
“Systemic banks, capital composition and CoCo bonds issuance: The effects on bank risk”

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Abstract

This paper shows that systemic banks are prone to increase their regulatory capital ratio through a decline in risk-weighted assets density and an intense use of lower level capital. The market access of systemic banks, and the fact that they were singled out for higher capital requirements seem to have biased them towards lower level capital, consistent with the theory that asymmetric information drives capital decisions. These effects are particularly strong for institutions that had a rather low level of capitalization at the start of the period and for those that exhibited a strong use of Additional Tier I capital before the regulatory changes. Strict capital composition requirements for firms with lower buffers would be an improvement.

JEL classification: G12,G21, G28.

Keywords: Contingent capital, banking regulation, risk-taking incentives, asset substitution, systemic risk.

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1. Introduction

This paper analyzes the effect of regulatory capital requirements for systemic banks on their capital structure. Since 2008, the regulation has tightened across all banks, with the introduction of stricter capital requirements for financial institutions. This was based on the idea that policymakers had that insufficient capital had made firms vulnerable (see, e. g., Admati and Hellwig, 2014; and Kashkari, 2016) and led to public bailouts.

One aspect of the regulation that was particularly heeded was the effect of systemic banks. The failure of these banks can have adverse effects on the overall financial system and spread on to the sovereign (see, e. g., Singh *et al.*, 2016)¹. As a result, they benefit from an implicit protection by the sovereign. Regulators have pushed regulation that improves the resiliency of these financial institutions, increasing their capital requirements (Hanoun, 2010) and thus lowering the probability that they will be bailed out and the eventual size of a bailout package (Calderon and Schaeck, 2016; Duchin and Sosyura, 2014 and Giannetti and Simonov, 2013).

We examine how systemic institutions have differed from other institutions in their approach to strengthening their equity ratios. Their approach may differ for several reasons. First, capital regulation is stricter with systemic institutions, in particular through the systemic surcharge, which affects only the highest level of capital (Common Equity Tier 1, CET1) and through certain requirements, like the total loss-absorbing capacity (TLAC) that pertain to overall capital and loss absorbing liabilities. This may lead banks to diversify their sources of capital. In particular, they may want to avoid further dilution of equity holders and so increase the issuance of debt-like capital. This may stem from a willingness to reduce the pressure on their return on equity (ROE).

Secondly, given the implicit bailout from authorities, systemic institutions have a tendency to use debt like instruments, in which they benefit from a subsidy (see Acharya *et al.*, 2013; Haldane and Madouros, 2012; or Deangelo and Shchultz 2013, among others), lowering their cost of debt relative to their cost of capital. This means that, *ceteris paribus*, systemic firms are more likely to use debt like instruments when they can choose how to boost their regulatory capital. In particular, meeting leverage ratios and TLAC requirements can lead to such an increase, but not particularly for the systemic surcharge.

Systemic banks are prone to high leverage (see, e. g., Haldane, 2009; and International Monetary Fund, 2009), and certain debt instruments like the Contingent Convertibles (CoCos) are almost exclusively used by these banks². This can be related to the advantages conferred by the size of the banks, which allows them more market access. Given the literature finds that CoCos are priced as debt and do not dilute original shareholders (Berg and Kaserer, 2015), one can expect systemic banks to use CoCos heavily.

We attempt to understand how systemic banks are more likely to meet their capital requirements through lower level capital than other banks. Our particular focus is on how

¹ Sovereign risk can also affect bank risk. Based on these linkages, some authors (Brunnermeier *et al.*, 2011 and Reichlin, 2013, among them) have described the development of a ‘diabolic loop’ as the major cause of the crisis in euro area countries.

² For an excellent primer on the CoCos, see Avdjiev *et al.* (2013).

banks have reacted to the regulatory changes implemented since 2009, and that have generally led to higher capital ratios. We focus particularly on the biases that financial institutions have had to use lower level capital. This is important, as the holders of lower level capital are often other financial institutions (Avdjiev *et al.*, 2013). As a result, from a financial stability perspective, understanding who issues lower capital level, and the effects it has on its behavior is important.

We propose a difference in difference estimation, using an approach similar to that of Schepens (2016) that was first fleshed out by Rosenbaum and Rubin (1985). A flurry of new regulation has affected banks since 2009. Of particular importance have been the rules of tax deductibility of CoCos, approved in the UK in 2013, and used by many banks in the euro area since then. We use a modified propensity score matching methodology based on a probit model, in order to construct a robust counterfactual to the banks that made it into the systemically important financial institution (SIFI) list, which we compare with banks that behaved similarly as determined by the probit model. We also use those banks that had similar government support when the first list of global systemically important banks (GSIFIs) was announced. This way we obtain a homogeneous sample. From there, we test how systemic banks adapted their capital ratios after their inclusion on the SIFI list and, secondly, to the other regulatory practices, like the change in the tax treatment of CoCos.

