Millán

CEMFI

June 2023

Introduction

- Motivation
  - Not all credit booms are alike.
  - Rapid **credit growth** in **real estate** sectors associated with:
    - **Higher** probability of **banking distress**.
    - **Lower** future **GDP growth**. [Jorda, Shularick and Taylor, 2014; Muller and Verner, 2021].
  - Bank **capital regulation** (limit on bank leverage):
    - Mortgages individually **safer** than corporate non real estate loans → existing regulation requires **less** bank capital per unit of loans (roughly 3.4% vs 6.7% in calibration period).
- **This paper:**
  - Study the **macroprudential** implications of the **microprudential** design of bank capital regulation.
  - Assess the effectiveness of different regulatory designs at **preventing and mitigating** banking crises.
  - Two sector DSGE model with structural credit risk and bank level distortions.

Preview of results

1. Expansions in real estate credit are predictive of lower future GDP growth:
    - A 1 percentage point increase in the real estate credit to GDP ratio predicts lower future GDP growth (about 0.1%) after 4 years.
2. Policy analysis (assessment of regulatory tools):
    - Higher average levels of capital requirements (post GFC reforms) **reduce the probability of banking crises roughly by half.**
    - However, crises are characterized by **sharper reallocation towards real estate credit and larger GDP losses.**
    - Stabilizing effectiveness of **countercyclical macroprudential buffers**:
        - **Generic** countercyclical buffers only partially successful → **fail to prevent** cross sector reallocation towards real estate.
        - **Sector specific** countercyclical buffers **reduce cumulative output losses by three percentage points** during crises episodes, while **keeping the probability of distress low.**

Related Literature

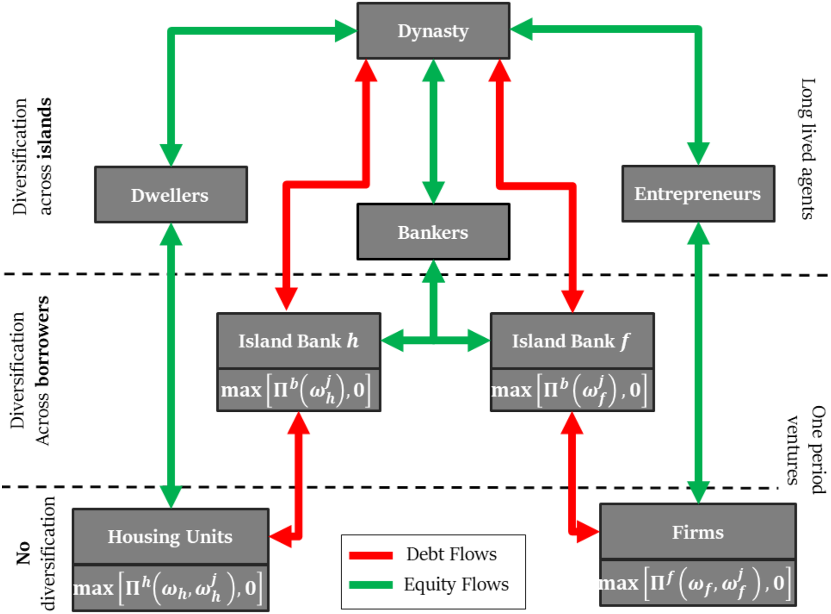
- Literature on credit cycles: excessive credit expansion in real estate sector/non tradeable sectors. [Gorton and Ordonez, 2020; Asriyan, Laeven, Martin, 2022; Schmitt-Grohe and Uribe, 2018,...]
  - **This paper**: Bank level distortions and capital regulation.
- Macro-banking papers with bank capital requirements [Malherbe (2020), Mendicino, Nicolov, Supera and Suarez (2018,2021),...]
  - **This paper:** Combine structural approach in credit risk and bank default with a multisectoral setup + Evaluation of sector specific capital buffers.
- Cyclical effects of risk based regulation [Repullo and Suarez, 2013; Andersen, 2013].
  - **This paper:** DSGE model, calibrated to Euro Area targets (quantification of effects).

Plan

Dissecting the mechanism

- Competitive banks with **limited liability** and **insured deposit funding**.
- **Risk shifting incentives** in response to volatility of a **non diversifiable** driver of returns:
  - Increase in non-diversifiable risk + no risk pricing of deposits →
  - Risk taking profitable for banks →
  - **Expand** balance sheet as much as possible.
- **Where** can banks expand leverage the most?
  - Sector with **lower** capital requirements.
- **Consequences:**
  - **Looser lending standards** → **increase** in borrower leverage.
  - **Reallocation** of credit towards sectors with low capital requirements (real estate) during episodes of increased volatility.
  - **Amplification** of small downturns in real estate markets, causing large losses (presence of bankruptcy costs + net worth channel).

