Calibrating the countercyclical capital buffer using AUROCs

Pierluigi Bologna and Maddalena Galardo

Bank of Italy

Workshop on Macroprudential Policy and the CCyB
Santiago, 15 January 2024

Disclaimer: The views expressed do not necessarily reflect those of the Banca d'Italia or of the Eurosystem.

Motivation

- The CCyB was introduced by the BCBS as part of the Basel III framework.

- To operate the CCyB, the BCBS
  - suggests as an indicator to capture the credit cycle the credit-to-GDP gap computed using the one-side HP filter,
  - provides a rule to translate this indicator into a percentage of the bank RWA. The rule envisages two thresholds: 2 percentage points of the gap for the activation of the CCyB and 10 percentage points as a cap at which the maximum buffer requirement should be reached,
  - indicates 2.5 percent as maximum CCyB level.

Motivation

- The existing literature has studied:

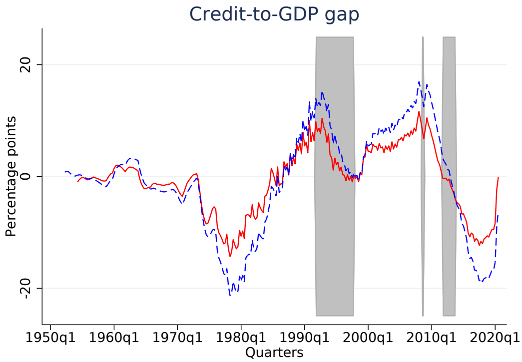
  (a) the reliability of the indicator used to capture the credit cycle (Alessandri et al. (2015), Alessandri et al (2022), Alessi and Detken (2018), Drehmann and Yetman (2018), Hamilton (2018), among others),

  (b) the appropriateness of setting the maximum level of the CCyB rate to 2.5 percent (Aikman et al. (2019), Van Oordt (2018), Faria-e-Castro (2019), among others).

Motivation

- Only a few studies have called into question the levels of the min-max thresholds (Detken et al. (2014) and Wezel (2019)).
- However, the setting of the min-max thresholds is critical. The activation threshold should be high enough to avoid repercussions on the real economy from a too early activation but low enough to allow a gradual accumulation of the buffer along the cycle. The maximum threshold should be such to ensure that the CCyB can work as intended while avoiding excessive capital constraints on banks.
- In this paper, we propose a new approach that exploits the area under the ROC curve (AUROC) to identify the optimal min-max pairs for the operationalisation of the CCyB.

- We test the AUROC approach using Italian data.
- Adjusted credit-to-GDP gap (a là Alessandri et al. (2015)) for the Italian banking system: quarterly data from 1950.
- Crises dates and timing: 1991Q4 and 2011Q4 (Lo Duca (2017)), 2008Q3 (Laeven and Valencia (2020)).



Note: Grey lines mark systemic crises. Red line refers to the adjusted gap computed following Alessandri et al. (2015) and Alessandri et al. (2022). Blue line refers to the one-side HP filtered gap computed following the BCBS guidance.

- BCBS has provided criteria for setting: i) the lower threshold of the gap (L), appropriate for starting to build up the CCyB; and ii) the upper threshold of the gap (H), in correspondence of which the maximum buffer rate would be reached.

  (a) Criteria for L
    - L should be low enough so that banks are able to build up capital in a gradual fashion before a potential crisis. As banks are given one year to raise additional capital, this means that the indicator should breach L at least 2-3 years prior to a crisis.
    - L should be high enough so that no additional capital is required during normal times.

  (b) Criteria for H
    - H should be low enough so that the buffer would be at its maximum prior to a banking crisis.

- Looking at the developments of the adjusted gap over the 5 years preceding a banking crisis.