The first main finding of this paper is that accounting-based equity ratios at systemic banks have not behaved very differently from overall banks. In fact, the regulation has led them to become lower. However, systemic banks have improved their regulatory ratios through three methods. First, by a reduction in the density of risk weighted assets, which has been particularly intense at systemic banks.

Secondly, our results suggest a high propensity to use lower level capital, and in particular CoCos, which increased when the market was liberalized after 2013 a tax change in British law made these more attractive. We find that CoCo issuance has been particularly intensive at systemic banks. This pattern can be extended to all lower level capital, such as Tier 2 (T2) capital, which increases at systemic institutions since after 2011, specially at firms that had less capital at the beginning of the period. This would be consistent with pecking order theory and asymmetric information theory of bank capital.

Third, we show that various risk measures suggest that bank risk increased after the regulation was passed, even though the intensity of risk-weighted assets (RWA) decreased. This is particularly true for banks that were relatively low capitalized in 2011. These banks showed, *ceteris paribus*, a higher propensity to capitalize through lower level capital. This finding would suggest that one of the unintended consequences of the push to increase capital ratios may have been a deterioration of the composition of capital and riskier banks than was intended.

To the best of our knowledge, it is the first paper to study empirically how the regulation affected the decisions of systemic institutions and that looks at the composition of their capital. We contribute to several strands of the literature. First, our finding suggests that systemic banks exploited the leeway in capital requirements to use more debt-like instruments, in line with the theory that asymmetry of information and ROE targeting guide bank capital decisions. Both of these theories suggest that banks increase the risk

of the portfolio, particularly if their starting level of capital is low, which is consistent with our results.

This paper contributes to the literature on how banks choose their equity ratio and how they respond to the different incentives found in the regulation. The optimal capital structure has been empirically studied by Marcus (1984), Flannery and Rangan (2008), Greenlaw *et al.* (2008), Brunnermeier and Pedersen (2009), Gropp-Heider (2010), and Schaeck *et al.* (2011), among others. The importance of the issue stems from the role of the capital structure in determining bank performance, in particular in crisis times (Berger and Bouwman, 2013; and Berger *et al.* 2016).

De Jonghe and Öztekin (2015) and Schepens (2016) argue that the way banks adjust their capital ratios depends on both the regulatory environment and the macroeconomic conditions. Our framework also allows for sluggish capital adjustment, in line with their results.

Acharya *et al.* (2013) finds that banks benefit from a subsidy, although he finds that as different bank bailouts were implemented, market discipline became laxer for all banks. That large banks are more prone to leverage is a well-established finding in the literature (see, e. g., De Jonghe and Öztekin, 2015; and Schepens, 2016).

However, what is surprising is that few papers have studied how banks determine the composition of capital one exception is Demirguc-Kunt *et al.* (2013). This is all the more relevant as a growing body of literature is showing that the composition of capital matters. Chan and Wijnbergen (2016) have shown that CoCos, which were designed to avoid having firms raise capital in times of stress (see Flannery, 2010), can actually have adverse consequences on bank health and induce negative incentives. As Chan and Wijnbergen (2016) and Berg and Kaserer (2015) show, this depends crucially on the contractual design of the Coco. Worryingly, they find that the contractual design of most CoCos does generate perverse incentives. That the systemic capital requirements led to more intense use of CoCos is, therefore, a point of concern.

Our results are consistent with different channels through which capital can affect risk taking. Horvath *et al.* (2014) point out that higher leverage induces higher risk taking through moral hazard and asymmetric information. In his view this is due to the fact that debt holders have less ability to monitor managers than equity holders. In his model, there are signs that banks tamper with RWA density. Stricter requirements lower RWA density but other risk measures suggest that they do not change the risk profile of the bank. This is line with our finding that while stricter requirements led to lower RWA density, they did not lead to lower risk at these banks.

Laeven and Levine (2009) suggest stricter regulations can lead to higher bank risk depending on bank characteristics. This finding is consistent with the different reaction to a rise in capital requirements for banks. Banks that, *ex ante* had less capital are likely to remain less capitalized than peers after the regulation of stricter requirements is passed.

We also provide evidence that supports the finding by Louri and Pagratis (2014) that banks target a certain level of ROE (see also Haldane, 2009). In such a context, banks tend to overshadow the effect of higher requirements in making banks safer and the buffers available, and react increasing the risk of the portfolio in an effort to maintain

their ROE. This would suggest that banks react to higher capital requirements trying to minimize the dilution of existing stockholders.

The GSIFI list and the increase in regulatory capital requirements provide the grounds for an experiment to understand how banks react to such shocks. In particular, the fact that certain institutions characterized by their size, complexity and interconnectedness were asked to do more can shed some light on the incentives to use lower level capital and the effect on bank risk taking of these changes.

