“Simple Implementable Financial Policy Rules”

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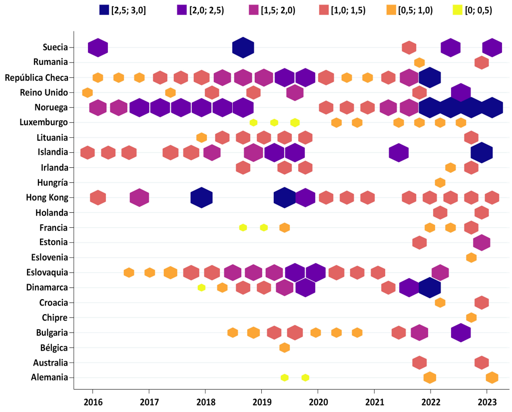
Fifth Conference on Financial Stability - CEMFI & BdE
June 2025, Madrid.

Motivation

- Empirically no clear pattern on when countries accumulate (Herz and Keller 2023) but generally released in Covid.
- From a theoretical point of view, there are only a few recent studies on when it is best timming to activate the CCyB (Lang and Menno 2023) or how fast to activate it (Nicoló et al. 2023; Herrera et al. 2024).
- There is some papers that use quantitative macro-banking modeles to understand the effects of a dynamic capital requirements (Mendicino et al. 2018; Muñoz and Smets 2025).



Levels of CCyB across countries.
No hexagon means deactivated CCyB. Source: FSR-CBC 2023-S1

Research questions

1. How should a Implementable Financial Policy Rule look like?
2. Can we make the case for a neutral CCyB?

What do we know?

1. Macroprudential tools can smooth the credit cycle.
   - Kuttner and Shim 2016, Jiménez et al. 2017.
2. Macroprudential policies as mitigators of systemic risk.
   - Empirics: Benbouzid et al. 2022
   - Macro-modeling: Clerc et al. 2014, Mendicino et al. 2018, 2020; Mendicino et al., Forthcoming, Malherbe 2020, Carrillo et al. 2021
3. Guidelines for the CCyB
   - Lang and Menno 2023, Nicoló et al. 2023, Herrera et al. 2024, Muñoz and Smets 2025

What are the key features to evaluated *Financial Policies* from a Macromodeling point of view?

1. Financial Fricction in Intermediation Problem (LL + DI) $\Rightarrow$ Excessive Leverage in Banks $\Rightarrow$ Static capital requirement.

2. Dynamic social externality $\Rightarrow$ Over-investment in booms $\Rightarrow$ Dynamic Capital Requirement.

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This paper

What do we do in this paper?

1. Build and estimate a DSGE model with a prominent role for banking finance:

Macro	**Intermediation**	**Financial Friction**	**Design**
SOE-NK Model	Savers/Banks/Borrowers	Incomplete Markets (CSV + Dep. Insurance + LL)	OBC in CCyB

2. Consider different financial policy rules (FPR) within those simple and implementable (SIFPR)
   → consumption equivalence

3. Explore implication of [0%–2.5%] range for (2) and for a Neutral CCyB

Main findings

1. Price-responsive rules generate higher welfare gains.
2. It is welfare-optimal to have a positive neutral CCyB.

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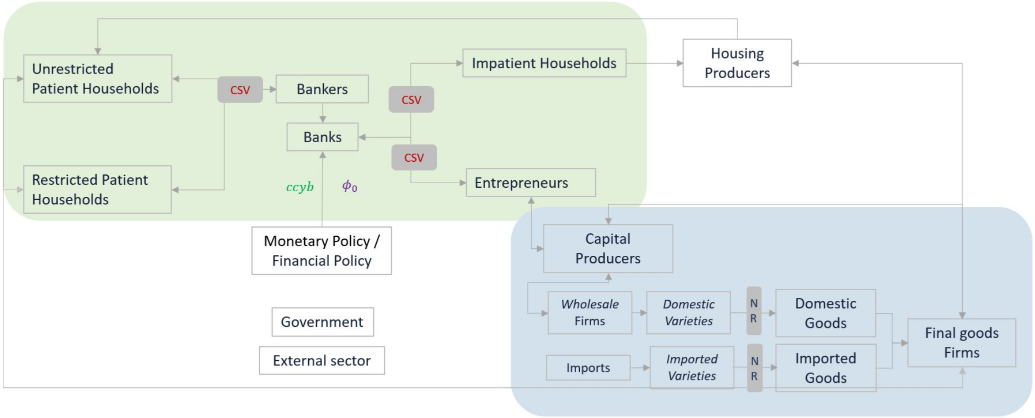
Figure: Overview of the model



Note.– CSV stands for costly state verification and NR stands for nominal rigidities. Green box emphasizes the financial modules of the model, which are directly affected by Financial Policy. The blue box emphasizes the more standard New-Keynesian modules of the model, more directly affected by nominal rigidities and for which monetary policy is directly relevant.

Model - Policies

- **Monetary Policy.** Forward looking Taylor Rule

$$\frac{R_t}{R} = \left(\frac{R_{t-1}}{R}\right)^{\alpha_R} \left[\left(\frac{(1-\alpha_E)\,\pi_t + \alpha_E \mathbb{E}_t\left\{\pi_{t+4}\right\}}{\pi_t^T}\right)^{\alpha_\pi} \left(\frac{GDP_t/GDP_{t-1}}{a}\right)^{\alpha_y}\right]^{1-\alpha_R} e_t^m$$

- **Financial Policy.** CCyB function of endogenous variable X_t as well as its expected value at some future *horizon*

$$\left(\frac{1+CCyB_t}{1+\overline{CCyB}}\right) = \left(\frac{1+CCyB_{t-1}}{1+\overline{CCyB}}\right)^{\theta_1} \left(\frac{(1-\alpha_E)X_t + \alpha_E \mathbb{E}(X_{t+horizon})}{X}\right)^{\theta_2}$$

  - θ_1 : CCyB Inertia
  - θ_2 : Reaction degree to change in X_t
  - α_E : Foward-looking degree of the financial policy.

Capital requirement

$$\frac{E_t^F}{L_t^F} \geq \lambda_F(\bar{\phi} + CCyB_t) \qquad \frac{E_t^H}{Q^L L^H} \geq \lambda_H(\bar{\phi} + CCyB_t) \quad \text{with} \quad \lambda_F > \lambda_H$$

Bank's Balance Sheet

$$L_t^F = E_t^F + D_t^F \qquad Q_t^L L_t^H = E_t^H + Q_t^{BB} BB_t$$

Model Details

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Model Details

Welfare and Consumption Equivalent.

