The impact of capital requirements on bank capital

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Introduction

Background

- The post-global financial crisis policy reforms largely relied on an enhanced regulatory regime for bank capital.
- 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 that the entire financial system is resilient to shocks and, therefore, that it does not amplify economic downturns.
    2. Limit the procyclicality of the financial sector by preventing the build-up of imbalances in the upswing of the financial cycle, thereby allowing it to absorb losses and support the real economic during downturns (Constâncio et al (2019)).
- It is essential to study the effects of macroprudential policy in the financial system and real economy → what is the response of banks to higher capital buffers.

Literature review

- The theoretical and empirical evidence on the effectiveness of macroprudential policy, on both, financial stability and economic growth is growing quickly. Yet, its relation to the banks' voluntary buffer is still scarce or nonexistent.
- The literature focus is on bank deleverage or derisking (capital ratio denominator) and finds that:
  - Banks may prefer not to raise equity, because it is costly due to several aspects such as:
    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 about 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

- Macroprudential measures are expressed in capital ratios and banks can react by adapting the numerator and/or the denominator of such ratios $\rightarrow$ i.e., by reducing the voluntary buffer (numerator) and/or by deleveraging or derisking (denominator), thus freeing up capital.
- Are banks responding to higher capital requirements by adjusting the size of their voluntary buffers (the capital held in excess of required minimum level)?
- Is the macroprudential policy generating unintended negative effects if banks use their voluntary/management buffer? To what extent the macroprudential policy is effective in absorbing shocks.

In this paper we investigate whether banks engage in such behavior and draw some first policy implications.

Research question

- Are banks using their voluntary capital buffer to comply with higher macroprudential requirements? Does the intensity (in terms of buffer size) of the macroprudential policy matter?
- Is there any heterogeneity when banks react to higher capital buffers?

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 macroprudential policy effectiveness, by studying the voluntary buffer usability when banks are constrained with higher buffer requirements
3. Assess the incentive scheme embedded in macroprudential buffers
4. Explore some relevant outcome variables, assessing:
    - intensity of macropudential measures on banks' voluntary buffer
    - banks' heterogeneity
5. 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, and potential effects in the economic activity.
2. Assess whether macroprudential policy is effective in enhancing banks' resilience. Bank failures impose negative externalities on their depositors, besides the moral hazard due to the possibility of generating systemic risk with severe effects in the real economy.

Setting

Institutional set-up

- Since 2015, several entities were identified as 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 for all 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, whereby it is assessed whether further institutions 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:
    - Euro area countries decision on the identification and calibration of the O-SII (Art. 131 CRD IV and EBA Guidelines).
    - Data used to compute the underlying banks' score based on four mandatory indicators: size, importance, complexity/cross-border activity and interconnectedness.
    - Underlying bank level data including the standardized scores for each bucket to determine the size of the O-SII buffer.
2. Granular supervisory data:
    - Quarterly reports for euro area banks, which include information on volumes of exposures, assets, risk-weighted assets, non-performing loans and return-on-assets, as well as indicators of capital, such as 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 first notification or implementation date process.
2. Buffer intensity: Multiple standardized scores for each bucket which determine the size of the capital buffer, as announced by the national authorities.

Methodology:

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

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

Methodology - Regression Discontinuity Design

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

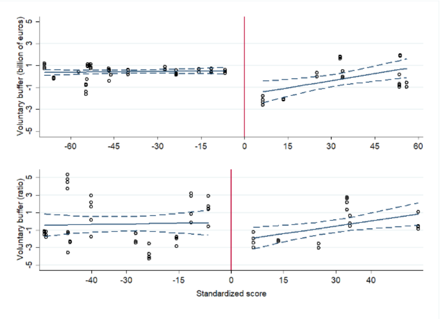
- $Y_{i,t+1}$ is the outcome variable $\rightarrow$ bank voluntary capital.
- *Treat* is a binary variable that takes on a value of one if a bank receives a marginally higher O-SII buffer and zero if receives a marginally lower or no requirement.
- u represents the unobserved bank characteristics.
- $X_{i,t}$ 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 bandwidth levels 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.

Banks constrained with marginally higher capital requirements use more, on average, their voluntary buffer.

