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Abstract

Frictions prevent banks to immediately adjust their capital ratio towards their desired and/or imposed level. This paper analyzes (i) whether or not these frictions are larger for regulatory capital ratios vis-à-vis a plain leverage ratio; (ii) which adjustment channels banks use to adjust their capital ratio; and (iii) how the speed of adjustment and adjustment channels differ between large, systemic and complex banks versus small banks. Our results, obtained using a sample of listed banks across OECD countries for the 2001-2012 period, bear critical policy implications for the implementation of new (systemic risk-based) capital requirements and their impact on banks' balance sheets.

JEL codes: G20, G21; G28

Keywords: capital structure, speed of adjustment, systemic risk, systemic size, bank regulation.

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1. Introduction

In the aftermath of the 2007-2008 global financial crisis, regulators have introduced stringent changes to the prudential regulation of banks, especially by redesigning existing frameworks for regulatory capital requirements and by tightening the supervision of the so called systemically important financial institutions (SIFIs), BIS (2010a, 2013). There is a rapidly growing literature analyzing the specific elements in the design of the Basel III capital requirements[4] (Cecchetti (2015), Dermine (2015), Repullo and Suarez (2013)) as well as their potential consequences for *bank performance* (Giordana and Schumacher (2012), Berger and Bouwman (2013), Admati et al. (2010)), *bank risk-taking* (Kiema and Jokivuolle (2014), Hamadi (2016)), *economic and financial stability* (Angelini et al. (2014), Rubio and Carrasco-Gallego (2016), Farhi and Tirole (2012), Acharya and Thakor (2016), Hanson et al. (2011), Brunnermeier and Pederson (2009)), and credit supply (e.g. Cosimano and Hakura (2011), Jimenez et al. (2017), De Jonghe et al. (2016), Kok and Schepens (2013), Francis and Osborne (2012), Ivashina and Scharfstein (2010)).

While this first stream of papers is interested in the equilibrium implications of capital requirements, there is another one that investigates the dynamics towards the new equilibrium. This other stream of bank capital research has analyzed how quickly banks can adjust their capital ratios and which mechanisms they can resort to (see e.g. Berger et al. (2008), Memmel and Raupach (2010), Öztekin and Flannery (2012), Lepetit, et al. (2015), De Jonghe and Öztekin (2015), Cohen and Scatigna (2016)).

We link these two strands of literature and aim to fill two specific gaps in the existing literature. First of all, we address the following questions: Are there differences in adjustment mechanisms and adjustment speed for leverage vis-à-vis regulatory capital requirements? Might they conflict? Second, while this first step results in unconditional, homogenous results describing average bank

[4] Regarding capital requirements, the most important innovations in Basel III are the introduction of a leverage requirement (next to risk-weighted capital requirements), a capital surcharge for systemically important banks and the introduction of a countercyclical capital buffer. The imposed changes aspire to achieve financial stability by increasing the resilience of banks to shocks and by forcing them to internalize systemic externalities.

behavior, we subsequently differentiate between SIFI banks and non-SIFI banks given the new regulatory and supervisory focus on the two groups. We analyze, both for leverage and risk-weighted capital ratios, whether systemically important financial institutions behave differently in terms of adjustment mechanisms and adjustment speed.

It is important to emphasize that, for both questions, we analyze the dynamics in banks' capital adjustment (mechanisms and speed) towards a bank-specific and time-varying optimal capital ratio. Such bank-specific and time-varying optimal capital ratios are determined by the regulatory minimum and banks' desire to hold a buffer over the minimum capital requirements. Both the requirement and the buffer are time-varying and bank-specific, and, unfortunately, cannot be disentangled as information on the former is not publicly available[5].

In the first part of the analysis, we focus on differences in adjustments of a leverage ratio (the equity-to-total asset ratio[6]) and two regulatory capital ratios (Tier 1 capital over risk-weighted assets and total capital over risk-weighted assets) for OECD banks. We follow the literature and estimate a partial adjustment model of bank capital towards a bank-specific and time-varying optimal capital ratio (see e.g. Berger et al., (2008), Memmel and Raupach (2010), Öztekin and Flannery (2012), Lepetit et al. (2015), De Jonghe and Öztekin (2015)). The partial adjustment model assumes that banks do have a target (or optimal) capital ratio, but that there might be frictions (such as adjustment costs) that prevent them from instantaneously adjusting towards the target. Hence, at each point in time, the actual capital ratio is a weighted average of the lagged capital ratio and the target capital ratio, where the weight is an indication of the magnitude of the frictions. It is ex-ante unclear whether the speed of adjustment should be higher for the regulatory capital ratios versus the leverage ratio. On the one hand, one could expect a faster adjustment for the Tier 1 and Total Capital ratio than for the leverage ratio given the regulatory focus on these measures at least during the sample period. On the other hand, because the set of adjustment

[5] Regulators can use Pillar 2 to impose bank-specific and time-varying capital requirements. However, these requirements are typically communicated privately to the bank and they are confidential. Evidence on the magnitude and variation in these requirements is available from Aiyar et al. (2014), who report a standard deviation of 2.2% in bank-specific capital requirements for the UK for the 1998-2007 period, or De Jonghe et al. (2016) who report a similar value for the standard deviation of bank capital requirements, due to time-varying and bank-specific pillar 2 requirements, for Belgian banks over the 2011-2014 period.

[6] We use the terms "leverage" and "equity-to-asset" interchangeably to refer to the unweighted equity-to-asset capital ratio.

mechanisms is smaller for the regulatory capital ratios vis-à-vis the leverage ratio, as not all types of equity count and because assets vary in risk weight[7], the opposite could be found. Our findings show that banks are more flexible and faster in adjusting the common equity capital ratio than regulatory capital ratios. More specifically, in our sample of listed OECD banks over the 2001-2012 period, the speed of adjustment for the non-weighted equity-to-asset capital ratio structure is 0.48, which is larger than the one for the Tier 1 capital ratio, 0.31, and the total capital ratio, 0.35. In economic terms, these speeds of adjustment correspond with half-lives[8] (the time required for banks to halve the gap between their actual capital ratio and their target) of 1.05, 1.88 and 1.59 years, respectively. To understand better why the speeds of adjustment differ, we subsequently investigate how banks achieve their adjustments towards their targets. The estimation procedure allows us to back out the estimated target capital ratio and hence also the gap between the target and the actual capital ratio. We then investigate growth rates in various assets classes, liability categories and types of equity, according to the sign of the gap for both the leverage and regulatory capital ratios. Facing an opportunity cost, overcapitalized (underleveraged) banks have no incentives to remain above their targeted capital ratio, i.e. hold a capital surplus over their target. Therefore, bank managers make proactive efforts to converge to their target by reducing their capital levels. For all capital specifications, we find that bank lever up by expanding assets, through an unrestrictive lending policy and risk-taking preferences, increasing liabilities both with long-term and short-term borrowings (except for the leverage ratio) and lessening equity growth, both internally (smaller amount of retained earnings) and externally (equity repurchasing and/or less equity issues). In contrast, when banks have a capital shortfall with comparison to their target, we find that undercapitalized banks de-lever by an aggressive growth reduction in all its subcomponents; i.e. loans and risk-weighted assets.

In the second part of the analysis, we investigate whether or not systemically important financial institutions behave differently in terms of capital structure adjustments. Although SIFIs and large banking groups are subject to prudential regulations and considerable research has pointed out their characteristics and performance (see e.g. Bertay et al. (2013), Barth and Schnabel (2013),

[7] For example, government bonds (of OECD countries) are securities that are easily adjustable, but have a zero risk-weight. They could help to adjust the leverage ratio, but not the regulatory capital ratios.
[8] The half-life is computed as log(0.5)/log(1- speed of adjustment).

Laeven et al. (2015)), how they manage their capital structure and rebalance to converge to their optimal capital levels remains an open question with important policy implications. Combining the insights from Bertay et al. (2013) and Barth and Schnabel (2013), we focus on four distinguishing aspects of SIFIs, which are their absolute size (natural log of total assets), their relative size (total assets over GDP), their systemic risk contributions (delta Conditional Value-at-Risk (ΔCoVaR)) and systemic risk exposures (Marginal Expected Shortfall (MES)). We also construct a systemic risk index based on the quintiles of such indicators. We find that systemically important banks adjust slower than other banks to their target leverage ratios but quicker to their regulatory target ratios. Moreover, our results suggest that systemic banks might be more reluctant to change their capital base by either issuing or repurchasing equity and prefer sharper downsizing or faster expansion. Any unexpected need for banks to raise capital ratios might therefore be more harmful for firms and households who are clients of such large institutions. To the extent that systemic banks account for a large portion of a banking industry (market share) the negative impact on the economy as a whole could also be more important.

The rest of the paper proceeds as follows. Section 2 presents information on the sample construction and variables of interest, in particular the various concepts of capital and the measures of (systemic) size and systemic risk. In Section 3, we examine and contrast the adjustment speed and adjustment mechanisms for various concepts of bank capital. Analyzing how and how quick SIFIs adjust their balance sheet in response to deviations between the actual capital ratio and the optimal capital ratio is performed in Section 4. Section 6 concludes.

2. Data: sample and variables

2.1. Sample selection

Because of the focus on systemically important institutions, which requires market-based data, we focus exclusively on banks that have publicly traded equity. For reasons of data availability and cross-country consistency, we limit the sample to listed banks headquartered in any of the OECD countries and analyze the 2001-2012 period, prior to the new rules introduced by Basel III in 2013 and the identification of globally systemically important banks (G-SIFIs) as well as stress tests performed by regulators, to better identify how banks have historically managed their leverage ratios and regulatory capital ratios[9]. We combine accounting and market data from various sources. We retrieve bank stock price information and other market data from Bloomberg. We obtain bank-level accounting data from Thomsen-Reuters Advanced Analytics and Bloomberg. We collect macroeconomic data from the OECD Metadata stats. Starting from the matched accounting and market data, we impose several selection criteria and cleaning conditions.

We drop banks with infrequently traded stocks and low variability in stock prices. More specifically, we disregard a stock if daily returns are zero over five rolling consecutive days. We also only regard bank stocks if more than 70% of the daily returns over the period are non-zero returns. Subsequently, all bank-specific variables are ratios, scaled by total assets, total income or total liabilities except bank size which is a variable defined in levels (logarithmic transformation of total assets). All variables are winsorized at the top and bottom 1 percent level to eliminate the adverse effects of outliers and misreported data. Information on the sample composition by country and by year can be found in panel A and B of Table 1.

[Insert Table 1 about here]

We end up with an unbalanced panel dataset of 567 banks[10], from the 28 major advanced OECD countries. It consists of 409 U.S. banks and 158 non-U.S. banks, among which 96 are European

[9] We end the sample period in 2012 in order to avoid interference with the implementation of the Basel III regulations (starting from 2013) that among other things introduced a leverage ratio as well as capital surcharges for systemically important banks. Doing so, we can study how banks treat regulatory capital ratios differently from plain leverage ratios in the absence of regulation on the latter. Moreover, we are able to study differential behavior by SIFIs and other banks in a period where the proposed methodologies for identifying G-SIFIs were not yet published for public consultation. These were published in January 2014.

[10] We use data on commercial banks, bank holding companies and cooperative and savings banks (S&L U.S. Thrifts included) which represent 65%, 23% and 11% of the sample, respectively.

(from 22 countries) and 22 are Japanese. Although we only consider publicly-traded OECD banks, our sample conveniently represents the U.S., euro area and Japanese banking sectors. The listed banks included in our sample account for approximately 73%, 52% and 31% of the total assets of all U.S., euro zone and Japanese banks recorded in BSI/Bloomberg statistics, respectively.

2.2. Bank capital, size and systemic risk

We focus on two types of capital measures. On the one hand, we consider the average non-weighted common equity ratio (leverage ratio), defined as common equity over total non-weighted assets. Blum (2008) argues that capitalization measures based on cruder risk-exposure proxies may be more relevant for stock market participants or debt holders, because risk weights may be viewed as highly opaque and uninformative. On the other hand, we also focus on capital ratios from a regulatory perspective (Basel II/III), by using the Tier1 regulatory capital ratio, defined as Tier 1 equity over total risk-weighted assets (RWA) and the total capital ratio, defined as the sum of Tier 1 and Tier 2 equity to total RWA.

In our analysis, we devote special attention to Systemically Important Financial Institutions (SIFIs). A first approach to capture whether banks are systemically important is assessing their size. Bertay et al. (2013) suggest the use of two proxies of systemic size, namely a bank's absolute size, defined as the logarithm of a bank's total assets, as well as a bank's relative size, defined as a bank's total assets over gross domestic product (GDP). Barth and Schnabel (2013) argue and document that bank size (be it absolute or relative) is not a sufficient measure of systemic risk because it neglects aspects such as interconnectedness, correlation, and the economic context. They suggest the use of market-based measures of systemic importance, such as the delta Conditional Value-at-Risk (ΔCoVaR), which captures the contribution to system wide risk of an individual bank, or a measure of an individual bank's systemic risk vulnerability/exposure to system wide distress such as the Marginal Expected Shortfall (MES). The difference between the two concepts is the directionality. The former assesses the extent to which distress at a bank contributes to system-wide stress, whereas the latter identifies the extent to which a bank's stock will lose value when there is a systemic event. We follow common practice and use the opposite of returns in the computation, such that losses are expressed with a positive sign. The MES and ΔCovaR will typically be positive and higher values correspond to larger systemic risk exposures and contributions. More information on the construction of these measures is in appendix A1 and the papers referenced therein. Finally, we also construct a SIFI-index by allocating bank-year observations in quintiles according to the four aforementioned characteristics (size, relative size, MES and ΔCovaR). More specifically, for each of the four size or risk metrics, we divide the sample in quintiles and give a score of one to banks in the lowest quintile, two in the second quintile and so on, with five for the highest. Subsequently, we take the sum of the scores to obtain an index that ranges from four to twenty, with the highest value representing the highest level of systemic importance that an individual bank can exhibit. This index provides a robust measure of systemic importance because it combines several measures of systemic risk and size in one metric.