- Our model is general enough for us to consider welfare a valid metric for actual policy implementation, so we define welfare as weighted discounted flow of utility from households given a set of parameters $\mathbf{W}(\theta; CCyB)$

$$\mathbf{W}(\theta; CCyB) = \sum_{i \in I,U,R} \wp_i \mathbb{E}_{0,i} \left\{ \sum_{t=1}^{\infty} \beta_i^t \varrho_t \left[\frac{1}{1-\sigma} \left(\hat{C}_t^i(\theta) \right)^{1-\sigma} - \Theta_t^i(\theta) A_t^{1-\sigma} \xi_t^n \frac{\left(n_t^i(\theta) \right)^{1+\varphi}}{1+\varphi} \right] \right\}$$

- We can define the Baseline welfare (no financial policy rule) $\mathbf{W^0} = \mathbf{W}(\theta^0; CCyB = 0)$ as the perpetuity of welfare

$$\mathbf{W^0} = \sum_{i \in I,U,R} \wp_i \frac{1}{1-\beta_i} \left[\frac{1}{1-\sigma} \left(\hat{C}_{ss}^{i,\mathbf{0}} \right)^{1-\sigma} - \Theta_{ss}^{i,\mathbf{0}} A_{ss}^{1-\sigma} \frac{\left(n_{ss}^{i,\mathbf{0}} \right)^{1+\varphi}}{1+\varphi} \right]$$

- Then we simulated the model using 2^{nd} order approximation with pruning techniques as in (Andreasen et al. 2017) to find the consumption equivalent ce, the wedge in the consumption, to equate $\mathbf{W^0}(ce, \theta) = \mathbf{W^j}(\theta)$.

- $ce > 0 \rightarrow$ welfare gain of implementing FPR j.

Simple Implementable Financial Policy Rules.

- **Simple and implementable FPRs** depend only on observable variables

$$\left(\frac{1+CCyB_t}{1+\overline{CCyB}}\right)=\left(\frac{1+CCyB_{t-1}}{1+\overline{CCyB}}\right)^{\theta_1}\left(\frac{(1-\alpha_E)X_t+\alpha_E\mathbb{E}(X_{t+h})}{X}\right)^{\theta_2}$$

- Consider
  1. **Commercial Spread rule**. $X_t = R_t^L - R_t$ (Carrillo et al. 2021)
  2. **Credit-to-GDP rule**. $X_t = \frac{L_t}{Y_t}$ (Drehmann 2013; BIS 2010)
  3. **Overall spread rule**. $X_t = R_{B,t} - R_t$
  4. **Fuding premium rule**. $X_t = R_D - R$
  5. **Aggregate credit rule** $X_t = \frac{L_t^F + L_t^H q_t^L}{L_{t-1}^F + L^H q_{t-1}^L}$
  6. **Commercial credit rule** $X_t = \frac{L_t^F}{L_{t-1}^F}$

- Keep θ_1 fixed and examine $\theta_2 \in \mathrm{R}$, $\alpha_E \in \{0, 0.4, 0.7\} \rightarrow$ examine Consumption Equivalence (ce)

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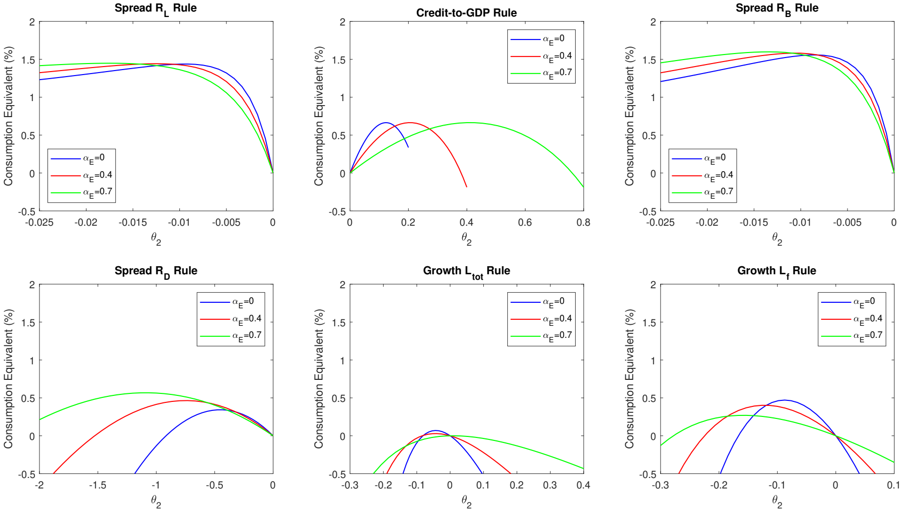
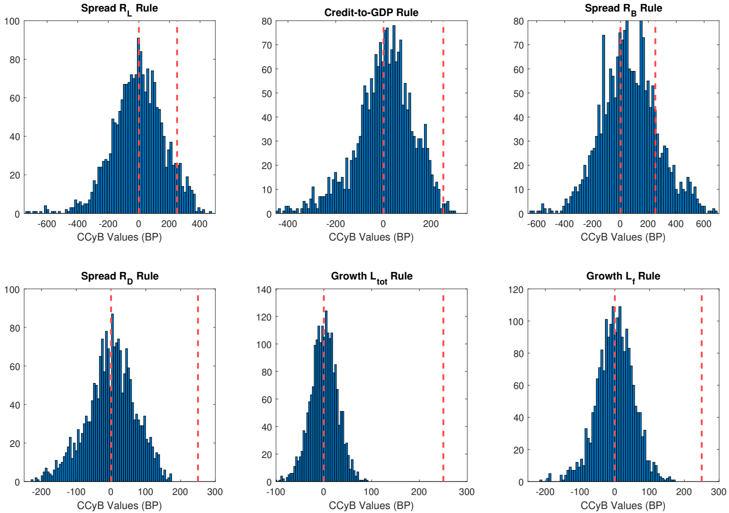
Simple Implementable Financial Policy Rules



Note – This figure shows the consumption equivalent for different values of θ_2, the weight on the endogenous variable to which the rule reacts. Every sub-figure shows the results for different values of α_E, which indicates the degree to which the rule based on variable X is forward or backward looking, where $\alpha_E = 1$ and $\alpha_E = 0$ correspond to a perfectly forward and backward looking, respectively

Simple Implementable Financial Policy Rules (cont.)