Model - Financial Flows



Risk layers

- Two layers of **cross sectional risk:**
  - Borrower specific shocks: mean one **idiosyncratic shocks** to the terminal value of firm and household assets. Notation: ω_f, ω_h.
  - Non diversifiable **island shock**: mean one shock to all assets of class i in island j. Notation: ω_f^j, ω_h^j.
- **Time variation**:
  - Standard AR(1) aggregate productivity shocks.
  - Shocks to the dispersion of ω_f, ω_h.

$$\log\left(\frac{\sigma_{s,t+1}}{\bar{\sigma}_s}\right) = \varrho_i \log\left(\frac{\sigma_{s,t}}{\bar{\sigma}_s}\right) + \varsigma_s \varepsilon_{s,t+1}, \tag{1}$$

  - Shock to the dispersion of ω_f^j, ω_h^j.

$$\log\left(\frac{\sigma_{s,t+1}^j}{\bar{\sigma}_s^j}\right) = \varrho_s^j \log\left(\frac{\sigma_{s,t}^j}{\bar{\sigma}_s^j}\right) + \varsigma_s^j \varepsilon_{t+1}, \tag{2}$$

Financial Sector

Banks
specialized in sector s
Diversify across borrowers
i in island j

Bank s balance sheet

Assets	Liabilities
Loans $B_{s,t}$	Deposits $D_{s,t}$
	Equity $EQ^b_{s,t}$

$$\phi_{s,t} B_{s,t} \leq EQ^b_{s,t}$$

Bank Returns

$$\Pi^b_{t+1}(\omega^j_s) = \tilde{R}^l_{t+1}(\omega^j_s) B_{s,t} - R_{d,t} D_{s,t}$$

Financial Sector

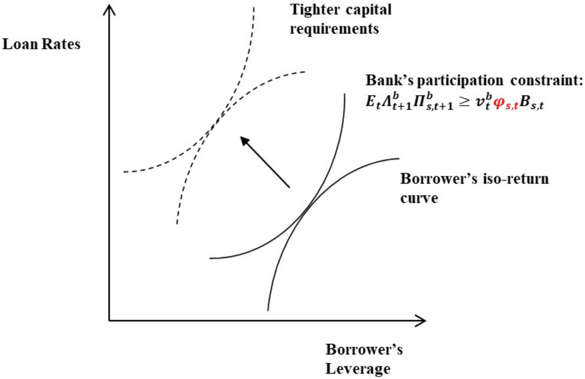
- Bankers' returns: $\Pi^b_{s,t+1} = \int_0^\infty \max[\Pi^b_{s,t+1}(\omega^j_s), 0] dF^j_{s,t+1}(\omega^j_s)$.
- Participation constraint of banks:

$$\mathbb{E}_t \underbrace{\Lambda^b_{t+1}}_{\substack{\text{Stcoh. disc.} \\ \text{factor (bankers)}}} \Pi^b_{s,t+1} \geq \underbrace{v^b_t}_{\substack{\text{Shadow value} \\ \text{bankers' net worth}}} \phi_{s,t} B_{s,t} \tag{3}$$

Higher (lower) capital charges $\phi_{s,t}$ tighten (relax) the participation constraint in (3).

Loan Contracts

- Borrowers (firms and households) decide on investment, consumption and borrowing taking into account the participation constraints of banks.
- Loan terms specify both a promised loan rate and the leverage of the borrower.



Calibration

- Calibration is done in two steps:
  - First step: pre-set parameters from the literature.
  - Second step: Internally calibrate parameters using SMM.
- Real and financial data from Euro Area in the period 2003:Q1-2013:Q4.
- Baseline calibration fits Basel II period.
- Model matches credit exuberance in the housing sector in the buildup of financial crises and the subsequent busts.

Calibration of capital requirements

- Regulators set capital requirements following Basel Committee on Banking Supervision standards.

$$\phi_{s,t} = \eta\phi_{s,t-1} + (1-\eta)\phi^*_{s,t}, \tag{4}$$

  where η is a smoothing parameter.

- Regimes
  - Basel I: $\phi^*_{f,t} = 0.08$, $\phi^*_{h,t} = 0.04$.
  - Basel II: $\phi^*_{s,t} = IRB_s(PD_{s,t})$.
  - Basel III: $\phi^*_{s,t} = M_{s,t} \times IRB_s(PD_{s,t})$, where $M_{s,t}$ is the impact of additional buffers (capital conservation and counter-cyclical buffers).

Details

Calibration

Table 2: Targeted Moments

Moment	Data	Model	Moment	Data	Model
Mean NFC Loans/GDP	1.785	2.046	Std. NFC Loans/GDP	0.128	0.237
Mean HH Loans/GDP	2.014	2.638	Std. HH Loans/GDP	0.053	0.059
Mean Spread NFC Loans	2.279	1.494	Std. Spread NFC Loans	0.493	0.907
Mean Spread HH Loans	1.331	0.5457	Std. Spread HH Loans	0.376	0.344
Mean write-off rate NFC Loans	0.543	0.584	Std. write-off NFC Loans	0.334	0.455
Mean write-off rate HH Loans	0.126	0.277	Std. write-off HH Loans	0.057	0.162
Mean Housing Wealth/ Total Non Financial wealth	0.947	0.633	Std. GDP	0.023	0.022
Mean ROE NFCs	4.706	4.223	Std. ROE NFCs	8.148	3.238
Mean ROE Banks	4.619	11.21	Std. ROE Banks	12.201	11.017
Mean Capital held by Households	0.185	0.153	Std. Investment/GDP	0.008	0.004
			Std. Housing prices	0.054	0.033

Notes: This table displays the targeted moments in the calibration and their model counterparts. Spreads, write-off rates and returns on equity are reported in annualized percentage points. The standard deviation of GDP corresponds to the standard deviation of the log of GDP, in quarterly terms. All variables are linearly detrended before computing standard deviations.

