The impact of capital requirements on bank capital

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Introduction

Background

- Macroprudential policy has gained prominence as a policy function in addressing externalities and market failures associated with financial intermediation, complementing supervision and monetary policy (De Nicolò et al. (2014)):

    1. Ensure the overall financial system's resilience to shocks, preventing it from exacerbating economic downturns.
    2. Limit the procyclicality of the financial sector by curbing imbalances during economic upswings, ensuring resilience to absorb losses and support the real economy in downturns (Constâncio et al, 2019).

- Macroprudential measures, expressed in capital ratios, prompt banks to adjust either the numerator (e.g. equity or voluntary buffer) or the denominator (e.g. deleveraging or derisking).

Literature review

- While the effects of macroprudential policy on financial stability and economic growth are widely studied, further research is needed to understand its relation to banks' voluntary buffers.

- The literature focus is mainly on bank deleverage or derisking:
  - Banks may prefer not to raise equity, because it is costly:
    1. intermediation costs (Allen and Carletti, 2013)
    2. debts' tax advantages (Miles et al., 2012) and role (Llorens and Martin-Oliver, 2017; Calomiris and Kahn, 1991; Diamond and Rajan, 2001)
    3. asymmetric information on banks' net worth (Bolton and Freixas, 2006; and Myers Majluf, 1984).
  - While higher capital requirements improve financial stability it also influences lending, risk-taking and the economic activity (Cappelletti et al., 2019; Acharya and Thakor, 2016; Elliott et al., 2013; Caruana, 2010b; Caruana, 2010; Hanson et al., 2010; Perotti and Suarez, 2009a; Crocket, 2000; Gropp and Heider, 2010; Berger and Bouwman, 2013; Acharya et al., 2011; Admati et al., 2011; Calomiris and Herring, 2011; Hart and Zingales, 2011).

Motivation and research question

Motivation:

- The effectiveness of macroprudential policy in absorbing shocks and maintain financial stability may be influenced when banks draw on their voluntary buffer

Research questions:

- Whether banks neutralise changes in capital requirements by adjusting their voluntary buffers (capital headroom)
  $\rightarrow$ Test of the Lucas' critique in the macroprudential context (Wagner, 2014; Horváth and Wagner, 2016)
- Does the intensity of the macroprudential policy matter (in terms of buffer size)?
- Is there any bank heterogeneity?

Contribution to the literature

1. Expand literature on the impact of higher capital buffers, focusing on the numerator of bank capital ratio

2. Assess the incentive scheme embedded in macroprudential buffers

3. Explore some relevant outcome variables, studying:
   - the voluntary buffer usability when banks are constrained with macroprudential policies
   - banks' heterogeneity

4. Exploit the two-tier O-SII framework for identification purposes

Contribution to the literature

Relevance from a financial stability perspective:

1. Allows to better understand the mechanisms underlying the pass-through of capital regulation on banks' behaviour.
2. Assess whether macroprudential policy is effective in enhancing banks' resilience. Bank failures impose negative externalities and moral hazard due to the possibility of generating systemic risk with severe effects on the real economy.

Setting

Institutional set-up

- Since 2015, several banks were identified as systemic (O-SIIs) and subject to additional capital buffers concerning the amount of Common Equity Tier 1 (CET1).
- Although the policy was implemented with different phase-in arrangements, the protocol for the identification of the O-SIIs has been established in the EBA guidelines (EU countries):

    1. Automatic score based on quantitative indicators – size, importance, complexity/cross-border, interconnectedness $\rightarrow$ each bank receives a score, which reflects its systemic importance. Banks with a score above a certain threshold are automatically designated as O-SIIs.
    2. Supervisory judgement, where it is assessed whether further banks are systemically relevant to be also qualified as O-SII, despite scoring below the threshold.

Dataset

Two unique datasets:

1. Internal dataset on O-SIIs:
   - Country's decision on the identification and calibration of O-SIIs.
   - Data used to compute the banks' score based on four mandatory indicators: size, importance, complexity/cross-border activity and interconnectedness.
   - Bank level standardized scores used to calculate the size of the O-SII buffer (per bucket).