Table: Banking crises and adjusted credit-to-GDP gap

Crises	Years before crisis				
	5	4	3	2	1
1991Q4	2.6	4.1	5.8	7.9	10.0
2008Q3	4.5	5.2	6.4	7.1	8.1
2011Q4	8.2	10.0	6.7	8.5	3.8

- The L and H thresholds consistent with the BCBS criteria would be, respectively, 3 and 8 percentage points. The combination is narrower than the one proposed by the BCBS.
- The advantage of using a country-specific approach to the calibration is confirmed also by repeating the exercise for the SSM countries. Table Figure

- At least two drawbacks emerge when implementing the Basel guidance.
  1. The chronological definition of crisis periods. Identifying and dating correctly financial crises is critical for the application of the Basel criteria.
  2. The heterogeneous dynamics of credit cycle across countries.

- In trying to address these challenges we propose an alternative approach to map *any* credit cycle indicator into the CCyB.

- Use the ROC to provide (by construction) an accurate calibration rule given the prevailing level of financial stress.

- Decision problem:

  (a) The CCyB should be raised promptly enough to enhance the resilience of the banking system to possible adverse shocks, but it should not be increased too early in the cycle to avoid undesirable effects on credit supply that could potentially affect economic growth.
  (b) The higher is the capital requirement the more costly is to implement a given policy, but this cost needs to be weighed against the benefits of reducing economic losses in case of a crisis.

- Assuming that the policymaker has a reliable indicator G^* to identify the state of the credit cycle in real-time, she also needs an optimal rule to translate such indicator into a policy decision $CCyB_t = \mathfrak{B}\{G_t^*, L, H\}$.

  $\rightarrow$ maximize the probability of implementing the adequate policy when needed and minimize the probability of a too stringent policy when not needed.

- Assume that the banking system can be in one of 4 states S:
  1. $S_1 = 0 \rightarrow$ no financial vulnerability is detected
  2. $S_2 = 1 \rightarrow$ vulnerabilities start to build up
  3. $S_3 = 2 \rightarrow$ boom phase
  4. $S_4 = 3 \rightarrow$ financial crisis

- Estimate the policymaker problem using an ordered logistic regression that has as a dependent variable the level of fnancial vulnerability.
- Use the ratio of bad loans to total loans as a proxy for the level of accumulated risks.
- Identify four levels of vulnerability, based on the quartiles of the distribution of the bad loans ratio. Figure
- Assuming that G_t^* has been chosen, identify the optimal (L, H) by computing the area under the ROC curve.

- Model classification accuracy by comparing sample bootstrapped with replacement to left-out cases.

1. Randomly select 90 percent of the observations of the initial sample, as a new sample Ψ.
2. Use Ψ to estimate by ordered logistic regression the equation:

$$FinRisksLevel_t = \alpha + \beta CCyB_{t-4} \tag{1}$$

   where $FinRisksLevel_t$ is a number from 0 to 3 capturing the level of financial vulnerability, and $CCyB$ is the benchmark buffer rate one year before.

3. Use the estimated model $\mathfrak{M}$ to predict $FinRisksLevel_t$ for the periods left out by the random selection and compute the share of states correctly predicted, i.e. the model accuracy.

Identifying the Optimal Calibration Rule Using AUROCs: Procedure

4. Estimate Equation 1 on the sample Ψ modified such that $FinRisksLevel_t$ are randomly assigned to the periods.

5. Use the estimated model $\mathfrak{M}_{\mathfrak{null}}$ to predict $FinRisksLevel_t$ for the periods left out and compute the share of correctly predicted states, i.e. the null accuracy.

6. Repeat the steps 1 to 5 for 300 iterations and compute smoothed probability distributions for both the accuracy of $\mathfrak{M}$ and $\mathfrak{M}_{\mathfrak{null}}$.

7. Compute the AUROC to compare the accuracy of $\mathfrak{M}$ measuring the true positive rate and the accuracy of $\mathfrak{M}_{\mathfrak{null}}$ meauring the false positive rate.

.

