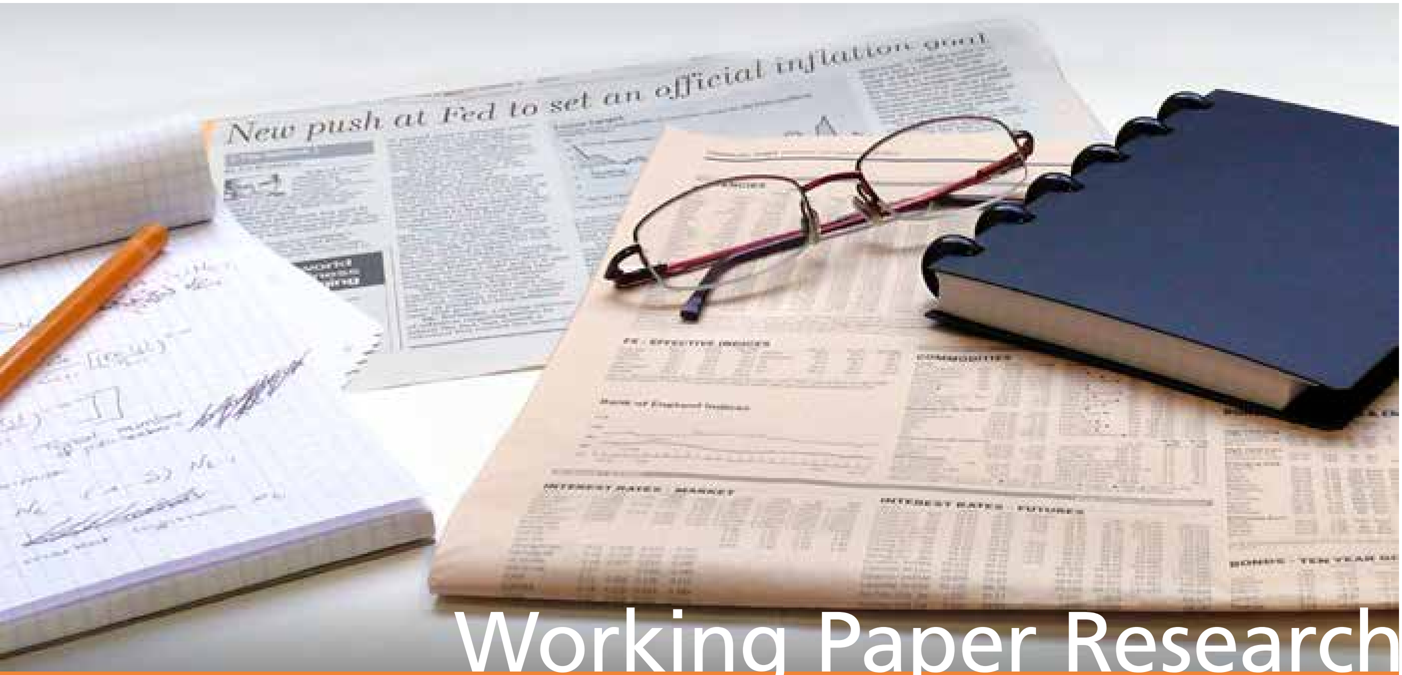
Does banks' systemic importance affect their capital structure and balance sheet adjustment processes ?



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by Yassine Bakkar, Olivier De Jonghe and Amine Tarazi

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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, specifically lending, and hence the real economy.

JEL classification: G20, G21; G28.

Keywords: capital structure, speed of adjustment, systemic risk, systemic size, bank regulation, lending, balance sheet composition.

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1. Introduction

In the aftermath of the 2007-2008 global financial crisis, regulators have introduced stringent changes to the 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)[1]. There is a rapidly growing literature analyzing various specific elements of the Basel III capital requirements[2] (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 stream that investigates the dynamics of bank capital towards a new equilibrium. This other stream of 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? Might they conflict? Although banks cannot set their desired leverage ratio ignoring the restrictions imposed by regulatory ratios, how and how quickly they adjust to leverage and regulatory ratios can differ

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[1] According to the definition of the Financial Stability Board, systemically important financial institutions (SIFIs) are financial institutions whose distress or disorderly failure, because of their size, complexity and systemic interconnectedness, would cause significant disruption to the wider financial system and economic activity.

[2] 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.

because of conflicting pressures from shareholders and regulators. Second, while this first step results in unconditional, homogenous results describing average bank 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.

In the first part of the analysis, we focus on differences in adjustments of a leverage ratio, i.e. the equity-to-total (unweighted) asset ratio, 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[3] (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. On the other hand, the opposite could also be found because the set of adjustment 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. 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.

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

3 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 as well as banks' desire to hold a buffer over the minimum capital requirements. Both the requirement and the buffer are time-varying and bank-specific. Moreover, both cannot be disentangled as information on the former is not publicly available since regulators can use Pillar 2 requirements to impose bank-specific and time-varying capital requirements. However, these requirements are typically communicated privately to the bank and they are confidential.

over the 2001-2012 period, the speed of adjustment for the non-weighted equity-to-asset capital ratio structure is 0.44, which is larger than the one for the Tier 1 capital ratio, 0.29, and the total capital ratio, 0.33. In economic terms, these speeds of adjustment correspond with half-lives of 1.18, 2.07 and 1.74 years, respectively. The half-life is computed as log(0.5)/log(1- speed of adjustment) and is equal to the time required for banks to halve the gap between their actual capital ratio and their target.

To understand better why the speeds of adjustment differ, we subsequently investigate how banks manage 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 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 banks 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, but at the same time also raise capital externally.

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), 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. Indeed, SIFIs could behave very differently. On the one hand, because they enjoy favorable treatment from financial markets (higher debt ratings, lower interest rates) due to their favored access to government safety nets and subsidies, SIFIs might adjust their capital structure more quickly and more frequently. On the other hand, SIFIs might not weigh the need to adjust quickly if they expect public support and bailout or because their complexity and opacity make it costlier for them to raise external capital.

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)). SIFIs are more likely to care about their sensitivity to a sudden market shortfall than to how much their operations might jeopardize the financial system in times of crisis. Nevertheless, regulatory scrutiny could also be effective in pushing SIFIs to internalize the threat that they pose on the system. 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. When we dig into the four aspects that define SIFIs, we find that these opposite findings on the leverage ratio and regulatory ratio are explained by the differential impact that size and systemic risk have. Larger banks adjust slower and this effect dominates for the leverage ratio, whereas systemically riskier banks adjust faster and more so their regulatory capital ratios.

Moreover, our results suggest that SIFIs 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 SIFIs account for a large portion of a banking industry (through a larger 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 5 concludes.

2. Data: sample and variables

2.1. Sample selection

We conduct the analysis on a sample of listed banks headquartered in any of the OECD countries and analyze the 2001-2012 period[4]. For these banks, we obtain 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 further drop banks with illiquid stocks, that is banks with infrequently traded stocks and low variability in stock prices (we disregard a stock if daily returns are zero over five rolling consecutive days or if more than 70% of the daily returns over the period are non-zero returns). 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 554 banks, from the 26 major advanced OECD countries. It consists of 407 U.S. banks and 147 non-U.S. banks, among which 112 are European (from 22 countries) and 22 are Japanfese. 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

[4] 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.