Note – This figure shows the distribution of the CCyB simulations implied by the best θ_2 performing rules in terms of consumption equivalence. Each simulation consists of 2 thousand periods. Vertical axis shows frequency, the horizontal axis is expressed in basis points. The red dashed lines show the feasible band where the CCyB can live [0 - 250 bp]

Algorithm to implement Effective Band

1. Simulate the model for each rule and save the $CCyB_t$ simulations.
2. For these simulation, we apply a *Quadratic Filter* to get

$$\widehat{CCyB}_t = a + b(CCyB_t - CCyB_{ss}) + c(CCyB_t - CCyB_{ss})^2$$

3. We find the parameters a, b and c of the quadratic function that minimize the distance with the value in the feasible band. Graphs

$$\min_{a,b,c} \sqrt{\sum_{i=1}^{T} \varepsilon(\widehat{CCyB}_t)}$$

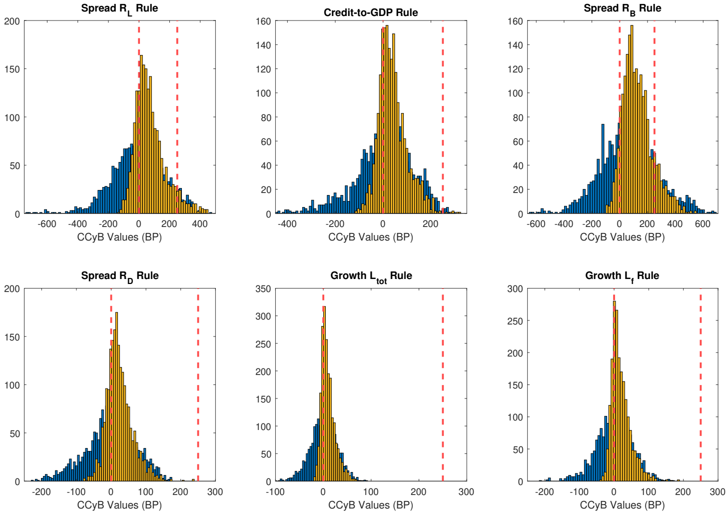
with

$$\varepsilon(\widehat{CCyB}_t) = \begin{cases} (\widehat{CCyB}_t - 250)^2 & \text{if } CCyB_t > 250 \\ (\widehat{CCyB}_t - CCyB_t)^2 & \text{if } 0 \leq CCyB_t \leq 250 \\ (0 - \widehat{CCyB}_t)^2 & \text{if } CCyB_t < 0 \end{cases}$$

4. With this *Quadratic Filter*, the capital requirements for each bank in the model are

$$\phi_{f,t} = \lambda_f(\phi + \widehat{CCyB}_t)$$
$$\phi_{h,t} = \lambda_h(\phi + \widehat{CCyB}_t)$$

Implementing Effective Band (cont.)



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Simple Implementable Financial Policy Rules with Effective Band

	Spread R_L			Credit-to-GDP			Spread R_B		
CE without EB	1.44%			0.66%			1.56%		
α_E	0	0.4	0.7	0	0.4	0.7	0	0.4	0.7
CE with EB	1.23%	1.12%	0.99%	0.49%	0.49%	0.48%	1.28%	1.12%	1.10%

	Spread R_D			Growth L_{tot}			Growth L_f		
CE without EB	0.57%			0.07%			0.47%		
α_E	0	0.4	0.7	0	0.4	0.7	0	0.4	0.7
CE with EB	0.25%	0.34%	0.40%	0.05%	0.02%	0.00%	0.33%	0.25%	0.14%

Note – This table shows the summary of the benefits of the different rules measured as equivalent consumption for the optimal value of θ_2, with and without effective band. For the latter, the results for different levels of foward-looking are also included.

Few take-aways

1. Applying Effective Bands decreases welfare gains for all rules.
2. Rules that react to prices generate higher welfare gains.
3. Rules inherit the characteristics of their observables in terms of the degree of foward-looking.
   - Spreads R_B and R_L are adjusted instantly $\Rightarrow$ Higher welfare gains with $\alpha_E = 0$.
   - Spreads R_D is *sticky* $\Rightarrow$ Higher welfare gains with $\alpha_E = 0.7$, similar to Monetary Policy.

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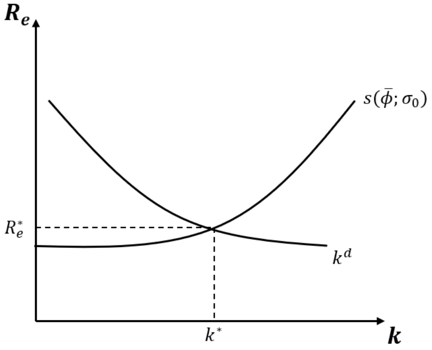
- Supply of credit is derived by imposing the condition of the bank's participation in the entrepreneur's problem:

$$\mathrm{E}\left[\frac{R_t^e}{\rho_t^F}\right] = s\left(\bar{\phi}; \sigma_0^e\right)$$

with $\frac{\partial s(\bar{\phi};\sigma^e)}{\partial \bar{\phi}} > 0$ and $\frac{\partial s(\bar{\phi};\sigma_0^e)}{\partial \sigma^e} > 0$.

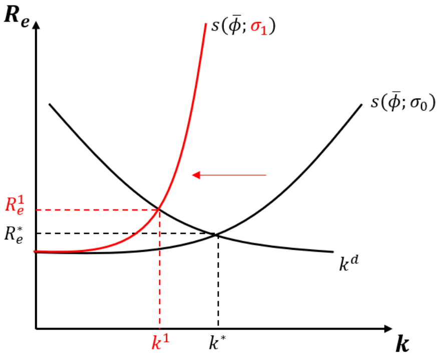
- Demand for capital (and therefore credit) is obtained from

$$R_t^e = \frac{R_{t+1}^k + (1-\delta_k)q_{t+1}^k}{q_t^k}$$



External Financial Premium.

- By impacting the economy with $\sigma_1 > \sigma_0$ it causes a higher probability of entrepreneur default.
- This increases the external financial primium by shifting the supply of credits to the left.
- Then, in the new equilibrium the economy converges to a lower level of capital $k_1 < k$ and a higher return on capital $R_e^* < R_e^1$.