2. Granular supervisory data:
   - Quarterly reports for euro area banks, which include information on volumes of exposures, assets, risk-weighted assets, non-performing loans, return-on-assets, CET1 and voluntary buffer.
   - Almost 340 banks (of which 49 O-SIIs) from euro area countries.
   - Data spanning from 2015 Q1 to 2018 Q3.

Descriptive statistics

Table 2: Descriptive statistics

	Voluntary buffer (percentage of RWA)	Voluntary buffer (million of euros)	Risk-weighted assets (billion of euros)	Return-on-assets (percentage of assets)	Non-performing loans ratio (percentage of loans)	Assets (billion of euros)	Risk-weights density (percentage of assets)
Non-OSII							
μ	5.74	72.61	21.35	0.18	13.61	60.56	42.98
σ	(6.8)	(202.1)	(67.3)	(1.1)	(14.7)	(230.6)	(17)
N	1,641	1,641	1,641	1,409	1,371	1,409	1,641
O-SII							
μ	4.75	591.01	156.69	0.09	7.41	365.44	27.31
σ	(6.3)	(636.8)	(156.3)	(0.5)	(8.6)	(406.5)	(12.8)
N	381	381	381	377	376	377	381
All banks							
μ	5.55	170.29	46.85	0.17	12.27	124.91	40.03
σ	(6.7)	(388.1)	(105.2)	(1.1)	(13.8)	(303.7)	(17.4)
N	2,022	2,022	2,022	1,786	1,747	1,786	2,022

Notes: Data spans between 2015 Q1 and 2018 Q3. The values for mean (μ), standard deviation (σ) and number observations (N) are computed for all institutions and separately for banks eligible (O-SII) and non eligible (Non-OSII) as systemically important institutions. The table depicts the mean and standard deviation values for the dependent variable, corresponding to the banks' voluntary buffer, presented both in million of euros and ratio. Also, the table presents the mean and standard deviation values for relevant bank characteristics, used as control variables, such as the risk-weighted assets (RWA) and assets, expressed in billion of euros, as well as the return-on-assets (ROA), non-performing loans (NPL) and risk-weights density (RW), expressed as percentage.

Identification strategy and Methodology

A quasi natural experiment is constructed to study:

1. Policy change: below/above the cut-off/threshold induced by the O-SIIs scoring process; and before/after the implementation date.
2. Buffer intensity: Multiple standardized scores for each bucket which determine the size of the capital buffer, as announced by national authorities.

Methodology:

1. Empirical setup (i) Outcome variable: Banks' voluntary buffer; (ii) Treatment: Banks identified as systemically important and constrained with the O-SIIs buffer.
2. Regression Discontinuity Design by exploiting the discontinuity to assess the impact of the macroprudential policy on banks' voluntary buffer.

Banks were excluded from the sample, when subject to: i) phase-in arrangements with no capital buffer allocation; and ii) expert judgment

Methodology - Regression Discontinuity Design

$$Y_{i,t+1} = \beta_0 X_{i,t} + \beta_1 (Treat)_{i,t} + u_i + \varepsilon_{i,t+1}$$