We focus on two types of capital measures. We focus on two regulatory capital ratios by using the Tier1 regulatory capital ratio, defined as Tier 1 equity over total risk-weighted assets (Tier1RWA hereafter) and the Total Capital ratio, defined as the sum of Tier 1 and Tier 2 equity to total risk-weighted assets. We also consider the average non-weighted common equity ratio (leverage ratio), defined as common equity over total non-weighted assets. The latter is based on cruder risk-exposure, which may be more relevant for stock market participants or debt holders whom may view risk weights as highly opaque and uninformative (Blum, 2008).

In our analysis, we devote special attention to Systemically Important Financial Institutions (SIFIs, for a definition see footntote 4). 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, by Adrian and Brunnermeier (2016)), 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, see Acharya et al. 2016 and Brownlees and Engle, 2012). 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. The MES and ΔCovaR will typically be positive (we use the opposite of returns such that losses are expressed with a positive sign) 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.

We also construct a composite SIFI-index that covers in an equally-weighted way these four dimensions of systemic importance: a proxy of absolute size, systemic size, systemic exposure and contagion risk. More specifically, for each of the four 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 associated to each of these quintiles of the four size or risk metrics 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 equally-weighted index of four characteristics provides a summary statistic 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 and the control variables we use in our estimations. All variables are winsorized at the top and bottom 1 percent level to eliminate the adverse effects of outliers and misreported data. The average leverage, Tier1RWA and Total Capital ratios are 9.3%, 11.7% and 14.1%, respectively. Furthermore, the fifth percentile of the Tier1RWA and Total Capital ratio suggests that regulatory capital ratios are well above the Pillar 1 minimum requirement for the majority of banks throughout the sample period.

In panel A, we also provide descriptive statistics for the bank-level variables we use to examine the determinants of banks' target capital ratios. 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 (89.7%), is reasonably liquid as indicated by the ratio of net loans to total deposits (108.9%), 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 is 19.6%). In terms of insolvency risk (bank default risk) and riskiness of assets, the average bank is relatively sound (average market-based Z-score is 3.43) but allocates a large fraction of its assets to high risk-weight assets (average risk-weighted asset ratio is 73.8%).

[Insert Table 2 about here]

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 8.15 and the median is 7.42 (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. This is clear from the standard deviation (2.311) and the range between the 5th percentile and the 95th percentile [5.585 to 13.010]. 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% (95th percentile) out of the domestic GDP, with a standard deviation of 19.7%. The summary statistics also reveal that banks vary in terms of systemic importance. The average values of MES and ΔCoVaR are 1.69% and 1.56% but the systemic risk measures are disperse with standard deviations of 1.91% and 1.74%, respectively.

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

where ij,t indicates bank i from country j in year 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, $K^{*}_{ij,t}$, is unobserved and is not necessarily constant over time. It consists of two building blocks: a linear combination of observed (lagged, hence time t−1) bank and country characteristics, $X_{ij,t-1}$, as well as bank and time fixed effects.

(1) $$K^{*}_{ij,t} = \beta X_{ij,t-1} + v_t + u_i$$

For the set of bank characteristics we build on Gropp and Heider (2010) who show that standard cross-sectional determinants of non-financial firms' leverage carry over to banks. These determinants and their relation to (bank) capital are based on departures from the Modigliani-Miller irrelevance proposition because of market imperfections and highlighted by various corporate finance theories (see Harris and Raviv, 1991 and Frank and Goyal, 2008, for surveys). We therefore include proxies for bank size (diversification benefits and cost of external finance), bank profitability (pecking order theory), overall risk (trade-off theory), fixed assets (collateral) and non-interest income (growth opportunities). In addition, we follow Berger et al. (2012) and include various proxies for exposures to counterparty risk (retail funding and loan to assets). A greater reliance on insured retail deposits should reduce pressure from counterparties to hold more capital. Business borrowers prefer well-capitalized lenders because borrower–lender relationships are costly to replace if the lender fails. There is ex-ante no theoretical or empirical guidance to decide on altering the set of factors for the leverage ratio vis-à-vis the regulatory capital ratios. Berger et al. (2008) and Gropp and Heider (2010), for example, also examine both leverage and regulatory capital ratios and do not differentiate between the set of explanatory variables for both types of capital ratios. Therefore, we also use the same set of factors for each capital ratio.[5]

[5] The specific ratios that we include are: 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), a bank efficiency proxy (non-interest expense to total income), a ratio of risk-weighted assets over total assets and a market-based Z-score. Subsets of these are also used in other papers (Lepetit et al. (2015), Francis and Osborne (2012), Lemmon et al. (2008), Flannery and and Rangan (2006)).

We also account for two sources of unobserved heterogeneity: v_t is a vector of year fixed effects. u_i is a vector of bank fixed effects (which subsume country fixed effects) and capture unobserved heterogeneity such as quality of management, governance, risk preference and the mix of markets in which the bank operates. The inclusion of bank (or firm) fixed effects in capital structure regressions is econometrically and economically important. Flannery and Rangan (2006), Lemmon et al. (2008), Huang and Ritter (2009), and Gropp and Heider (2010) advocate the importance of including bank (or firm) dummies for an unbiased estimation of targets. They have also shown that capital ratios tend to fluctuate around a bank specific time-invariant parameter, which can be viewed as a long-term target. In fact, De Jonghe and Öztekin (2015) report for a sample of worldwide banks that the fraction of the total variation in banks' capital ratios due to time-invariant bank characteristics (bank fixed effects) is 85%. This is similar to what is found for US non-financial firms by Lemmon et al. (2008) and for US and European banks by Gropp and Heider (2010). Hence, an extremely important component of a bank's leverage and regulatory target capital ratios is thus a bank fixed effect.

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

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

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.

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.[6,7] The estimated adjustment speeds (λ, Eq. (3)) are significant and quite different for the three capital ratio models. The speed of adjustment for the non-weighted equity-to-asset capital ratio structure is 0.444 (=1–0.556, where 0.556 is the coefficient of the lagged equity-to-asset reported in the first column). This speeds of adjustment is 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).

The adjustment speed for the regulatory capital ratios is lower, namely 0.285 (1-0.715, column 2) for the Tier 1 RWA ratio and 0.328 (1-0.672, 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 1.18, 2.07 and 1.74 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

[6] For each model, we also report the coefficient estimates and the significance levels of bank-specific drivers of the target capital ratios. Smaller banks, banks with more credit risk 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. Nor the ratio of risk-weighted assets to total assets neither the Z-score enter significantly, likely because of the high correlation with other bank characteristics. However, we do include them as they are important theoretical drivers of target leverage (trade-off theory) and because they are important for obtaining accurate speed of adjustment estimates.

[7] 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.