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

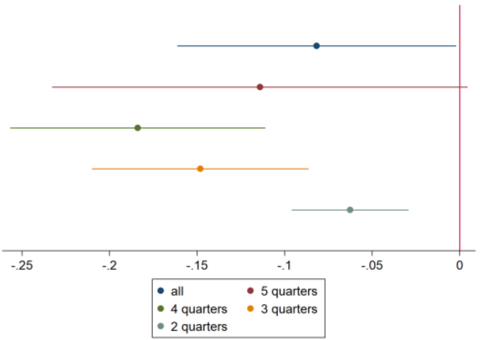
Variables	Billion of euros	Ratio	Billion of euros	Ratio
MSEsum-optimal bandwidth	-0.08**	-0.62***	-2.19**	-2.83*
	(0.041)	(0.119)	(1.049)	(1.665)
Bandwidth	[63,63]	[60,60]	[108,108]	[78,78]
Observations	712	699	1121	1097
CERrd-optimal bandwidth	-0.14***	-0.20*	-2.77***	-3.33**
	(0.048)	(0.116)	(0.807)	(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 regression in which the effect of marginally higher treatments is analysed. Thus, the distances of the score from the bucket to which a bank is assigned for incremental O-SII buffers are considered. The estimates for the sharp regression discontinuity design are presented. 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 constrained with marginally higher buffer requirements decrease their voluntary buffers therefore avoiding raising new equity.

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). The distances of the standardized score from the bucket to which a bank is assigned for incremental O-SII buffers are considered. 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.

Banks constrained with marginally higher capital requirements decrease their voluntary capital and the intensity of the treatment matters.

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 ratio (higher than the median) are more prone use to 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. Model 1 presents results for MSE-sum optimal bandwidth, Model 2 for the CER-rd optimal bandwidth and Model 3 for the MSE-two optimal bandwidth. The dependent variable is the banks' voluntary buffer, in billion of euros. The variables of interest are dummies indicating if the bank is above the median with respect some 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 characteristics of the banks considered are the a dummy indicating if the 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) interacted with a dummy indicating if the bank is above (1) or below (0) the specific threshold with respect to. 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 present evidence of 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. This provides evidence of the absence of non-random sorting by banks close to the threshold, therefore justifying a randomized experiment. Results are robust and independent of the selected bandwidths.
3. Consistent results using different specifications. Besides the specifications presented in these slides, 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. Our 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 (as suggested by Cattaneo et al. (2020a and 2020b)). Results show the robustness of the regression discontinuity design, where no significant treatment effect occur 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 regression discontinuity design.

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).
- Heterogeneous effects: banks with a larger stock of non-performing loans are more prone use to their management buffer (i.e. compress their voluntary buffer) to offset an increase in capital requirements. These banks tend to be seen as less efficient by investors, therefore increasing 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, in particular in those banks that do not seem to increase new equity to comply with higher capital requirements.

Conclusions

Financial stability concerns - Preliminary considerations

- Banks tend to comply with higher capital buffers by dampen down their voluntary buffer - follows the debate on how banks adjust their capital ratios in response to higher capital requirements.
- Banks with a larger stock of non-performing loans have the incentive to offset an increase in capital requirements via a compression of the voluntary buffer due to their difficulties in raising new equity.
- There is a need to assess whether macroprudential policy is effective in enhancing the resilience of the financial system. Bank failures impose negative externalities and moral hazard due to the possibility of generating systemic risk with severe effects in the real economy.
- As suggested by Hanson et al. (2011), Gropp et al. (2019) and Cappelletti et al. (2019), targeting the absolute amount of new capital that has to be raised instead the capital ratio could: i) ensure the effectiveness of macroprudential policy; ii) mitigate potential optimisation of risk-weighted assets and iii) minimize the adverse impact on the real economy ($\downarrow$ credit supply).

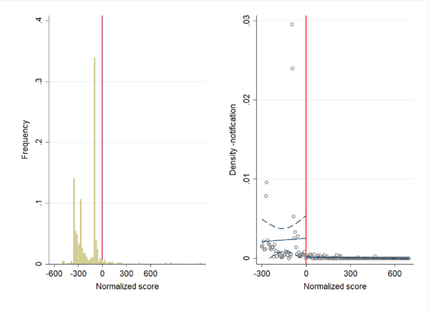
Feedback and comments are welcome

Thank you!