Panel A of Table 2 reports definitions, sources and summary statistics on the bank-level capital ratios, systemic risk measures and the control variables we use in our estimations. The average equity-to-asset, Tier1RWA and Total capital ratios are 9.4%, 11.7% and 14.2%, respectively. Thus, on average, throughout the sample period banks' ratios remained above the regulatory minimum. Panel B of Table 2 presents the summary statistics of systemic risk and size measures at the individual bank level for the full sample period. The mean of the natural logarithm of total book assets is 8.17 and the median is 7.44 (which correspond to about $3 billion and $2 billion respectively). Although, we only consider publicly traded OECD banks, our sample still exhibits considerable size heterogeneity across banks as is clear from the standard deviation (2.313) and the range between the 5^{th} percentile and the 95^{th} percentile [5.585 to 13.085]. The relative bank size measure confirms the heterogeneity across banks and the presence of large banks relative to a country's economic importance. For example, relative size varies between 0.00% (fifth percentile) and 51.8% (95^{th} percentile) out of the domestic GDP, with a standard deviation of 19.6%. The summary statistics reveal that banks vary in terms of systemic importance. The average values of MES and ΔCoVaR are 1.69% and 1.55% but the systemic risk measures are disperse with standard deviations of 1.91% and 1.74%, respectively.

[Insert Table 2 about here]

In Table 2, Panel C, we also provide descriptive statistics for the rest of bank-level variables we use to examine the determinants of bank capital and capital adjustment. Overall, across the sample period and countries, we observe that the average bank has low credit risk (average loan loss provisions to total loans of 0.7%), is strongly reliant on retail market funding (89.6%), is reasonably liquid as indicated by the ratio of net loans to total deposits (108.5%), has a low amount of fixed assets (1.6%), is moderately diversified in terms of assets (average loans to assets is 69%) and revenue (average non-interest income share of 19.6%).

Table 3 presents pairwise correlations among all variables at the bank level.

[Insert Table 3 about here]

3. Leverage versus regulatory capital requirements: dynamic adjustment mechanisms

3.1. Inferring adjustment speeds and implied targets: a partial adjustment model

In a frictionless world, banks would always maintain their target capital ratio. However, if adjustment costs are significant, the bank's decision to adjust its capital structure depends on the trade-off between the adjustment costs and the costs of operating with suboptimal leverage (Flannery and Rangan (2006), Flannery and Hankins (2013)). To allow for sluggish adjustment, it has become common practice in the empirical (corporate and bank) capital structure literature to model leverage using a partial adjustment framework (see e.g., Flannery and Rangan (2006), Lemmon et al. (2008), Gropp and Heider (2010), De Jonghe and Öztekin (2015) and Lepetit et al. (2015)). In a partial adjustment model, a bank's current capital ratio, $K_{ij,t}$, is a weighted average (with weight $\lambda \in [0,1]$) of its target capital ratio, $K^*_{ij,t}$, and the previous period's capital ratio, $K_{ij,t-1}$, as well as a random shock, $\varepsilon_{ij,t}$:

(1) $$K_{ij,t} = \lambda K^*_{ij,t} + (1-\lambda) K_{ij,t-1} + \varepsilon_{ij,t}.$$

Each year, the typical bank closes a proportion λ of the gap between its actual and target capital levels. The smaller the lambda, the more rigid bank capital is, and the longer it takes for a bank to return to its target after a shock to bank capital. Thus, we can interpret λ as the speed of adjustment and its complement $(1-\lambda)$ as the portion of capital that is inertial.

Banks' target capital ratio is unobserved and is not necessarily constant over time. We model each bank's target level of bank capital as a function of observed (lagged) bank and country characteristics, $X_{ij,t-1}$. We follow the recent literature on the selection of the variables that determine leverage targets[11]. Brewer et al. (2008) and Gropp and Heider (2010) provide surveys and investigate motivations on the factors that explain banks' target capital ratio.

(2) $$K^{*}_{ij,t} = \beta X_{ij,t-1}.$$

We also account for two sources of unobserved heterogeneity: bank fixed effects (which subsume country fixed effects) and year fixed effects. Flannery and Rangan (2006), Lemmon et al. (2008), Huang and Ritter (2009), and Gropp and Heider (2010) advocate the importance of including firm (bank) dummies for an unbiased estimation of targets.

Substituting the equation of target leverage, equation (2), in equation (1) yields the following specification:

(3) $$K_{ij,t} = \lambda\beta X_{ij,t-1} + (1-\lambda)K_{ij,t-1} + \varepsilon_{ij,t}.$$

In the presence of a lagged dependent variable and a short panel, using ordinary least squares (OLS) or a standard fixed effects model would yield biased estimates of the adjustment speed. Therefore, following Flannery and Hankins (2013), we estimate equation (3) using Blundell and Bond's (1998) generalized method of moments (GMM) estimator[12].

We estimate the partial adjustment model of equation (3) separately for each of the three alternative capital ratios: Leverage, Tier1RWA and Total capital. The results are reported in Table 4.

[insert Table 4 about here]

We focus the description of the results on the variable of interest, which is the coefficient on the lagged dependent variable.[13,14] The estimated adjustment speeds (λ, Eq. (3)) are significant and

[11] We include proxies for bank absolute size (natural logarithm of total assets), bank profitability (return on assets), bank credit risk (loan loss provisions to net loans), retail funding (customer deposits to total funding), liquidity ratio (net loans to total assets). We also include the ratio of fixed assets to total assets, a diversification proxy (non-interest income to total income) and a bank efficiency proxy (non-interest expense to total income).

[12] Using Stata's XTABOND2 procedure.

[13] For each model, we also report the coefficient estimates and the significance levels of bank-specific drivers of the target capital ratios. Smaller, riskier, and banks with more asset diversification (less loans) hold higher capital ratios. Besides, less liquid banks and banks with more retail funding have a higher equity-to-target ratio, but not higher regulatory capital ratios.

[14] At the bottom of panel A of Table 4, we report test statistics documenting the validity of the instruments. In particular, two crucial tests are required. Using the Hansen J test (test of exogeneity of the instruments), we cannot reject the null of joint validity of all GMM instruments (lagged values); we hence confirm the validity of the instruments. We also use the Arellano and Bond AR(2) test, and confirm the absence of second order serial autocorrelation in the residuals.

quite different for the three capital ratio models. The speed of adjustment for the non-weighted equity-to-asset capital ratio structure is 0.482 (=1–0.518, where 0.518 is the coefficient of the lagged equity-to-asset reported in the first column)[15]. The adjustment speed for the regulatory capital ratios is lower, namely 0.31 (1-0.69, column 2) for the Tier 1 RWA ratio and 0.352 (1-0.648, column 3) for the total capital ratio. This implies that adjustment is partial for each of the capital ratios, but faster when banks are closing the equity-to-asset ratio deviation during the next period t, than when they are closing the two regulatory capital deviations (columns 2 and 3). Another informative metric, which provides economic meaning to the estimated parameters, is the half-life. The half-life provides an indication of the time required for banks to halve the gap between their actual capital ratio and their target. The estimated adjustment speeds for the leverage, Tier1 RWA and total capital ratios deviations correspond with half-lives of 1.05, 1.88 and 1.59 years, respectively. The results highlight that banks are slightly more concerned about readjusting quickly towards optimal leverage ratios compared to the speed to adjust towards optimal regulatory capital. This finding can be rationalized by at least two arguments. On the one hand, it could indicate that deviations from optimal leverage ratios are more costly for bank shareholders (as the target capital should be chosen such to maximize bank value) than deviations from regulatory capital. On the other hand, it could also be created by differences in adjustment costs and the range of adjustment mechanism that can be used. All else equal, banks have more (and less costly) options in asset adjustments that affect non-risk weighted assets than risk weighted assets. For example, government bonds (of OECD countries) are securities that are easily adjustable, but have a zero risk-weight. They could help to adjust the leverage ratio, but not the regulatory capital ratios.

3.2. Balance sheet adjustment mechanisms

In this section, we investigate how banks adjust their capital structure to close their deviation (gap) from the target. To do that, we use the following procedure. Based on the estimated vector of coefficients $\hat{\beta}$ we can compute fitted time-varying target capital ratios[16] for each individual

[15] These speeds of adjustment are similar to those of European banks (0.34, Lepetit, et al., 2015), a sample of banks in the U.S. and 15 European countries (0.47, Gropp and Heider, 2010), and large U.S. banks (0.40, Berger et al., 2008).
[16] We perform additional specification checks. We subject the baseline capital adjustment model (Eq. 3) to three alternative specifications, so as to re-estimate the target capital ratio, re-compute the deviation and ascertain that our results are not driven by the first stage regression specification. First, we follow Flannery and Rangan (2006) and use a pooled ordinary least squares OLS regression. Second, we follow Berrospide and Edge (2010) and Lemmon et al.

bank, $\widehat{K^*_{i,j,t}}$. Subsequently, we compute the time-varying capital deviation for bank i at time t-1, hereinafter called "the gap", and defined as $GAP_{ij,j,t-1} = \widehat{K}^*_{ij,t} - K_{ij,t-1}$. If banks make adjustments when there is a gap, then these adjustments should be reflected in their observed balance sheet transactions. We evaluate the percentage growth rates in various balance sheet components for three quintiles of the gap (first, middle and fifth). To do this, we first allocate banks to quintiles based on their gap at the end of year. Subsequently, we compute the yearly change in the relevant variable in the following year. We then average these growth rates across all bank-year observations in that quintile.

In a first step, we analyze the balance sheet adjustments for each capital ratio separately. These results are reported in Table 5. In a second step, we examine balance sheet adjustments in situations where the gap of the leverage ratio and Tier 1 RWA ratio have similar or opposite signs (yielding four cases; (i) both signal overcapitalization, (ii) both signal undercapitalization, (3) overcapitalized leverage, but undercapitalized regulatory, and (4) undercapitalized leverage, but overcapitalized regulatory).

[Insert Table 5 about here]

Looking at the three capital specifications, Table 5 presents the average growth rates of the main balance sheet items for banks allocated to the first quintile (i.e. most overcapitalized/underleveraged banks), the third quintile (i.e. banks with a negligible gap) and the fifth quintile (i.e. most undercapitalized/overleveraged banks) based on their gap at the end of year. For each capital set, we report the p-values of difference in means tests using the third quintile as benchmark.

First, with respect to leverage ratio, overcapitalized (underleveraged) banks have a negative and significant change in leverage ratio (-2.30% vs. 0.07%) compared with the change rate of the third quintile, implying that banks reduce their capital ratio to reach their target capital level. In fact, facing an opportunity cost, banks have no incentives to remain above their targeted leverage ratio.

(2008) and use country fixed effect regression to control for unobserved country heterogeneity while also controlling for year fixed effects. Third, we use a time varying country fixed effect to capture time varying country-specific regulation or business cycle effects on capital and heterogeneity at the country-year level. Non-reported results and analyses indicate that the statistical significance, the economic magnitudes as well as these alternative regression specifications are robust.

Therefore, bank managers make proactive efforts to lever up so to converge to their target and reduce the ongoing costs of capital surplus accordingly. To achieve a negative capital growth, our results show for a global sample of banks that they significantly expand their asset growth (22.34% vs. 8.41%), debt growth (11.44% vs. 8.73%), while equity growth is significantly slowed down (4.14% vs. 9.37%) always compared to the growth rates in the third quintile (i.e. when the gap between actual and target capital is negligible). Analyzing the mechanisms through which those banks lever up, the results indicate that underleveraged banks progress by increasing loans (6.81%), riskier assets (7.73%), and to a smaller (economic) extent also long-term debt (2.01%). We note that the average loan growth is not economically significantly different with respect to the growth rate of the third quintile (6.01%). In the same line, banks having a capital surplus shrink their internal funding, the growth in bank retained earnings is roughly zero (0.88%), and the external funding (Tier1) growth is substantially lowered (5.64% vis-à-vis 9.67%). Such results indicate that banks tend to lever up by engaging more in risky activities, being financed more with long-term debt, but without engaging any significant change in their loan policy or reduction in the capital level.