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 $\hat{\beta}$ from equation (3) we can compute fitted time-varying target capital ratios for each individual 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 $GAP_{ij,j,t-1}$= $\widehat{K}^*_{ij,t} - K_{ij,t-1}$. Therefore, according to equation (3), the bank fixed effects are part of these estimated targets and gaps. If banks make adjustments when there is a gap, then these adjustments should be reflected in their observed balance sheet transactions. We follow the approach of De Jonghe and Öztekin (2015) and 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 (subsection 3.2.1). These results are reported in Table 5. In a second step (subsection 3.2.2), 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.

3.2.1. Balance sheet adjustments following a leverage or regulatory capital gap

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 ratio, we report the p-values of difference in means tests using the third quintile as benchmark. The p-values are obtained by a bootstrap procedure using 500 replications to correct for the estimated nature of banks' target capital ratio (see Pagan, 1984). This bootstrap approach has become common practice in the empirical literature using partial adjustment models for corporate capital structure (see e.g., Faulkender et al., 2012; Çolak et al., 2018).

[Insert Table 5 about here]

First, with respect to the leverage ratio, overcapitalized (underleveraged) banks (Q1) have a negative and significant change in leverage ratio compared with the change rate of the third quintile (-2.19% vs. 0.07%), 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. 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 (21.78% vs. 8.19%), debt growth (10.43% vs. 8.17%), while equity growth is significantly slowed down (4.37% vs. 8.89%) 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 (6.25%) and to a smaller (economic) extent also long-term debt (1.87%). We note that the average loan growth and riskier assets are not economically significantly different with respect to the growth rate of the third quintile (5.75% and 5.43%, respectively). In the same line, banks having a capital surplus shrink their internal funding, the growth in bank retained earnings is roughly one (1.09%), and the external funding (Tier1) growth is substantially lowered (4.79% vis-à-vis 8.60%). 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 (Q5), results show that the change in leverage ratio is significantly larger (2.08% 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 (-7.69% vs. 8.19%) and the average debt growth is significantly lower (4.73% vs. 8.17%), 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.

On the whole, what would actually pose a problem to the real economy is if lending falls when banks are undercapitalized but does not actually increase when they are overcapitalized. We notice that the average growth of loans (2.87% vs. 5.75%) and riskier assets (4.41% vs. 5.43%) 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) and lowering risk-weighted assets (substituting riskier assets for safer ones).

Second, with respect to regulatory capital ratio (Tier1RWA), overcapitalized banks (Q1) have a negative growth in the Tier1 capital ratio which is significantly different from the change rate in the third quintile of the gap (-0.97% vs. 0.18%). 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 (12.62% vs. 8.02%), debt growth (11.35% vs. 8.40%), while their equity growth is significantly lower (5.96% vs. 8.89%) 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 expansionary growth rate (relative to Q3) in loans (7.92%), risky assets (9.40%) and long-term debt (1.74%); and a slow-down in internal capital (1.53%) and external capital (4.19%) growth relative to banks in the middle quintile of the regulatory gap distribution. Therefore, a Tier1 capital surplus leads banks to lever up by combinations of an asset expansion strategy, risk-taking activities, an aggressive lending policy, long and short-term debt financing policies and a slower equity growth but without engaging any reduction in the capital level.

Concerning the regulatory undercapitalized banks (Q1), the results show that their Tier 1 regulatory capital change is significantly higher (1.23%) than the change rate of the banks in the third quintile (0.18%). 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 (1.95% vs. 8.02%) and debt growth (4.78% vs. 8.40%) compared with growth rates of the benchmark, and only a moderate increase in the growth rate of equity (p-value of 0.11). 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 (2.17%), risky asset growth (1.83%), long-term debt (0.26%) and short-term debts (-0.68%) are significantly lower than the growth rates of the benchmark (Q3), while the external capital growth (12.28%) is significantly larger than the benchmark (Q3). 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 lending 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 (if anything, we find stronger significant differences) and are for the sake of space not discussed here.

Finally, the results and capital management patterns of the total capital ratio are unreported but are similar to the ones discussed above for the Tier1RWA regulatory capital ratio.

3.2.2. Balance sheet adjustments: joint stance of the leverage and regulatory gap

As the leverage ratio and regulatory capital ratios share aspects both in the numerator and the denominator it is likely that banks do not treat them independently. We therefore 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 (7.60%), risky asset (8.28%), long-term debt (1.97%) and short-term debt (0.86%), 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 achieved by external capital (10.81%) and earning retention (3.07%), which are statistically larger than the growth rates of the group of overcapitalized banks (column 5).

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 vice-versa (Groups 3 and 4). Test results for equality of means test are reported in the rightmost panel (columns 6 to 10). First, we explore differences with regards to Group 1. Underleveraged but regulatory undercapitalized banks (Group 3) have a significantly smaller asset growth compared to Group 1, and this is true for all their subcomponents (loans 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 especially notice 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. However, although the non-significant lower growth of earnings retention (1.31% vs. 1.72%) of banks in Group 3 (with regards to Group 1), the growth of equity remains significant. 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 but regulatory overcapitalized) differ from those in Groups 1 and 3. They are overleveraged, but regulatory overcapitalized (with respect to 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. Hence, when they are regulatory overcapitalized, but also overlevered, they will raise equity internally and most of the asset growth will be realized via high risk-weight assets.

In sum, this analysis provides interesting insights in the mechanisms and the relative dominance of leverage vis-à-vis risk-weighted capital ratios. The sign of the leverage and risk-weighted capital ratio gap determines whether equity is adjusted via earnings retention (leverage dominates regulatory capital) or externally raised equity (regulatory stance matters). Moreover, it also determines whether asset side adjustments are done via loans and risky assets (regulatory gap matters), versus safer assets with a lower risk weight (such as securities).

4. Bank capital adjustments: are SIFIs different?

The 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). 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.

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 by systemic risk and size characteristics, so does the speed with which banks adjust leverage and regulatory capital to reach their targets.

This section involves three 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. Finally, we examine the role of regulatory pressure in SIFIs' adjustment channels.

4.1. Do SIFIs adjust their capital ratios quicker?

Equation (3) constitutes a standard partial adjustment model for capital structure in which the speed of adjustment is homogeneous across all banks and over time. We now relax this assumption and conjecture that the speed with which banks adjust their capital ratio depends on different bank specific characteristics. In particular, we analyze whether or not (relative) size and systemic risk (exposure/contribution) affect the speed of adjustment. We therefore 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:

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

where Λ is a vector of coefficients for the adjustment speed function and $Z_{i,j,t-1}$ 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:

(4) $$\Delta K_{ij.t} = (\lambda_0 + \Lambda Z_{ij,t-1})(\beta X_{ij,t-1} + \mathrm{v_t} + \mathrm{u_i} - K_{ij,t-1}) + \varepsilon_{i,t}.$$

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, $\widehat{K}^*_{ij,t} = \hat{\beta} X_{ij,t} + \widehat{\mathrm{v_t}} + \widehat{\mathrm{u_i}}$, 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:

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

Equation (6) 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.[8]

Table 7 reports the empirical results from a model where we allow for heterogeneity in the adjustment speed towards the optimal capital structure. The impact of (systemic) size and risk on the adjustment speed is analyzed in two different setups. First of all, we include a measure of bank size (ln(total assets), relative bank size, systemic risk exposure and systemic risk contribution. Subsequently, we use the SIFI-index which allocates bank-year observations in quintiles according to these four characteristics. The composite SIFI-index provides a summary statistic of systemic importance as it covers in a meaningful way four equally-weighted dimensions of systemic importance: a proxy of absolute size, systemic size, systemic exposure and contagion risk. The index ranges from four to twenty, with the highest value representing the highest level of systemic importance that an individual bank can exhibit. For a precise construction of the SIFI-index, see section 2.2.