More

Calibration

Table 1: Internally calibrated parameters

Parameter	Symbol	Value	Parameter	Symbol	Value
New bankers' endowment	χ_b	0.682	Std. Island risk (Firms)	ς_f^j	0.055
New entrepreneurs' endowment	χ_f	0.584	Std. Island risk (HH)	ς_h^j	0.035
Housing equity	χ_h	0.388	Std. Firm risk	ς_f	0.075
Mean Island risk shock (Firms)	$\bar{\sigma}_f^j$	0.263	Std. HH risk	ς_h	0.025
Mean Island risk shock (HH)	$\bar{\sigma}_h^j$	0.216	Std. productivity shocks	ς_A	0.003
Mean Firm risk shocks	$\bar{\sigma}_f$	0.304	Pers. Island risk (Firms)	ϱ_f^j	0.705
Mean HH risk shocks	$\bar{\sigma}_h$	0.047	Pers. Island risk (HH)	ϱ_h^j	0.705
Relative housing preference	λ_h	0.109	Pers. Firm risk	ϱ_f	0.906
HH backyard technology	α_{hh}	0.1	Pers. HH risk	ϱ_h	0.926
Investment adjustment costs	ψ	1.99	Pers. Productivity	ϱ_A	0.98
			CR partial adjustment coefficient	η	0.9

- Model assigns higher (relative) importance of non diversifiable risk in the real estate sector.

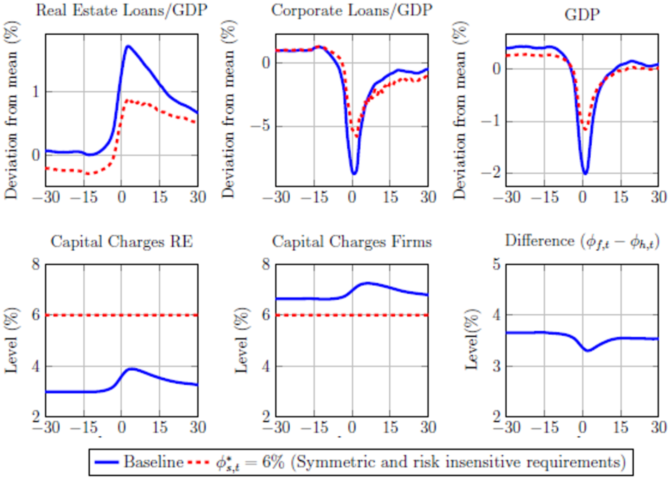
Results

- Study **banking crises** episodes: Periods with gross deposit insurance outlays greater than 3% of GDP (Laeven and Valencia, 2013).
- Understand the role of capital regulation in the buildup and aftermath of crises.

1. Characterization of banking crises (reallocation towards real estate lending).
2. Relevance of sector-specific capital buffers.
3. Probability of banking crises under different regimes.

Risk sensitive capital requirements and the path to crises

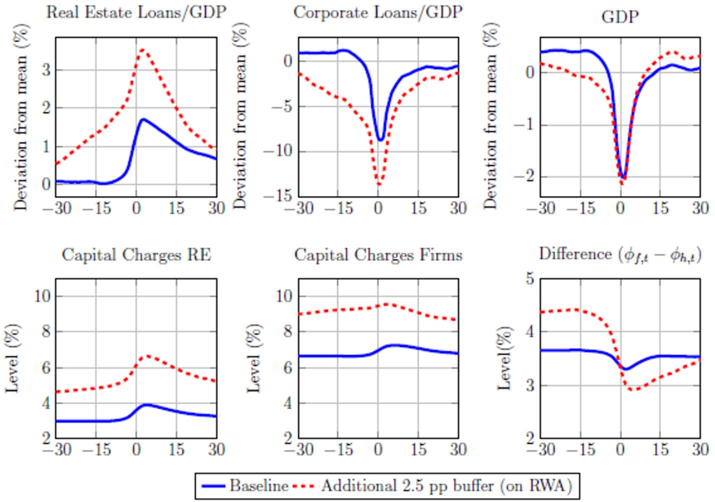
Figure 3: Role of Capital Requirements



Notes: Solid lines correspond to the baseline model. Dashed lines correspond to a version of the model where capital charges are set to 6% and are equal across sectors. Sample paths correspond to shock realizations that generate banking crises in the baseline model.