In contrast, for undercapitalized (overleveraged) banks, results show that the change in leverage ratio is significantly larger (2.06% vs. 0.07%) than the third quintile, implying that bank managers also actively rebalance their capital ratios to revert to their targeted leverage when they are undercapitalized. To that extent, facing regulatory and market constraints, banks with a capital shortfall are more prone to deleverage in order to close the gap and get to their optimal target. More specifically, results for those undercapitalized banks show that the average asset expansion is significantly negative (-7.31% vs. 8.41%) and the average debt growth is significantly lower (4.61% vs. 8.73%), while the average equity growth is not significantly higher than the growth rate of the benchmark. Not surprisingly, this translates into a rationalized capital adjustment for banks to reach their leverage capital target, only by reducing assets rather than injecting external equity which is costly because of frictions and governance problems.

Regarding these results, we analyze the key mechanisms through which overleveraged bank de-lever and rebalance their capital structure. We notice that all the subcomponents of the asset and the liabilities sides of balance sheet shrink. Thus, the average growth of loans (2.80% vs. 6.01%), riskier assets (2.64% vs. 6.33%), and long-term borrowings (-0.51% vs. 1.06%) are significantly lower than the benchmark. Indeed, deleveraging is achieved by downsizing (selling assets), restricting loan policy (reducing lending vis-à-vis a lower amount of debt), lowering risk-weighted assets (substituting riskier assets for safer ones) and shrinking long-term debt.

Second, with respect to regulatory capital ratio (Tier1RWA[17]), overcapitalized banks have a negative growth in the Tier1 capital ratio which is significantly different from the change rate in the third quintile of the gap (-1.14% vs. 0.09%). Hence, we inspect growth rates of adjustment mechanisms that lead these banks to reduce their capital surplus to converge to their optimal regulatory level. Findings show that banks allocated in this quantile lever up by a large and significant increase of their asset growth (13.34% vs. 9.56%), debt growth (12.49% vs. 9.56%), while their equity growth is significantly lower (6.17% vs. 7.92%) compared to the growth rates of the benchmark. Thus, overcapitalized banks proceed by significantly altering all the subcomponents of the balance sheet with regards to the benchmark. This translates into an expansion in loan (8.64%), risky assets (11.04%), long-term debt (1.68%) and short-term debts (1.07%); and a slow-down in internal capital (1.67%) and external capital (5.30%) growth. Therefore, a Tier1 capital surplus leads banks to lever up by combinations of an asset expansion strategy, risk-taking activities, an aggressive loan policy, long and short-term debt financing policies and a slower equity growth but without engaging any reduction in the capital level.

Concerning the undercapitalized banks, results show that the Tier 1 regulatory capital change is significantly higher (1.37% vs. 0.09% for equity-to-assets specification) than the change rate of the third quintile, where the gap is close to zero. Accordingly, banks are expected to increase their regulatory capital, so to reach their internal regulatory capital target and to comply with capital requirements. They proceed by significantly shrinking asset growth (1.32% vs. 9.56%), debt growth (3.96% vs. 8.40%) and significantly expanding equity (10.45% vs. 7.92%) compared with growth rates of the benchmark. Based on these results, we then analyze the key mechanisms through which these banks de-lever and rebalance their capital structure. Similarly, we find that these banks react actively by significantly altering all the subcomponents of the balance sheet, with regards to the benchmark. Results show that the loan growth (1.60%), risky asset growth (-0.31%), long-term debt (0.10%) and short-term debts (-0.67%) are significantly lower than the growth rates

[17] Results and capital management patterns are similar for both regulatory measures of capital. Here, we only present results of Tier1 regulatory capital ratio.

of the benchmark, while the external capital growth (10.78%) is significantly larger than the benchmark. Thus, facing a regulatory capital shortfall, deleveraging takes place by injecting external capital (equity issues), but not by using internal capital (earnings retention). Deleveraging is also achieved by downsizing, tightening loan policy (reducing lending vis-à-vis a lower amount of debt), selling risky assets and reducing long and short-term financing (selling debts). In the rightmost panel, we also show the adjustment mechanisms for the total capital ratio. They are by and large similar to the ones of the Tier 1 risk-weighted capital ratio.

We now turn to an analysis of balance sheet adjustments when examining the joint stance of the leverage gap and the regulatory capital (Tier 1 capital over risk-weighted assets) gap. The results are reported in Table 6. The four blocks of columns correspond with the situations where (i) both signal overcapitalization, (ii) both signal undercapitalization, (iii) overcapitalized leverage ratio, but undercapitalized regulatory ratio, and (iv) undercapitalized leverage ratio, but overcapitalized regulatory ratio.

[Insert Table 6 about here]

Table 6 shows that when both capital ratios show overcapitalization (Group 1), banks' equity growth is significantly lower, while asset growth and debt growth are significantly larger than when both capital ratios show undercapitalization (Group 2). In line with previous results, overcapitalized banks mainly lever up by expanding all assets and liabilities items, loans (8.1%), risky asset (9.85%), long-term debt (2.15%) and short-term debt (0.89%), which are statistically larger than the growth rates of the group of undercapitalized banks. In contrast, deleveraging for undercapitalized banks (Group 2) is more likely realized by external capital (9.98%) and earning retention (3.10%), which are statistically larger than the growth rates of the group of overcapitalized banks.

Now, we investigate the main disparities between these two groups of banks with two other groups that are regulatory overcapitalized but undercapitalized with regards to the leverage ratio, or vise-versa (Groups 3 and 4). First, we explore differences with regards to Group 1. Underleveraged and regulatory undercapitalized banks (Group 3) have a significantly smaller asset growth compared to Group 1, and this is true for all their subcomponents (loan and risky assets) and liabilities growth (only short-term debt) compared to the growth rates of the overcapitalized banks (Group 1). However, in economic terms, we notice especially differences in the adjustments via loan growth and risk-weighted assets. Banks in Group 3 increase leverage mainly by expanding assets with low risk-weights. Regarding equity growth, their external capital growth is significantly larger compared to the growth rate of banks in Group 1. The non-significant growth of equity of banks in Group 3 (with regards to Group 1) is mainly due to the significantly lower growth of earnings retention (0.87% vs. 1.68%). Thus, to increase their regulatory capital, besides raising more external capital and decreasing risky assets, banks in Group 3 restrict their lending and long- and short-term financing policies. However, capital management of the banks in Group 4 (overleveraged and regulatory overcapitalized) differ from those in Groups 1 and 3. They are overleveraged, but regulatory overcapitalized (w.r.t. their target). Compared to underleveraged banks, their assets grow much less quickly and relatively speaking they rely more on earnings retention than external capital growth. Most strikingly is that the growth in net loans and risk-weighted assets is of similar magnitude in group 1 and 4, even though total asset growth in group 4 is much smaller compared to growth in group 1.

In sum, the sign of the leverage and risk-weighted capital ratio gap determines whether equity is adjusted via earnings retention or externally raised equity. Moreover, it also determines whether asset side adjustments are done via loans and risky assets, versus safer assets with a lower risk weight (such as securities).

4. Bank capital adjustments: are SIFIs different?

Adjustment speed depends on the trade-off between the costs (or the benefits) of being off the capital target and the costs of adjusting back to the optimal (target) capital structure. Both the cost of being off-target and the cost of adjustment need not be homogenous for all banks.

Theory and empirical studies document that institutional features affect banks' speed of adjustment by restricting the access to equity and debt markets, limiting the flexibility to easily alter capital structure and imposing more stringent capital requirements and supervisory monitoring (e.g. financial constraints, differences in regulatory and supervisory environments and financial system characteristics[18]). Not only a country's institutional setting but also bank-level characteristics could reduce (increase) costs or increase (reduce) benefits of being close to the target and thus lead to higher (lower) adjustment speeds (see Laeven et al. (2015), among others). We hence hypothesize that as costs and benefits of rebalancing the capital structure might be affected with bank-individual systemic risk and size characteristics, so does the speed with which banks adjust leverage and regulatory capital to reach their targets.

This section involves two steps. We first describe the approach we take to estimate the effects of systemic risk and size on the speed of adjustment of leverage and regulatory capital ratios toward their targets. We then examine their impact on banks' capital structure and balance sheet adjustments. Addressing this issue is paramount to draw effective regulatory and policy implications regarding SIFIs.

4.1. Do SIFIs adjust their capital ratios quicker?

To analyze whether or not (relative) size and systemic risk (exposure/contribution) affects the speed of adjustment, we extend the partial adjustment model (as in equation (3)) to allow for time-varying and bank-specific adjustment speeds. We follow the approach of Berger et al. (2008), Oztekin and Flannery (2012) and De Jonghe and Öztekin (2015). More specifically, we adjust the model such that the adjustment speed, λ, can vary over time, banks, and countries:

(4) $$\lambda_{ij,t} = \lambda_0 + \Lambda Z_{ij,t-1},$$

where Λ is a vector of coefficients for the adjustment speed function and $\mathrm{Z}_{\mathrm{i,j},t-1}$ is a set of covariates that could affect the adjustment speed. Substituting equation (4) in equation (3) yields the equation for a partial adjustment model with heterogeneity in the speed of adjustment:

(5) $$\Delta K_{ij.t} = (\lambda_0 + \Lambda Z_{ij,t-1})\left(\beta X_{ij,t-1} - K_{ij,t-1}\right) + \varepsilon_{i,t}.$$

[18] See e.g. De Jonghe and Öztekin 2015; John et al., 2012; Faulkender et al., 2012a; Öztekin and Flannery 2011; Berger et al. 2008; Flannery and Hankins, 2013, among others.

As Berger et al. (2008), Öztekin and Flannery (2012) and De Jonghe and Öztekin (2015), we estimate equation (5) in two steps. In the first step, we estimate equation (3) using system GMM and obtain an estimate of the target capital ratio, $\widehat{K}^{*}_{ij,t} = \hat{\beta} X_{ij,t}$, which we use to compute each bank's deviation from its (estimated) target capital ratio, $GAP_{ij,j,t-1}$= $\widehat{K}^{*}_{ij,t} - K_{ij,t-1}$. Substituting the gap in equation (5) we get:

(6) $$\Delta K_{ij.t} = (\lambda_0 + \Lambda Z_{ij,t-1}) GAP_{ij,t-1} + \varepsilon_{i,t}.$$

Which is the second step that only involves a pooled OLS regression of the dependent variable (the change in a capital ratio) on a set of variables defined as the product of $GAP_{ij,t-1}$ and the covariates (proxies for systemic risk and (relative and absolute) size, introduced one-by-one) affecting the adjustment speed. The vector of estimated coefficients allows us to test various hypotheses on the determinants of the adjustment speed. To ease economic interpretation, we standardize the independent variables, $Z_{ij,t-1}$, before interacting them with $GAP_{ij,t-1}$. Hence, the coefficient λ_0 can be interpreted as the average speed of adjustment in the sample. Such a setup also allows investigating asymmetric effects of systemic risk and size for overcapitalized banks (above the target) and undercapitalized banks (below the target), by further interacting the variables in the vector $Z_{ij,t-1}$ with indicator variables that are one when the bank's capital ratio is above (below) target.

Table 7 reports the empirical results from a model where we allow for heterogeneity in the adjustment speed towards the optimal capital structure. The sources of heterogeneity we consider are fivefold. We include a measure of bank size (ln(total assets), relative bank size, systemic risk exposure and systemic risk contribution. In addition, we also use the SIFI-index which allocates bank-year observations in quintiles according to these four characteristics.

[Insert Table 7 about here]

In the upper panel, we provide the results for the leverage ratio. In column 1, we report the homogenous speed of adjustment. In line with previous results, average leverage speed is 0.40. Thus, on average, banks adjust at 40 percent per year, if they are further away from the target leverage. In the next four columns, we introduce one-by-one the effects of systemic risk and size on leverage speed of adjustment. We find a negative and statistically strong (at the 1 percent level) relationship between the MES, the relative bank size, the absolute bank size and the adjustment speed, while ΔCoVaR carries a positive effect, statistically significant at the 10 percent level. This implies that banks adjust their leverage more slowly toward the target (yielding a higher half-life) when the MES and both bank's size measures are higher; whereas, they adjust faster (yielding a lower half-life) if ΔCoVaR is higher. This suggests that omission of systemic risk and size effects in estimating the adjustment of banks' capital structure leads to biased results.

These results shed light on two aspects regarding SIFIs and TBTF. As highlighted above, ΔCoVaR apprehends the aggregate financial system performance conditional on a given bank's returns drop below a certain threshold. Such a measure is hence expected to capture contagion risks. Accordingly, banks are more sensitive to adjust their leverage faster when they choose to take more correlated risks and this appears to overweigh the MES effect. Although they have access to inexpensive external capital and cheap debt funding, sizeable banks can, presumably because of their TBTF status, afford to adjust their leverage ratio slowly. Such a ratio is indeed not a regulatory risk-based capital measure that they need to comply with. Such a finding is consistent with moral hazard behavior that leads banks to take on excessive risk-taking and engage in multiple activities (e.g., combining lending and trading), when they expect to be bailed out in case of distress. Alternatively, larger banks could be regarded as more complex and opaque making it relatively more difficult and costlier for them to raise capital. Finally, in column 6, using the index of systemic importance and risk, we find that SIFIs adjust slower towards their target ratio.