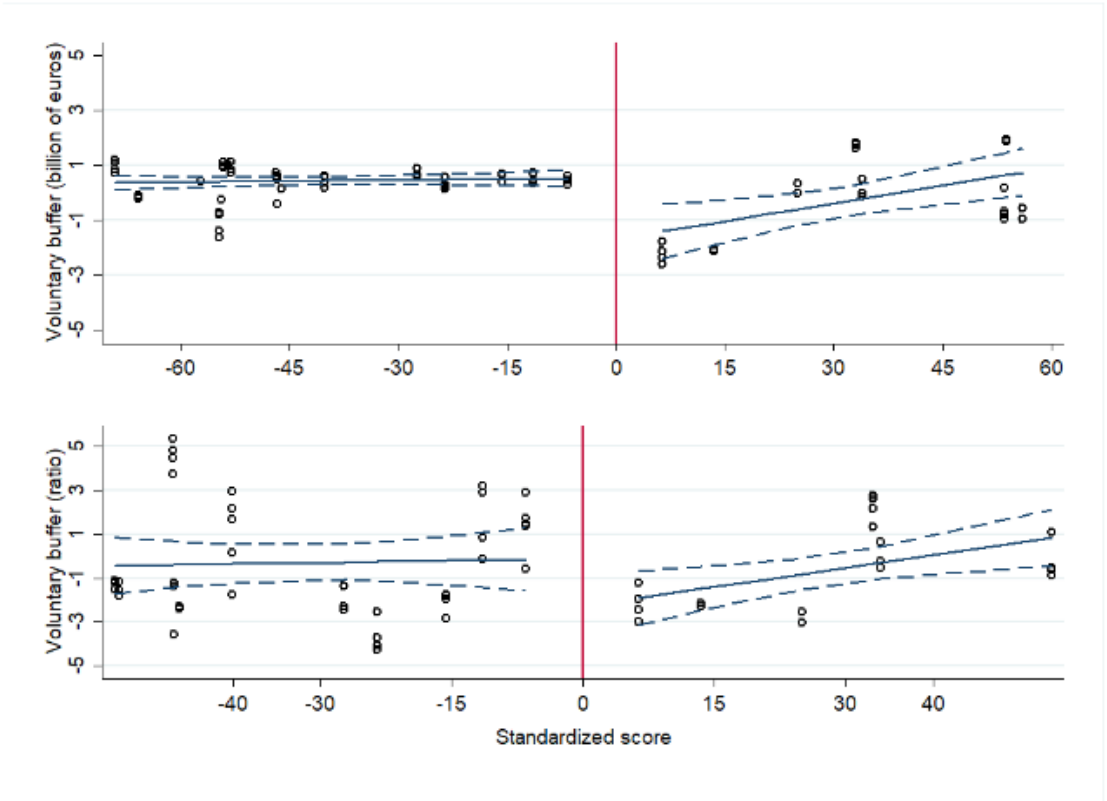
- $Y_{i,t+1}$ is the outcome variable $\rightarrow$ bank voluntary capital.
- *Treat* is a binary variable that takes on a value of one if a bank receives a marginally higher O-SII buffer and zero if receives a marginally lower or no requirement.
- u represents the unobserved bank characteristics.
- $X_{i,t}$ is a vector of control variables, representing the observable bank characteristics such as risk-weighted assets, non-performing loans, return-on-assets and capital requirements one quarter lagged (calculated as CET1 minus voluntary buffer).
- $\varepsilon_{i,t+1}$ is the individual error term.
- $t = 1,...,T$ and $i = 1,...,N$ are quarter and bank subscripts, respectively.
- A triangular kernel function with different optimal bandwidths are used: mean squared error (MSE) and coverage error rate (CER).
- Standard errors are clustered by bank and models include country-quarter fixed effects.

Results

Results - Regression Discontinuity Design

Effect of marginally higher O-SII requirement (by bucket) on banks' voluntary buffer

Figure 2: Bank voluntary buffer close to marginally higher O-SII buffer (buckets)



Notes: The y-axis displays the outcome variable, which is the voluntary buffer in billion of euros and in ratio. The data is presented in deviations from the mean for each bucket associated to the O-SII buffer amount. The data is trimmed at the 5nd and 95th percentiles. The x-axis depicts the standardized score distance for each bank from the country's threshold. No controls are included. The non-dashed line plots fitted values of the regression of the dependent variable on the score distance from the threshold. It is estimated separately on each side of the cutoff. The dashed lines represent the 95 percent confidence interval. The mean square error (MSE) optimal bandwidth used is the MSEsum that reports the common bandwidth that minimizes the MSE of the sum of the regression coefficients, not their difference. The reporting data used is at consolidated level.