Evaluation of an increase in levels of CRs (CCB)

Figure 4: Assessment of Uniform Increase in Capital Requirements



Notes: Solid lines correspond to the baseline model. Dashed lines correspond to capital requirements equal to 10.5% of risk weighted assets (introducing a 2.5% buffer as in the Capital Conservation Buffer of Basel III). Sample paths correspond to shock realizations that generate banking crises in each model

Evaluation of CCyB rules

- Evaluate generic counter cyclical buffers

$$M_{s,t} = CCyB(\text{Total Credit/GDP gap at time t}) \tag{5}$$

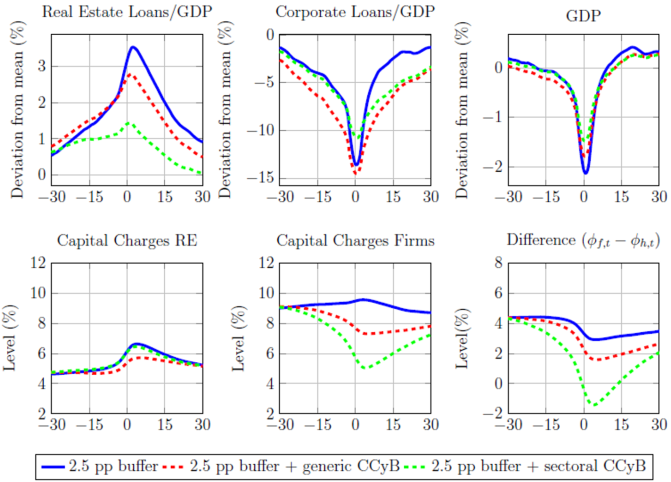
- Sector specific buffers

$$M_{s,t} = CCyB(\text{Sector } s \text{ Credit/GDP gap at time t}) \tag{6}$$

- Parameters in this function are chosen to match existing Basel guidelines on the CCyB.

Evaluation of CCyB rules (on top of CCB)

Figure 6: Evaluation of Basel III buffers



Notes: Solid lines correspond to Basel III levels of capital requirements. Red dashed lines correspond to a generic CCyB. Green dashed lines correspond to a sectoral CCyB. Sample paths correspond to shock realizations that generate banking crises in each model.

Comparison across regimes

Table 3: Comparison across Regulatory Designs

Outcome Variable	Baseline	Basel III (extra 2.5 pp buffer)	Generic CCyB	Sectoral CCyB
Frequency of Banking Crises	3.024	1.352	1.4229	1.35
Output Losses in Crises	-13	-14.3	-14.08	-11.28
Capital Charge (Firms)	6.68	8.81	8.99	9.08
Capital Charge (Households)	3.02	4.57	4.68	4.64
Default Rate Banks	1.04	0.96	0.96	0.96
Default Rate Firms	1.54	1.55	1.55	1.54
Default Rate Households	0.81	1	1.02	1.02
Welfare	–	0.055	0.01	0.085

Notes: Output losses are reported in cumulative percentage points of GDP in the three years following a banking crisis. Welfare is reported as the percentage change in permanent consumption that would leave consumers as well off in the Baseline scenario as in each of the different regimes. Default rates are reported in annualized percentage points. Each column corresponds to simulations of the model for 500,000 periods, under each different regulatory regime.

Conclusion

- Increasing (just) the **level** of risk sensitive capital requirements (as in Basel III) decreases the probability of financial crises but leads to more severe real state boom and bust episodes (”scarcity” of bank capital).
- **Sector specific** countercyclical buffers can be **effective** macroprudential tools as they correct banks’ incentives in the buildup of crises.
- The **reallocation** of credit towards real estate and the severity of crises can be **exacerbated by the microprudential design** of bank capital requirements.

Thank you for your attention!

Appendix

Dynasty

- Dynasty's utility function:

$$V_t = \mathbb{E}_t \sum_{s=t}^{\infty} \beta^{s-t} \left[\log(C_s) + \lambda_h \log(H_s) - \lambda_L \frac{L_s^{1+\varphi}}{1+\varphi} \right], \qquad (7)$$

where

  - C_t: consumption of the final good.
  - H_t: consumption of housing units.
  - L_t: labor supplied by the dynasty.
  - β is the subjective discount factor; λ_H measures preference for housing; λ_L measures the disutility of labor and φ is the Frisch elasticity of labor.

Dynasty

- Dynasty's budget constraint:

$$C_t + D_t + q_{k,t}K_{h,t} \leq W_t - EQ_t^h, \quad (8)$$

where

$$W_t = w_tL_t + R_{d,t-1}D_{t-1} + q_{k,t}(1-\delta)K_{h,t-1} + K_{h,t-1}^{\alpha_h} + \Pi_t^h + \Upsilon_t \quad (9)$$

- Housing units financing constraint:

$$q_{h,t}H_t \leq B_{h,t} + EQ_t^h, \quad (10)$$

where $EQ_t^h = \chi_h W_t$.

D_t: bank deposits; $R_{d,t}$: gross rate on deposits; $q_{k,t}$: price of physical capital; $K_{h,t-1}$: physical capital directly held by the dynasty; α_h: household backyard technology; $q_{h,t}$: price of housing units; χ_h: housing equity as fraction of total wealth. Υ_t: net transfers from entrepreneurs, bankers and producers of capital and housing units.