Appendix

Appendix: McCrary's manipulation test of the running variable

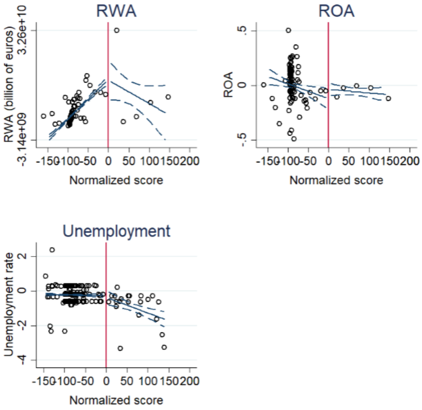
Figure 3: McCrary's manipulation test of the running variable



Notes: We present here the McCrary's test (McCrary, 2008) that we use to assess the continuity at the cutoff of the score density. In the panel on the left we plot the density of the normalized scores. On the vertical and horizontal axes there are, respectively, the frequency of the banks' scores and the score distance from the threshold. Moreover, on the right panel, we represent the McCrary test of density continuity. The full line in between the dashed lines plots fitted values of the correlation between the bank score and the score distance from the threshold, estimated separately on each side of the cutoff. The dashed lines represent the 95 percent confidence interval. From the two figures we can conclude that there is no significant visual evidence of systematic manipulation of the running variable. We present here the test for the quasi natural experiment performed considering multiple thresholds and the probability of receiving a marginally higher O-SII capital requirement. We do not show the figure with respect to the natural experiments based on a single threshold by country, as the outcome is similar and, is also similar to that presented by Cappelletti, Ponte Marques, Salleo, Vila (2019, pg. 20) in Figure 1 in the Appendix.

Appendix: Covariates Continuity Test

Figure 7: Continuity of covariates: RWA, ROA and unemployment near the threshold



Notes: Test of continuity for covariates by Skorovron and Titiunik (2015). The vertical axis presents the outcome variable: the RWA, the ROA and unemployment. The horizontal axis measures the normalized score of the bank. The central non-dashed line plots the fitted values of the regression dependent variable on a first-order polynomial in the score distance from the threshold. The fitted values are estimated separately on each side of the cutoff. The dashed lines represent the 95 percent confidence interval. The covariates just above and below the cutoff is not statistically different across treated and untreated banks. This implies the bank's inability to manipulate the value of the score received. The variable ROA and RWA are trimmed 5 percent up and down.

Appendix: Covariates Continuity Test

Table 9: Continuity of covariates: Average effect of changes in the O-SII bucket on the ROA

Coeff	S.E.	p - value	Eff. Left Obs.	Eff. Right Obs.	Tot Obs.	Bw Method	Controls
-0,24	0,20	0,22	180	41	1890	mserd	Yes
-0,30	0,22	0,17	111	41	1890	cerrd	Yes
-0,23	0,17	0,19	70	48	1890	msetwo	Yes
-0,36	0,20	0,07	45	41	1890	certwo	Yes
-0,21	0,19	0,27	227	48	1890	msesum	Yes
-0,29	0,21	0,17	118	41	1890	cersum	Yes

Notes: Test of continuity for covariates (Skorovron and Titiunik, 2015). We present the sharp regression discontinuity design estimates for the effect of the banks identified as systemically important (O-SII) on their ROA. The dependent variable consist of the ROA of the individual banks in percentage of assets. In this regression we analyze the effect of the marginally higher treatments. Thus, we consider the distances of the score from the different threshold to which the bank is assigned for incremental O-SII capital requirements. Local linear regressions with a triangular kernel using both the diffenrent optimal bandwidthsare used (cerrd, cetwo, mserd and msetwo). Covariates include: risk-weighted assets (in logs) and the amount of capital requirements that the banks is required to hold at t-1. Regressions include quarter fixed effects, country fixed effects, interacted time and country fixed effects and a polynomial of degree one in the score distance from the threshold. The data is trimmed at the 1nd and 99th percentiles for RWA and ROA, in order to reduce the influence of extreme values on the precision of the estimates.