The rest of the paper is organized as follows. Section 2 reviews recent regulatory initiatives that pertain to systemic banks' capital ratio. Section 3 introduces our empirical model. The data and empirical results are reported in Section 4. Finally, Section 5 offers some concluding remarks.

2. The regulation

The new capital regulation forces banks to increase their capital ratios. Since the financial crisis, several initiatives have led to these higher capital requirements. The various initiatives are designed to tackle different aspects of bank regulation.

The systemic surcharge specifies that banks must increase the CET1 capital ratio. The magnitude of the increase can be up to 2 percentage points. The list of systemic banks affected by the regulation is published yearly since 2011. Banks are affected gradually by this, and need to increase their CET1 ratio by 2019.

Other initiatives that do not differentiate amongst levels of capital but rather set an overall requirement is the TLAC. The TLAC sets an overall level of loss absorbing liabilities that the GSIFIs must hold. These liabilities include capital and long term unsecured debt. The level of these instruments is based on risk-weighted assets and the range is 16% to 20%.

The leverage ratio, binding for all institutions, also does not differentiate across capital quality. Finally, there are requirements in terms of the ratio that each of the capital tranches must meet. As a result, banks have in general, and particularly for systemic institutions, to increase their capital ratios substantially since the post crisis period. However, they have leeway in terms of the pace and the quality of the capital they will increase.

Some banks have increased their capital ratios through the use of AT1 capital. This capital bucket is composed mainly of contingent convertible capital, which counts toward the Tier 1 (T1) capital. This is debt issued by banks, which can be converted into capital at a pre specified conversion ratio once a trigger, generally set at a solvency ratio. In order to be considered AT1, the solvency ratio must be above a certain threshold.

Much of this increase in AT1 has been through CoCos. While CoCos were generally seen as a good idea that would reduce the pro-cyclicality of capital regulation (see Flannery, 2010; Coffee, 2011; and Calomiris and Herring, 2012, among others), they have their difficulties. However, recent experience suggests that there are risks: stockholders may ask for a larger net present value (NPV) to accept projects when close to the trigger point: if they feel they will have to share the returns with new equity holders, they will increase the required return of projects so as to make up for the dilution of capital. This is lower bank incentives to lend in difficult times.

Secondly, equity holders at bank will be willing to accept greater asset volatility, as they know that any losses will be carried on at least partially by the CoCo holders. As a result, banks that issue many CoCos will be riskier.

CoCos have also shown to be subject to substantial regulatory uncertainty, which explains some the volatility in their prices. This uncertainty pertains both to coupon payments and to their placement in the capital structure once resolution is implemented. The first was related to the uncertainty regarding whether CoCo coupon payments would be subject to maximum distributable amount (MDA) requirements, which would have rendered more difficult the payment of coupons of firms in difficulty.

A second source of uncertainty stems from the difficulty for investors to estimate how close banks are to the trigger point. In particular, given that the trigger point is usually a level to T1 capital, and that firms are not forced to make their levels of Pillar 2 capital required public, it is theoretically difficult to estimate the

Part of this was solved when the requirements for the MDA were clarified (Chance, 2016). However, an essential element of uncertainty stems from the fact that banks are not forced to disclose their Pillar 2 capital. As a result, a coco holder can have trouble understanding how far it is from the trigger point. This makes pricing of CoCos difficult, and so prone to volatility.

Large banks have been the largest issuers of hybrid instruments in general. This is explained by both the need for a certain size of the issuer that can mitigate some of the risks that arise from the hybrids and, secondly, the fact that systemic banks had a larger regulatory pressure to strengthen their capital ratios.

If being systemic, and in particular, being added to the list of GSIFIs confers, first, tougher capital requirements, and second, a certain advantage in issuing debt like instruments, banks will have an incentive to search for lower level capital. If these incentives are strong enough, banks may, as a result, end up being weaker than originally thought, just because they now have to face the effects of lower level capital.

Understanding the determinants of the structure of capital is all the more important given the relevance of the issue for financial stability. Most CoCos are held by other banks. Given their asymmetric risk profile, understanding what leads institutions to issue them will shed light on one of the factors of instability for the financial system. Such is the purpose of our empirical model.

3. Empirical model

We run a regression of the form shown below using the generalized method-of-moments (GMM) estimator proposed by Blundell and Bond (1998). The basic regression model is the following:

$$ETA_{i,t} = \alpha + \beta_1 Treated_{i,t} + \beta_2 Post_t + \beta_3 Treated_{i,t} * Post_{i,t} + \beta_4 X_{i,t} + \varepsilon_{i,t} \quad (1)$$

where $ETA_{i,t}$ is the equity ratio of bank i at time t , defined as equity over total assets; $Treated_{i,t}$ is a dummy that equals one for a bank in the GSIFI list each year (treatment group indicator); $Post_t$ is a dummy indicator equal to one in the post-treatment period

(2013–2015 in our main regression); and $X_{i,t}$ represents a set of explanatory variables that have been consistently seen as important bank capital structure determinants.