8 In the second stage of the two-step procedure, there is no constant term or additional fixed effects. In the second stage, the dependent variable is defined as the first difference of the capital ratio. A non-zero constant or bank fixed effect would imply that there is a trend in capital ratios. Note, however, that bank fixed effects are included in the estimated target. The gap is the difference between this estimated target and the lagged capital ratio.

We report results in three panels, corresponding with the three capital definitions we employ. However, for each column, the three regressions are estimated as a system of equations using Seemingly Unrelated Regressions, to account for possible contemporaneous cross-equation error correlation (see Zellner, 1962). The reported p-values are based on standard errors obtained via a bootstrap procedure to mitigate issues related to predictor-generated regressors (see Pagan, 1984), as the gap depends on the estimated targets (Faulkender et al., 2012; Çolak et al., 2018).

[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 0.36. Thus, on average, banks close 36 percent of the gap between actual and target leverage per year. In the next column, we introduce jointly the effects of systemic risk and size on leverage speed of adjustment. We find a positive and statistically significant relationship between ΔCoVaR (systemic risk contribution) and the speed of adjustment, indicating that banks who impose more externalities on the system adjust faster. Relative bank size and absolute bank size carry a negative and statistically significant effect.

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 dropping 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. 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 more 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.

The economic effect of a one standard deviation change in absolute and relative size on the speed of adjustment is slightly larger than that of a similar change in systemic risk contributions. This is also reflected in column 3, where we use an index of systemic importance and risk. We find that SIFIs adjust significantly slower towards their target ratio, indicating once more that for leverage adjustments, the size effect dominates the systemic risk aspect.

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. In subsequent columns, conversely to what we find in the leverage ratio specifications, only the coefficient on the interaction terms related to the MES is significantly positive, while the effects of ΔCoVaR and size on speed of adjustment are not significant. Hence, banks with higher MES adjust faster to the target Tier 1 regulatory ratio.

As there are no opposite effects on the adjustment speed for the various constituents of the SIFI index, it is not surprising that we find, in column 3, that the systemic index coefficient is positive and significant, just as for the MES. The result is also economically important and similar in magnitude for the MES interaction effect. A one standard deviation increase in the index of systemic importance and risk increases the average Tier1 regulatory adjustment speed by 0.018, 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) dominates the effects of contagion risk and size effects, possibly because banks have to face internally increased market monitoring and macroprudential regulatory supervision on the one hand and high expected capital shortfall on the other 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, we learn that the asymmetry in behavior across capital concepts is driven by different elements of the SIFI index. 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. Does regulatory pressure affect (SIFIs') adjustment speeds?

We find that the speed of adjustment for leverage ratios is faster than that of regulatory capital ratios. Furthermore, we also find that SIFIs adjust their regulatory capital ratios swifter than other banks and vice versa for the leverage ratio. In this subsection, we analyze whether these differences are caused by regulatory pressure. Banks might indeed have less latitude to freely adjust their regulatory capital ratios and specifically to even a lesser extent when their regulatory capital buffer is small or when they are below the minimum requirements.

We divide banks in a group of well capitalized banks on the one hand, and banks under regulatory pressure on the other hand. The group distinction is based on whether or not banks have both regulatory capital ratios, the Tier1 ratio and the total capital ratio, above the FDICs 'Well Capitalized' levels, 8% and 10% respectively. If they do not meet both thresholds, we classify them as potentially being under "Regulatory Pressure". Specifically, we introduce the dummy variable 'Regulatory Pressure' in our model to distinguish the two groups[9].

In column 4 of Table 7, we analyze whether banks under regulatory pressure have a different adjustment speed. In column 5 of Table 7, we interact the SIFI-index and the Regulatory Pressure variable and investigate their joint impact on adjustment speeds.

[9] This dummy variable takes the value of one if a bank's Tier1 RWA capital ratio falls below 8% and/or its Total RWA capital ratio falls below 10%. These thresholds coincide with the levels used by the FDIC to determine whether US banks are well-capitalized or not. Whenever they are not Well Capitalized, various Prompt Corrective Actions may come into play putting regulatory pressure on adjustment (mechanisms) of bank characteristics. We use the FDIC thresholds for all banks in the sample in the absence of such information for non-US banks. Recall further, from Table 2, that most banks hold regulatory capital ratios well above the minimum requirements. We are thus mostly differentiating banks that are well above both regulatory requirements versus banks with small, but positive buffers.

First of all, using the dummy variable for being under regulatory pressure or not, we find that banks that are not in the highest capitalization group (i.e. under regulatory pressure) adjust slower to the target leverage compared to those who are. The difference is economically large. This indicates that banks that are not in the most comfortable zone with respect to regulatory thresholds may indeed not have discretion in their channels of adjustment, which could slow down the adjustment speed on the leverage ratio. Subsequently, in panels B and C of column 4, we do not find a significant difference in the adjustment speed for banks under regulatory pressure. Contrary to what we find for the leverage ratio, the potential lack of discretion that leads to slower speeds of adjustment for the leverage ratio does not lead to slower speeds of adjustment for the Tier 1 regulatory ratios. This indicates that the adjustment mechanisms imposed by the regulators effectively aim at affecting the regulatory capital ratio solely. Finally, in column 5, we do not find that the interaction effect between the SIFI-index and the dummy variable 'regulatory pressure" is significant. Yet, the results documented in columns 3 and 4 pertain.

In sum, the results in Table 7 indicate that banks adjust their regulatory capital ratios slower than their leverage ratios possibly because they are constrained in their scope by regulation. In general, they can make faster adjustments to the leverage ratio. The latter are, however, slowed down when they hold small regulatory capital buffers, because of additional scrutiny and pressure from regulators.

4.3. 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 in a uniform setup whether the adjustment mechanisms differ for SIFIs, depend on the type of capital ratio and depend on the sign of the capital gap.