Table 10: Continuity of covariates: Average effect of being identified as O-SII on the RWA

Coeff	S.E.	p - value	Eff. Left Obs.	Eff. Right Obs.	Tot Obs.	Bw Method	Controls
-0,04	0,96	0,97	697	48	1890	mserd	Yes
-0,30	1,01	0,77	165	41	1890	cerrd	Yes
-0,43	0,90	0,63	111	55	1890	msetwo	Yes
-0,45	1,01	0,65	53	48	1890	certwo	Yes
-0,03	0,96	0,97	693	48	1890	msesum	Yes
-0,42	1,00	0,67	143	41	1890	cersum	Yes

Notes: Test of continuity for covariates (Skorovron and Titiunik, 2015). We present the fuzzy regression discontinuity design estimates for the effect of the banks identified as systemically important (O-SII) on their RWA. In this regression we analyze the effect of the treatment *per se*. Thus, we only consider the distances of the score from the threshold that defines if the bank is an O-SII. The dependent variable consist of the RWA of the individual banks in billions of euros. Local linear regressions with a triangular kernel using both the diffenrent optimal bandwidthsare used (cerrd, cetwo, mserd and msetwo). Covariates include: ROA and the amount of capital requirements that the banks is required to hold at t-1. Regressions include quarter fixed effects, country fixed effects, interacted time and country fixed effects and a polynomial of degree one in the score distance from the threshold. The data is trimmed at the 1nd and 99th percentiles for RWA and ROA, in order to reduce the influence of extreme values on the precision of the estimates.

Appendix: Covariates Continuity Test

Table 12: Continuity of covariates: Average effect of being identified as O-SII on unemployment

Coeff	S.E.	p - value	Eff. Left Obs.	Eff. Right Obs.	Tot Obs.	Bw Method	Controls	FE
-0,11	0,08	0,19	87	38	1890	mserd	Yes	
-0,06	0,18	0,75	50	31	1890	cerrd	Yes	
-0,07	0,10	0,50	66	41	1890	msetwo	Yes	
-0,02	0,19	0,90	45	38	1890	certwo	Yes	
-0,16	0,08	0,04	106	41	1890	msesum	Yes	
-0,07	0,16	0,66	50	31	1890	cersum	Yes	

Notes: Test of continuity for covariates (Skorovron and Titiunik, 2015). We present the fuzzy regression discontinuity design estimates for the effect of the banks identified as systemically important (O-SII) on their capital requirement at t-1. In this regression we analyze the effect of the treatment *per se*. Thus, we only consider the distances of the score from the threshold that defines if the bank is an O-SII. The dependent variable consist of the capital requirement at t-1 of the individual banks in percentage of RWA. Local linear regressions with a triangular kernel using both the diffenrent optimal bandwidthsare used (cerrd, cetwo, mserd and msetwo). Covariates include: risk-weighted assets (in logs) and ROA. Regressions include quarter fixed effects, country fixed effects, interacted time and country fixed effects and a polynomial of degree one in the score distance from the threshold. The data is trimmed at the 1nd and 99th percentiles for RWA and ROA, in order to reduce the influence of extreme values on the precision of the estimates.

Appendix: RDD Robustness Check with placebo threshold

Table 14: Average effect of O-SII identification on voluntary buffer: RDD with a Placebo Cutoffs

Coeff	S.E.	p - value	Eff. Left Obs.	Eff. Right Obs.	Tot Obs.	Bw Method	Controls
-0,27	0,16	0,09	479	53	1712	mserd	Yes
-0,31	0,17	0,06	129	36	1712	cerrd	Yes
-0,23	0,17	0,18	642	48	1712	msetwo	Yes
-0,27	0,17	0,11	497	36	1712	certwo	Yes
-0,31	0,17	0,06	129	36	1712	msesum	Yes
-0,27	0,16	0,09	479	53	1712	cersum	Yes