Dynasty's problem and mortgage loans

- Housing purchases are chosen by the dynasty jointly with consumption and investment.
- Dynasty chooses $H_t, B_{h,t}, R^l_{h,t}, C_t, L_t, K_{h,t}$ such that

$$(H_t, B_{h,t}, R^l_{h,t}, C_t, L_t, K_{h,t}) = \text{argmax } V_t, \ \textbf{s.t.} \tag{11}$$

$$C_t + D_t + q_{k,t} K_{h,t} \leq W_t - EQ^h_t, \tag{12}$$

$$q_{h,t} H_t \leq B_{h,t} + EQ^h_t, \tag{13}$$

and the real estate banks' participation constraint

$$\mathbb{E}_t \underbrace{\Lambda_{t+1}(1 - \theta_b + \theta_b v^b_{t+1})}_{\text{Disc. factor bankers}} \underbrace{\Pi^b_{h,t+1}}_{\text{Aggregate payoff on loan portfolios } h} \geq \phi_{h,t} B_{h,t} \underbrace{v^b_t}_{\text{shadow value of bank equity}} . \tag{14}$$

Housing payoffs

- Terminal housing net worth

$$\Pi_{t+1}^{h}(\omega_h, \omega_h^j) = \omega_h \omega_h^j R_{h,t+1} q_{h,t} H_t - R_{h,t}^l B_{h,t}, \tag{15}$$

where $R_{h,t+1} = \frac{q_{h,t+1}(1-\delta_h)}{q_{h,t}}$.

- Aggregate returns on housing

$$\Pi_{t+1}^{h} = \int_0^{\infty} \int_0^{\infty} \max \left[\Pi_{t+1}^{h}(\omega_h, \omega_h^j), 0 \right] dF_{h,t+1}(\omega_h) dF_{h,t+1}^{j}(\omega_h^j), \tag{16}$$

Firms

- Firms produce the final consumption good according to

$$Y_{t+1} = A_{t+1} K_{f,t}^{\alpha} L_t^{1-\alpha}, \tag{17}$$

- Firms' financing constraint: $q_{k,t} K_{f,t} + w_t L_t = B_{f,t} + EQ_{f,t}$
- The terminal net worth of a firm f in island j is given by

$$\Pi_{t+1}^{f}(\omega_f, \omega_f^j) = \omega_f \omega_f^j \left[Y_{t+1} + q_{k,t+1}(1-\delta) K_{f,t} \right] - R_{f,t}^{l} B_{f,t}, \tag{18}$$

- Aggregate firm payoffs

$$\Pi_{t+1}^{f} = \int_0^{\infty} \int_0^{\infty} \max \left[\Pi_{t+1}^{f}(\omega_f, \omega_f^j), 0 \right] dF_{f,t+1}(\omega_f) dF_{f,t+1}^{j}(\omega_f^j)$$

Entrepreneurs

Firms' problem and Corporate loans

- Corporate loans: choose $K_t, L_t, B_{f,t}, R^l_{f,t}$ such that

$$(K_t, L_t, B_{f,t}, R^l_{f,t}) = \text{argmax}\ \mathbb{E}_t \underbrace{\Lambda_{t+1}(1-\theta_f+\theta_f v^f_{t+1})}_{\substack{\text{Disc. factor}\\ \text{entrepreneurs}}} \Pi^f_{t+1}, \ \textbf{s.t.} \tag{19}$$

$$q_{k,t}K_t + w_t L_t \leq B_{f,t} + EQ_{f,t}, \tag{20}$$

and the banks' participation constraint

$$\mathbb{E}_t \underbrace{\Lambda_{t+1}(1-\theta_b+\theta_b v^b_{t+1})}_{\substack{\text{Disc. factor}\\ \text{bankers}}} \underbrace{\Pi^b_{f,t+1}}_{\substack{\text{Aggregate payoff on}\\ \text{loan portfolios } f}} \geq \phi_{f,t} B_{f,t} \underbrace{v^b_t}_{\substack{\text{shadow value of}\\ \text{bank equity}}}. \tag{21}$$

Entrepreneurs

Banks

- Specialized island-sector bank subsidiaries.
- Issue equity and fully insured deposits.
- Invest in diversified portfolio of loans.
- Capital requirements $\phi_{s,t}$ (binding in equilibrium).
- Bank i payoffs

$$\Pi^b_{s,t+1}(\omega^j_s) = \tilde{R}^l_{s,t+1}(\omega^j_s) B_{s,t} - R_{d,t} D_{s,t}, \tag{22}$$

- Aggregate banks payoff (diversification across islands)

$$\Pi^b_{s,t+1} = \int_0^\infty \max\left[\Pi^b_{s,t+1}(\omega^j_s), 0\right] dF^j_{s,t+1}(\omega^j_s), \tag{23}$$