External Financial Premium.

Intuition of CCyB Neutral

- With a neutral level the new requirement $\hat{\phi} = \bar{\phi} + CCyB_N$ in steady state causes a lower level of capital $k_N^* < k^*$.
- Given the lower level of credit, the same shock σ_1 contracts the supply curve, but to a lower degree than in the case without $CCyB_N$ ($k^1 < k_N^1$).
- In addition, it is possible to release the $CCyB_N$, reducing the external financial premium $R_e^{**} < R_e^{N.1}$ and shifting the credit supply curve to the right and mitigating the effects of the shock on the level of credit in the economy $k_N^1 < k_N^{**}$.

What is the trade-off?

1. Lower credit in steady state ($k_N^* < k^*$)
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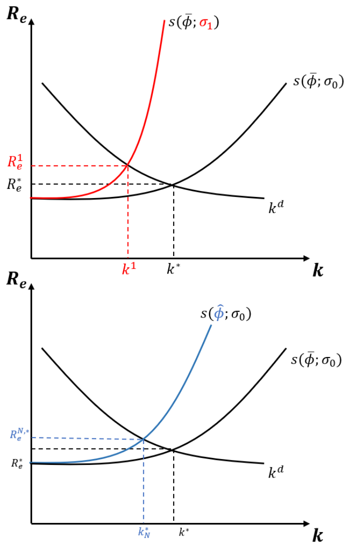

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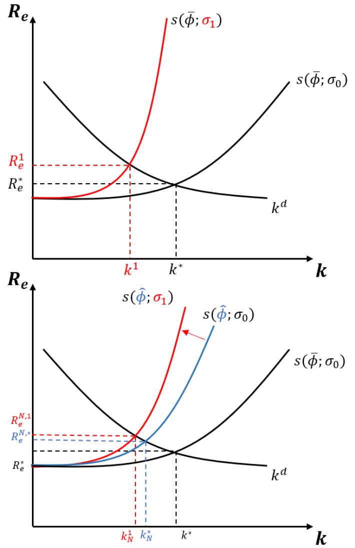

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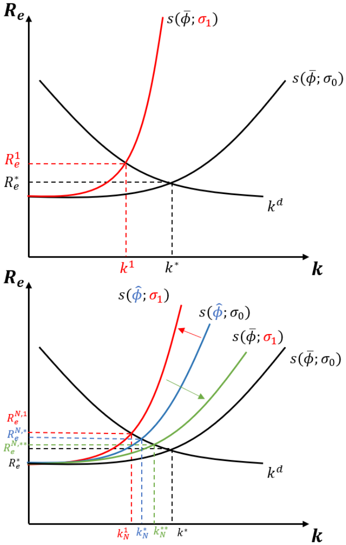

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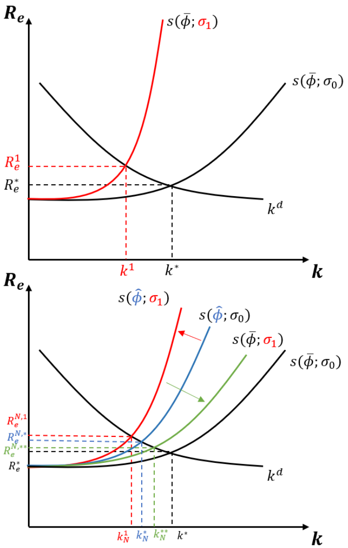
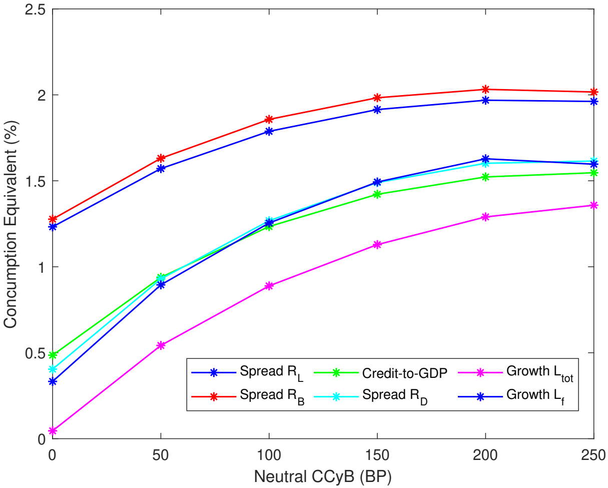


- Formally, we evaluated different levels of Neutral CCyB and quantified their welfare effects with the *consumption equivalent*.
- To do this, we change the definition of the error function in the algorithm for implementation of the Effective Band to the following one

$$\varepsilon(\widehat{CCyB}_t) = \begin{cases} (\widehat{CCyB}_t - 250)^2 & \text{if } \widehat{CCyB}_t > 250 - CCyB_N \\ (\widehat{CCyB}_t - CCyB_t)^2 & \text{if } 0 \leq CCyB_t \leq 250 - CCyB_N \\ (0 - \widehat{CCyB}_t)^2 & \text{if } CCyB_t < -CCyB_N \end{cases}$$

this is equivalent to shifting the *quadratic filter* at the level of $CCyB_N$.

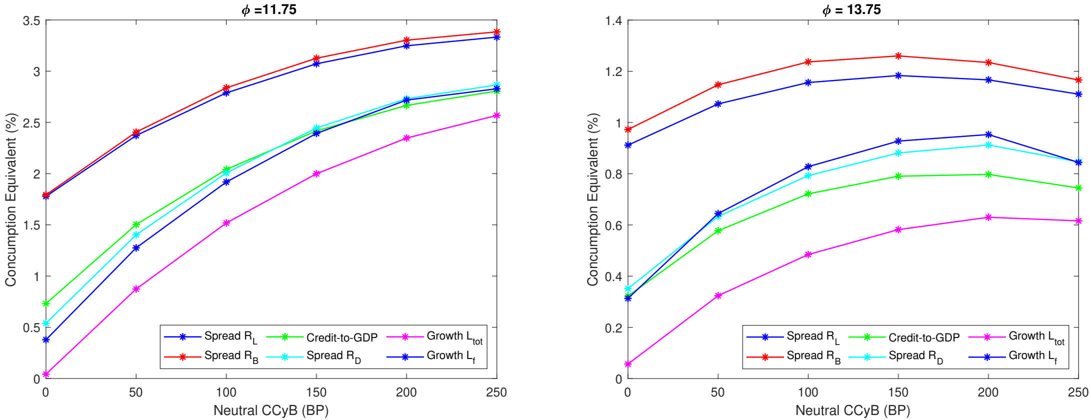
Consumption Equivalent for different Neutral CCyB



Note – This figure shows the consumption equivalent for different values of neutral *CCyB*, for the optimal θ_2 found previously for each rule, and $\theta_1 = 0.8409$.

