When and at what level?

Calibration of the countercyclical capital buffer using Early Warning Models

Introduction

- We develop a **measure of systemic risk** based on **an ensemble of early warning models.**
  - **Many logit models** rather than a single model.
  - The capital ratio (Tier 1) as one of the explanatory variables in each of these models.
  - **We reverse-engineer each logit model** and provide information on the minimum, threshold capital ratio that avoids the crisis signal.
  - To guide the **timing and the level of the CCyB increase**:
    - We compare the minimum threshold capital ratio that avoids the crisis signal with minimum capital requirements.
  - To guide the **setting of the positive neutral rate for CCyB ($\mathbf{CCyB^{PN}}$)**:
    - We use quantified uncertainty concerning the systemic risk measurement.

Data

- **Sample**: 45 countries (EU + other big economies); timespan: 1970 – 2023.
- **Explanatory variables**: a broad set of variables most commonly used in early warning models. The variables are related to:
  - Credit; real estate; bank profitability; global risk; general macro; **Tier 1 capital ratio.**
- **Dependent variable**: a binary variable indicating the occurrence or absence of a financial crisis in each quarter.
  - Two sources: Lo Duca et al. (2017) for European countries and Laeven and Valencia (2020) for other countries.
  - The raw crisis variable is transformed into a leading indicator.

The CCyB framework

$$CCyB_t = max(\underbrace{CCyB_t^{ER}}_{\text{CCyB aimed at addressing Emerging Risks}}, \underbrace{CCyB^{PN}}_{\text{positive neutral rate for CCyB}}) \quad (1)$$

$$CCyB_t^{ER} = \underbrace{\kappa_t^g}_{\kappa_t^g \text{ - macroprudential capital ratio guide}} - \underbrace{\kappa_t^r}_{\kappa_t^r \text{ - macroprudential capital ratio requirement}} \quad (2)$$

- $\boldsymbol{\kappa_t^g}$ is the measure of systemic risk based on an ensemble of early warning models.
- $\boldsymbol{\kappa_t^r}$ is the sum of the capital ratio requirements common for all banks. Usually, $\boldsymbol{\kappa_t^r}$= 8.5% $\frac{Tier\ 1}{TREA}$.

Main Results

1. **The model is a good measure of systemic risk.**
   - It recognizes pre-crisis periods reliably.
   - It translates the systemic risk measured into the capital required.