Notes: Falsification test for our in the case of the sharp RDD (Cattaneo, Idrobo and Titiunik, 2019). This test replaces the true cutoff value by another value at which the treatment status does not really change, and performs estimation and inference using this artificial cutoff point. The expectation is that no significant treatment effect will occur at placebo cutoff values. The dependent variable consist of the voluntary buffer of the individual banks. In this regression we analyze the effect of the marginally higher treatments. Thus, we consider the distances of the score from the different threshold to which the bank is assigned for incremental OSII capital requirements. The dependent variable consist of the voluntary buffer of the individual banks. Local linear regressions with a triangular kernel using both the diffenrent optimal bandwidths are used (cer-sum, mse-sum, cerrd, cetwo, mserd and msetwo). The results are ordered by size of the bandwith. Covariates include: risk-weighted assets (in logs), ROA and the amount of capital requirements that the banks is required to hold at t-1. Regressions include quarter fixed effects, country fixed effects, interacted time and country fixed effects and a polynomial of degree one in the score distance from the threshold. The data is trimmed at the 5nd and 95th percentiles for voluntary buffer and at the 1nd and 99th percentiles for RWA and ROA, in order to reduce the influence of extreme values on the precision of the estimates.

Appendix: Cerulli and Ventura (2019) parallel trend F - test for joint significance on the leads

Table 17: Parallel trends

	P-value
F(2, 257)	0.58
Prob > F	0.5622

Notes: This table reports the results for the Cerulli and Ventura (2019) parallel trend F-test for the joint significance on the leads. This test is constructed by estimating the dynamic regression, $Y_{i,t} = \mu_{i,j} + \lambda X_{i,t} + \beta_{t+2} D_{i,t+2} + \beta_{t+1} D_{i,t+1} + \beta_t D_{i,t} + \beta_{t-1} D_{i,t-1} + \beta_{t-2} D_{i,t-2} + \varepsilon_{i,t}$, where $Y_{i,t}$ represents the outcome variable of interest, $\mu_{i,j}$ represents the fixed effects, $D_{i,t}$ represents the binary treatment (at different points in time) and $X_{i,t}$ is a matrix containing the matching covariates, which are the CET1 voluntary buffer, the logged risk-weighted assets and the country's unemployment rate. The coefficients for the leads β_{t+2} and β_{t+1} are jointly tested for significance. Since the test fails to reject the hypothesis of the lead coefficients being statistically different than zero, it is assumed that $Y_{i,t}$ is determined by the contemporaneous and lagged values of the treatment, and hence the necessary condition for the existence of the parallel pre-treatment trends holds.

Appendix: Durbin-Hausman test

Table 15: Durbin–Wu–Hausman test

	Test Ho
χ^2 (18)	52.89
Prob $> \chi^2$	0

Notes: The Hausman test can be used to differentiate between fixed effects model and random effects model in panel analysis. In this case, it is rejected the null hypothesis that supports the use of the Random effects (RE) and is confirmed the alternative hypothesis that suggests to use Fixed effects (FE) as it is at least as consistent and thus preferred.When we reject the null hypothesis, it means that the coefficient b_1 is inconsistent.

Appendix: Fixed effect estimator for with a perfectly balanced sample

Table 16: Fixed effect estimator for with a perfectly balanced sample

VARIABLES	(1) Model 1	(2) Model 2	(3) Model 3
Intensity of treatment	-0.0980	-0.302**	-0.424***
	(0.0717)	(0.127)	(0.139)
Constant	-0.0503***	0.285	0.175
	(0.00654)	(1.408)	(1.707)
Observations	2,628	1,399	1,352
R-squared	0.072	0.059	0.076
Number of banks	186	173	169
Controls	NO	YES	YES

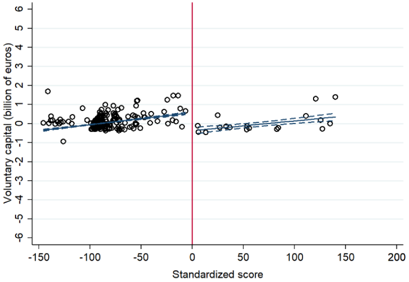
Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Notes: Estimates for the effect of O-SII identification on voluntary buffer for a perfectly balanced sample. We deleted the observations for which we did not have all the quarters. The dependent variable is the voluntary buffer in billions of euros. The estimates are conditional on the following controls: the logarithm of the RWA and the level of ROA. All the variables are trimmed 5 percentage up and down. The estimates are obtained using bank and quarter fixed effects. The standard errors in parentheses are clustered by bank. ∗ ∗ ∗, ∗∗, and ∗ denote significance at the 1, 5 and 10 percent level, respectively.