In the middle and lower panel, we report results for similar regressions except that we focus now on regulatory risk weighted capital ratios (Tier 1RWA ratio in middle panel and Total capital ratio in lower panel). The first column examines the average adjustment speed deviation from the targeted regulatory Tier1 ratio. In subsequent columns, conversely to what we find in the leverage ratio specifications, the coefficients on the interaction terms related to the MES, the relative bank size and the absolute bank size are now significantly positive. Hence, larger banks and/or banks with higher MES adjust faster to the target Tier 1 regulatory ratio. In the last column, using the systemic index, we thus find that SIFIs adjust their regulatory capital ratio faster whenever they deviate from their target regulatory ratio. The results are also economically important and similar in magnitude for each of the interaction effects. A one standard deviation increase in the index of systemic importance and risk increases the average Tier1 regulatory speed (0.32) by 0.034, leading to a slightly lower half-life. Such results confirm the hypothesis that SIFIs and TBTF institutions may find it easier to change their regulatory capital structure by altering the composition of new equity (Tier1) issuances and adjusting their risky asset compositions, and thus adjust faster. This is possibly because of higher financial flexibility through relative cost advantages on the one hand and adjustments in external growth funding on the other hand. The exposure to common shocks that affect the whole financial system (namely the MES[19]) dominates the effects of contagion risk and size effects, possibly because banks had to face internally increased market monitoring and macroprudential regulatory supervision on one hand and high expected capital shortfall on the second hand, which translate into higher regulatory adjustment speed. In addition, it confirms the hypothesis that systemic banks may find it easier to change their capital structure by raising inexpensive external capital, cheap debt funding and by altering the asset compositions of their balance sheets.

In the lower panel, we repeat the same regressions for the total regulatory capital. All results are similar to those we obtain for the Tier 1 regulatory ratio in the middle panel. In sum, our results show two important things. First of all, systemic risk and size affect the extent to which banks adjust their capital ratios. Second, these factors play an opposite role (on the speed of adjustment) for a leverage ratio vis-à-vis regulatory capital ratios.

4.2. Do SIFIs use different adjustment mechanisms

The analyses thus far indicate that: (i) the mechanisms that banks use to adjust their capital ratios to return to target depend on whether they are over- or undercapitalized, (ii) the magnitude of the adjustments vary with the type of capital ratio, (iii) the speed of adjustment depends on the systemic importance of the bank. These combined insights lead to the last research question, which is analyzing whether SIFIs use different adjustment mechanisms and whether the heterogeneity in the adjustment is asymmetric with respect to the capital gap sign.

[19] The MES captures bank performance conditional on a distress event in the financial system returns, so it is more closely capturing exposure to common shocks that affect the whole financial system.

To address this question, we regress the average growth rates in key balance sheet components on the deviation from the target, while controlling for potential asymmetric reactions. This approach is similar to the one used by previous researchers to examine adjustment mechanisms (Berrospide and Edge, 2010; Francis and Osborne,2009, 2012; Lepetit et al. 2015). Banks can adjust to their target by either issuing or buying back equity capital (Tier1 capital), increasing or decreasing retained earnings or by reducing or increasing their size as well as by reshuffling their assets (change in total assets, net loans and risk-weighted assets) or liabilities (change in total liabilities, long-term borrowings and short-term borrowings). Furthermore, we not only allow for asymmetric adjustments but also heterogeneous adjustments depending on how systemically important banks are. In particular, we estimate the following threshold regression model:

$$(7) \qquad \Delta \mathrm{BS}_{i,t} = c + \beta_1 \mathrm{SIFI}_{i,t-1} + \begin{cases} \left(\delta_0^+ + \delta_1^+ \mathrm{SIFI}_{i,t-1}\right) \times \mathrm{Gap}_{i,t}, & \text{if } \mathrm{Gap}_{i,t} > 0 \\ \left(\delta_0^- + \delta_1^- \mathrm{SIFI}_{i,t-1}\right) \times \mathrm{Gap}_{i,t}, & \text{if } \mathrm{Gap}_{i,t} < 0 \end{cases} + u_i + \varepsilon_{i,t}$$

where $\Delta \mathrm{BS}_{i,t}$ is the average growth rate for one of the balance sheet variables (Equity, Tier1 capital, Retained Earnings, Assets, RWA, Loans and Liabilities) which could be affected by the deviation from the optimal target and SIFI is the systemic risk index that we constructed based on the quintiles of MES, ΔCoVaR, size and relative size. The index has been standardized such that it has zero mean and unit standard deviation. Equation 7 allows us to look at the impact of capital deviations on the numerator and denominator of the target (and their components), when banks' actual capital ratio is either below or above the target. Furthermore, we assess whether the adjustment mechanisms depend on banks' systemic size and importance measured by the SIFI index.

[Insert Table 8 about here]

In Table 8, we report the results of our estimates of the model presented in equation (7). The columns correspond with the growth rates in balance sheet elements of interest used to view behavior of banks' capital adjustment. In the three different panels, we use deviations between target and actual capital for the leverage ratio (panel A) the Tier 1 over risk-weighted asset ratio (panel B) and the total capital ratio (panel C), respectively. The results are also presented graphically in Figures 1, 2 and 3. Figure 1 (panel A of Table 8) shows the results for the leverage ratio and figures 2 and 3 (panels B and C of Table 8) for the two risk-weighted regulatory ratios, Tier1RWA and Total capital respectively. Each subplot in the graph corresponds with the fitted values of equation (7) over the relevant range of the gap between the actual and target capital ratio. Three fitted value lines are plotted corresponding with $\Delta BS_{i,j,t}$ over the range of $Gap_{i,j,t}$ for SIFIs (standardized SIFI index gets value 1, i.e. one standard deviation above the mean, short dashed line), average banks (SIFI score is average and hence 0 for the standardized index, full line) and small banks (standardized SIFI index gets value of minus one, i.e. banks for which SIFI index is one standard deviation below the mean, long-dashed line).

[insert Figures 1, 2 and 3 about here]

First of all, the coefficients associated with the systemic index variable (SIFI-index) are always significantly negative indicating that compared to "less" systemic banks, "more" systemic banks have ceteris paribus a lower growth rate in total assets but also in the different balance sheet components. Graphically, this implies a downward (upward) shift for SIFI (small) banks.

Second, to be consistent with a return to target capital, we expect, when banks are below the target, a (piecewise) flat or upward sloping line for the equity components, whereas for assets and liability categories, we expect a downward sloping line. That is, the more positive the gap is (undercapitalized banks), the larger the growth in equity needs to be (relative to the growth in assets) to close the gap. If a bank is above target (negative gap) we expect banks close to the gap by either reducing equity growth or accelerating asset growth (compared to growth rates of equity and assets when banks are on or close to target).

We begin by looking at the impact of deviations from the optimal leverage ratio on the capital structure adjustments in Panel A. An increase in the leverage ratio shortfall will lead to a significantly larger growth rate of total common equity (Equity), particularly by increasing capital internally (Retained Earnings) rather than issuing equity (Tier1 capital). Furthermore, an increase in the gap (when undercapitalized) results in significantly decreasing growth of total assets (Assets) and adjusting their compositions (both loans and RWA). The relative magnitudes of these estimated coefficients provide interesting insights in how the mix of equity and asset adjustments change the leverage speed of adjustment. In absolute magnitude, the coefficients on the capital shortfall variable is larger for total assets growth (as well as RWA growth and loan growth) than the corresponding coefficient in the total common equity growth (or retained earnings growth) regression. This finding indicates that as the gap becomes larger (as banks become more undercapitalized), banks might become constrained in raising equity and need to resort more to adjustments via the assets side (relative downsizing).

The interaction terms with the SIFI index enter negative and statistically significant for the three mechanisms of capital adjustments (Equity, Tier1 capital and Retained Earnings) and positive and statistically significant for the three elements of asset adjustments (Assets, RWA and Loans). In all instances, these findings imply that SIFIs' balance sheet adjustments are less responsive to the extent of undercapitalization. This suggests that undercapitalized SIFIs tend to adjust the capital structure at a lower speed than less systemic ones, which is confirmed by the slower adjustment speed for SIFIs obtained in the last column of panel A of table 7.

Turning to the situation in which banks are underleveraged (overcapitalized, negative gap), we find that as the gap becomes more negative equity growth becomes much smaller. Moreover, while overall asset growth rates are strongly and significantly related to the extent of being underleveraged, growth of risk-weighted assets and lending policies are unaffected by the extent of capital surplus hence indicating that the size expansion is mainly achieved by venturing into low-risk weight, non-lending activities such as cash and sovereign debt. As assets grow faster than equity, banks seem to take advantage of such a situation to reduce equity dilution and also adjust their size (volume of assets), rather conservatively by tilting the composition to lower-risk weight assets. In addition, we find that SIFIs behave differently when it comes to equity adjustments (whenever overcapitalized) but not assets, suggesting that the response of capital adjustment is more pronounced (strong negative effect, sharp decrease), in response to a capital surplus, with regards to the less systemic banks. Also, such larger and more systemic banks lever up by increasing significantly their lending growth compared to the less systemic banks, which indicates less prudent expansions compared to non-SIFIs which mainly expand via cash and securities.

We now turn to Panels B and C where we investigate the balance sheet adjustments in response to gaps in the regulatory capital ratios, also allowing for heterogeneity depending on the SIFI index and the sign of the gap. First of all, results are very similar in panel B and C, and we discuss them together. When banks are below their regulatory capital targets, an increase in undercapitalization leads to significantly higher growth rates in common equity and Tier 1 capital and significantly lower (risk-weighted) asset growth. The coefficient in the Tier 1 capital column is larger than in the risk-weighted assets column indicating that as banks become more undercapitalized they have to resort more to raising capital externally in order to swiftly close the gap. In general, we do not find that small banks or SIFIs behave differently in this respect. None (but one, weakly) of the interaction effects between the shortfall and the SIFI index is significant.

When banks are overcapitalized in terms of regulatory ratios (negative values for the gap), we find that equity growth rates are unaffected by the size of the gap, whereas assets and liabilities growth strategies depend on the magnitude of the capital surplus. These findings are consistent with the idea that banks with excess capital have more capacity to grow, lend and/or get into debt compared with other banks. The only significant interaction effect with the SIFI index is obtained when analyzing the effect on the growth rate of total assets. The (negative) slope becomes steeper for SIFIs, but only for total assets and not for risk-weighted assets or loans. This indicates that for increasingly larger gaps, compared to smaller banks, SIFIs allow their asset base to expand more. As there is no differential behavior between SIFIs and small banks with respect to loans or risk-weighted assets, this implies that SIFIs also use this situation to additionally scale up their safe assets even though that does not contribute to closing their regulatory gap. Surprisingly, when banks are above their regulatory capital targets, an increase in the gap leads to higher growth in their retained earnings. This can be observed for both definitions of regulatory risk-weighted capital ratios (Panels B and C). As for the findings in Panel A, banks seem to be more reluctant to distribute earnings in these situations for two reasons. They may hoard it as a buffer as they expect new investment opportunities might arise or they might become more cautious that extremely good times might be followed by bad times where they would face a shortfall.

To summarize, our results show that when banks are below target for any of the three capital definitions (Leverage, Tier1RWA and Total capital) they always accelerate equity and more generally capital growth except when they are systemically very important and adjusting to the leverage ratio. With respect to earnings retention, we observe a discrepancy between leverage and regulatory capital ratios. Banks tend to increase earnings retention (hence limiting dividend distribution) to move upwards towards the target leverage ratio but earnings distribution policy is not affected when banks are shocked below their weighted regulatory ratios. Somewhat surprisingly, the more overcapitalized banks are with respect to their regulatory targets, the larger the earnings retention is; but still relatively smaller than growth in (risk-weighted) assets such that they do get back to target. In all cases banks always decelerate assets growth, loan growth and risk-weighted assets. However, when it comes to leverage adjustments, banks show more flexibility in their balance sheets adjustments when they experience a negative capital shock (and hence have a positive gap); but when they are above their target leverage, banks of a given size or systemic importance expand their loans and risk-weighted assets at the same speed.

5. Conclusion

The Basel III Accord has, among other things, introduced more stringent capital requirements faced by banks, a new leverage ratio and also capital surcharges for systemically important banks. In this paper, we investigate how banks adjust their capital ratios to reach their desired levels by focusing on two dimensions. We look at whether the adjustment speeds and mechanisms are different for ratios set by regulators (risk-weighted capital ratios) and those internally targeted by bank managers (leverage) and pay special attention to systemically important banks. We consider a pre-Basel III period ranging from 2001 and 2012 to examine how banks have managed their capital ratios by using a sample of listed banks across OECD countries. We augment standard partial adjustment models of bank capital towards bank-specific and time-varying optimal capital ratios with various SIFI indicators as well as a systemic risk index based on the quintiles of such indicators. On the whole, our findings reveal that the speed at which banks adjust and the way they adjust show large differences. In general, banks are more flexible and faster in adjusting to their leverage capital ratio than to regulatory capital ratios. However, SIFIs are slower than other banks in adjusting to their target leverage ratio but quicker in reaching their target regulatory ratios. Hence for systemically important banks the adjustment speed is roughly similar for all capital ratios, whereas the wedge between leverage adjustment speed and regulatory capital adjustment speed is larger for small banks. Our results also suggest that systemically important banks might be more reluctant to change their capital base by either issuing or repurchasing equity and prefer sharper downsizing or faster expansion. Our findings contribute to the bank capital structure adjustment literature and carry various policy implications. In case of any sudden need to augment capital ratios at systemically important, banks regulators and supervisors should be aware that such institutions would, according to our results, downsize to a larger extent than smaller banks. If in a given country the market share of systemic banks is relatively large, the real effect on the economy will consequently be more important. Symmetrically, a relief in capital constraints or a positive capital shock is also expected to push SIFIs to expand faster than other banks. On the whole, this procyclical behavior is more pronounced for systemic institutions which are however also found to more extensively rely on equity issues when needed than other banks. Such findings are also expected to be particularly useful for supervisors when they gauge and adjust the specific capital requirement they can impose on each bank in the industry differently and separately, which they are allowed to do trough Pillar 2 of the Basel III Accord.