Neutral CCyB for differents Capital Requirements.

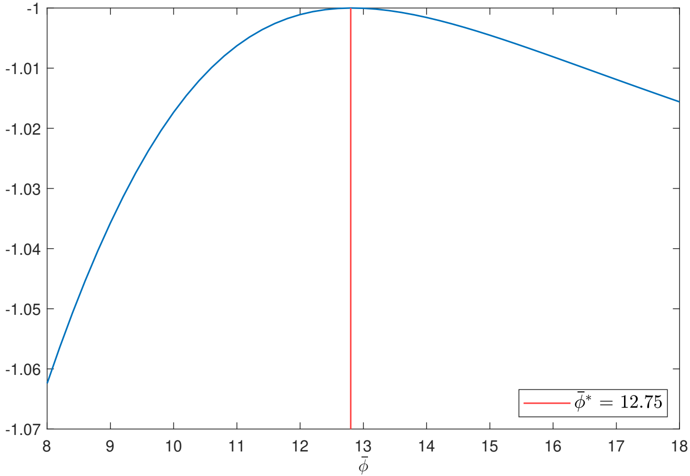
- However, so far all the results have been with an optimal capital requirement equal to $\bar{\phi} = 12.75\%$.



Note – This figure shows the consumption equivalent for different values of neutral $CCyB$, for the optimal θ_2 found previously for each rule, and $\theta_1 = 0.8409$. The figure on the left is for a base capital requirement equal to $\bar{\phi} = 11.75\%$, while the one on the right is for $\bar{\phi} = 13.75\%$.

Neutral CCyB for differents Capital Requirements. (cont)

Stochastic Steady State of Welfare



Note – The figure shows the stochastic steady state for welfare for different values of the base capital requirement without Neutral *CCyB*.

Wrapping up

- Rules that follow the spread of commercial or mortgage rates generate considerably higher welfare gains than those that follow quantities, such as credit growth or the credit-to-gdp gap.

- It is welfare-optimal to have a positive neutral CCyB.
  - Gains are obtained by including non-linearities in the model (ZLB).
  - The optimal neutral CCyB, as well as welfare gains, depend critically on the minimum capital requirement.

“Simple Implementable Financial Policy Rules”

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Fifth Conference on Financial Stability - CEMFI & BdE
June 2025, Madrid.

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Appendix

Model - Households

- Infinitely lived representative consumers: Impatient (I) and Patient (P), with $\beta^I < \beta^P$
- **Preferences.** Value consumption of final goods (C^i), housing services (H^i) and disutility from labor (n^i)
- **Budget Constraint.** Differs for savers (U,R) and borrowers.
  - Patient Restricted: access to long term assets
  - Patient Unrestricted: access to short and long term assets (at a cost)
  - Impatient borrows from bank to buy housing good s.t. CSV and limited liability
    - Long term mortgages
    - Fixed conditions
    - Non-recourse
    - Adjutment cost to renegotiate mortgage debt
- There is mortgage default in equilibritum

Back

Model - Entrepreneurs

- Sole owners of productive capital K_t, which they rent to firms for the production of intermediate goods.
- Live two periods.
  - In $t+1$ old leave bequest to young: their initial net-worth (N^e_{t+1}) or distribute dividends to HH from their wealth Ψ^e_{t+1}
  - In t they use receive the bequests from the previous generation N^e_t, and maximize expected second period wealth, Ψ^e_{t+1}, by choosing purchases of capital at nominal price Q^K_T, commercial borrowing L_F

$$Q^K_T K_t = N^e_t + L^F_t$$

- Borrowing is also subject to CSV and limited liability

$$\Psi^e_{t+1} = \max\left[\omega^e_{t+1}\left(R^k_{t+1} + (1-\delta_K)\, Q^K_{t+1}\right) K_t - R^L_t L^F_t,\ 0\right]$$

- There is commercial default in equilibrium

Back

Model - Bankers

- Exclusive access to the opportunity of investing in banks' inside equity capital
- Invest in two banks: H and F
- Live to periods
  - In $t+1$ old banker leaves bequest to young (initial net worth) or distributes dividends, from profits Ψ^b_{t+1}.
  - In t young banker receives N^b_t and invests in F-bank or H-bank

$$N^b_t = E^F_t + E^H_t$$

    to maximize expected profits

$$\max_{\bar{\omega}^e_{t+1}, K_t} \mathbb{E}_t \left\{ \Psi^b_{t+1} \right\} = \rho^F_{t+1} E^F_t + \xi^{b,roe}_t \rho^H_{t+1} \left(N^b_t - E^F_t \right)$$

    where ρ^j_{t+1} is the realized return on each j bank and $\xi^{b,roe}_t$ is a relative profit shock.

- In equilibrium

$$\mathbb{E}_t \left\{ \rho^F_{t+1} \right\} = \mathbb{E}_t \left\{ \xi^{b,roe}_t \rho^H_{t+1} \right\} = \bar{\rho}_t$$

Back

- Banks are *projects* that invest in credit portfolios. Banker borrows from HH and levers own capital E_t^j
- No maturity mismatch. Balance sheets of banks are

$$L_t^F = E_t^F + D_t^F$$
$$Q_t^L L_t^H = E_t^H + Q_t^{BB} BB_t$$

- Banks are subject to limited liability

$$\Pi_{t+1}^F = \max\left[\omega_{t+1}^F \tilde{R}_{t+1}^F L_t^F - R_t^D D_t^F, 0\right]$$
$$\Pi_{t+1}^H = \max\left[\omega_{t+1}^H \tilde{R}_{t+1}^H Q_t^L L_t^H - R_{t+1}^{BB} Q_{t+1}^{BB} BB_t, 0\right]$$