To address this question, we estimate the following two threshold regression models:

(7a)

$$\Delta \mathrm{BS}_{i,t} = c + \beta_1 \mathrm{SIFI-index}_{i,t-1} + \begin{cases} \begin{cases} (\delta_0^+) \times \mathrm{LevGap}_{i,t} & , \text{ if LevGap}_{i,t} > 0 \\ (\delta_0^-) \times \mathrm{LevGap}_{i,t} & , \text{ if LevGap}_{i,t} < 0 \end{cases} \\ \begin{cases} (\delta_2^+) \times \mathrm{Tier1Gap}_{i,t} & , \text{if Tier1Gap}_{i,t} > 0 \\ (\delta_2^-) \times \mathrm{Tier1Gap}_{i,t} & , \text{ if Tier1Gap}_{i,t} < 0 \end{cases} \end{cases} + u_i + \varepsilon_{i,t}$$

And

(7b)

$$\Delta \mathrm{BS}_{i,t} = c + \beta_1 \mathrm{SIFI-index}_{i,t-1} + \begin{cases} \begin{cases} (\delta_0^+ + \delta_1^+ \mathrm{SIFI-index}_{i,t-1}) \times \mathrm{LevGap}_{i,t} & , \text{ if LevGap}_{i,t} > 0 \\ (\delta_0^- + \delta_1^- \mathrm{SIFI-index}_{i,t-1}) \times \mathrm{LevGap}_{i,t} & , \text{ if LevGap}_{i,t} < 0 \end{cases} \\ \begin{cases} (\delta_2^+ + \delta_3^+ \mathrm{SIFI-index}_{i,t-1}) \times \mathrm{Tier1Gap}_{i,t} & , \text{if Tier1Gap}_{i,t} > 0 \\ (\delta_2^- + \delta_3^- \mathrm{SIFI-index}_{i,t-1}) \times \mathrm{Tier1Gap}_{i,t} & , \text{ if Tier1Gap}_{i,t} < 0 \end{cases} \end{cases} + u_i + \varepsilon_{i,t}$$

More specifically, $\Delta BS_{i,t}$ is the growth rate for one of the balance sheet variables (Equity, Tier1 capital, Retained Earnings, Assets, RWA, Loans, Liabilities, Cash and marketable securities and Liquid Assets). 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), liabilities (change in total liabilities, long-term borrowings and short-term borrowings) or liquid options (change in (short-term) cash and marketable securities and liquid assets). This growth rate in key balance sheet components is regressed on deviations from target capital. 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; De-Ramon et al., 2016).

We allow for asymmetric adjustments depending on the sign of the gap and jointly investigate the impact of the sign of the leverage ratio gap and the sign of the regulatory capital ratio gap. Furthermore, in Equation (7b), we also allow this asymmetric adjustment to depend on banks' systemic size and importance as measured by the SIFI index. More precisely, we jointly include in one regression equation the leverage gap and the regulatory gap and their interactions with the SIFI index to examine which one is more important for each adjustment mechanism. This setup thus allows testing whether banks chose a specific adjustment mechanism in response to a regulatory surplus/shortfall vis-à-vis a leverage ratio surplus/shortfall[10].

[10] In this specification, we include two rather than three capital ratios, to avoid multicollinearity problems. We leave out the total regulatory capital ratio (gap) as it is highly correlated with the Tier 1 capital ratio (gap). This is not the case for the leverage gap and the Tier1RWA gap. The correlation between these two is only 34%. Moreover, in about 1/3th of bank-year observations, the leverage gap and Tier 1 gap will have opposite signs.

In Table 8, we report the results of our estimates of the model presented in equations (7a) and (7b). The columns correspond with the growth rates in various balance sheet items. The reported standard errors are obtained via a bootstrap procedure to mitigate issues related to predictor-generated regressors (see Pagan, 1984), as the gap depends on the estimated targets (Faulkender et al., 2012; Çolak et al., 2018).

[Insert Table 8 about here]

In panel A, we first report results for the restricted Equation (7a), in which we do not allow yet for interaction terms between the capital ratio gaps and the SIFI. First of all, the coefficients associated with the systemic index variable (SIFI-index) are in general significant and 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.

Furthermore, we find that active capital management (growth in equity and Tier 1 capital) is mainly used when banks are undercapitalized with respect to their own regulatory capital target. The larger the shortfall of the Tier 1 capital ratio from its target, the larger the growth rate in equity and Tier 1 capital implying that banks rely on equity issuance. Moreover, the relative magnitudes of these estimated coefficients is larger for Tier 1 than for common equity indicating that they prefer other instruments eligible for Tier 1 capital over pure equity in these occasions.

Interestingly and as expected, total asset growth is driven by deviations from the leverage target, whereas risk-weighted asset growth is driven by regulatory capital deviations. Concerning total asset growth, we find an economically large effect of a positive leverage gap. The more undercapitalized a bank is with respect to its leverage target, the larger the reduction in bank size. Concerning the RWA growth rate, we find that it to be lower, the more the bank’s regulatory capital ratio falls below its own target. However, when banks are overcapitalized with respect to their Tier 1 target, the growth rate of RWA is larger, the more they are overcapitalized (i.e., the more negative the Tier 1 gap becomes). Moreover, the responsiveness of RWA growth to the magnitude of the gap is larger when they are above their regulatory target capital ratio, than when they are below.

Regarding liability growth rate, we find it to be affected both by the leverage ratio gap and the regulatory capital ratio gap, and to a similar extent for both ratios and also irrespective of the sign of the gap. On the one hand, the more banks are undercapitalized (i.e., increases in the positive gap), the lower is the growth in liabilities. On the other hand, the more banks are overcapitalized (i.e., decreases in the negative gap), the higher is their liabilities growth rate. Similarly to liabilities, loan growth is driven by both shortfalls and surpluses of both the leverage ratio and Tier 1 capital ratio. In terms of economic magnitude, the responsiveness is slightly larger for the regulatory capital definition.

Finally, cash growth and liquid asset growth is larger when the Tier 1 capital ratio is below target. The additional Tier 1 capital that undercapitalized banks raise is mainly hoard as cash (hence the growth), which subsequently reduces the RWA growth. However, when their leverage ratio is above their target (negative leverage gap), banks reduce their liquid asset growth, which is in contract to expectations as it harms in closing the gap.

We now turn to the unconstrained Equation (7b). That is, we now investigate the balance sheet adjustments in response to gaps in the leverage ratio and Tier 1 regulatory capital ratio, also allowing for heterogeneity depending on the SIFI index and the signs of both the leverage and regulatory gaps. In panel B of Table 8, we find that the interaction with the SIFI index is more often significant when banks experience a positive gap (hence capital shortfall) and this both for the leverage ratio and the Tier 1 capital ratio. The responsiveness of equity, liabilities and asset growth with respect to shortfalls from the Tier 1 capital target ratio is larger, for a given magnitude of the shortfall, for SIFIs compared to non-SIFIs. This indicates that for increasingly larger regulatory capital gaps, compared to smaller banks, SIFIs resort more to raising equity, downsizing and shrinking debts. On the contrary, SIFIs exhibit a lower responsiveness in adjustment mechanisms (equity, Tier 1 capital, retained earnings and total assets) when they are undercapitalized with respect to the leverage ratio target. These findings are consistent with the idea that banks with capital shortfall have less capacity to grow, lend and/or get into debt compared with other banks. In all instances, these both sets of results are consistent with the results in panels of Table 7, where we found a lower adjustment speed for SIFIs for the leverage ratio and a faster adjustment speed for SIFIs for the regulatory capital ratios than less systemic institutions.

Finally, in panel C, we present an extension of Equation (7b) and also analyze whether regulatory pressure affects the channels that banks use to adjust their capital ratio towards their target. First of all, note that adding these additional interaction terms leaves the results on the other coefficients unaffected. The discussion of the results of panel B thus pertains. Second, we find that banks that are under regulatory and supervisory pressure, adjust certain items to a different extent compared to their well-capitalized peers.