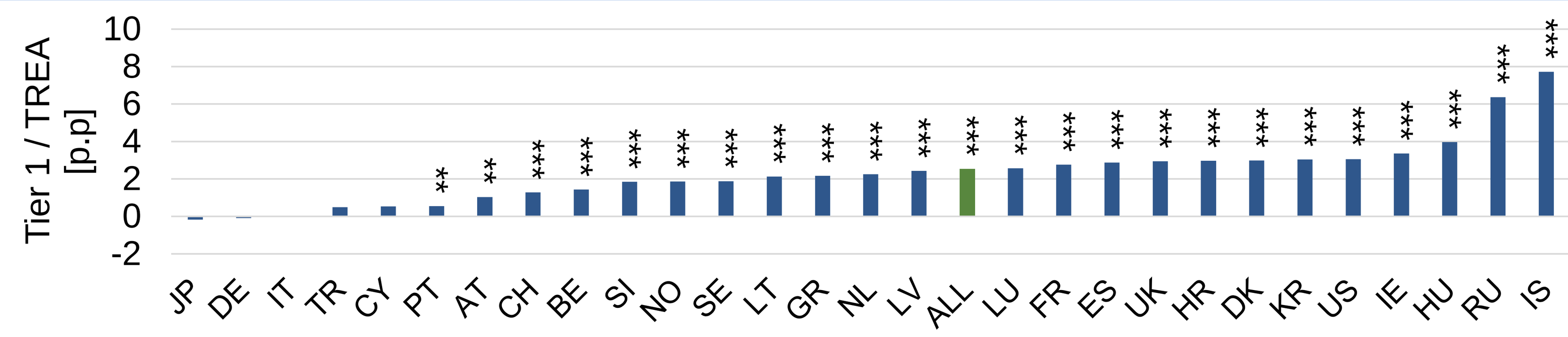
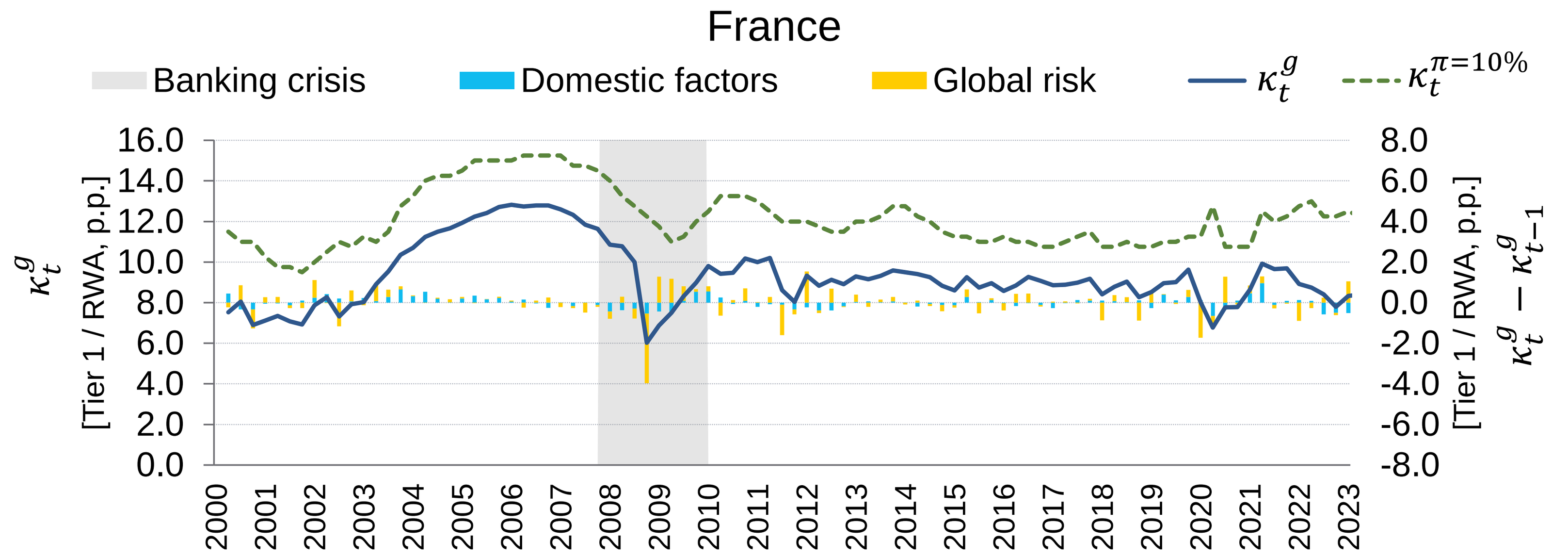


Figure 1. The difference in the risk measure, κ_t^g, between pre-crisis periods and regular periods.

2. **The model offers insight into systemic risk evolution over time.**
   - In our framework the CCyB often surpasses the implicit limit of 2.5%.
   - The model is universally applicable to any country, including those that have not yet experienced crises.