- There is bank default

Back

Production

Goods producers

- Final consumption good Y_t^C combines intermediate domestic good X_t^H and intermediate imported good X_t^F
- Intermediate inputs X_t^H, X_t^F combine varieties X_{jt}^H, X_{jt}^F
- Variety producers demand wholesale goods (domestic and imported) and have market power. Set prices subject to Calvo pricing

→ Monetary Policy

Capital and housing producers

- Adjustment costs K and H
- Time to build H

Back

Estimation

- Calibration of some standard parameters in large NK models
  Adolfson et al. 2007; Chen et al. 2012; Clerc et al. 2014; Garcia et al. 2019; Christiano et al. 2014

- Bayesian Estimation (full ML) uses 25 macro and financial time series 2001Q3 - 2019Q3

Table: Observable Data

Non Financial		Financial	
$\Delta \log Y_t^{NoCo}$	Non mining real GDP	R_t^L	Comercial Loans interest Rate
$\Delta \log Y_t^{Co}$	Copper real GDP	R_t^I	Housing Loans Interest Rate
$\Delta \log C_t$	Total Consumption	R_t^D	Nominal Interest Rate on Deposits
$\Delta \log G_t$	Goverment Consumption	R_t^{LG}	10 Year BCP Rate
$\Delta \log I_t^K$	Real Capital Investment	$\Delta \log L_t$	Housing and Corporate Loan
$\Delta \log I_t^H$	Real Housing Investment	ROE_t	Banks ROE
$TB_t / GDPN_t$	Trade Balance-GDP Ratio	R_t^*	LIBOR
$\Delta \log N_t$	Total Employment	Ξ_t^R	EMBI Chile
$\Delta \log WN_t$	Nominal Cost of labor	rer_t	Real Exchange Rate
π_t	Core CPI	R_t	Nominal MPR
$\Delta \log y_t^*$	Real External GDP	π_t^H	Household Price Index
π_t^*	Foreign Price Index		
π_t^M	Imports Deflactor		
π_t^{Co*}	Nominal Copper Price		
π_t^H	Housing Price Index		

Note.– This table summarizes the observable data time-series we feed the model for Bayesian estimation. The symbol Δ log implies we take the log of the referred series, take first differences and subtract the mean. For all other variables we subtract the sample mean. Sources: INE, CBC, CMF, and Bloomberg.

Calibration 1 Calibration 2 Estimation 1 Estimation 2

Estimation (cont.)

- Variance Decomposition is very similar to the seminal paper Christiano et al. 2014.
- Risk shocks are very important to explain the volatility of the main (real and financial) variables of the model.

Table: Variance Decomposition at Quarterly Frequency

Shock Variable	Risk shocks	M.E.I.	Technology	MP	Demand	Gov. Spend.	Others	Total
GDP without Commodities	23.9	16.1	5.2	1.5	20.1	0.3	32.9	100.0
Total Investment	11.3	40.3	6.3	0.9	5.2	0.0	36.1	100.0
Commercial Loans	71.9	5.3	4.5	0.2	2.5	0.0	15.6	100.0
Commercial Spread	24.8	6.0	8.6	0.9	7.2	0.2	52.3	100.0
Mortgage Spread	11.9	4.0	10.3	0.4	8.7	0.2	64.5	100.0
Mortgage Loans	73.9	1.6	2.6	0.1	1.0	0.0	20.7	100.0

Note.– This table shows the variance decomposition for selected macro and financial variables. The results are generated by model evaluated at the mode of posterior the posterior distribution.

Calibration Real Sector

Table: Calibration, Real Sector

Parameter	Description	Value	Source
α	Capital share in production function	0.34	Garcia et al. 2019
α_E	Expected Inflation weight in Taylor Rule	0.50	Garcia et al. 2019
α^{BSG}	Short-term govt. bonds as percentage of GDP	-0.40	Data: 2009-2019
α^{BLG}	Long-term govt. bonds as percentage of GDP	-4.50	Data: 2009-2019
β_U, β_R	Patient HH Utility Discount Factors	0.99997	Garcia et al. 2019
β_I	Impatient Utility HH Discount Factor	0.98	Clerc et al. 2014
δ_K	Capital Annual depreciation rate	0.01	Adolfson et al. 2013
δ_H	Housing Annual Depreciation rate	0.00529	Same as capital depreciation
ϵ_F	Elasticity of substitution among foreign varieties	11	Garcia et al. 2019
ϵ_H	Elasticity of substitution among home varieties	11	Garcia et al. 2019
ϵ_W	Elasticity of substitution among types of workers	11	Garcia et al. 2019
ϵ_τ	Convergence speed towards SS Gov debt	0.10	Normalization
N_H	Time-to-build periods in housing goods	6	CBC 2018S2 Financial Stability Report
κ	Coupon discount in housing loans	0.975	10 years duration of loan contract
κ_{BL}	Coupon discount in long term government bonds	0.975	10 years bond duration
κ_{BB}	Coupon discount in long term banking bonds	0.975	10 years bond duration
π^T	Annual inflation target of 3%	$1.03^{1/4}$	Garcia et al. 2019
$\rho_{\varphi h}$	Spending profile for long term housing investment	1	Even investment distribution
σ	Log Utility	1	Garcia et al. 2019
υ	Strength of households wealth effect	0	No wealth effect
χ	Government share in commodity sector	0.33	Garcia et al. 2019
ω	Home bias in domestic demand	0.79	Garcia et al. 2019
$\wp_U$	Fraction of unrestricted patient households	0.70	Chen et al. 2012
ω_{BL}	Ratio of long term assets to short assets	0.822	Chen et al. 2012

Calibration Financial Sector

Table: Calibration, Financial Sector

Parameter	Description	Value	Source
χ_b	Banks dividend policy	0.04	Clerc et al. (2015)
χ_e	Entrepreneurs dividend policy	0.05	Clerc et al. (2015)
γ_{bh}	Household cost bank bonds default	0.10	Clerc et al. (2015)
γ_d	Cost of recovering defaulted bank deposits	0.10	Clerc et al. (2015)
ϕ_F	Bank Capital Requirement (RWA)	0.1683	Data (2000-2022)
ϕ_H	Bank Capital Requirement (RWA)	0.1183	Data (2000-2022)

Note.– The values for the parameters related to bank capitalrequirements, ϕ_F and ϕ_H, are set as the ratio between the average level of TIER-I capital of over the risk weightedassets of the banking system from the year 2000 to the year 2020. In particular, we calculate 4.3% excess of TIERI capital in addition to legal 9.75%. For corporate banks we assume 100% weight in corporate loans, while for housing bank we assume 60% weight in housing loans.