Banks under regulatory pressure are found to issue Tier1 capital more extensively, the more negative the leverage gap becomes. Hence, even though these banks would need lower equity growth to get back to their leverage target, they possibly make adjustments in line with the regulatory requirements. Consequently, this will slow down their leverage adjustment speed, which supports the findings reported in column 4 of panel A of Table 7. Moreover, such banks reduce their asset growth to a lesser extent for a given leverage shortfall, also in line with the lower adjustment speed of leverage ratios for banks that are under regulatory pressure. On the other hand, they reduce their liabilities and loan growth to a larger extent when their leverage ratio is below their target (when banks are overleveraged).

We now turn to the interaction effects of the Tier1RWA gap and the regulatory pressure variable. In contrast to the results in rows 5 and 6, we hardly find any significant interaction coefficients in rows 11 and 12 (except for Cash and marketable securities and Liquid assets) indicating that the impact of the magnitude and sign of the regulatory capital gap on the adjustment mechanisms does not differ when banks are under regulatory pressure or not. This lack of significance squares with the findings presented in panels B and C of Table 7, where we showed that the speed of adjustment of regulatory capital ratios was not different when banks might be facing regulatory pressures.

5. Robustness checks and further issues

We examine the robustness of our results to alternative specifications. First, we analyze two sources of non-linearities in the speed of adjustment. First, we test whether the speed of adjustment depends on the sign of the gap. Put differently, we allow for asymmetric adjustment speeds for over –and undercapitalized banks. Second, we also test whether the speed of adjustment of the leverage ratio depends on the stance (sign) of the regulatory capital ratio and vice versa. These two sources of asymmetries in the speed of adjustment are analyzed in Table 9. In summary, we show in column 1 of panels A, B and C that the speed of adjustment is significantly lower when banks are overcapitalized than when they are undercapitalized, but this effect is more dominant for the leverage ratio than the regulatory capital ratio. Furthermore, in column 2, the interaction coefficient with the dummy of being undercapitalized with respect to the other capital concept (i.e., Tier 1 capital gap in panel A, the leverage ratio in panels B and C) is significant in three occasions and if so, it is negative. In panel A, we find that the asymmetry in adjustment speed above and below target is exacerbated when banks are undercapitalized in the other capital dimension, i.e. with respect to their internal target for the regulatory capital ratio. This is not only an indication that these two capital concepts are not treated in isolation by banks, but also that banks that are below their regulatory target respond slower. The latter finding could be due to more regulatory scrutiny (and hence less room for flexibility) when banks' regulatory capital ratios are lower. Meanwhile, we do not find that the stance of the leverage gap matters for the speed of adjustment of the regulatory capital ratio.

[Insert Table 9 about here]

Second, De-Ramon et al. (2016) have shown that the balance sheet adjustments that UK banks make to get back to their target have changed since the global financial crisis. We investigate a similar issue, but rather than looking at each and every adjustment mechanisms, we look at the impact on the speed of adjustment, which summarizes the underlying adjustment mechanism. In particular, we not only check whether the speed of adjustment has changed since 2007, but also whether systemic importance have different effects on the adjustment speed during the pre-global financial crisis period and during the (post-)crisis period. Indeed, capital management and balance sheet behavior may be influenced by banks' ability to tap capital markets. For that purpose, we analyze the impact of systemic importance on adjustment speed estimations allowing for non-linearity in the relationship by a dummy capturing the normal pre-crisis times (2001-2006) and crisis and post global financial crisis sample years (2007-2012). In panel A of Table 10, we report the regression results. In the lower panel B, we present the adjustment speeds implied by the estimated coefficients (by capital ratio definition) for the pre- and post-2007 period, for small banks, average banks and SIFIs. Small banks (SIFIs) are defined as those for which the normalized SIFI index is -1 (+1), i.e. one standard deviation below (above) the mean.

[Insert Table 10 about here]

In this robustness check, we find first of all, that adjustment speeds went up since 2007, both for small and average banks as well as SIFIs and for all capital ratio definitions. Second, we find prior to 2007 that SIFIs adjust slower than small banks, with larger differences between the two groups for leverage ratios compared to regulatory capital ratios. Third, in the post 2007 period, SIFIs still adjust their leverage ratio slower than small banks, but the difference in adjustment speeds between the two groups has narrowed compared to the pre-2007 period. Fourth, an opposite pattern is found for regulatory capital ratios. Since the global financial crisis, the adjustment speed of regulatory capital ratios has been higher for SIFI banks vis-à-vis small banks. The observation that SIFIs adjust slower to their leverage capital ratio, and faster to their regulatory capitals ratios, indicates that SIFIs have become more concerned about their regulatory capital levels than their leverage since the global financial crisis.

Finally, our sample focuses on banks from 28 OECD countries as these are the countries where most of the G-SIBs (Globally Systemically Important Banks) are headquartered. One other country where G-SIBs are prevalent is China. One may wonder whether our results would hold in the case of the Chinese banking sector which is characterized by a specific institutional environment. How Chinese banks adjust their capital ratio has been examined by Molyneux et al. (2014). In particular, they study the role of ownership structure on Chinese banks' target capital and speed of adjustment. They do find differences in adjustment speeds depending on ownership (foreign banks adjust swifter than domestic government-owned banks); but only for regulatory capital ratios. Furthermore, De Jonghe and Oztekin (2015) report that the speed of adjustment is slightly lower for mutual institutions (cooperative and savings banks)[11] compared with commercial banks, mostly because they cannot use external capital to make adjustments. Finally, the insights of De Jonghe and Öztekin (2015) on the cross-country drivers of adjustment speeds shed light on

[11] In De Jonghe and Öztekin (2015)'s sample, there are no government owned/connected banks (which would be the case for China), but the closest resemblance with (Chinese) government-owned banks may be with cooperative and savings banks who are also not necessarily profit maximizers.

whether our results would hold for Chinese SIFIs. While China's inflation rate is similar to the average OECD country, its stock market is not yet as developed as in most OECD countries. The latter may harm swift adjustments in the capital ratio by limiting the possibility to raise equity. As such, although it could be argued that such banks could easily rely on government capital injections, we conjecture, but leave it for further research to demonstrate, that SIFIs in China would, all else equal, have a slower adjustment speed than SIFIs in our sample of banks belonging to OECD countries.

6. Conclusion

The Basel III Accord has, among other things, introduced more stringent capital requirements, 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. When we dig into the four aspects that define SIFIs, we find that these opposite findings on the leverage ratio and regulatory ratio are explained by the differential impact that size and systemic risk have. Larger banks adjust slower and this effect dominates for the leverage ratio, whereas systemically riskier banks adjust faster and more so their regulatory capital ratios. Furthermore, banks that are closer to the regulatory minimum requirements are constrained in the adjustments they can make on their leverage ratio, resulting in a slower speed of adjustment.

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 effects 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 through Pillar 2 of the Basel III Accord.