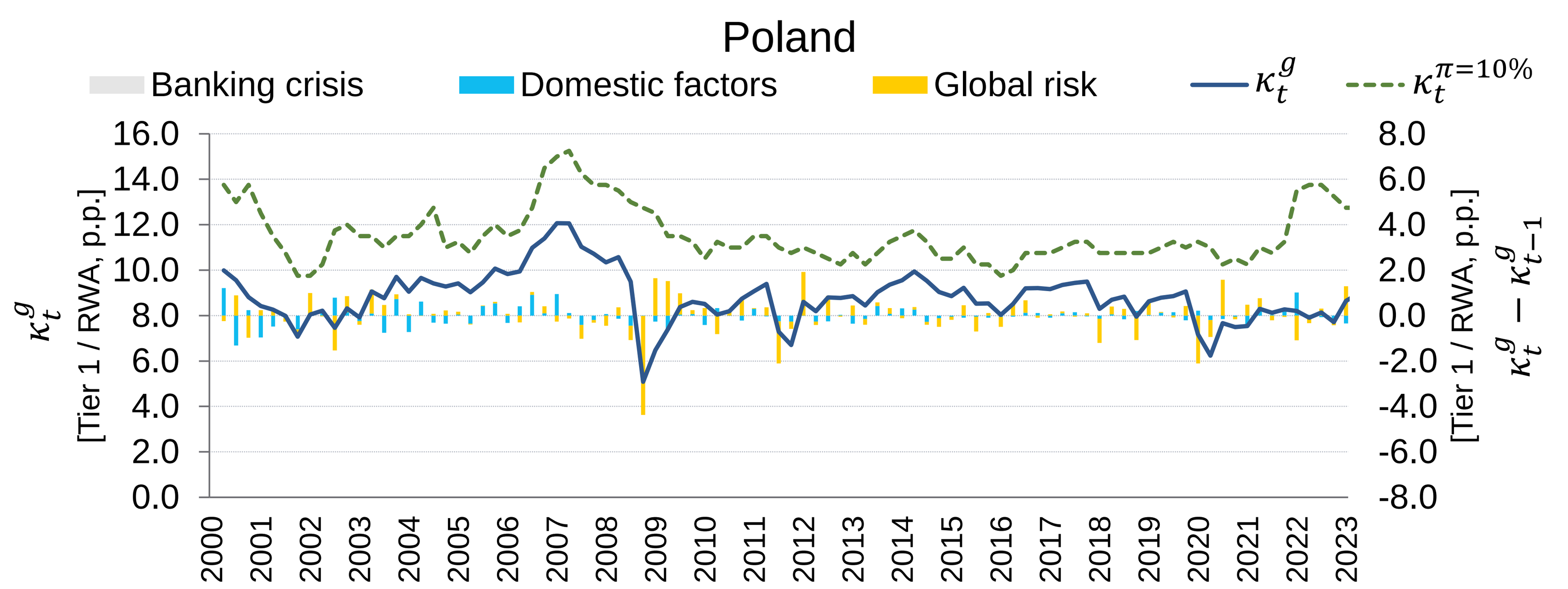


Figure 2. Evolution of the risk measure, κ_t^g, for selected countries and its drivers

Notes: The bars represent the decomposition of a change in κ_t^g, that is, $\kappa_t^g - \kappa_{t-1}^g$. The values of the lines (solid - κ_t^g, dashed - $\kappa_t^{\pi=10\%}$) are represented on the left axis. The values of the bars ('Domestic factors' and 'Global risk') are represented on the right axis.

3. **The model allows to calibrate $\mathbf{CCyB^{PN}}$ in reference to a country-specific uncertainty concerning the risk measurement.**
   - In the baseline calibration the $CCyB^{PN}$ was found to be 1.5% - 3.5%.

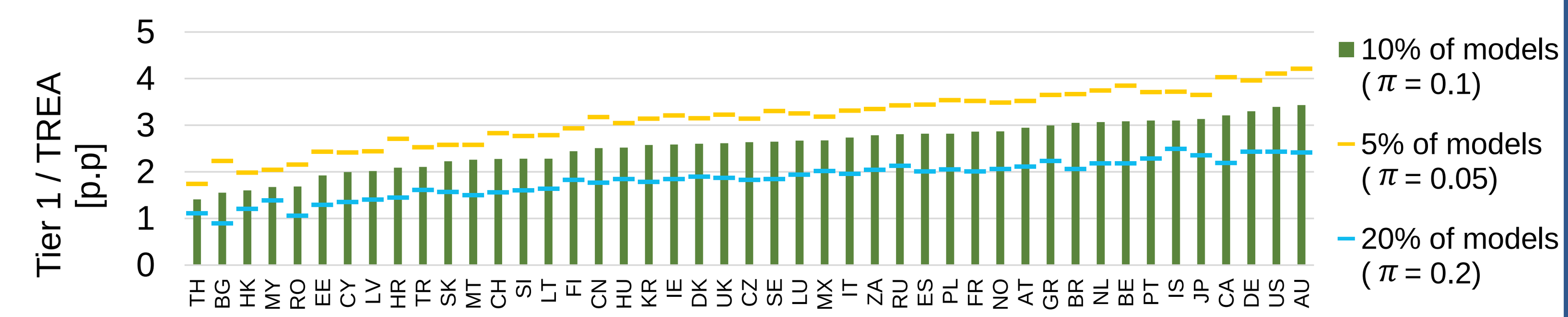


Figure 3. The calibrated positive neutral CCyB for individual countries

The model: the systemic risk measure

$$\kappa_t^g = \overbrace{\frac{1}{n}\sum_{i=1}^{n} \underbrace{\omega_i}_{\text{Weights}} \underbrace{\kappa_{i,t}^g}_{\text{A result of a single early warning model}}}^{\text{An ensemble of early warning models}} \quad (3)$$