Full Information Estimation Results - Parameters

Parameter	Description	Prior			Posterior		
		Dist	Mean	St Dev	Mean	95% Inter	
α_π	Inflation weight in Taylor Rule	N	1.70	0.10	1.98	[1.77	2.07]
α_R	Lagged interest rate weight in Taylor Rule	β	0.85	0.025	0.75	[0.73	0.81]
α_W	Weight on past productivity on wage indexation	β	0.25	0.075	0.15	[0.05	0.27]
α_y	Output weight in Taylor Rule	N	0.25	0.075	0.11	[0.01	0.26]
η	Elasticity of subst. home and foreign goods	γ	1.00	0.25	0.96	[0.69	1.24]
$\eta_{\hat{C}}$	Elasticity of subst. consumption and housing goods	γ	0.15	0.03	0.13	[0.07	0.16]
η^*	Foreign demand elasticity of substitution	γ	0.2	0.11	0.19	[0.10	0.27]
γ_H	Housing investment adjustment cost parameter	γ	3.00	0.25	2.44	[2.55	3.40]
γ_K	Capital investment adjustment cost parameter	γ	3.00	0.25	2.83	[2.48	3.41]
γ_n	Labor adjustment cost parameter	γ	3.00	0.25	1.80	[1.45	2.13]
γ_L	Housing debt cost parameter	γ	0.12	0.01	0.12	[0.10	0.13]
κ_F	Weight on past inflation on foreign good indexation	β	0.50	0.075	0.66	[0.55	0.79]
κ_H	Weight on past inflation on home good indexation	β	0.50	0.075	0.76	[0.66	0.86]
κ_W	Weight on past inflation on wages indexation	β	0.85	0.025	0.84	[0.79	0.90]
ϕ^*	Country premium elasticity to NFA position	γ^{-1}	1.00	Inf	0.29	[0.19	0.44]
ϕ_c	Habit formation in good consumption	β	0.85	0.025	0.93	[0.87	0.91]
ϕ_{hh}	Habit formation in housing consumption	β	0.85	0.025	0.76	[0.75	0.86]
θ_F	Calvo param. foreign goods producers	β	0.50	0.075	0.71	[0.68	0.75]
θ_H	Calvo param. domestic goods producers	β	0.50	0.025	0.82	[0.79	0.83]
θ_W	Calvo param. wage setters	β	0.50	0.075	0.65	[0.59	0.71]
φ	Inverse Frisch elasticty	γ	7.50	1.50	7.2	[4.66	9.80]
μ_e	Monitoring cost of corporate loan default	β	0.30	0.05	0.51	[0.42	0.60]
μ_F	Monitoring cost of F bank default	β	0.30	0.05	0.20	[0.12	0.27]
μ_H	Monitoring cost of H bank default	β	0.30	0.05	0.25	[0.16	0.34]
μ_i	Monitoring cost of housing loan default	β	0.30	0.21	0.23	[0.13	0.30]
η_{ζ_L}	Term premium elasticity to relative bond liquidity	γ	0.15	0.03	0.14	[0.08	0.20]

Full Information Estimation Results - Shocks

Shock process	A.R	Prior		Posterior			S.D.	Prior		Posterior		
		Mean	S.D	Mean	90% HPD			Mean	S.D	Mean	90% HPD	
Non stat. productivity	ρ_a	0.5	0.075	0.54	[0.42	0.67]	$100 \times \sigma_a$	0.50	Inf	0.36	[0.27	0.46]
Monetary Policy	ρ_{e^m}	0.25	0.075	0.26	[0.14	0.38]	$1000 \times \sigma_{e^m}$	1.00	Inf	1.63	[1.32	1.95]
Government spending	ρ_g	0.75	0.075	0.74	[0.59	0.88]	$100 \times \sigma_g$	1.00	Inf	1.76	[1.44	2.07]
Copper price	$\rho_{p^{co}}$	0.75	0.075	0.90	[0.85	0.95]	$10 \times \sigma_{p^{co}}$	1.00	Inf	1.07	[0.89	1.26]
Foreign inflation	ρ_{π^*}	0.75	0.075	0.47	[0.39	0.55]	$100 \times \sigma_{\pi^*}$	2.00	Inf	2.15	[1.77	2.53]
Foreign interest rate	ρ_{R^W}	0.75	0.075	0.90	[0.87	0.94]	$1000 \times \sigma_{R^W}$	1.00	Inf	1.12	[0.94	1.32]
Entrepreneurs risk	ρ_{σ^e}	0.75	0.075	0.98	[0.97	0.99]	$100 \times \sigma_{\sigma^e}$	2.00	Inf	2.95	[2.32	3.57]
Corporate bank risk	ρ_{σ^F}	0.75	0.075	0.94	[0.91	0.97]	$10 \times \sigma_{\sigma^F}$	2.00	Inf	1.67	[1.28	2.08]
Housing bank risk	ρ_{σ^H}	0.75	0.075	0.76	[0.61	0.92]	$10 \times \sigma_{\sigma^H}$	1.00	Inf	0.47	[0.07	0.88]
Housing valuation risk	ρ_{σ^I}	0.75	0.075	0.91	[0.81	1.02]	$10 \times \sigma_{\sigma^I}$	2.00	Inf	3.13	[0.21	6.06]
Current consumption prefs.	ρ_{ϱ}	0.75	0.075	0.41	[0.31	0.51]	$10 \times \sigma_{\varrho}$	1.00	Inf	5.06	[2.77	7.33]
Housing consumption prefs	ρ_{ξ^h}	0.75	0.075	0.88	[0.84	0.92]	$10 \times \sigma_{\xi^h}$	1.00	Inf	1.11	[0.70	1.53]
Investment mg. eff.(K)	ρ_{ξ^i}	0.75	0.075	0.63	[0.49	0.77]	$10 \times \sigma_{\xi^I}$	0.50	Inf	1.05	[0.73	1.37]
Investment mg. eff.(H)	$\rho_{\xi^{ih}}$	0.75	0.075	0.24	[0.16	0.32]	$10 \times \sigma_{\xi^{ih}}$	1.00	Inf	8.42	[5.78	11.1]
Import prices	ρ_{ξ^m}	0.75	0.075	0.91	[0.85	0.97]	$100 \times \sigma_{\xi^m}$	1.00	Inf	2.58	[1.98	3.20]
Labor disutility	ρ_{ξ^n}	0.75	0.075	0.66	[0.53	0.80]	$10 \times \sigma_{\xi^n}$	1.00	Inf	6.57	[2.80	10.3]
Country premium	ρ_{ξ^R}	0.75	0.075	0.83	[0.75	0.91]	$1000 \times \sigma_{\xi^R}$	0.50	Inf	0.63	[0.50	0.76]
Banker dividend	$\rho_{\xi^{\chi_b}}$	0.75	0.075	0.79	[0.69	0.90]	$10 \times \sigma_{\xi^{\chi_b}}$	0.50	Inf	1.55	[1.11	2.01]
Entrepreneur dividend	$\rho_{\xi^{\chi_e}}$	0.75	0.075	0.49	[0.34	0.60]	$10 \times \sigma_{\xi^{\chi_e}}$	1.00	Inf	2.28	[1.81	2.76]
Banker required return	$\rho_{\xi^{roe}}$	0.75	0.075	0.82	[0.74	0.91]	$10 \times \sigma_{\xi^{roe}}$	0.50	Inf	0.4	[0.29	0.51]
Foreign demand	$\rho_{\xi^{y*}}$	0.85	0.075	0.91	[0.80	1.03]	$100 \times \sigma_{\xi^{y*}}$	0.50	Inf	0.21	[0.08	0.34]
Mining productivity	$\rho_{\xi^{yco}}$	0.85	0.075	0.80	[0.64	0.96]	$10 \times \sigma_{\xi^{yco}}$	1.00	Inf	3.20	[2.61	3.80]
Stat. productivity	ρ_z	0.85	0.01	0.84	[0.82	0.86]	$10 \times \sigma_z$	0.50	Inf	1.30	[1.01	1.60]
UIP shock	ρ_{ζ^u}	0.75	0.075	0.96	[0.94	0.98]	$1000 \times \sigma_{z_T}$	0.50	Inf	1.74	[1.07	2.41]
Liquidity costs	ρ_{ϵ^L}	0.75	0.05	0.76	[0.66	0.86]	$100 \times \sigma_{\epsilon^L}$	0.20	Inf	0.09	[0.02	0.17]
Bank Balance Sheet	$\rho_{\xi^u_B}$	0.75	0.05	0.76	[0.66	0.86]	$10 \times \sigma_{\xi^u_B}$	0.20	Inf	0.09	[0.02	0.17]
Long-term government bonds supply	ρ_{BL_g}	0.75	0.05	0.76	[0.66	0.86]	$10 \times \sigma_{BL_g}$	0.50	Inf	0.23	[0.04	0.42]