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Figure 1: Leverage ratio deviation and bank capital structure adjustments for SIFIs, average banks and non-SIFIs.

We present graphical evidence on the behavior of bank-specific balance sheet characteristics (fitted values of Eq. (7) corresponding with $\Delta BS_{i,j,t}$) over the estimated gap of the targeted leverage ratio. The graphs plot average growth rates of total common equity, Tier1 capital, retained earnings, total assets, risk-weighted-asset, total net loans and total liabilities, for SIFIs (short-dashed line), average banks (full line) and non-SIFI (long-dashed Line), over the relevant range of the gap between the actual and target leverage ratio. A positive gap indicates a situation where banks have capital shortfalls and a negative gap indicates a situation where banks have capital surpluses. We define as SIFIs (non-SIFIs) those banks with a one standard deviation above (below) the mean standardized SIFI index, while average banks have a zero mean of the standardized SIFI index.

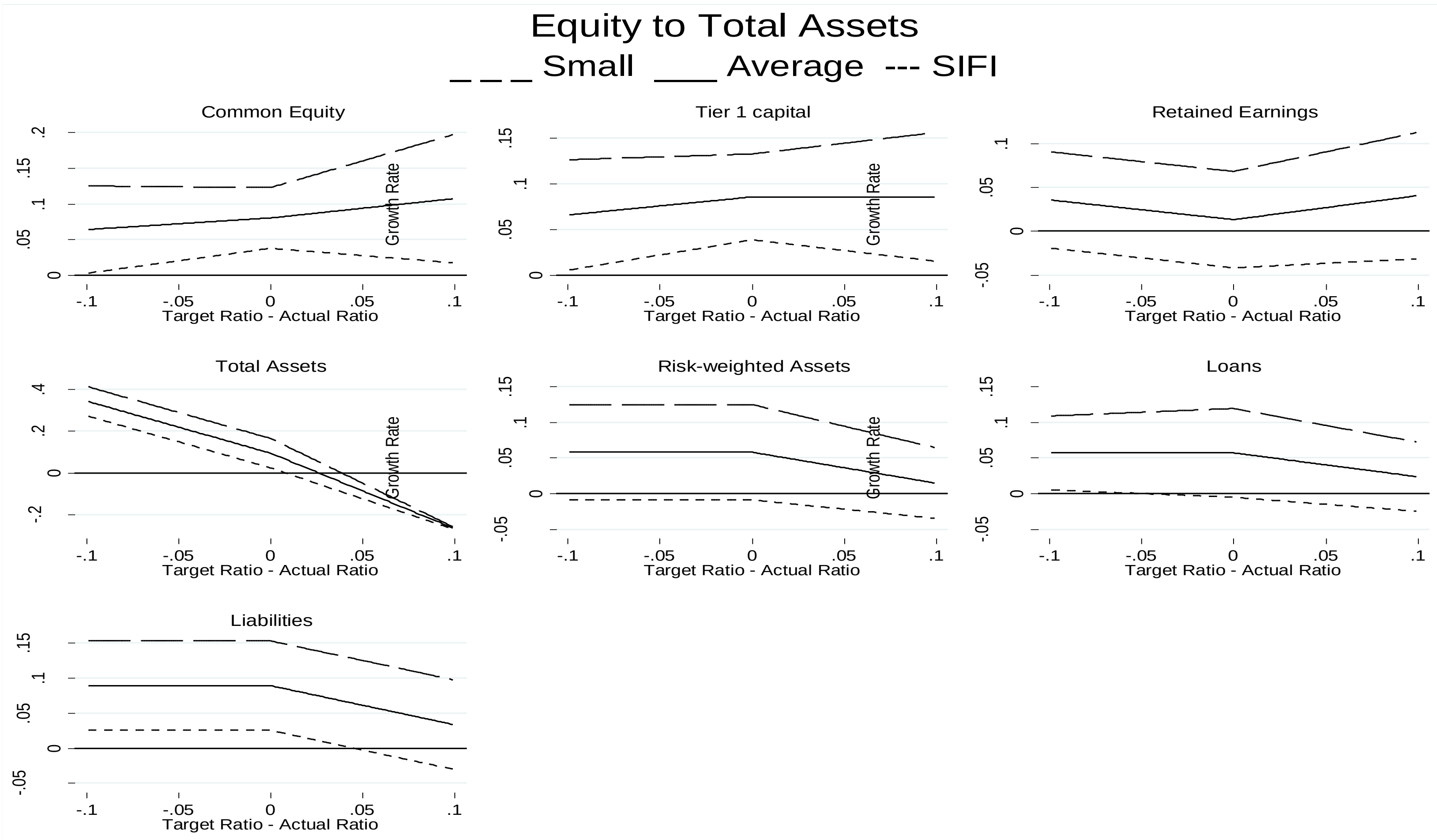

Figure 2: Tier1 capital ratio deviation and bank capital structure adjustments for SIFIs, average banks and non-SIFIs.

We present graphical evidence on the behavior of bank-specific balance sheet characteristics (fitted values of Eq. (7) corresponding with $\Delta BS_{i,j,t}$) over the estimated gap of the targeted regulatory Tier1 over risk-weighted-assets ratio. The graphs plot average growth rates of total common equity, Tier1 capital, retained earnings, total assets, risk-weighted-asset, total net loans and total liabilities, for SIFIs (short-dashed line), average banks (full line) and non-SIFIs (long-dashed Line), over the relevant range of the gap between the actual and target Tier1RWA ratio. A positive gap indicates a situation where banks have capital shortfalls and a negative gap indicates a situation where banks have capital surpluses. We define as SIFIs (non-SIFIs) those banks with a one standard deviation above (below) the mean standardized SIFI index, while average banks have a zero mean of the standardized SIFI index.

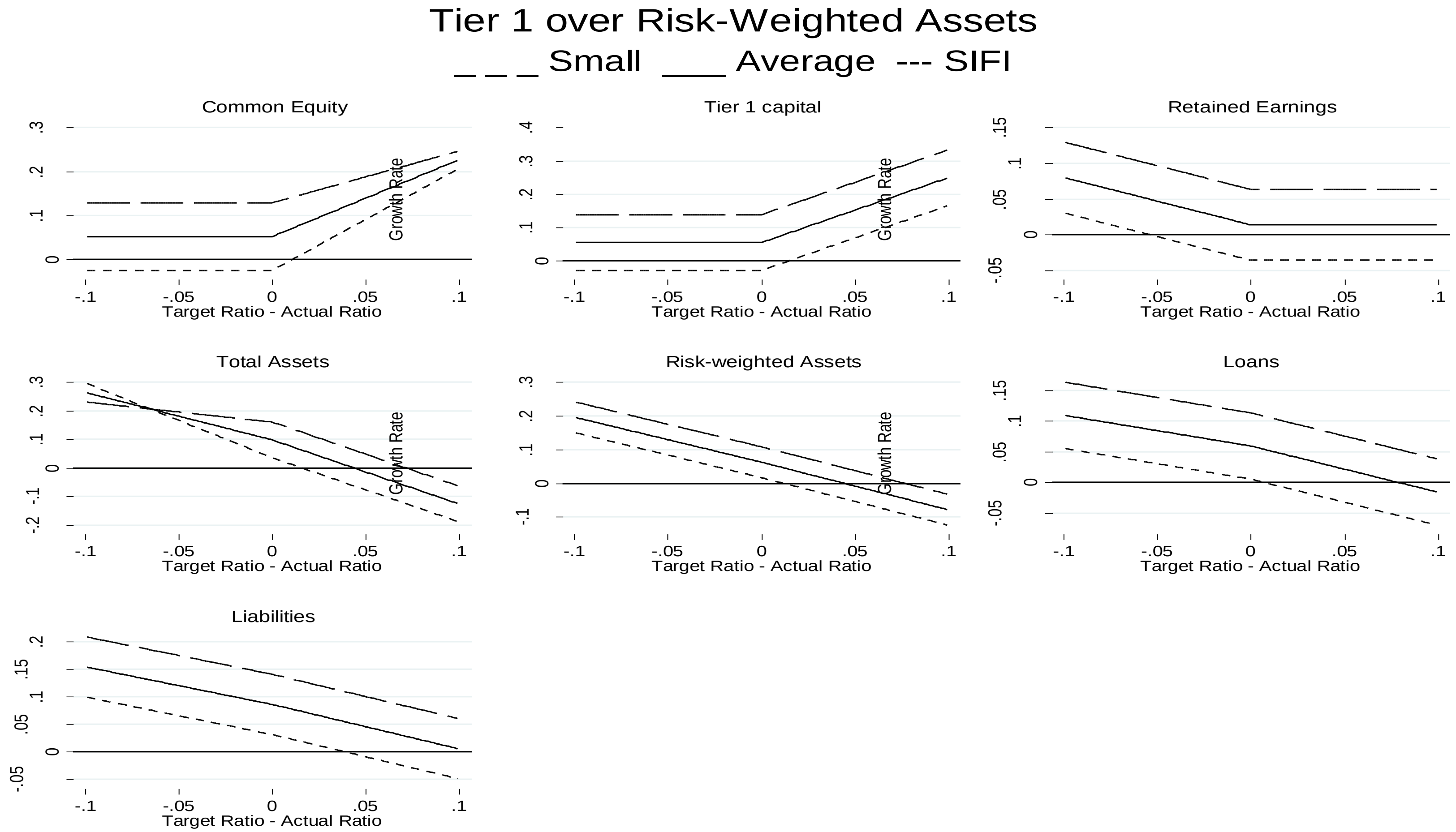

Figure 3: Total capital ratio deviation and bank capital structure adjustments for SIFIs, average banks and non-SIFIs.

We present graphical evidence on the behavior of bank-specific balance sheet characteristics (fitted values of Eq. (7) corresponding with $\Delta BS_{i,j,t}$) over the estimated gap of the targeted regulatory total capital ratio. The graphs plot average growth rates of total common equity, Tier1 capital, retained earnings, total assets, total net loans, risk-weighted-asset and total liabilities, for SIFIs (short-dashed line), average banks (full line) and non-SIFIs (long-dashed Line), over the relevant range of the gap between the actual and target total capital ratio. A positive gap indicates a situation where banks have capital shortfalls and a negative gap indicates a situation where banks have capital surpluses. We define as SIFIs (non-SIFIs) those banks with a one standard deviation above (below) the mean standardized SIFI index, while average banks have a zero mean of the standardized SIFI index.