Results - Regression Discontinuity Design

Effect of marginally higher O-SII requirement (by bucket) on banks' voluntary buffer

Table 3: Average effect of marginally higher O-SII buffer requirements on banks' voluntary buffer

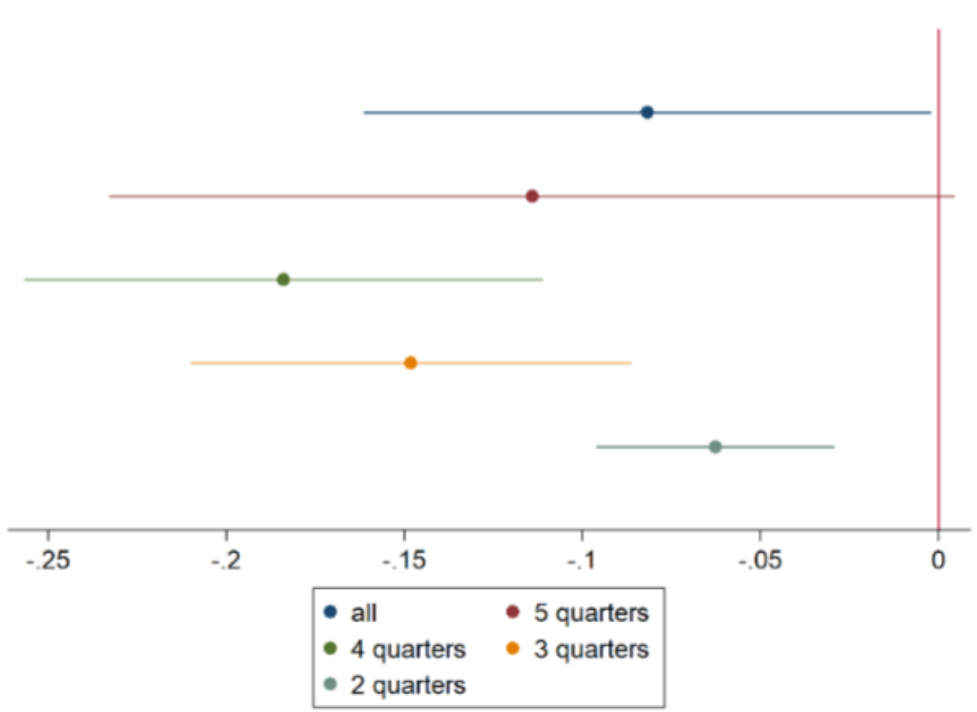
Variables	Billion of euros	Ratio	Billion of euros	Ratio
MSEsum-optimal bandwidth	-0.08**	-0.62***	-2.19**	-2.83*
	(0.041)	(0.119)	(1.049)	(1.665)
Bandwidth	[63,63]	[60,60]	[108,108]	[78,78]
Observations	712	699	1121	1097
CERrd-optimal bandwidth	-0.14***	-0.20*	-2.77***	-3.33**
	(0.048)	(0.116)	(0.807)	(1.659)
Bandwidth	[71,71]	[47,47]	[81,81]	[66,62]
Observations	712	699	1121	1097
CERtwo-optimal bandwidth	-0.18**	-0.51**	-1.92*	-1.38
	(0.067)	(0.243)	(1.067)	(1.706)
Bandwidth	[94,54]	[75,92]	[86,117]	[96,13]
Observations	712	699	1121	1097
Controls	Yes	Yes	No	No
FE	Yes	Yes	No	No

Notes: This table presents the estimates for the sharp regression discontinuity design in which the effect of marginally higher treatments is analysed. We consider the standardized score's distances from the assigned bucket to which a bank is assigned for incremental O-SII buffers. The dependent variable is the banks' voluntary buffer in amount (billion of euros) and ratio. Local linear regressions with a triangular kernel using both the different optimal bandwidths are used (MSEsum, CERrd, CERtwo). Covariates include: return-on-assets (ROA), risk-weighted assets (RWA), non-performing loans ratio (NPL) and the capital requirements at t-1 (CR_{t-1}). The standard errors in parentheses are clustered by bank and all models include country-quarter fixed effects. The data is trimmed at the 5th and 95th percentiles to reduce the influence of extreme values on the precision of the estimates. The number of observations decreases adding the controls as can be seen from Table 2.