Future research could bridge the gap between De Jonghe and Oztekin (2015) and our paper. They show that the speed of capital structure adjustments by banks is heterogeneous across countries. In particular, they find that banks make faster capital structure adjustments in countries with more stringent capital requirements, better supervisory monitoring, more developed capital markets and high inflation. In our work, we focus instead on heterogeneity in the capital structure adjustment process across types of banks. An interesting avenue for further research is examining both issues jointly. That is, one could investigate whether the speed of adjustment differences between SIFIs and smaller banks are heterogeneous across countries depending on the institutional setting (e.g., strength of supervision, capital market development) or market structure. The effects in our sample may be limited as we focus on banks from 28 OECD countries for which the institutional setting is more homogeneous. A larger cross-country setup could uncover these potential relationships.

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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 554 listed banks from 26 OECD countries, Australia, Austria, Belgium, Britain, Canada, Czech, Denmark, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Japan, Netherlands, Norway, Poland, Portugal, Slovakia, Spain, Sweden, Switzerland, Turkey, and United-States, totaling 4962 bank-year observations.

Country	Number of banks	Number of Bank-Year observations	Country	Number of banks	Number of Bank-Year observations
Australia	5	56	Luxembourg	1	5
Austria	7	54	Mexico	0	0
Belgium	2	24	Netherlands	1	6
Canada	8	86	Norway	11	103
Czech	1	6	Poland	3	13
Denmark	16	117	Portugal	3	36
Finland	1	12	Slovakia	1	1
France	6	52	South Korea	0	0
Germany	5	43	Spain	6	59
Greece	7	32	Sweden	4	46
Hungary	1	4	Switzerland	6	31
Ireland	2	18	Turkey	9	32
Italy	14	118	United-Kingdom	5	55
Japan	22	148	United-States	407	3805
			Total	554	4962

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	349	7.03
2002	362	7.30
2003	375	7.56
2004	386	7.78
2005	405	8.16
2006	450	9.07
2007	467	9.41
2008	477	9.61
2009	440	8.87
2010	431	8.69
2011	415	8.36
2012	405	8.16
Total	4962	100

Table 2. Descriptive statistics

This table provides the definition and summary statistics for all the regression variables of a sample of 554 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)	4962	0.093	0.043	0.039	0.069	0.088	0.109	0.162
Tier1RWA	Ratio of capital tier1 over to total risk weighted assets.	Bloomberg, Bankscope.	4962	0.117	0.036	0.07	0.093	0.111	0.135	0.182
Total capital	Ratio of total capital tier1 over to total risk weighted assets.	Bloomberg	4962	0.141	0.039	0.102	0.117	0.132	0.155	0.209
Log(Total Assets)	Natural logarithm of bank total assets (in USD billion).	TRAA	4962	8.151	2.311	5.585	6.401	7.421	9.395	13.1
Credit Risk	Loan Loss Provisions over net loans.	TRAA	4962	0.007	0.009	0	0.002	0.004	0.008	0.023
Retail Funding	Total customer deposit divided by total funding (st borrow+Tot.Cust.Dep).	Bloomberg, TRAA	4962	0.897	0.119	0.652	0.863	0.937	0.979	1
Liquidity	Net loans over total deposit.	TRAA	4962	1.089	0.312	0.583	0.911	1.085	1.259	1.598
Fixed Assets	Net fixed assets over total assets.	Bloomberg, TRAA	4962	0.016	0.011	0.003	0.009	0.015	0.021	0.036
Diversification	Non-interest income over total income.	TRAA	4962	0.196	0.109	0.053	0.119	0.175	0.252	0.414
Loan-to-asset	Net loans over total assets.	TRAA	4962	0.690	0.148	0.44	0.61	0.692	0.775	1
Efficiency	Cost income ratio, non-interest expense over total income.	TRAA	4962	0.451	0.131	0.249	0.367	0.44	0.528	0.685
RoA	Return on assets, defined as the ratio of net income to total assets.	TRAA	4962	0.007	0.01	-0.009	0.004	0.008	0.011	0.017
Market Z-score	Return-based Z-score	Bloomberg, TRAA	4962	3.429	1.874	0.564	2.053	3.331	4.556	6.844
RWA_TA	Risk-weighted asset ratio	Bloomberg, TRAA	4945	0.738	0.184	0.415	0.632	0.743	0.869	1
Panel B: Determinants of the adjustment speed										
MES (%)	Marginal Expected Shortfall	Appendix Eq. A1	4859	1.692	1.907	-0.417	0.259	1.257	2.601	5.53
ΔCoVaR (%)	ΔConditional Value-at-Risk	Appendix Eq. A2	4841	1.557	1.743	-1.006	0.405	1.33	2.609	4.721
TAGdp	Natural logarithm of bank total assets over GDP.	TRAA, OECD stats Metadata, IMF WEO	4962	0.063	0.197	0	0	0	0.004	0.518
logTA	Natural logarithm of bank total assets (in USD billion).	TRAA	4962	8.151	2.311	5.585	6.401	7.421	9.395	13.1
SIFI-index	aggregated systemic importance index	Subsection 4.1.2								
Panel C: Growth in adjustment mechanisms										
Total Equity	Average growth in total equity scaled by average total equity	Bloomberg, TRAA	4962	0.081	0.18	-0.159	0.007	0.064	0.143	0.375
Tier1 capital	Average growth in Tier1 capital scaled by average total equity	Bloomberg, Bankscope.	4945	0.08	0.172	-0.147	0.008	0.061	0.136	0.376
Retained Earnings	Average growth in retained earnings by average total equity	Bloomberg, Bankscope.	4962	0.023	0.135	-0.192	-0.012	0.04	0.085	0.185
Total Assets	Average growth in total assets scaled by average total assets	Bloomberg, TRAA.	4962	0.079	0.196	-0.287	0.001	0.066	0.158	0.421
Net Loans	Average growth in net loans scaled by average total assets	Bloomberg, TRAA.	4962	0.052	0.092	-0.082	-0.004	0.042	0.095	0.224
Risk-Weighted Assets	Average growth in risk-weighted assets by average total assets	Bloomberg, TRAA.	4945	0.055	0.122	-0.107	-0.006	0.043	0.103	0.251
Total Liabilities	Average growth in total liabilities by average total liabilities	Bloomberg, TRAA.	4962	0.081	0.124	-0.09	0.006	0.063	0.141	0.305
LT borrowing	Average growth in long-term borrowing by average total liabilities	Bloomberg, TRAA.	4961	0.009	0.048	-0.056	-0.01	0	0.023	0.094
ST borrowing	Average growth in short-term borrowing scaled by average total liabilities	Bloomberg, TRAA.	4962	0.003	0.048	-0.074	-0.016	0	0.022	0.083
ΔLeverage	Change in common equity ratio (percentage)	Bloomberg, TRAA.	4962	-0.009	2.506	-3.911	-0.635	-0.016	0.569	3.991
ΔTier1RWA	Change in Tier1 capital ratio (percentage)	Bloomberg, Bankscope.	4962	0.144	1.713	-2.54	-0.64	0.09	0.84	2.99
ΔTotal capital	Change in total capital ratio (percentage)	Bloomberg, Bankscope.	4962	0.080	1.822	-2.77	-0.78	0.03	0.9	3.05
groLeverage	Average growth rates of common equity ratio.	Bloomberg, TRAA.	4962	0.025	0.241	-0.328	-0.075	-0.002	0.073	0.482
groTier1RWA	Average growth rates of Tier1 capital ratio.	Bloomberg, Bankscope.	4962	0.024	0.154	-0.192	-0.056	0.008	0.081	0.31
groTotal capital	Average growth rates of total capital ratio.	Bloomberg, Bankscope.	4962	0.015	0.131	-0.176	-0.057	0.003	0.07	0.257

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, containing 4962 bank-year observations. All correlations are significant at the 1% level, unless otherwise noted. , ** and * indicate significance of pair-wise correlations at the 10% and 5%, whereas ^{NS} indicates insignificance at the 10% level.