Evaluating L and H

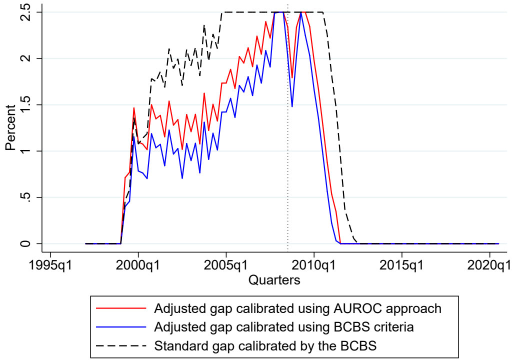
- Apply the procedure to search for the calibration that has the higher ability to rightly distinguish the levels of $FinRisksLevel_t$, i.e. the combination of (L,H) that maximizes AUROC.
- Compute AUROC for all combinations of (L,H) from 0 to 10 (100 pairs).
- The AUROC is maximised (0.87) for the pair (1,9). Table
- The (3,8) pair identified applying the Basel calibration principles would fall outside this area. Figure

Evaluating L and H: Two Alternatives

- Exercise 1
  - Weight model outcome consistently with financial vulnerability with weighs $W_s = \{0, 1, 2, 3\}$ associated to the states $S_t = \{0, 1, 2, 3\}$, that is $W_s = S_t$.
  - The pairs with L below 2 and H above 7 are those with higher values of the AUROCs. Figure
- Exercise 2
  - Impose a penalty of 1 when the model fails to identify a high financial vulnerability period.
  - The pairs with L below 2 and H above 8 are those with higher values of the AUROCs. Figure
- Results are robust to a higher number of simulations (1000).

Comparing the Buffer Guides

- All guides allow reaching max CCyB 1 year before the crisis.
- BCBS approach suggests that the CCyB is increased to 2 per cent in a very short time and reaches the maximum very early.
- AUROC approch suggests to rise the CCyB more smoothly, reaching 2 percent 2 years before the crisis.



A Simple Application

- If in place before the GFC would the CCyB have been adequate mitigate the impact on Italian banks?
- Compare the resources that banks had to set aside to face expected losses on their loan portfolio with the accumulated buffer.
- At the beginning of the crisis in 2008Q3 the CCyB rate would have been at 2.5 percent for almost 1 year, accounting for about 1/6 of banks' total capital ratio. Figure
- The full release of the buffer would have freed 40 bln euros. Would have been enough to ensure the resilience and support credit?

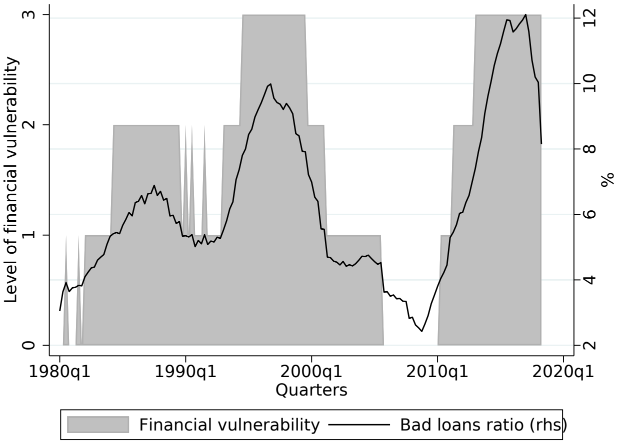
- The amount on loan loss provisions is comparable to a decline in banks' capital.
- The growth rate of loan loss provisions peaked in 2009 and remained positive until the end of 2015.
- The cumulated amount of new provisions in the three years following the GFC, i.e., from 2009 to the end of 2011, was 36 bln euros. Figure
- The release of the countercyclical capital buffer at the end of 2008 would have therefore delivered enough capital to cover banks' provisions for the three following years.

Conclusions

- Three relevant issues for the implementation of the CCyB are: 1) the selection of indicators to capture the credit cycle, 2) the identification of the maximum level of the cyclical capital add-on, and 3) the best rule for mapping the credit cycle indicator into the buffer guide.
- The possibility to depart from the standard credit gap based on the one-side HP filter and from the calibration suggested by the BCBS are provided for by the BCBS itself and, in the European context, by the guidelines of the ESRB.
- This paper proposes a new approach to identify the optimal rule to transform indicators capturing the credit cycle into the guide to set the CCyB. It leverages on the maximization of the AUROC.
- We use this approach to identify the min-max thresholds pair for Italy. The optimal pair (1,9) identified by the AUROC procedure is different from the one provided by the BCBS.