$$\kappa_{i,t}^g = \min\left[\underset{\kappa_{i,t}}{\operatorname{argmin}}\left[b(\widehat{p_{i,t}}, \tau_i)\right]\right] \quad (4)$$

$$b(\widehat{p_{i,t}}, \tau_i) = \begin{cases} 1 \text{ if } \widehat{p_{i,t}} \geq \tau_i \\ 0 \text{ if } \widehat{p_{i,t}} < \tau_i \end{cases} \equiv \widehat{y_{i,t}} \quad (5)$$

$$\widehat{p_{i,t}} = \Pr[y_{i,t} = 1 | \boldsymbol{x}_{i,t}, \boldsymbol{\kappa}_{i,t}] = \underbrace{f_i}_{\text{A single early warning model (logit)}}(\underbrace{\boldsymbol{x}_{i,t}}_{\text{Other explanatory variables}}, \underbrace{\boldsymbol{\kappa}_{i,t}}_{\text{The capital ratio}}) \quad (6)$$

Summary:

- Estimate a suite of early warning models to predict banking crises.
- Check for capital ratio which just avoids positive signal of banking crisis, $\kappa_{i,t}^g$.
- Aggregate the $\kappa_{i,t}^g$ to κ_t^g.

The model: the Positive Neutral Rate for CCyB ($CCyB^{PN}$)

- $CCyB^{PN}$ based on the dispersion of $\kappa_{i,t}^g$ across individual models, i.e., based on country-specific uncertainty regarding $CCyB_t^{ER}$ calibration.

$$\kappa_t^\pi = \kappa_{i,t} \quad s.t. \quad \underbrace{\frac{1}{n}\sum_{i=1}^{n} \omega_i \widehat{y_{i,t}} = \pi}_{\text{Fraction of models which signal crises for given } \kappa_t^\pi} \quad (7)$$

$$CCyB^{PN} = \frac{1}{T}\sum_{t=1}^{T}(\kappa_t^\pi - \kappa_t^g) \quad (8)$$

- The choice of π affects level of $CCyB^{PN}$
- The lower the π, the higher the $CCyB^{PN}$

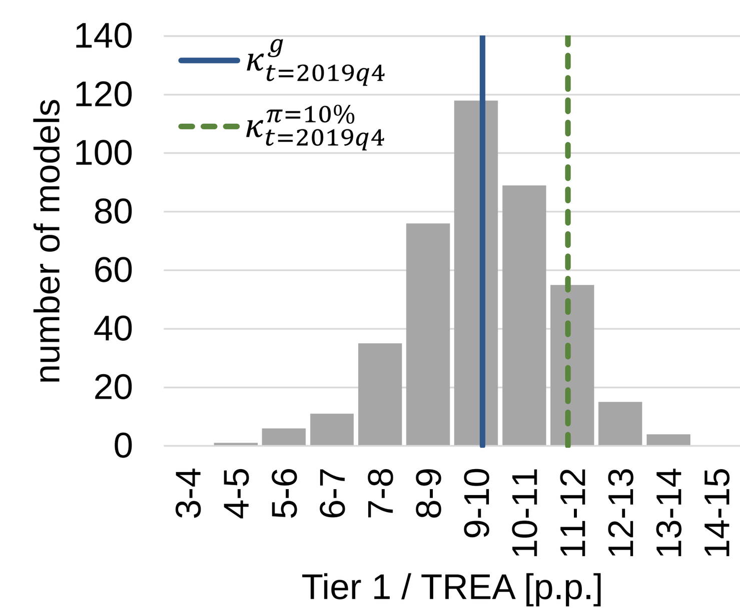


Figure 4. Distribution of $\kappa_{i,t}^g$ (France, 2019q4)

References

Lo Duca, Marco, Anne Koban, Marisa Basten, Elias Bengtsson, Benjamin Klaus, Piotr Kusmierczyk, Jan Hannes Lang, Carsten Detken (editor), Tuomas Peltonen (editor), 2017, A new database for financial crises in European countries, ESRB Occasional Paper Series, No. 13.

Laeven, Luc, Fabian Valencia, 2020, Systemic Banking Crises Database II, *IMF Economic Review*, Vol. 68(2), 307-361.

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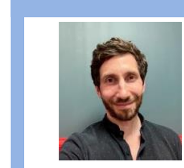
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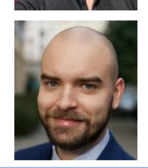
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