4. Data and empirical results

4.1. Data

The data consists of 260 listed financial institutions in Europe. The sample is from 2000 to 2015. Some regulatory ratios are not available for the whole sample, which limits the samples used in some cases.

4.2. Control group

For the appropriate estimation of the difference in differences model, the selection of the control group is fundamental. The parallel path hypothesis states that the control group must be such that if there had been no policy intervention, then both groups would have evolved in the same manner.

Our control group is, ideally, those institutions perceived by the market to have the same backing as the government, but which were later not classified as systemic and so did not have to increase their capital ratios so much. We would expect these institutions to benefit from the subsidy initially, but not after the list was made public.

They can also be expected to have less pressure in increasing their capital ratios, given that they are not subject to the requirements that were specific to systemic institutions. And the fact that they were not classified as systemic means that while they may be similar to systemic institutions, when they had to raise their capital ratios, they did not have the bias towards debt issuance, as they had less pressure from equity holders.

We employ two methods to determine the control group, which yield similar results. First, as shown in Table 1, we run a probit model, where the dependent variable is a dummy that is 1 when the bank is included in the GSIFI list. The explanatory variables of this probit model are the characteristics that should define systemic banks: size (total assets), complexity (proxied by the weight of non-interest income in total income) and connectedness [calculating the conditional value at risk (CoVaR) of the firm: its contribution to the overall value at risk (VaR) of the system]. Finally, we introduce interest income over total income as a measure of a bank's complexity (IRINCOME). Following Schepens (2016), we take the nearest neighbor of each of the systemic institutions, selecting three institutions for each systemic one.

Table 1: Probit results

Dependent Variable: SYSTEMIC				
Variable	Coefficient	Std. Error	z-Statistic	Prob.
COVAR	2.3	0.35	6.53	0.05
LASSETS	1.6	0.16	9.75	0
IRINCOME	-0.4	0.07	-6.66	0
C	-32.1	3.24	-9.91	0
R ²	0.60			
Total obs	640			
Sample	2011-2015			
Method	ML			

Notes:

The dependent variable is a dummy that equals 1 for each bank each year that it is included in the G-SIFI list.

COVAR indicates the CoVar of each firm. LASSETS the log of total assets and IRINCOME interest income over total income.

Secondly, and as a robustness check, we use as a control group those institutions that in 2011 (when the first list of GSIFI was made public) had the highest Fitch support rating. Various tests suggest that the control group meets the parallel path hypothesis. We employ two methods to test this.

First, the residuals of the probit regression for institutions in our control group is not significantly different from 0, suggesting that by reducing the sample we are using a group that is rather similar to the systemic institutions.

Secondly, the statistics on the control group provide evidence that our selection algorithm is effective in creating a control group. The pre 2011 level of most of the variables of interest [in particular additional Tier 1 (AT1) securities] is not significantly different from that on the GSIFI list, even though the overall sample is (see Table 2). This is true for the main variables of interest. However, while there is a remaining significant difference in terms of size.

Table 2: Equality of means test for systemic institutions and non-systemic ones

	AT1	ETA	LASSETS	LT2	LHYBRID	RWAIN	ROAA
FULL SAMPLE	0	0	0	0	0	0	0.05
CONTROL GROUP	0.19	0.72	0	0	0.3	0.09	0.97

Notes:

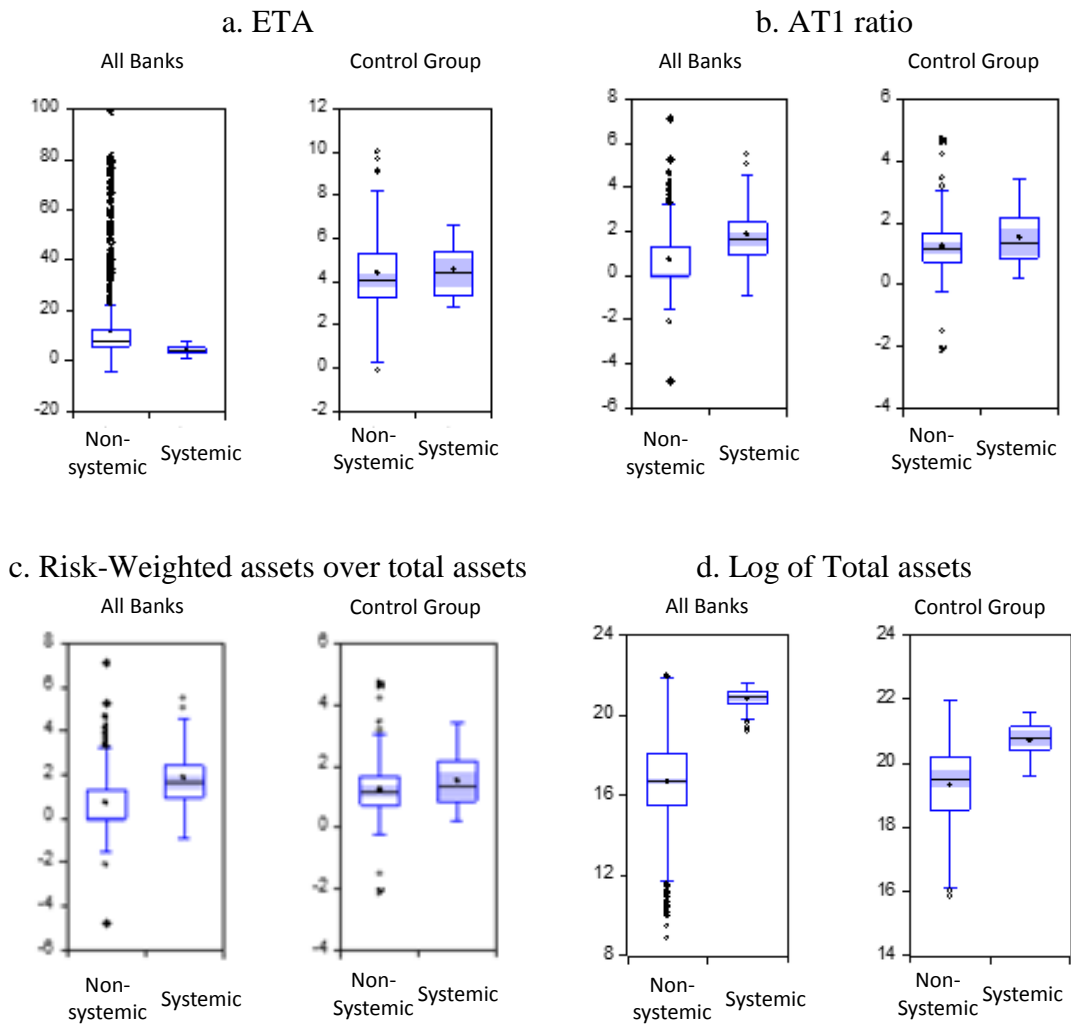
Based on pre-2011 data.

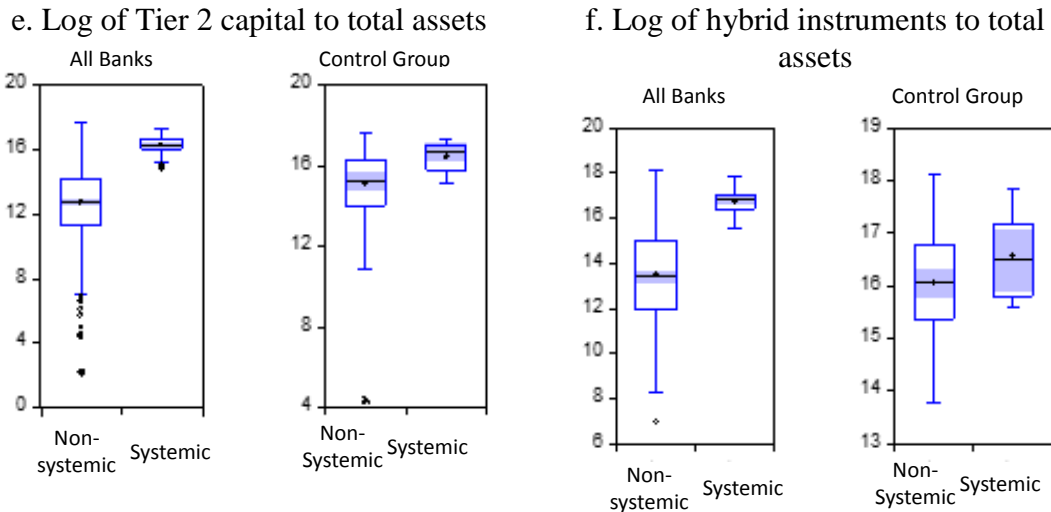
The number shown is the p-value of the test.

Yet as the box plots show, this difference is greatly reduced when we consider only our control group. Figure 1 depicts how the distribution of different variables changes according to the sample. In particular, for each variable of interest (the ETA ratio, AT1 to total assets, RWA intensity, the log of total assets, the log of Tier 2 to total assets ratio,

the log of hybrids to total assets and the return on average assets (ROAA)), we present two charts. The chart on the left compares the distribution of that variable for the whole sample of banks and those in the SIFI list. The chart on the right compares the distribution of that variable for our control group and those in the SIFI list. As can be seen, there is much more overlap with the control group than with the overall sample of banks, providing further evidence that our control group renders a better counterfactual than the overall sample.

Figure 1: Box plots (2000-2011)





We estimate equation (1) with a lagged dependent variable to correct for autocorrelation, making use of the Blundell-Bond's GMM estimator to correct for the possibility of a bias from using a lagged dependent in a panel set up. Furthermore, we employ random cross section effects, in line with the results of a Hausman test.