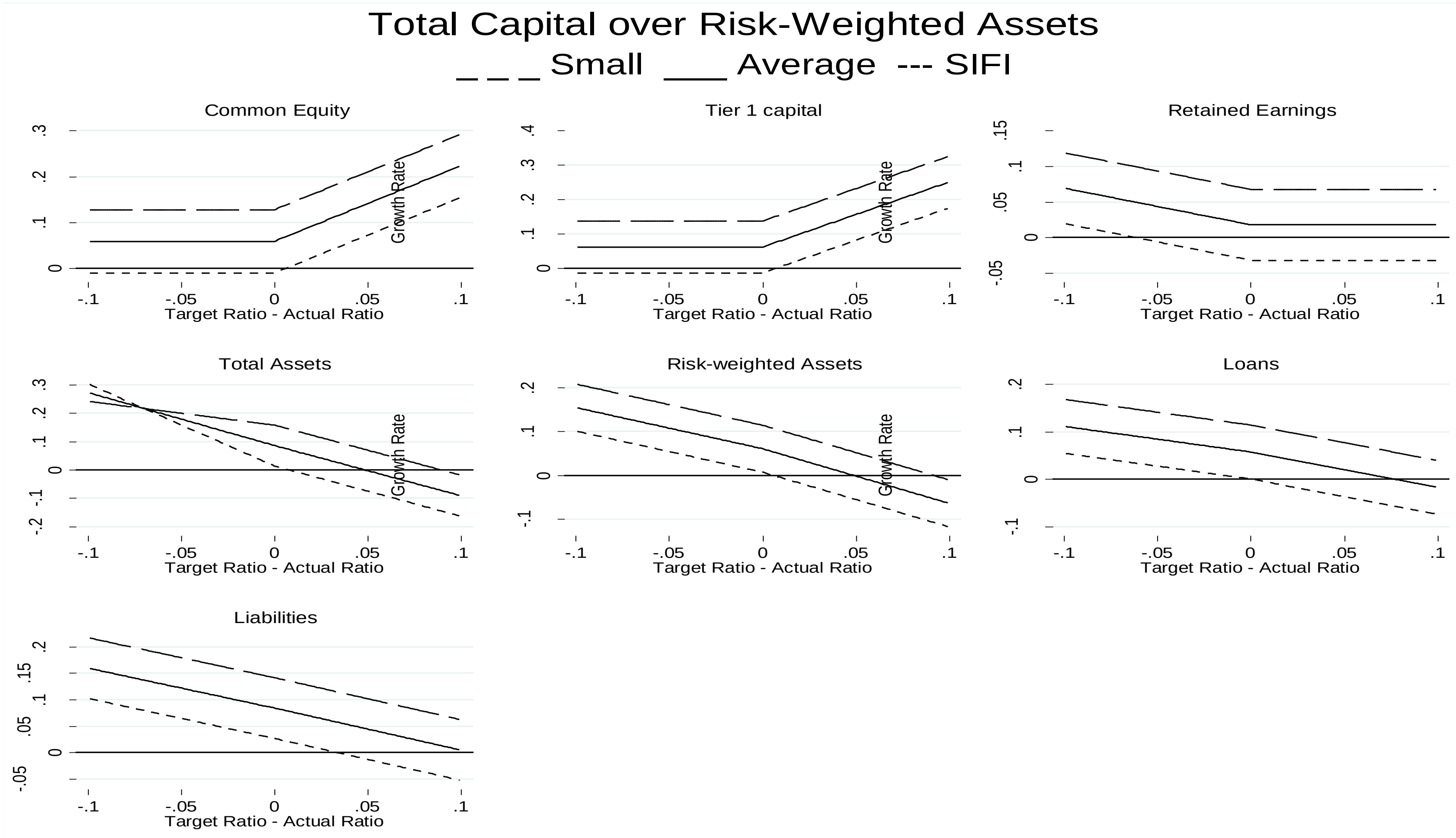

Table 1. Sample composition

Panel A shows the sample country composition used for estimating the speed of adjustments towards target capital structures. It presents the distribution of 567 listed banks from 28 OECD countries, Australia, Austria, Belgium, Britain, Canada, Czech, Denmark, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Japan, Mexico, Netherlands, Norway, Poland, Portugal, Slovakia, South Korea, Spain, Sweden, Switzerland, Turkey, and United-States, totaling 5164 bank-year observations.

Country	Number of banks	Number of Bank-Year observations	Country	Number of banks	Number of Bank-Year observations
Australia	5	60	Luxembourg	1	6
Austria	7	55	Mexico	2	6
Belgium	2	24	Netherlands	1	7
Canada	8	86	Norway	11	103
Czech	1	6	Poland	5	20
Denmark	16	124	Portugal	3	36
Finland	1	12	Slovakia	1	1
France	6	59	South Korea	2	11
Germany	5	45	Spain	6	60
Greece	8	44	Sweden	4	46
Hungary	1	5	Switzerland	7	44
Ireland	2	22	Turkey	11	45
Italy	15	123	United-Kingdom	5	55
Japan	22	149	United-States	409	3910
			Total	567	5164

Panel B shows the distribution of the number of observations (banks) by year, both in absolute numbers as well as frequencies

Year	Freq.	Percent
2001	369	7.15
2002	382	7.40
2003	391	7.57
2004	403	7.80
2005	423	8.19
2006	472	9.14
2007	488	9.45
2008	498	9.64
2009	453	8.77
2010	442	8.56
2011	425	8.23
2012	418	8.09
Total	5164	100

Table 2. Descriptive statistics

This table provides the definition and summary statistics for all the regression variables of a sample of 567 publicly listed OECD banks from 2001 to 2012. We report summary statistics for variables measured at time t. For all variables (in panels A, B and C), we provide number of observations, mean, standard deviation, as well as some percentiles (p5, p25, median, p75 and p95) for each variable, across all banks and countries.

Variable	Definition	Source	N	Mean	SD	p5	p25	p50	p75	p95
Panel A: Determinants of the target capital structure										
Leverage	Common equity ratio defined as total equity over total unweighted assets.	Bloomberg, Thomsen-Reuters Advanced Analytic (TRAA)	5164	0.094	0.044	0.038	0.069	0.089	0.109	0.167
Tier1RWA	Ratio of capital tier1 over to total risk weighted assets.	Bloomberg, Bankscope.	5164	0.117	0.036	0.070	0.093	0.111	0.135	0.183
Total capital	Ratio of total capital tier1 over to total risk weighted assets.	Bloomberg	5164	0.142	0.040	0.101	0.116	0.132	0.156	0.212
Log(Total Assets)	Natural logarithm of bank total assets (in USD billion).	TRAA	5164	8.167	2.313	5.585	6.407	7.435	9.437	13.085
Credit Risk	Loan Loss Provisions over net loans.	TRAA	5164	0.007	0.009	0.000	0.002	0.004	0.008	0.024
Retail Funding	Total customer deposit divided by total funding (st borrow+Tot.Cust.Dep).	Bloomberg, TRAA	5164	0.896	0.119	0.649	0.862	0.936	0.978	1.000
Liquidity	Net loans over total deposit.	TRAA	5164	1.085	0.314	0.581	0.904	1.080	1.253	1.597
Fixed Assets	Net fixed assets over total assets.	Bloomberg, TRAA	5164	0.016	0.011	0.003	0.009	0.014	0.021	0.036
Diversification	Non-interest income over total income.	TRAA	5164	0.196	0.110	0.053	0.118	0.175	0.252	0.415
Loan-to-asset	Net loans over total assets.	TRAA	5164	0.691	0.148	0.440	0.610	0.694	0.776	1.000
Efficiency	Cost income ratio, non-interest expense over total income.	TRAA	5164	0.449	0.131	0.246	0.365	0.439	0.526	0.683
RoA	Return on assets, defined as the ratio of net income to total assets.	TRAA	5164	0.007	0.010	-0.009	0.004	0.008	0.011	0.017
Panel B: Determinants of the adjustment speed										
MES (%)	Marginal Expected Shortfall	Appendix Eq. A1	5058	1.691	1.919	-0.422	0.250	1.237	2.607	5.576
ΔCoVaR (%)	ΔConditional Value-at-Risk	Appendix Eq. A2	5038	1.550	1.742	-1.006	0.392	1.320	2.602	4.717
TAGdp	Natural logarithm of bank total assets over GDP.	TRAA, OECD stats Metadata, IMF WEO	5164	0.064	0.196	0.000	0.000	0.000	0.005	0.518
logTA	Natural logarithm of bank total assets (in USD billion).	TRAA	5164	8.167	2.313	5.585	6.407	7.435	9.437	13.085
SIFI-index	aggregated systemic importance index	Subsection 4.1.2	4947	11.98	4.76	5	8	12	16	19
Panel C: Growth in adjustment mechanisms										
Total Equity	Average growth in total equity scaled by average total equity	Bloomberg, TRAA	5164	0.082	0.182	-0.160	0.007	0.065	0.146	0.383
Tier1 capital	Average growth in Tier1 capital scaled by average total equity	Bloomberg, Bankscope.	5014	0.081	0.172	-0.147	0.008	0.061	0.136	0.377
Retained Earnings	Average growth in retained earnings by average total equity	Bloomberg, Bankscope.	5164	0.023	0.136	-0.191	-0.012	0.040	0.086	0.186
Total Assets	Average growth in total assets scaled by average total assets	Bloomberg, TRAA.	5164	0.081	0.195	-0.272	0.002	0.068	0.160	0.424
Net Loans	Average growth in net loans scaled by average total assets	Bloomberg, TRAA.	5164	0.054	0.093	-0.082	-0.003	0.043	0.098	0.227
Risk-Weighted Assets	Average growth in risk-weighted assets by average total assets	Bloomberg, TRAA.	5014	0.056	0.124	-0.107	-0.006	0.044	0.104	0.254
Total Liabilities	Average growth in total liabilities by average total liabilities	Bloomberg, TRAA.	5164	0.083	0.125	-0.091	0.006	0.064	0.144	0.313
LT borrowing	Average growth in long-term borrowing by average total liabilities	Bloomberg, TRAA.	5160	0.010	0.048	-0.056	-0.010	0.000	0.024	0.095
ST borrowing	Average growth in short-term borrowing scaled by average total liabilities	Bloomberg, TRAA.	5164	0.004	0.048	-0.073	-0.016	0.000	0.023	0.084
ΔLeverage	Change in common equity ratio (percentage)	Bloomberg, TRAA.	5164	-0.031	2.497	-3.987	-0.646	-0.018	0.563	3.905
ΔTier1RWA	Change in Tier1 capital ratio (percentage)	Bloomberg, Bankscope.	5164	0.126	1.727	-2.600	-0.670	0.080	0.820	3.000
ΔTotal capital	Change in total capital ratio (percentage)	Bloomberg, Bankscope.	5164	0.061	1.847	-2.860	-0.795	0.020	0.900	3.050
groLeverage	Average growth rates of common equity ratio.	Bloomberg, TRAA.	5164	0.023	0.239	-0.327	-0.076	-0.002	0.073	0.470
groTier1RWA	Average growth rates of Tier1 capital ratio.	Bloomberg, Bankscope.	5164	0.023	0.155	-0.195	-0.057	0.007	0.078	0.310
groTotal capital	Average growth rates of total capital ratio.	Bloomberg, Bankscope.	5164	0.014	0.131	-0.180	-0.058	0.001	0.069	0.254

Table 3. Pairwise Correlation matrix

This table reports the correlation matrix of the main regression variables for the sample of publicly listed OECD banks from 2001 to 2012. *, ** and *** indicate significance of pair-wise correlations at the 10%, 5%, and 1% level, respectively.

	Capital Ratio	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
Tier1RWA (1)	0.591***	1													
Total capital (2)	0.646***	0.788***	1												
Log(Total Assets (3)	-0.366***	-0.291***	-0.223***	1											
Credit Risk (4)	-0.0349*	-0.0352*	-0.0633***	0.0560***	1										
Retail Funding (5)	0.303***	0.214***	0.138***	-0.553***	0.0373**	1									
Liquidity (6)	0.174***	0.320***	0.243***	-0.311***	-0.0312*	0.470***	1								
Fixed Assets (7)	0.253***	0.132***	0.0438**	-0.360***	0.106***	0.269***	0.177***	1							
Diversification (8)	-0.150***	-0.0725***	-0.108***	0.515***	0.0563***	-0.265***	-0.0176	0.0328*	1						
Loan-to-asset (9)	0.216***	-0.144***	-0.196***	-0.247***	0.0889***	0.246***	-0.438***	0.197***	-0.228***	1					
Efficiency (10)	0.0892***	0.111***	0.0343*	-0.160***	0.195***	0.274***	0.347***	0.370***	0.400***	-0.00376	1				
RoA (11)	0.275***	0.223***	0.154***	-0.0218	-0.626***	0.0219	0.0575***	-0.0361**	0.0781***	-0.0165	-0.299***	1			
MES (12)	-0.0593***	-0.0373**	-0.0495***	0.528***	0.303***	-0.221***	-0.143***	-0.143***	0.249***	-0.0728***	-0.0181	-0.143***	1		
ΔCoVaR (13)	0.0475***	0.0111	-0.00522	0.392***	0.245***	-0.130***	-0.0895***	-0.0951***	0.185***	0.0249	0.0133	-0.0850***	0.642***	1	
TAGdp (14)	-0.338***	-0.165***	-0.124***	0.651***	-0.00680	-0.518***	-0.314***	-0.269***	0.299***	-0.213***	-0.147***	-0.0779***	0.301***	0.195***	1
SIFI-index (15)	-0.201***	-0.184***	-0.170***	0.831***	0.167***	-0.405***	-0.264***	-0.285***	0.421***	-0.0946***	-0.109***	-0.0496***	0.777***	0.696***	0.423***
N	5164														

Table 4. Estimating the target capital ratio

This table presents results for two-step System Generalized Method of Moments (GMM) estimation (Blundell and Bond's (1998)) of a partial adjustment model of bank capital: $k_{i,j,t} = (1-\lambda)k_{i,j,t-1} + \lambda(\beta X_{i,j,t-1} + \delta' Country + \tau' Year + \mu_{i,j}) + \varepsilon_{i,j,t}$. Bank capital, $k_{i,j,t}$, is measure of capital for bank i in country j in period t. We use a sample of 567 listed banks from 28 OECD countries, over the 2000–2012 period. We estimate the partial adjustment model separately using three alternative capital ratio measures: Leverage ratio defined as total equity over total assets, Tier1RWA defined as regulatory capital Tier 1 capital over risk-weighted assets and Total capital defined as the sum of Tier 1 and Tier 2 capital to risk-weighted assets.
. $X_{i,j,t-1}$ is a vector of bank-characteristics that define banks' target capital ratio. To check the validity of the estimators, we conduct two tests, over-identifying test and test for autocorrelation. Hansen test is a test of exogeneity of all instruments as a group. Arellano-Bond test is a test of the absence of second order residual autocorrelation. In below, we report the summary statistics (mean, standard deviation, p5, p25, p50, p75 and p95) of the estimated target capital ratio. p-values based on robust standard errors are shown in parentheses. *, ** and *** indicate statistical significance at the 10%, 5%, and 1% level, respectively.