- Each rule operates differently. Use the simplest possible FPR

$$\left(\frac{1 + CCyB_t}{1 + \overline{CCyB}}\right) = \left(\frac{1 + CCyB_{t-1}}{1 + \overline{CCyB}}\right)^{\theta_1} e_t^{req}$$

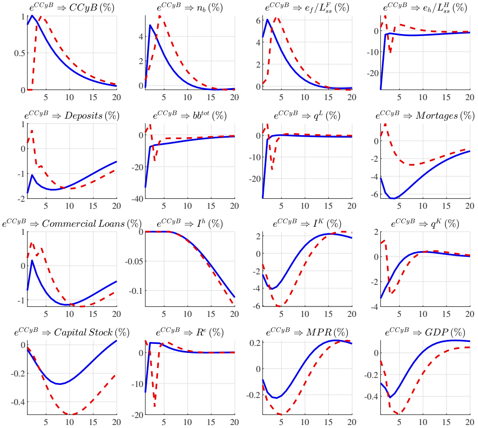
where $\theta_1 = 0.8409 \rightarrow$ mean-life of 4 quarters

- On impact: Effective capital is fixed.
  - Reallocation of capital among banks: $\downarrow e_h$ and $\uparrow e_f$.
  - Assets (Loans) and liabilities $(d_f, bb^{tot}) \downarrow$ to meet capital requirement $\phi + CCyB$.
  - Price of capital Q^K drops instantaneously $\Rightarrow$ Return of capital $R^e \downarrow$
  - $\downarrow$ investment K and H $\Rightarrow$ MPR and $GDP \downarrow$

- After impact
  - More capital n^b into the system
  - Short (long) term credit recovers quickly (slowly)
  - Investment takes longer

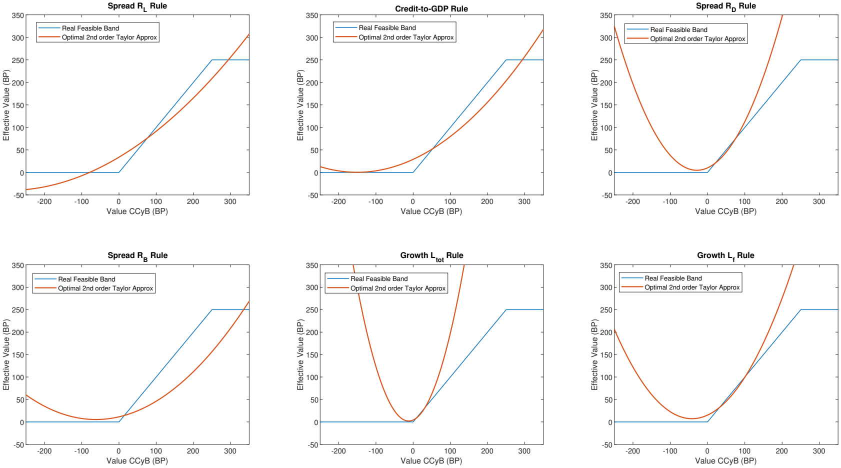
- Phase-in periods smooth the financial cycle (Loans) but amplify the business cycle (I, GDP).

Figure: Impulse response function for CCyB activation



Note.– Impulse response functions to an activation of CCyB of 100bp with no phase-in period (blue), which implies CCyB requirement must be met in full the period after its announcement, and the activation with a phase-in period of 2Q. Variables with (%) represent deviations from same variable steady states.

Optimal Approximation. Go back



Note – This figure shows the Real Feasible Band (blue) and the second order approximation (orange) for each rule. The last one was obtained by finding the parameters that minimize error function.