Regarding $X_{i,t}$, we have considered the following variables: First, the lagged equity to assets ratio. This is in line with the use in the literature that banks adjust their capital ratios sluggishly, as they use a mix of passive adjustment (through retained benefits) and active adjustment (through equity raising or changes in risk weight assets, be it through changes in the average risk weight or on assets).

Secondly, we use as a control banks profitability, proxied by the return on average assets (ROAA). The coefficient on this variable is uncertain. On one hand, higher profitability should lead to higher capital ratios, as retained earnings lead to passive increases in the capital ratios. On the other, more profitable banks have a lower probability of distress and higher taxable income. This will increase their incentives to use more debt, which should be relatively cheaper than capital.

Risk is captured by the ratio of risk weighted assets to total assets (RWAINTE), and in other specifications by the standard deviation of ROAA and the z-score. Generally, riskier banks should have higher capital ratios. This is because debt should be relatively more expensive for the riskier banks, and also because these banks will face higher capital requirements.

Thirdly, bank size will also determine the equity ratio through different channels. A priori, these channels point in different directions: on one hand, larger banks can diversify. This lowers the riskiness of their portfolio and so allows them to use less capital. On the other hand, larger banks are well known, and so may have access to larger pools of investors. As a result, they should have a lower cost of capital and so a larger equity ratio. We use the log of total assets (LASSETS) as a proxy for bank size.

Finally we introduce controls for the macroeconomic context (GDP and CPI), which should also affect bank capital decisions.

We use different time dummy variables to test how the process of adjusting equity ratios changed during the different steps of regulation. While the first SIFI list was published in 2011, we focus on the 2013-2015 period. This is meant to capture how the regulatory changes that took part in 2013 (regarding the fiscal treatment of hybrid instruments) changed the way SIFIs built up capital. This way, we show the new regulations regarding TLAC, and the ease in issuing Cocos from the changes in its tax treatment were used by systemic firms³.

The coefficients of interest are those associated with *Post*, *Treated* and the interaction term. These coefficients will indicate whether systemic institutions, had a certain bias in the way they determined their equity ratio of the different types of capital: We use two separate dates, to check the effect of different regulatory initiatives. First, 2011, after the first list of GSIFIs was made public, and, second, 2014. The latter reflects the legal changes to which Cocos were subject in many jurisdictions, which equated their tax treatment and equated them to debt, thus increasing their use.

4.3. Empirical results

The main results are shown in Tables 3 and 4. Table 3 reports the results of the regression when the control group is determined by the results of the probit model. Table 4 presents the results when the control group is composed of the banks that had the highest support rating by Fitch. We find that the systemic regulation did not induce higher ETA ratios. In fact, some specifications suggest that the systemic regulation led to a lowering of ETA ratio. However, overall solvency ratios may have increased by the reduction in RWA intensity. This finding is robust to the use of different control groups (i.e. by government support in 2011, by the probit result or by size). The similarity in findings for both groups can be found for the main results.

³ We also run robustness checks using a dummy variable from 2011 onward. These additional results are not shown here to save space, but they are available from the authors upon request.

Table 3: Regression results using the nearest neighbor criteria for determining the counterfactual

	ETA	LASSETS	LT2	LT1	LT2 Hybrid	AT1
LAGGED DEP	0.87 ***	0.95 ***	0.93 ***	0.80 ***	0.94 ***	0.94 ***
ROAA	0.31 ***	0.03 ***	0.03 ***	0.06 ***	0.02 ***	-0.01 ***
GDP	-0.33 ***	0.01 ***	0.14 ***	-0.02	0.12 ***	0.04 ***
CPI	-0.25 ***	0.015 ***	0.02 ***	-0.02 ***	0.02	0.02 ***
RWAIN	0.01 ***		0.00 ***	0.00 ***	0.00 ***	0.00 ***
Lassets	-0.01 ***		0.11 ***	0.19 ***	0.11 ***	0.01 ***
POST2013	0.22 **	-0.02 ***	-0.05	0.03	-0.08 **	0.00
SYSTEMIC	0.17	0.01 ***	-0.02	0.02	-0.03	-0.04
POST2013*SYSTEMIC	-0.39 **	-0.12 ***	0.18 ***	-0.03	0.16 *	0.20 ***
C	4.35	0.84 ***	-2.67 ***	-0.38	-2.59 ***	-0.56 ***
Number of observations	447	447	447	447	447	447
R squared	0.7	0.85	0.72	0.88	0.75	0.65
Bank RE	Yes	Yes	Yes	Yes	Yes	Yes
Method	GMM	GMM	GMM	GMM	GMM	GMM
Control group	PROBIT	PROBIT	PROBIT	PROBIT	PROBIT	PROBIT