Panel A. Estimating bank capital targets

Dependents	(1) Leverage	(2) Tier1RWA	(3) Total capital
Lagged dependent variable	0.518***	0.690***	0.648***
	(0.0512)	(0.0403)	(0.0563)
Log(Total Assets)	-0.00244***	-0.00109***	-0.00110**
	(0.000681)	(0.000404)	(0.000549)
Credit Risk	0.199*	0.208***	0.234***
	(0.108)	(0.0749)	(0.0788)
Retail Funding	0.0576***	-0.000169	0.00265
	(0.00657)	(0.00442)	(0.00491)
Liquidity	-0.0458***	0.000503	-0.00358
	(0.00661)	(0.00308)	(0.00389)
Fixed Assets	-0.121	0.00789	-0.0309
	(0.139)	(0.0611)	(0.0783)
Diversification	-0.0120	-0.00919*	-0.0144**
	(0.00819)	(0.00541)	(0.00641)
Loan-to-asset	-0.137***	-0.0270***	-0.0351***
	(0.0133)	(0.00653)	(0.00898)
Efficiency	0.00296	-0.00527	-0.00821
	(0.00758)	(0.00530)	(0.00559)
RoA	0.197	0.0582	0.0761
	(0.134)	(0.0901)	(0.101)
Bank FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Observations	5,164	5,164	5,164
Bank	567	567	567
Country	28	28	28
Hansen test (p-value)	0.242	0.298	0.960
AR2 test (p-value)	0.315	0.669	0.570

Panel B. Deriving capital deviations

	N	Mean	SD	p5	p25	p50	p75	p95
Dev_CAPR	5164	-0.000	0.049	-0.081	-0.014	0.001	0.016	0.089
Dev_Tier1RWA	5164	0.004	0.031	-0.046	-0.011	0.006	0.022	0.048
Dev_TotalCap	5164	0.002	0.031	-0.047	-0.012	0.004	0.019	0.042

Table 5. Impacts of capital deviations quintiles on capital adjustment mechanisms

The table provides evidence of whether the average annual growth rates of the main banks' adjustment mechanisms vary in various quintiles of the capital ratio deviation (gap) for three definitions of capital deviations (leverage ratio, Tier1RWA and Total capital, respectively). For each of the three definitions of capital ratios, we report three columns corresponding with three of five quintiles (bottom, middle, and top quintile) of the gap between the estimated target and lagged actual capital ratio. Quintile 1 (Q1) corresponds with the most overcapitalized banks (underleveraged banks, i.e. largest negative gap), Quintile 3 (Q3) banks are closest to their capital ratio target, whereas banks in quintile 5 (Q5) are the most undercapitalized (overleveraged banks, i.e. largest positive gap). Thus, we compare the change rates of the capital ratios (ΔCapital ratio) and the scaled annual growth rates of the financial characteristics: the three definitions of capital ratios (groCapital ratio), total assets (Assets), total common equity (Equity), total liabilities (Liabilities), net loans (Loans), risk-weighted-assets (RWA), long-term (LT) and short-term (ST) borrowing, internal capital (Retained Earnings) and external capital (Tier1 capital). All variables are expressed in percentages (see Table 2 for more details). For each variable, we report the average growth rate, the number of observations per group (below the mean value) and the p-value of pairwise t-tests of equality of means of the extreme quintiles compared with the middle quintile, respectively. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively, for a bilateral test. Differences in the observations are due to differences in data availability.

	Leverage Gap			Test for equality of mean		Tier1RWA Gap			Test for equality of mean		Total capital Gap			Test for equality of mean	
Adjustment mechanisms (Means/Observations)	Q1	Q3	Q5	Quintile 1 vs 3	Quintile 3 vs 5	Q1	Q3	Q5	Quintile 1 vs 3	Quintile 3 vs 5	Q1	Q3	Q5	Quintile 1 vs 3	Quintile 3 vs 5
	Overcap.		Undercap.	p-value	p-value	Overcap.		Undercap.	p-value	p-value	Overcap.		Undercap.	p-value	p-value
ΔCapital ratio	-2.30%	0.07%	2.06%	**0.000**	**0.000**	-1.14%	0.09%	1.37%	**0.000**	**0.000**	-1.37%	0.04%	1.41%	**0.000**	**0.000**
	1033	1033	1032			1033	1033	1032			1033	1033	1032		
groCapital ratio	-15.31%	1.48%	23.54%	**0.000**	**0.000**	-7.63%	1.19%	14.15%	**0.000**	**0.000**	-7.62%	0.52%	11.74%	**0.000**	**0.000**
	1033	1033	1032			1033	1033	1032			1033	1033	1032		
Total Assets	22.34%	8.41%	-7.31%	**0.000**	**0.000**	13.34%	9.56%	1.32%	**0.000**	**0.000**	13.22%	8.08%	2.41%	**0.000**	**0.000**
	1033	1033	1032			1033	1033	1032			1033	1033	1032		
Total Liabilities	11.44%	8.73%	4.61%	**0.000**	**0.000**	12.49%	8.40%	3.96%	**0.000**	**0.000**	11.94%	8.10%	4.26%	**0.000**	**0.000**
	1033	1033	1032			1033	1033	1032			1033	1033	1032		
Common Equity	4.14%	9.37%	10.22%	**0.000**	0.324	6.17%	7.92%	10.45%	**0.020**	**0.004**	5.62%	7.50%	10.73%	**0.008**	**0.000**
	1033	1033	1032			1033	1033	1032			1033	1033	1032		
Net Loans	6.81%	6.01%	2.80%	**0.058**	**0.000**	8.64%	5.66%	1.60%	**0.000**	**0.000**	8.15%	5.33%	1.79%	**0.000**	**0.000**
	1033	1033	1032			1033	1033	1032			1033	1033	1033		
Risk-Weighted Assets	7.73%	6.33%	2.64%	**0.012**	**0.000**	11.04%	6.06%	-0.31%	**0.000**	**0.000**	9.87%	5.30%	0.87%	**0.000**	**0.000**
	997	1000	1008			995	1003	1003			1000	1003	1006		
LT borrowing	2.01%	1.06%	-0.51%	**0.000**	**0.000**	1.68%	1.09%	0.10%	**0.005**	**0.000**	1.75%	0.85%	0.15%	**0.000**	**0.001**
	1031	1033	1032			1033	1033	1030			1033	1033	1030		
ST borrowing	0.72%	0.31%	0.29%	0.067	0.922	1.07%	0.51%	-0.67%	**0.007**	**0.000**	1.08%	0.48%	-0.55%	**0.005**	**0.000**
	1033	1033	1032			1033	1033	1032			1033	1033	1033		
Retained Earnings (internal capital)	0.88%	3.22%	2.39%	**0.000**	0.168	1.67%	2.75%	0.85%	**0.045**	**0.006**	1.63%	3.09%	0.99%	**0.006**	**0.002**
	1033	1033	1032			1033	1033	1032			1033	1033	1032		
Tier1 (external capital)	5.64%	9.67%	8.29%	**0.000**	0.088	5.30%	8.00%	10.78%	**0.000**	**0.001**	4.53%	7.34%	11.25%	**0.000**	**0.000**
	997	1000	1008			995	1003	1003			1000	1003	1006		

Table 6. Capital and adjustment mechanisms: joint stance of the leverage gap and Tier1RWA gap

This table presents average annual growth rates of the main banks' adjustment mechanisms in four blocks of columns, when examining the joint stance of the leverage gap and the regulatory capital. We report information for four groups of banks based on the situations of joint stance of the leverage gap and Tier1RWA gap: the situations where both signal overcapitalization (Group 1), both signal undercapitalization (Group 2), overcapitalized leverage, but undercapitalized regulatory (Group 3), and undercapitalized leverage, but overcapitalized regulatory (Group 4). Thus, we compare the change rates of the capital ratios (ΔLeverage and ΔTier1RWA) and the scaled annual growth rates of the financial characteristics: capital ratios (groLeverage and groTier1RWA), total assets (Assets), total common equity (Equity), total liabilities (Liabilities), net loans (Loans), risk-weighted-assets (RWA), long-term (LT) and short-term (ST) borrowing, internal capital (Retained Earnings) and external capital (Tier1 capital). All variables are expressed in percentages (see Table 2 for more details). For each variable, we report the number of observations per group, the average growth rate and the p-value of pairwise t-tests of equality of means of a specific growth rate in a given group of banks with the corresponding growth rate for another group. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively, for a bilateral test. Differences in the observations are due to differences in data availability.

Adjustment mechanisms (Observations, Means, p-values)	Group 1: **Above** target for leverage: k*<k **Above** target for Tier1RWA: k*<k (1)		Group 2: **Below** target for leverage: k*>k **Below** target for Tier1RWA: k*>k (2)		Test for equality of mean Group 1 vs. 2 p-value (3)	Group 3: **Above** target for leverage: k*<k **Below** target for Tier1RWA: k*>k (4)		Group 4: **Below** target for leverage: k*>k **Above** target for Tier1RWA: k*<k (5)		Test for equality of mean Group 3 vs. 4 p-value (6)	Test for equality of mean: Group 1 vs. 3 p-value (7)	Group 1 vs. 4 p-value (8)	Group 2 vs. 3 p-value (9)	Group 2 vs. 4 p-value (10)
ΔLeverage	1302	-1.24%	1903	1.14%	**0.000**	1167	-0.87%	792	0.37%	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**
ΔTier1RWA	1302	-0.78%	1903	0.81%	**0.000**	1167	0.47%	792	-0.54%	**0.000**	**0.000**	**0.001**	**0.000**	**0.000**
groLeverage	1302	-8.20%	1903	13.83%	**0.000**	1167	-5.79%	792	4.00%	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**
groTier1RWA	1302	-5.22%	1903	8.24%	**0.000**	1167	5.31%	792	-3.99%	**0.000**	**0.000**	**0.022**	**0.000**	**0.000**
Total Assets	1302	15.40%	1903	0.08%	**0.000**	1167	13.55%	792	7.10%	**0.000**	**0.010**	**0.000**	**0.000**	**0.000**
Total Liabilities	1302	12.42%	1903	5.55%	**0.000**	1167	7.57%	792	9.16%	**0.005**	**0.000**	**0.000**	**0.000**	**0.000**
Common Equity	1302	5.58%	1903	10.58%	**0.000**	1167	6.20%	792	9.63%	**0.000**	0.376	**0.000**	**0.000**	0.226
Net Loans	1302	8.17%	1903	3.43%	**0.000**	1167	4.17%	792	7.34%	**0.000**	**0.000**	0.052	**0.025**	**0.000**
Risk-Weighted Assets	1258	9.85%	1858	2.88%	**0.000**	1132	3.34%	766	8.77%	**0.000**	**0.000**	0.059	0.298	**0.000**
LT borrowing	1300	2.15%	1903	0.09%	**0.000**	1165	1.23%	792	0.71%	**0.014**	**0.000**	**0.000**	**0.000**	**0.001**
ST borrowing	1302	0.89%	1903	-0.03%	**0.000**	1167	0.06%	792	1.02%	**0.000**	**0.000**	0.518	0.594	**0.000**
Retained Earnings (internal capital)	1302	1.68%	1903	3.10%	**0.000**	1167	0.87%	792	3.52%	**0.000**	0.161	**0.000**	**0.000**	0.435
Tier1 capital (external capital)	1258	6.04%	1858	9.98%	**0.000**	1132	8.00%	766	6.84%	0.118	**0.005**	0.280	**0.003**	**0.000**

Table 7: Determinants of adjustment speed to target capital structure: effects of systemic risk and size on speed of adjustment.

This table reports the coefficient estimates for the ordinary least square (OLS) regressions (Eq. (6): $\mathrm{k}_{i,\mathrm{j},t} - \mathrm{k}_{i,\mathrm{j},t-1} = (\lambda_0 + \Lambda\, Z_{ij,t-1}) \times \mathrm{Gap}_{i,j,t-1} + \varepsilon_{\mathrm{i,j,t}}$) for a sample of listed OECD banks over 2001-2012 period, to sscess the determinants of a bank's adjustment speed. Capital deviation is computed using three definitions of capital ratio (Leverage, Tier1RWA and Total capital), corresponding with the three different panels in the Table. The determinants of the adjustment speed ($Z_{ij,t-1}$) are as follows: the MES is the marginal expected shortfall, ΔCoVaR is the delta Conditional Value-at-Risk, RelativeSize is the relative bank size to GDP, Size is the natural logarithm of bank total assets as well as an aggregate SIFI-Index. The latter is an indicator of systemic importance constructed based on the quintiles of the MES, ΔCoVaR, relative size and absolute size. All continuous variables are standardized before being interacted with the capital deviation to facilitate the economic magnitude interpretation. We show the results when we add interaction terms separately. P-values based on robust standard errors, clustered by bank are shown in parentheses. Coefficients significantly different from zero at the 1%, 5% and 10% level are marked with ***/**/*. The Wald test statistic refers to the null hypothesis that all coefficients on the determinants of capital deviation are jointly equal to zero.