Bankers Return on loans

Bankers

- Bankers manage their wealth and invest it in corporate and mortgage banks.
- They exit with probability $1 - \theta_b$.
- When exiting, they rebate their terminal net worth $n_{b,t+1}$ to the dynasty.
- Value function of individual banker

$$V_{t+1}^b(n_t^b(i)) = \max_{\substack{\text{div}_t^b(i), EQ_{h,t}^b(i), \\ EQ_{f,t}^b(i), n_{t+1}^b(i)}} \left\{ \text{div}_t^b(i) + \mathbb{E}_t \Lambda_{t+1} \left[(1-\theta_b) n_{t+1}^b(i) + \theta_b V_{t+1}^b(n_{t+1}^b(i)) \right] \right\}, \tag{24}$$

$$\text{s.t. } \text{div}_t^b(i) + EQ_{h,t}^b(i) + EQ_{f,t}^b(i) = n_t^b(i), \tag{25}$$

$$n_{t+1}^b(i) = \rho_{h,t+1}^b EQ_{h,t}^b(i) + \rho_{f,t+1}^b EQ_{f,t}^b(i), \tag{26}$$

$$\text{div}_t^b(i) \geq 0, \tag{27}$$

with $\rho_{s,t+1}^b \equiv \frac{\Pi_{s,t+1}^b}{EQ_{s,t+1}^b}$.

Back to banks

Bankers II

- Gertler and Kiyotaki (2010) $\rightarrow$ value function linear in net worth +

$$v_t^b n_t^b = \max_{\text{div}_t^b, EQ_{f,t}^b, EQ_{h,t}^b} \{\text{div}_t^b + \mathbb{E}_t \underbrace{\Lambda_{t+1}\left[(1-\theta_b)+\theta_b v_{t+1}^b\right]}_{\substack{\text{Stoch. disc.} \\ \text{factor bankers } \equiv \Lambda_{t+1}^b}} n_{t+1}^b\} \quad (28)$$

- As long as $v_{t+1}^b > 1$, we have $\text{div}_t^b = 0$.
- No arbitrage type condition: $\mathbb{E}_t \Lambda_{t+1}^b \rho_{f,t+1}^b = \mathbb{E}_t \Lambda_{t+1}^b \rho_{h,t+1}^b$.
- Shadow value of bankers' net worth
$v_t^b = \mathbb{E}_t \Lambda_{t+1}^b \rho_{f,t+1}^b = \mathbb{E}_t \Lambda_{t+1}^b \rho_{h,t+1}^b$

Back to banks

Entrepreneurs

- Entrepreneurs manage their wealth and invest it in firms.
- They exit with probability $1-\theta_f$.
- When exiting, they rebate their terminal net worth $n_{f,t+1}$ to the dynasty.
- Value function of individual entrepreneur

$$V_t^f\left(n_t^f(i)\right)=\max_{\substack{\mathrm{div}_t^f(i),\\ n_{t+1}^f(i),EQ_t^f(i)}}\left\{\mathrm{div}_t^f(i)+\mathbb{E}_t\Lambda_{t+1}\left[(1-\theta_f)n_{t+1}^f(i)+\theta_f V_{t+1}^f(n_{t+1}^f(i))\right]\right\} \tag{29}$$

$$\text{s.t. } \mathrm{div}_t^f(i)+EQ_t^f(i)=n_t^f(i), \tag{30}$$

$$n_{t+1}^f(i)=\rho_{t+1}^f EQ_t^f(i), \tag{31}$$

$$\mathrm{div}_t^f(i)\geq 0 \tag{32}$$

with $\rho_{t+1}^f \equiv \frac{\Pi_{t+1}^f}{EQ_{t+1}^f}$.

Back to firms

Entrepreneurs II

- Gertler and Kiyotaki (2010) $\rightarrow$ value function linear in net worth then

$$v_t^f n_t^f = \max_{\text{div}_t^f, EQ_t^f} \{\text{div}_t^f + \mathbb{E}_t \underbrace{\Lambda_{t+1}\left[(1-\theta_f) + \theta_f v_{t+1}^f\right]}_{\substack{\text{Stoch. disc.} \\ \text{factor entrepreneurs } \equiv \Lambda_{t+1}^f}} \rho_{t+1}^f n_t^f\} \quad (33)$$

- As long as $v_{t+1}^f > 1$, we have $\text{div}_t^f = 0$.
- Shadow value of entrepreneurial equity $v_{t+1}^f = \mathbb{E}_t \Lambda_{t+1}^f \rho_{t+1}^f$.

Back to firms

Laws of motion

- Law of motion of aggregate bankers' net worth

$$N^b_{t+1} = [\theta_b + (1-\theta_b)\chi_b]\left[\rho^b_{f,t+1} EQ^b_{f,t} + \rho^b_{h,t+1} EQ^b_{h,t}\right] - T_t, \quad (34)$$

  where T_t are taxes levied by the prudential authority.

- Law of motion of aggregate entrepreneurial net worth

$$N^f_{t+1} = [\theta_f + (1-\theta_f)\chi_f]\rho^f_{t+1} EQ^f_t. \quad (35)$$

- Capital and housing stock

$$X_{t+1} = S\left(\frac{I_{x,t}}{X_t}\right) X_t + (1-\delta_x) X_t, \quad (36)$$

  with $X = K, H$ and $S\left(\frac{I_{x,t}}{X_t}\right) = \frac{a_1}{1-1/\psi}(I_{x,t}/X_t)^{1-1/\psi} + a_2$

Market clearing

- Bankers' net worth: $N_t^b = EQ_{f,t}^b + EQ_{h,t}^b$
- Entrepreneurs' net worth: $N_t^f = EQ_t^f$
- Capital: $K_t = K_{f,t} + K_{h,t}$.
- Final consumption good $Y_t = C_t + I_{k,t} + I_{h,t} + \Sigma_{f,t} + \Sigma_{h,t} + \Sigma_{b,t}$, where $\Sigma_{s,t}$ are bankruptcy costs associated to firms, households and banks.
- Deposits: $D_t = D_{f,t} + D_{h,t}$.