Thank you!

Defining Financial Vulnerability



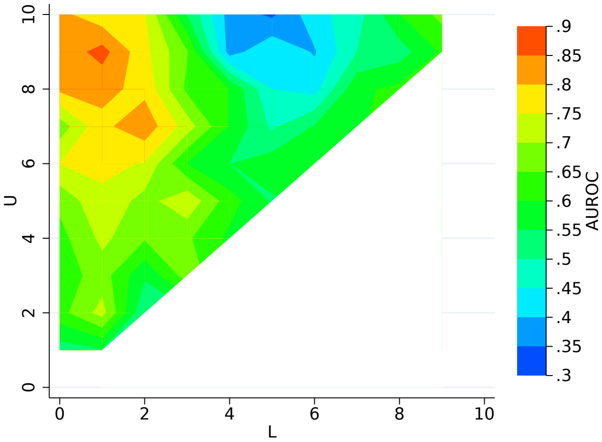
Back

AUROCs for Different (L,H) Pairs

L/H	1	2	3	4	5	6	7	8	9	10
0	0.53	0.63	0.62	0.63	0.66	0.75	0.67	0.81	0.82	0.81
1		0.72	0.67	0.71	0.74	0.76	0.79	0.81	0.87	0.77
2			0.56	0.66	0.68	0.75	0.83	0.79	0.76	0.75
3				0.66	0.74	0.60	0.73	0.64	0.65	0.55
4					0.62	0.55	0.60	0.60	0.38	0.38
5						0.58	0.49	0.45	0.44	0.34
6							0.55	0.43	0.40	0.43
7								0.59	0.50	0.48
8									0.53	0.60
9										0.67

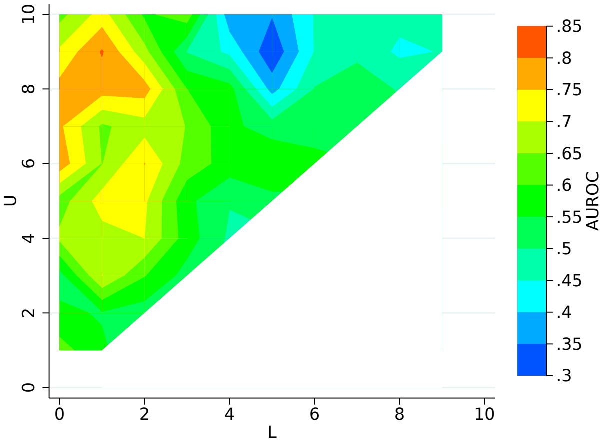
Back

Estimated AUROCs by Comparing Randomly Selected Cases with Left-out Cases. 300 interactions.



Back

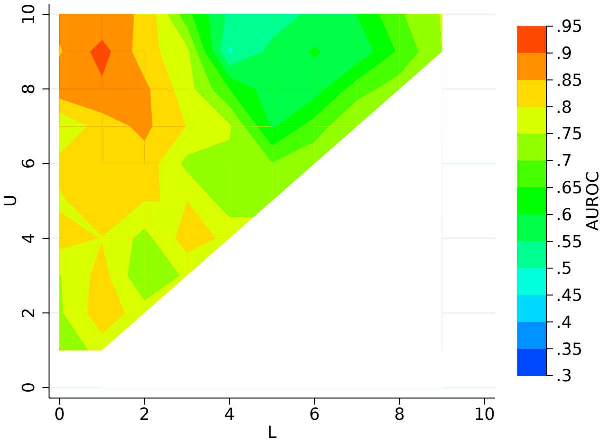
AUROCs Using Weights Computed by Comparing Randomly Selected Cases with Left-out cases. 300 interactions.