Note: LAGGED DEP is the lagged dependent variable. The different determinants are the levels of capital. ETA shows the equity to assets ratio, LT2 the log of Tier 2 capital, LT1 the log of Tier 1 capital, LT2 hybrid the use of Tier 2 hybrid instruments and AT1 the level of additional Tier 1 capital

Table 4: Regression results using the Fitch support rating criteria for determining the counterfactual

	ETA	LASSETS	LT2	LT1	LT2 Hybrid
LAGGED DEP	0.85 ***	0.97 ***	0.95 ***	0.999 ***	1.02 ***
ROAA	0.54 ***	0.09 ***	0.13 ***	0.16 ***	0.16 ***
GDP	-0.85 **	-0.03 ***	-0.08	-0.05	-0.06
CPI	-0.3 ***	0.007 ***	-0.03	-0.03 ***	0 ***
RWAIN	0.01 ***	0.001 ***	0 ***	0.01 ***	0.005 *
Lassets	0.06 ***		0.19 ***	0.36 ***	-0.1
POST2013	0.08 ***	0.0001 ***	-0.23 ***	-0.06 ***	-0.2 **
SYSTEMIC	0.1 ***	0.011 ***	-0.08	-0.09 **	-0.23
POST2011*SYSTEMIC	-0.46 ***	-0.022 ***	0.44 ***	0.06	0.388 **
C	10.14	0.84	1.67	0.66	
Number of observations	280	280	280	280	155
R squared	0.7	0.85	0.74	0.88	0.65
Bank FE					
Method	GMM	GMM	GMM	GMM	GMM
Control group	FITCHSUPPORT1	FITCHSUPPORT1	FITCHSUPPORT1	FITCHSUPPORT1	FITCHSUPPORT1

Note: LAGGED DEP is the lagged dependent variable. The different determinants are the levels of capital. ETA shows the equity to assets ratio, LT2 the log of Tier 2 capital, LT1 the log of Tier 1 capital, LT2 hybrid the use of Tier 2 hybrid instruments and AT1 the level of additional Tier 1 capital. The sample here is the systemic institutions and those institutions that, before 2011, had the largest support rating by Fitch.

Secondly, systemic banks were more likely to increase the use of lower level capital. This includes T2 capital, hybrids and AT1 capital. This result is consistent with our hypothesis that systemic banks had a comparative advantage on these levels of capital and that they used it to boost their ratio.

The latter effect is found when we run the exercise setting the treatment period to start in 2011⁴, but becomes particularly strong for the period after 2013, consistent with the effect of the regulatory change mentioned before, which equated AT1 issuance to debt issuance for banks in the European Union. This finding is consistent with that of Schepens (2016), which suggests that firms adjust their financial structure in reaction to the tax treatment of the different instruments.

Finally, we find evidence that systemic banks were more likely to decrease assets in the period analyze, which served as another means to boost capital ratios.

The essential question that remains is what the effect of these changes was on bank risk. On one hand, higher AT1 issuance should lead to greater asset volatility (Berg and Kaserer, 2015) and induce bank weakness in times of stress. On the other, the decline in RWA intensity would suggest that bank risk declined.

We find some evidence that this has increased the risk of banks, as shown in Table 5. Risk factors like the SD of ROAA seem were negatively affected by the regulatory change. However, we find no increase of a worsening in the z score, defined as the ratio of profitability (measured as the Return On Average Assets, ROAA) over the standard deviation of ROAA for systemic institutions. As a result, overall, we find an inconclusive effect on bank risk. Systemic regulation may not have been effective in reducing bank risk.

However, this result is likely to depend on the level of *ex ante* capital at these institutions. We now test, with the same framework, how the results change when we consider the level of capital of institutions in the beginning of the period, by introducing a normalized ETA ratio (ET) as an interaction term. This is shown in Table 5 by the last term, which shows the interaction of the post 2013 dummy, the systemic banks dummy and ET, which shows the equity to assets ratio in 2013.

We find that higher capitalized used less AT1. This suggests that the drive to higher capital perpetuated the *ex-ante* differences in banks safety. The coefficient on AT1 is always at about 0.5, showing that systemic banks were more prone to use AT1. AT1 is defined as a ratio on total assets. We find low capitalized systemic banks were even more likely to use lower level capital (AT1, T2).

The reduction of RWA density was particularly important for lower capitalized institutions, as shown in Table 5. This suggests that these institutions tried to boost their capital ratios this way. This is not consistent with the increase in the standard deviation of ROAA, pointing to greater risk being taken on, in spite of the lower RWA intensity at the lower capitalized firms.

⁴ These additional results are not shown here to save space, but they are available from the authors upon request.