Realized return on loans

- Realized return on mortgage loans

$$\tilde{R}^l_{h,t+1}(\omega_{j_h})B_{h,t} \equiv R^l_{h,t}B_{h,t}\left[1 - F_{h,t+1}(\bar{\omega}_{h,t+1}(\omega^j_h))\right] +$$
$$(1-\mu_h)\omega^j_h R_{h,t+1}q_{h,t}H_t \int_0^{\bar{\omega}_{h,t+1}(\omega^j_h)} \omega_h dF_{h,t+1}(\omega_h), \quad (37)$$

- Realized return on corporate loans

$$\tilde{R}^l_{f,t+1}(\omega^j_f)B_{f,t} \equiv R^l_{f,t}B_{f,t}\left[1 - F_{f,t+1}(\bar{\omega}_{f,t+1}(\omega^j_f))\right] +$$
$$(1-\mu_f)\omega^j_f\left[Y_{t+1} + q_{t+1}(1-\delta)K_{f,t}\right] \int_0^{\bar{\omega}_{f,t+1}(\omega^j_f)} \omega_f dF_{f,t+1}(\omega_f), \quad (38)$$

Back to banks

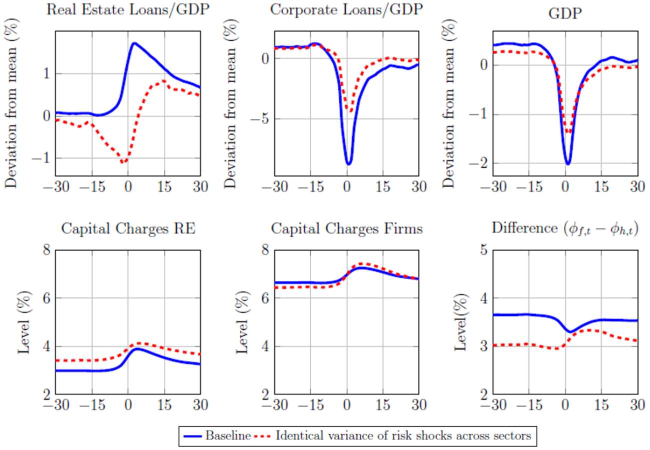
IRB formulas

$$\mathrm{IRB}_{s,t} = \mathrm{LGD}_s \left[\Phi \left(\frac{\Phi^{-1}\left(\mathrm{PD}_{s,t}\right) + \sqrt{\zeta_{s,t}}\Phi^{-1}(0.999)}{\sqrt{1-\zeta_{s,t}}} \right) - \mathrm{PD}_{s,t} \right], \quad (39)$$

where LGD_s is the loss given default; $PD_{s,t}$ is the IRB default probability, and $\zeta_{s,t}$ is the portfolio correlation coefficient of each class of loans.

Role of differences in non-diversifiable risk

Figure 2: Role of non-diversifiable risk

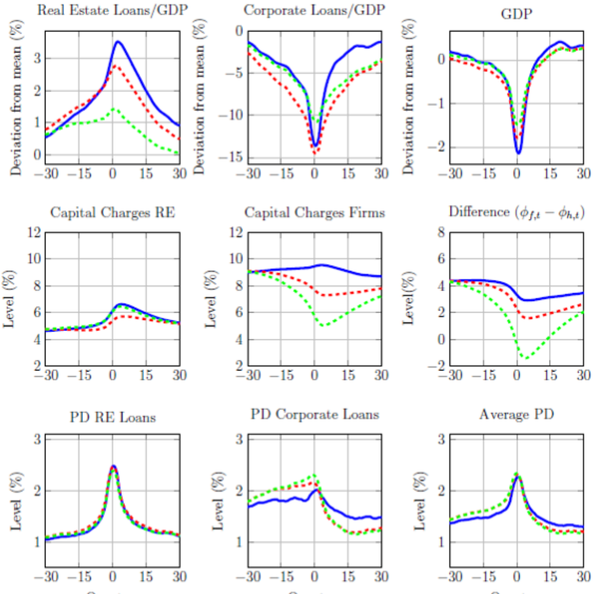


Notes: Solid lines correspond to the baseline model. Dashed lines correspond to a version of the model where real estate and corporate lending have identical parameters for the variance and persistence of risk shocks (borrower idiosyncratic and island specific). Sample paths correspond to shock realizations that generate banking crises in the baseline model.