Panel A:	ΔLeverage					
Gap(i,t-1)	0.403***	0.406***	0.397***	0.392***	0.392***	0.406***
	(0.010)	(0.011)	(0.011)	(0.010)	(0.011)	(0.011)
Gap(i,t-1) * MES(i,t-1)		-0.022**				
		(0.010)				
Gap(i,t-1) * ΔCoVaR(i,t-1)			0.014*			
			(0.007)			
Gap(i,t-1) * RelativeSize(i,t-1)				-0.093***		
				(0.011)		
Gap(i,t-1) * Size(i,t-1)					-0.059***	
					(0.017)	
Gap(i,t-1) * SIFI-index(i,t-1)						-0.027**
						(0.011)
Observations	4339	4339	4339	4339	4339	4339
Adjusted R-squared	0.612	0.614	0.613	0.635	0.624	0.615
Panel B:	ΔTier1RWA					
Gap(i,t-1)	0.318***	0.320***	0.317***	0.318***	0.324***	0.323***
	(0.010)	(0.010)	(0.010)	(0.010)	(0.009)	(0.010)
Gap(i,t-1) * MES(i,t-1)		0.039***				
		(0.009)				
Gap(i,t-1) * ΔCoVaR(i,t-1)			0.009			
			(0.012)			
Gap(i,t-1) * RelativeSize(i,t-1)				0.020***		
				(0.005)		
Gap(i,t-1) * Size(i,t-1)					0.033***	
					(0.008)	
Gap(i,t-1) * SIFI-index(i,t-1)						0.034***
						(0.009)
Observations	4339	4339	4339	4339	4339	4339
Adjusted R-squared	0.281	0.285	0.281	0.282	0.284	0.284
Panel C:	ΔTotal capital					
Gap(i,t-1)	0.362***	0.367***	0.363***	0.362***	0.368***	0.370***
	(0.012)	(0.011)	(0.011)	(0.012)	(0.011)	(0.011)
Gap(i,t-1) * MES(i,t-1)		0.038***				
		(0.011)				
Gap(i,t-1) * ΔCoVaR(i,t-1)			0.015			
			(0.011)			
Gap(i,t-1) * RelativeSize(i,t-1)				0.013*		
				(0.007)		
Gap(i,t-1) * Size(i,t-1)					0.031***	
					(0.009)	
Gap(i,t-1) * SIFI-index(i,t-1)						0.034***
						(0.010)
Observations	4339	4339	4339	4339	4339	4339
Adjusted R-squared	0.306	0.309	0.306	0.306	0.308	0.308

Table 8: Effects of systemic risk and size on mechanisms of capital adjustments.

This table reports the coefficient estimates for the ordinary least square (OLS) regressions (Eq. (7)):

$$\Delta \mathrm{BS}_{\mathrm{i,t}} = \mathrm{c} + \beta_1 \mathrm{SIFI}_{\mathrm{i,t-1}} + \begin{cases} (\delta_0^+ + \delta_1^+ \mathrm{SIFI}_{\mathrm{i,t-1}}) \times \mathrm{Gap}_{\mathrm{i,t}}, & \text{if } \mathrm{Gap}_{\mathrm{i,t}} > 0 \\ (\delta_0^- + \delta_1^- \mathrm{SIFI}_{\mathrm{i,t-1}}) \times \mathrm{Gap}_{\mathrm{i,t}}, & \text{if } \mathrm{Gap}_{\mathrm{i,t}} < 0 \end{cases} + u_i + \varepsilon_{i,t}$$

for a sample of OECD banks over the 2001-2012 period, to assess the relation between the annual growth rates of diverse balance sheet items and capital deviations, for banks with a Capital shortfall (positive gap, undercapitalized) or a Capital surplus (negative gap, overcapitalized) vis-à-vis its target capital ratio. $\Delta BS_{i,t}$ is the average growth rate for one of the balance sheet variables. Across columns, the specification is identical except for the dependent variable, which is respectively the average annual growth rates of total common equity (Equity), Tier1 capital, retained earnings, total assets (Assets), risk-weighted assets (RWA), net loans (Loans) and total liabilities (Liabilities). Growth rates variables are scaled by average total equity, total assets and total liabilities. The gap is computed using three definitions of capital ratio (Leverage, Tier1RWA and Total capital) corresponding with the three different panels. $SIFI_{i,t-1}$ is an aggregate systemic risk index (SIFI-Index) constructed based on the quintiles of the MES, ΔCoVaR, relative size and size. All regressions include a constant term. P-values based on robust standard errors, clustered by bank are shown in parentheses. *, ** and*** indicate statistical significance at the 10%, 5% and 1% levels respectively.

Panel A: Leverage ratio

Dependent variable. Growth in:	Equity	Tier1 capital	Retained Earnings	Assets	RWA	Loans	Liabilities
Capital shortfall(i,t-1)	0.274**	-0.047	0.275***	-3.605***	-0.436***	-0.336***	-0.558***
	(0.130)	(0.127)	(0.093)	(0.097)	(0.083)	(0.050)	(0.069)
Capital shortfall(i,t-1) * SIFI-index(i,t-1)	-0.478***	-0.236*	-0.172*	0.654***	0.175**	0.139***	0.051
	(0.129)	(0.123)	(0.093)	(0.109)	(0.087)	(0.051)	(0.071)
Capital surplus(i,t-1)	0.164***	0.199***	-0.226***	-2.491***	-0.102	-0.027	-0.008
	(0.063)	(0.059)	(0.042)	(0.110)	(0.076)	(0.033)	(0.049)
Capital surplus(i,t-1) * SIFI-index(i,t-1)	0.187***	0.135**	0.036	-0.058	-0.078	-0.106***	-0.042
	(0.060)	(0.057)	(0.041)	(0.100)	(0.073)	(0.032)	(0.049)
SIFI-Index(i,t-1)	-0.043***	-0.047***	-0.055***	-0.070***	-0.067***	-0.062***	-0.064***
	(0.008)	(0.008)	(0.006)	(0.006)	(0.005)	(0.004)	(0.005)
Constant	0.080***	0.086***	0.013***	0.095***	0.058***	0.057***	0.089***
	(0.003)	(0.003)	(0.002)	(0.002)	(0.002)	(0.001)	(0.001)
Observations	4339	4231	4339	4339	4231	4339	4339
Adjusted R-squared	0.025	0.027	0.038	0.602	0.082	0.125	0.093

Panel B: Tier 1 over risk-weighted assets ratio

Dependent variable. Growth in:	Equity	Tier1 capital	Retained Earnings	Assets	RWA	Loans	Liabilities
Capital shortfall(i,t-1)	1.753***	1.958***	0.086	-2.255***	-1.418***	-0.753***	-0.806***
	(0.267)	(0.254)	(0.218)	(0.282)	(0.168)	(0.117)	(0.156)
Capital shortfall(i,t-1) * SIFI-index(i,t-1)	0.571*	0.403	0.103	0.335	0.120	0.146	-0.061
	(0.293)	(0.259)	(0.216)	(0.248)	(0.161)	(0.116)	(0.159)
Capital surplus(i,t-1)	-0.308	0.363	-0.667***	-1.670***	-1.340***	-0.503***	-0.683***
	(0.296)	(0.288)	(0.255)	(0.443)	(0.251)	(0.158)	(0.238)
Capital surplus(i,t-1) * SIFI-index(i,t-1)	-0.017	0.293	0.006	-0.960**	-0.145	-0.076	0.112
	(0.306)	(0.294)	(0.287)	(0.382)	(0.234)	(0.155)	(0.223)
SIFI-Index(i,t-1)	-0.077***	-0.084***	-0.050***	-0.063***	-0.046***	-0.054***	-0.055***
	(0.008)	(0.008)	(0.006)	(0.009)	(0.006)	(0.004)	(0.006)
Constant	0.053***	0.055***	0.014***	0.098***	0.063***	0.059***	0.086***
	(0.005)	(0.005)	(0.004)	(0.006)	(0.003)	(0.002)	(0.003)
Observations	4339	4231	4339	4339	4231	4339	4339
Adjusted R-squared	0.039	0.058	0.036	0.078	0.136	0.140	0.099

Panel C: Total capital ratio

Dependent variable. Growth in:	Equity	Tier1 capital	Retained Earnings	Assets	RWA	Loans	Liabilities
Capital shortfall(i,t-1)	1.653***	1.904***	-0.136	-1.775***	-1.255***	-0.748***	-0.793***
	(0.270)	(0.262)	(0.230)	(0.299)	(0.182)	(0.127)	(0.176)
Capital shortfall(i,t-1) * SIFI- index(i,t-1)	0.334	0.103	0.128	0.435	0.137	0.186	-0.130
	(0.293)	(0.269)	(0.218)	(0.265)	(0.187)	(0.130)	(0.180)
Capital surplus(i,t-1)	-0.144	0.378	-0.517**	-1.876***	-0.945***	-0.543***	-0.757***
	(0.253)	(0.237)	(0.215)	(0.366)	(0.211)	(0.145)	(0.227)
Capital surplus(i,t-1) * SIFI- index(i,t-1)	0.011	0.150	-0.105	-1.034***	-0.190	-0.208	-0.096
	(0.270)	(0.244)	(0.207)	(0.323)	(0.224)	(0.159)	(0.239)
SIFI- Index(i,t-1)	-0.069***	-0.075***	-0.050***	-0.072***	-0.054***	-0.057***	-0.057***
	(0.008)	(0.008)	(0.006)	(0.008)	(0.006)	(0.004)	(0.006)
Constant	0.059***	0.061***	0.018***	0.085***	0.061***	0.057***	0.084***
	(0.004)	(0.004)	(0.003)	(0.005)	(0.003)	(0.002)	(0.003)
Observations	4339	4231	4339	4339	4231	4339	4339
Adjusted R-squared	0.034	0.052	0.036	0.069	0.111	0.138	0.098

Appendix

A1 Construction of the two systemic risk measures

The Marginal Expected Shortfall (MES) corresponds to the marginal participation of bank i to the Expected Shortfall (ES) of the financial system (Acharya et al. 2016 and Brownlees and Engle, 2012). Formally, it corresponds to the mean expected stock return for bank i, conditional on the market return when the latter performs poorly. Acharya et al. (2016) define the MES as the expectation of the bank's equity return conditional on market crash.

$$MES_{i,t}^{q} \equiv E\left(R_{i,t} | R_{M,t} \leq VaR_{R_M,t}^{q}\right),$$

where R_i is one-day stock return for bank i, R_M is one-day market return[20], q is a pre-specified quantile and $VaR_{R_M,t}^{q}$ is the critical threshold equal to the p-percent quantile of the market return $R_{M,t}$ distribution. Herewith, we take q to be equal to 5-percent, the term $R_{M,t} \leq \mathrm{VaR}_{\mathrm{R_M,t}}^{\mathrm{q}}$ reflects the set of days when the market return is being at or below the worst 5-percent tail outcomes.

The CoVaR is introduced by Adrian and Brunnermeier (2016) (based on the VaR concept). $CoVaR_{R_{M|i}}^{q}$is the q-percent quantile of a conditional probability distribution which is written as [21]:

(A1) $$\mathrm{Prob}_{t-1}\left(\mathrm{R_M} \leq \mathrm{CoVaR}_{\mathrm{R_{M|i,t}}}^{\mathrm{q}} \mid \mathrm{R_{i,t}} = \mathrm{VaR}_{\mathrm{R_{i,t}}}^{\mathrm{q}}\right) = \mathrm{q}$$

Explicitly, Adrian and Brunnermeier (2016) define bank's ΔCoVaR as the difference between the VaR of the financial system conditional on the firm being in distress and VaR of the system conditional on the bank being in its median state. It catches the externality a bank causes to the entire financial system. Therefore, bank ΔCoVaR is the difference between the $\mathrm{CoVaR}_{\mathrm{R_{M|i,t}}}^{\mathrm{q=distress\ state}}$ of the financial system when bank i is in financial distress (i.e. the bank stock return is at its bottom q probability level), and the $\mathrm{CoVaR}_{\mathrm{R_{M|i,t}}}^{\mathrm{q=median}}$ of the financial system when this bank i is on its median return level (i.e. the inflection point at which bank performance starts becoming at risk). The $\Delta\mathrm{CoVaR}_{\mathrm{R_{M|i,t}}}^{\mathrm{q}}$ of individual bank is defined as:

[20] We refer to the broader stock market index, as market portfolio benchmark; so as to, catch bank's contribution to the economy stability.
[21] MES and ΔCoVaR are computed at time t given information available in t-1 on the financial system tail-risk. Our paper derives systemic risk based on two standard measures of tail risk: value-at-risk (VaR) and expected shortfall (ES). Losses are expressed in positive sign. The MES and ΔCovaR are positive and given in absolute risk value. I.e. an increase in these bank's systemic risk measures is thus given by a positive change

(A2) $$\Delta \mathrm{CoVaR}^{q}_{R_{M|i,t}} = \mathrm{CoVaR}^{q}_{R_{M|i,t}} - \mathrm{CoVaR}^{median}_{R_{M|i,t}}$$

MES and ΔCoVaR are computed at time t given information available in t-1 on the financial system tail-risk. Our paper derives systemic risk based on two standard measures of tail risk: value-at-risk (VaR) and expected shortfall (ES). Losses are expressed in positive sign. MES and ΔCovaR are positive and given in absolute risk value. I.e. an increase in these bank's systemic risk measures is thus given by a positive change