Appendix: Results RDD

Effect of receiving an O-SII buffer on banks' voluntary buffer

Figure 5: Level voluntary buffer of banks close to the threshold



Notes: the graph represent the effect of receiving a O-SII requirement vs not receiving it. A fuzzy RDD is used to deal with the experts judgment. The vertical axis displays the outcome variable. It is the voluntary buffer in billions of euros. The data is presented in deviations from the mean for each bucket. The variable is trimmed 5 percent up and down. The horizontal axis measures the score distance from the threshold. 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 95percent confidence interval.

Appendix: Results RDD

Effect of receiving an O-SII buffer on banks' voluntary buffer

Table 4: Average effect of being identified as O-SII on voluntary buffer (Fuzzy RDD)

Coeff	S.E.	p - value	Eff. Left Obs.	Eff. Right Obs.	Tot Obs.	Bw Method	Controls
-2,43	1,47	0,10	109	34	1798	cersum	Yes
-2,33	1,64	0,16	172	34	1798	msesum	Yes
-2,40	1,65	0,15	118	34	1798	cerrd	Yes
-2,44	1,14	0,03	66	24	1798	certwo	Yes
-2,13	1,44	0,14	311	41	1798	mserd	Yes
-2,39	1,64	0,15	118	34	1798	msetwo	Yes

Notes: We present the fuzzy regression discontinuity design estimates for the effect of the banks identification as systemically important (OSII) on their voluntary buffer. In this regression we analyze the effect of the treatment *per se*. Thus, we only consider the distances of the score from the threshold that defines if the bank is an OSII. The dependent variable consist of the voluntary buffer of the individual banks. Local linear regressions with a triangular kernel using both the diffenrent optimal bandwidths are used (cer-sum, mse-sum, cerrd, cetwo, mserd and msetwo). The results are ordered by size of the bandwith. Covariates include: risk-weighted assets (in logs), ROA and the unemployment ratio. The result present clustered errror terms at bank level. The data is trimmed at the 5nd and 95th percentiles for voluntary buffer and at the 5nd and 95th percentiles for RWA and ROA, in order to reduce the influence of extreme values on the precision of the estimates.

But, when the banks receive an O-SII buffer *per se*, they do not use their voluntary buffer to satisfy the capital requirement, without raising new capital for it.

Effect of marginally higher O-SII requirement by bucket on voluntary buffer - 1 quarter

Table 5: Effect of marginally higher the O-SII bucket on voluntary buffer - one quarter

Coeff	S.E.	p - value	Eff. Left Obs.	Eff. Right Obs.	Tot Obs.	Bw Method	Controls
-1,40	0,49	0,00	8	5	63	cersum	Yes
-1,17	0,54	0,03	9	5	63	msesum	Yes
-1,38	0,49	0,00	8	5	63	cerrd	Yes
-2,03	1,13	0,07	7	5	204	certwo	Yes
-1,12	0,54	0,04	9	6	63	mserd	Yes

Notes: We present the fuzzy regression discontinuity design estimates for the effect of the banks identification as systemically important (OSII) on their voluntary buffer on the quarter of the notification and implementation of the buffer. In this regression we analyze the effect of the treatment *per se*. Thus, we only consider the distances of the score from the threshold that defines if the bank is an OSII. The dependent variable consist of the voluntary buffer of the individual banks. Local linear regressions with a triangular kernel using both the diffenrent optimal bandwidths are used (cer-sum, mse-sum, cerrd, cetwo, mserd and msetwo). The results are ordered by size of the bandwith. Covariates include: risk-weighted assets (in logs), ROA and the unemployment ratio. The result present clustered errror terms at bank level. The data is trimmed at the 5nd and 95th percentiles for voluntary buffer and at the 5nd and 95th percentiles for RWA and ROA, in order to reduce the influence of extreme values on the precision of the estimates.