Back

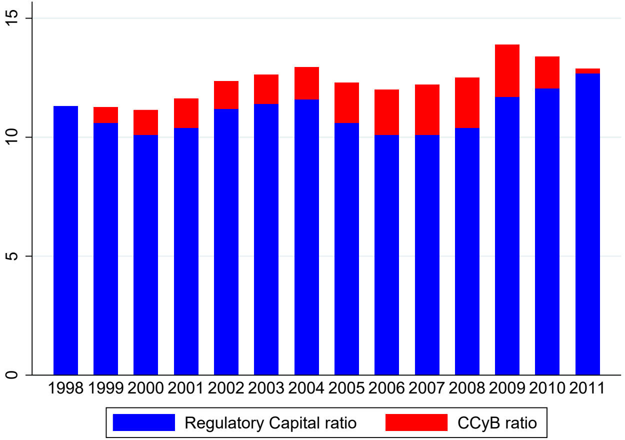
Estimated AUROCs Imposing a Penalty

AUROCs imposing a penalty computed by comparing randomly selected cases with left-out cases. 300 interactions.



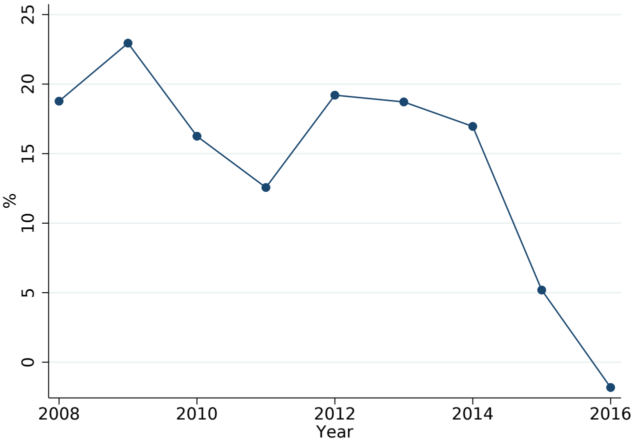
Back

Italian Banks Regulatory Capital to Risk-Weighted Assets



Back

Italian Banks Loans Loss Provisions



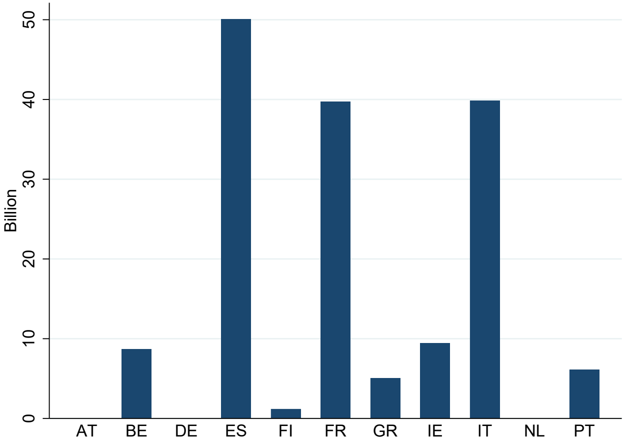
Back

Calibrating the CCyB for SSM Countries with the Basel Approach

	Years before crisis				
Country	5	4	3	2	1
Austria	-2	-1	-2	0	0
Belgium	6	4	-2	-2	5
Finland	1	4	5	6	8
France	0	0	3	4	5
Germany	0	3	3	2	4
Greece	11	11	13	15	12
Ireland	4	14	20	36	32
Italy	6	7	7	8	7
Netherlands	-7	-8	-7	5	8
Portugal	20	20	8	3	7
Spain	15	18	22	26	21
Average	5	7	6	9	10
P25	0	2	1	3	5
Median	4	4	5	5	7

The adjusted credit-to-GDP gap is estimated for the total credit to the non-financial private sector. The gap is computed exploiting data since 1971.

Back



The graph reports the level of the CCyB for the eleven SSM countries at the end of 2008.The amount of the buffer is calculated multiplying the CCyB rate by the risk weighted assets, assuming that all the exposure are domestic.

Back