Table 5. Additional regression results using the Fitch support rating criteria for determining the counterfactual

	RWAIN	LASSETS	AT1	SDROAA	ZSCORE	LT2
LAGGED DEP	0.95 ***	0.98 ***	0.9 ***	0.77 ***	0.08 ***	0.76 ***
ROAA		0.02 ***	-0.0009 ***	0	-0.39 ***	-0.07 *
GDP	-0.23 ***	-0.01 ***	0.14 ***	-0.19 ***	-1.76 ***	-0.55 *
CPI	-0.38 ***	0.015 ***	0.04 ***	0.021	-0.88 ***	-0.03
RWAIN					-0.07 ***	
Lassets	0.04 ***			-0.03 ***	***	0.18 ***
POST2013	0.39 ***	-0.02 ***	0.08 ***	-0.11	-1.848 ***	-0.23 ***
SYSTEMIC	0.36 ***	0.01 ***	0.007	0.12	-0.044	-0.02
POST2013*SYSTEMIC	-1.06 ***	-0.02 ***	0.47 ***	0.12 ***	0.05	0.52 ***
POST2013*SYSTEMIC*ETI	0.2 ***	0.2 ***	-0.04 ***	0.011	0.15 ***	-0.1 ***
C	4.27 ***	0.84 ***	-1.59 ***	0.66	19.6	5.79 **
Number of observations	525	525	525	525	525	525
R squared	0.7	0.85	0.74	0.88	0.65	0.65
Method	GMM	GMM	GMM	GMM	GMM	GMM
Control group	FITCHSUPPORT1	FITCHSUPPORT1	FITCHSUPPORT1	FITCHSUPPORT1	FITCHSUPPORT1	FITCHSUPPORT1

Note: LAGGED DEP is the lagged dependent variable. The different determinants are the levels of capital. ETA shows the equity to assets ratio, LT2 the log of Tier 2 capital, LT1 the log of Tier 1 capital, LT2 hybrid the use of Tier 2 hybrid instruments and AT1 the level of additional Tier 1 capital. The sample here is the systemic institutions and those institutions that, before 2011, had the largest support rating by Fitch

We also find evidence that they reduced assets, and this was particularly true of the lower capitalized banks, consistent with lower capitalized banks being stingier with credit, and with the higher use of CoCos.

This is only true for the lower capitalized banks, which do show a decrease in their z score. It suggests a decline in RWA intensity was not a genuine decline in the risk of their portfolio.

Our results suggest that recent regulatory changes, combined with prevailing market access by these institutions has led to a sharp increase in the risk profile of their capital base, in particular for those banks that started off in a relatively weak position. Indeed the result of the tightening in regulation was an increase in bank risk for the lower capitalized institution.

The results are broadly in line with the literature. For instance, in terms of deleveraging without reducing assets for the whole sample are consistent with those of De Jonghe 2015. Our results also suggest there are lags in the correction of ETA ratios (consistent also with De Jonghe, 2015) and that these depend on both macroeconomic and bank specific characteristics. That lowly capitalized institutions react differently to deleveraging has been documented by Schepens (2016), and is confirmed by our results.

Less capitalized firms used lower level capital when asked to increase their capital ratios. This is consistent with these firms facing a higher cost of capital. It is consistent with Schepens (2016) finding that lower capitalized firms have a tendency to increase risk, as they are more prone to use debt. We add to those findings, by showing that not only are they prone to issue more debt, but rather, they also use lower level capital, which adds more risk their financial structure in times of stress.

In line with the literature, lower capitalized firms are found to be more prone to reduce lending when asked for higher capital requirements. They decreased the RWA intensity (more so than all systemic institutions, which did that too), however, the higher capital also led to lower z-score.

4. Concluding remarks

The drive to build up stricter capital requirements after the crisis should have positive effects. These requirements build up the buffers available to banks, lowering the risk of default. However, when dealing with systemic institutions, there is a substantial gap in terms of how these institutions react to more stringent capital requirements.

Some of the perverse effects identified in the literature become particularly acute at these institutions. In particular, we provide evidence that they prone to using lower level capital, consistent with pecking order theory and ROE targeting by firms.

As a result, bank weakness may actually have been enhanced by the new regulation. Further research is needed to understand the systemic effects of lower level capital. Their pricing, and in particular the spillovers to equity pricing can bring further difficulties. In addition, since most hybrid holders are banks themselves, the effects on financial stability can be worsened.

In this context, a further avenue for research involves the effects of capital requirements. Tight capital requirements, like for instance basing the requirements only on CET1 can bring the advantage that the destabilizing effects are avoided. However, if the effect that dominates is the ROE stabilization, then this effect may be counterproductive. From a welfare perspective, it should be important to understand which of the effects dominates.

The premium is then on regulators. Debt like capital has certain benefits for financial stability over CET1, but the fact is that their design has been bad for welfare and it seems to have been used by riskier firms. The latter need not be bad. However, firms that are badly capitalized should not use lower level capital, compensating it with more risk. In order to achieve this, a combination of larger buffers for riskier firms, more transparency regarding the key elements of capital, and strict regulation on the design and the magnitude of CoCos would be a solution.

The results presented in this paper should be of value to macro-prudential and monetary policymakers.

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