Banks use their capital headroom to comply with marginally higher requirements, instead of raising new equity $\rightarrow$ the intensity of the treatment matters

Results - by quarter

Figure 3: Average effect of marginally higher O-SII buffer requirements on banks' voluntary buffer (billion of euros) - by quarters after the treatment



Notes: The plot shows the mean and the confidence interval at 95 percent of the estimated coefficients obtained from the sharp regression discontinuity design considering all quarters after the application of the O-SII buffer requirement (the treatment). We consider the standardized score's distances from the assigned bucket to which a bank is assigned for incremental O-SII buffers. The dependent variable is the banks' voluntary buffer ratio. The model consists of local linear regressions with a triangular kernel using MSEsum-bandwidth. Covariates include: return-on-assets (ROA), risk-weighted assets (RWA), non-performing loans ratio (NPL) and capital requirements at t-1 (CR_{t-1}). The standard errors are clustered by bank and all models include country-quarter fixed effects. The data is trimmed at the 5th and 95th percentiles for all variables to reduce the influence of extreme values on the precision of the estimates.

Results - Heterogenenous effects

Table 4: Heterogeneous effects of higher capital requirements (O-SII buffer) on banks' voluntary buffer (billion of euros)

Variables	Model 1 ROA	Model 2 RWA	Model 3 NPL	Model 4 CR_{t-1}
Interaction	-0.011	-0.096	-0.111*	0.017
	(0.083)	(0.080)	(0.062)	(0.059)
Above the threshold	-0.145**	-0.100*	-0.091**	-0.053
	(0.062)	(0.047)	(0.037)	(0.045)
High x	-0.156***	0.096	0.019	-0.070
	(0.046)	(0.082)	(0.058)	(0.045)
Constant	0.219***	0.104***	0.124**	0.058
	(0.053)	(0.025)	(0.042)	(0.042)
Observations	734	734	734	734
R-squared	0.192	0.162	0.130	0.082
Controls	YES	YES	YES	YES
MSEsum-optimal bandwidth	[71,71]	[71,71]	[71,71]	[71,71]

Notes: This table presents the estimates for the heterogeneous effects of the application of capital requirements across different banks' characteristics (x). The dependent variable is the banks' voluntary buffer, in billion of euros. The variable of interest, interaction, is a dummy indicating if the bank is above the median with respect some banks characteristics interacted with a dummy indicating if the bank is above (1) or below (0) the specific threshold for O-SII capital requirements. The characteristics of the banks considered are the return-on-assets ratio (ROA) in model 1, risk weighted assets (RWA) in model 2, non-performing loans ratio (NPL) in model 3 and capital requirements one quarter lagged value in percentage points (CR_{t-1}: calculated as CET1 minus voluntary buffer) in model 4. The estimates are conditional on the following controls: model 1: RWA, NPL and CR_{t-1}; model 2: ROA, NPL and CR_{t-1}; model 3: ROA, RWA and CR_{t-1}; model 4: ROA, RWA and NPL. The estimates are obtained using bank and quarter fixed-effects and the robust standard errors are clustered by bank. ***, **, and * denote significance at the 1, 5 and 10 percent level, respectively.

Banks with a larger stock of non-performing loans are more prone use their management buffer to offset an increase in capital requirements.

Results - Heterogenenous effects

Table 5: Heterogeneous effects of capital requirements on voluntary buffer (billion of euros) - Multivariate analysis

Variables	Model 1	Model 2	Model 3
Interaction ROA	-0.087	-0.091	-0.332
	(0.094)	(0.095)	(0.423)
Interaction RWA	-0.162	-0.171	-0.002*
	(0.100)	(0.117)	(0.001)
Interaction NPL	-0.044	-0.073	-0.025***
	(0.094)	(0.102)	(0.007)
Interaction CR_{t-1}	-0.001	0.001	-0.061*
	(0.103)	(0.106)	(0.034)
Above the threshold	0.057	0.073	-0.014
	(0.064)	(0.066	(0.041)
High CR	-0.018	-0.020	-0.016
	(0.070)	(0.073)	(0.031)
High ROA	-0.140***	-0.136***	-0.034
	(0.039)	(0.039)	(0.033)
High RWA	0.075	0.083	0.012
	(0.093)	(0.111)	(0.025)
High NPL	0.000	0.030	0.004
	(0.060)	(0.072)	(0.026)
Constant	0.121**	0.105**	0.023
	(0.041)	(0.043)	(0.030)
Observations	81	77	243
R-squared	0.148	0.145	0.034
Controls	YES	YES	YES
MSEsum-optimal bandwidth	[71/71]		
CERrd-optimal bandwidth		[62/62]	
MSEtwo-optimal bandwidth			[138/63]