Back to results

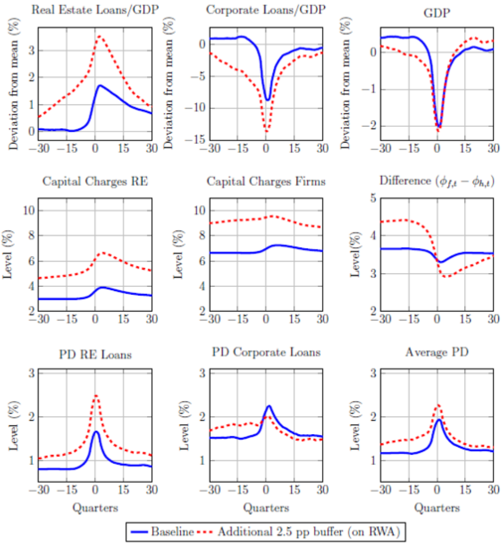
Basel III buffers

Figure 6: Evaluation of Basel III buffers



Basel III (CCB only)

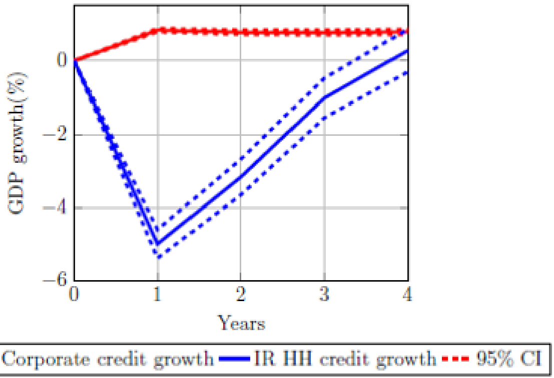
Figure 4: Assessment of Uniform Increase in Capital Requirements



Notes: Solid lines correspond to the baseline model. Dashed lines correspond to capital requirements equal to 10.5% of risk weighted assets (introducing a 2.5% buffer as in the Capital Conservation Buffer of Basel III). Sample paths correspond to shock realizations that generate banking crises in each model

Sector-specific credit growth and GDP growth

Figure 1: Responses of GDP growth to innovations in Credit to GDP ratios

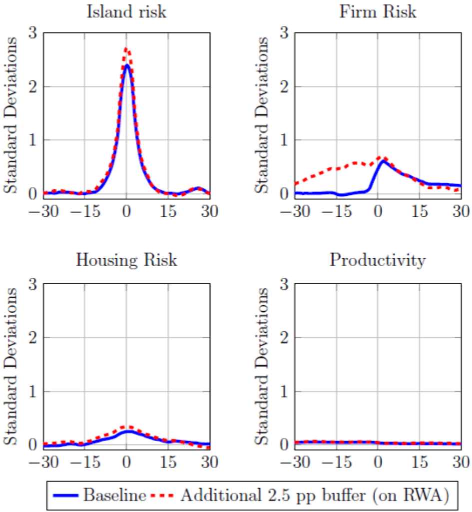


Notes: Impulse responses of GDP growth over a horizon k years ahead, to innovations in credit to GDP ratios (in levels, not percent) in each sector, computed using local projections estimates of $\Delta_k GDP_{t+k} = \Sigma_{j=0}^{J} \beta^h_{k,j} \Delta b_{h,t-j} + \Sigma_{j=0}^{J} \beta^f_{k,j} \Delta b_{f,t-j} + \Sigma_{j=0}^{J} \gamma_{k,j} \Delta GDP_{t-j} + \nu_{t+k}$.

- Expansions in residential real estate loans predictive of lower future GDP growth.
- Consistent with empirical evidence in e.g. Muller and Verner (2021).

Shocks leading to crises

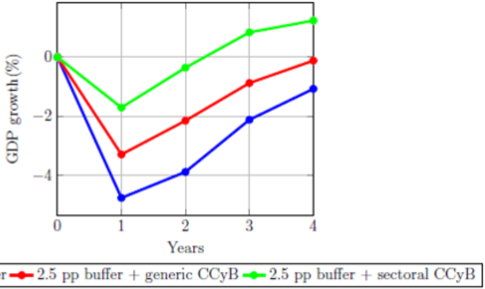
Figure 5: Shocks leading to a crisis in baseline vs higher levels of capital requirements



Notes: Solid lines correspond to the baseline model. Dashed lines correspond to capital requirements equal to 10.5% of risk weighted assets (introducing a 2.5% buffer as in the Capital Conservation Buffer of Basel III). Sample paths correspond to shock realizations that generate banking crises in each model.

Real Estate Credit growth, GDP growth and CRs

Figure 8: Responses of GDP growth to innovations in Credit to GDP ratios



Note: Impulse responses of GDP growth over a horizon of k years ahead, to innovations in the ratio of real estate credit to GDP in different regulatory regimes regimes, computed using local projections estimates of $\Delta_k GDP_{t+k} = \Sigma_{j=0}^{J}\beta_{k,j}^{h}\Delta b_{h,t-j} + \Sigma_{j=0}^{J}\beta_{k,j}^{f}\Delta b_{f,t-j} + \Sigma_{j=0}^{J}\gamma_{k,j}\Delta GDP_{t-j} + \nu_{t+k}$.

- Sector specific buffers help breaking the connection between real estate credit growth and negative future GDP growth.
- Achieved by correcting bank risk shifting incentives + building buffers (also achieved under generic CCyB).