Notes: This table presents all covariates interacted with the running variable together in one regression. It represents the multivariate analysis of the heterogeneous effects of the application of capital requirements across different bank characteristics. Models 1 and 3 present the results for mean squared error (MSE) for sum and two optimal bandwidths, respectively, and Model 2 presents the results for the coverage error rate (CER) optimal bandwidth. The dependent variable is the banks' voluntary buffer, in billion of euros. The bank characteristics considered are a dummy indicating if a bank is above the median with respect to return-on-assets ratio (ROA), risk weighted assets (RWA), non-performing loan ratio (NPL) and capital requirement one quarter lagged value in percentage points (CR_{t-1}): calculated as CET1 minus voluntary buffer). The variables of interest are dummies indicating if the bank is above the median with respect bank characteristics interacted with a dummy indicating if the bank is above (1) or below (0) the specific threshold for O-SII capital requirements: interaction ROA, interaction RWA, interaction NPL and interaction CR_{t-1}. The estimates are conditional on the following controls: ROA, RWA, NPL and CR_{t-1}. The estimates are obtained using bank and quarter fixed-effects and the robust standard errors are clustered by bank. ***, **, and * denote significance at the 1, 5 and 10 percent level, respectively.

Validity tests

1. McCrarys's test (McCrary, 2008) for manipulation of the running variable. The density of the standardized scores does not show manipulation at the threshold.
2. Continuity of observable variables test (Cattaneo, Jansson and Ma, 2015a) for the bank covariates. Results confirm the continuity of the covariates between treated and untreated groups, as the jumps are non-significant, confirming the random sorting of banks close to the threshold.
3. Consistent results using different specifications. A fuzzy regression discontinuity design is also studied, as the probability of being identified as O-SII bank is not dichotomous, due to the supervisory expert judgment, and results are consistently negative as well.

These validation tests ensure the **validity** of our methodology (Appendix).

Robustness checks

1. Placebo cutoff to check whether the regression functions are continuous at points other than the given cutoff (Cattaneo et al., 2020a and 2020b). Results show the robustness of our specification, with no significant treatment effect occurring at the artificial cutoff values.
2. Controls do not influence the result. Coefficients and significance are consistent when including covariates ensuring the soundness of the specification.

These tests ensure the **robustness** of our methodology (Appendix).

Conclusions

Conclusions

Results

- Banks partly use their voluntary buffer to comply with marginally higher capital requirements, instead of raising new equity (i.e., the intensity of the treatment matters).
- Banks with a larger stock of non-performing loans are more prone use their voluntary buffer to offset an increase in capital requirements. These banks are perceived as less efficient, exacerbating their difficulties in raising new equity.
- This confirms that there is a need to assess whether macroprudential policy is still effective in enhancing the resilience of the financial system.

Conclusions

Financial stability concerns - Preliminary considerations

- **Do banks offset changes in capital requirements by adjusting their voluntary buffers (capital headroom)?**
  - Banks use their capital headroom to comply with higher requirements and the intensity of the treatment matters $\rightarrow$ critical for banks with high non-performing loans due to equity-raising challenges.
- **Is macroprudential policy effective in achieving its objective of enhancing financial stability?**
  - Evaluating the respective effectiveness is crucial to prevent systemic risk events and subsequent negative externalities severely affecting the real economy.
  - E.g., targeting the absolute amount of new capital, instead of the capital ratio (Hanson et al., 2011, Gropp et al., 2019) could:
    - enhance the effectiveness of macroprudential policy as banks would be more capitalised
    - reduce the potential optimization of risk-weighted assets
    - minimize the adverse effects on the real economy ($\downarrow$ credit supply)

Feedback and comments are welcome

Thank you!