	Capital Ratio	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
Panel A: Capital ratios																	
Tier1RWA (1)	0.58																
Total capital (2)	0.635	0.784															
Panel B: Determinants of the target capital structure																	
Log(Total Assets (3)	-0.367	-0.285	-0.212														
Credit Risk (4)	-0.033*	-0.032*	-0.057	0.048													
Retail Funding (5)	0.305	0.21	0.134	-0.553	0.045												
Liquidity (6)	0.18	0.317	0.239	-0.304	-0.023^{NS}	0.475											
Fixed Assets (7)	0.266	0.137	0.049	-0.362	0.107	0.273	0.18										
Diversification (8)	-0.155	-0.079	-0.106	0.523	0.055	-0.266	-0.019^{NS}	0.035*									
Loan-to-asset (9)	0.239	-0.135	-0.185	-0.26	0.085	0.248	-0.429	0.2	-0.228								
Efficiency (10)	0.09	0.112	0.035*	-0.15	0.204	0.276	0.345	0.374	0.399	0.002^{NS}							
RoA (11)	0.274	0.217	0.151	-0.021^{NS}	-0.637	0.019^{NS}	0.055	-0.043	0.077	-0.011^{NS}	-0.305						
Market Z-score (12)	-0.003^{NS}	-0.048	0.006^{NS}	0.048	-0.489	-0.102	-0.024**	-0.129	0.044	-0.081	-0.241	0.439					
RWA_TA (13)	0.438	-0.139	0.046	-0.455	0.085	0.322	-0.05	0.247	-0.282	0.51	0.014^{NS}	0.044	-0.023^{NS}				
Panel C: Determinants of the adjustment speed																	
MES (14)	-0.069	-0.046	-0.05	0.536	0.296	-0.228	-0.146	-0.153	0.248	-0.079	-0.015^{NS}	-0.153	-0.422	-0.173			
ΔCoVaR (15)	0.046	0.008^{NS}	-0.004^{NS}	0.397	0.24	-0.133	-0.09	-0.104	0.187	0.022^{NS}	0.015^{NS}	-0.087	-0.327	-0.097	0.637		
TAGdp (16)	-0.342	-0.159	-0.118	0.652	-0.008^{NS}	-0.524	-0.315	-0.27	0.305	-0.223	-0.142	-0.079	-0.016^{NS}	-0.46	0.306	0.196	
SIFI-index (17)	-0.206	-0.186	-0.165	0.833	0.157	-0.409	-0.262	-0.291	0.423	-0.103	-0.104	-0.051	-0.169	-0.317	0.778	0.697	0.424

Table 4. Estimating the target capital ratio

Panel A of 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: $K_{ij,t} = \lambda(\beta X_{ij,t-1} + v_t + u_i) + (1-\lambda)K_{ij,t-1} + \varepsilon_{ij,t}$. $k_{i,j,t} = (1-\lambda)k_{i,j,t-1} + \lambda(\beta X_{i,j,t-1} + v_t + u_i) + \varepsilon_{i,j,t}$. Bank capital, $k_{i,j,t}$, is measure of capital for bank i in country j in period t. We use a sample of 554 listed banks from OECD countries, over the 2001–2012 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 panel B, we report summary statistics (mean, standard deviation, p5, p25, p50, p75 and p95) of the deviations from 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. A partial adjustment model of bank capital

	(1)	(2)	(3)
Dependents	Leverage	Tier1RWA	Total capital
Lagged dependent variable	0.556***	0.715***	0.672***
	(0.0864)	(0.0560)	(0.0668)
Log(Total Assets)	-0.00231***	-0.000878*	-0.000647
	(0.000701)	(0.000488)	(0.000538)
Credit Risk	0.248*	0.268*	0.188
	(0.133)	(0.147)	(0.159)
Retail Funding	0.0529***	-0.00260	0.00324
	(0.00917)	(0.00504)	(0.00695)
Liquidity	-0.0468***	-0.000793	-0.00212
	(0.00660)	(0.00372)	(0.00449)
Fixed Assets	-0.0689	0.0604	-0.000797
	(0.128)	(0.0692)	(0.0783)
Diversification	-0.0136	-0.0152*	-0.0164**
	(0.0106)	(0.00831)	(0.00819)
Loan-to-asset	-0.114**	-0.0155	-0.0418
	(0.0456)	(0.0171)	(0.0317)
Efficiency	-0.000564	-0.00144	-0.00600
	(0.0117)	(0.00990)	(0.00959)
RoA	0.0865	-0.0352	0.0392
	(0.212)	(0.135)	(0.162)
Market Z-score	0.00224	0.00306	-0.000786
	(0.00449)	(0.00589)	(0.00609)
RWA_TA	-0.0480	-0.0232	0.0175
	(0.0791)	(0.0352)	(0.0579)
Bank FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Observations	4,962	4,962	4,962
Bank	554	554	554
Country	26	26	26
Hansen test (p-value)	0.263	0.948	0.919
AR2 test (p-value)	0.619	0.575	0.548

Panel B. Deriving capital deviations

	N	Mean	SD	p5	p25	p50	p75	p95
Dev_CAPR	4962	-0.000	0.055	-0.090	-0.018	0.001	0.020	0.104
Dev_Tier1RWA	4962	0.009	0.055	-0.082	-0.024	0.008	0.042	0.096
Dev_TotalCap	4962	0.003	0.036	-0.053	-0.015	0.005	0.023	0.053

Table 5. Balance sheet adjustment mechanisms in response to a capital surplus or shortfall

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 results of pairwise t-tests of equality of means of the extreme quintiles compared with the middle quintile, respectively. We report the p-values of these equality of means tests and use a bootstrap procedure to account for the fact that the classificiation in quintiles is based on an estimated target.. Differences in the observations are due to differences in data availability.

Adjustment mechanisms (Means/Observations)	Leverage Gap			Test for equality of mean		Tier1RWA Gap			Test for equality of mean		Total capital Gap			Test for equality of mean	
	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	-2.19	0.07	2.08	**0**	**0**	-0.97	0.18	1.23	**0**	**0**	-1.31	0.09	1.44	**0**	**0**
	993	993	992			993	993	992			993	993	992		
groCapital ratio	-14.51	1.62	23.65	**0**	**0**	-6.47	2.13	12.52	**0**	**0**	-7.35	0.89	12.06	**0**	**0**
	993	993	992			993	993	992			993	993	992		
Total Assets	21.78	8.19	-7.69	**0**	**0**	12.62	8.02	1.95	**0**	**0**	12.58	8.17	2.37	**0**	**0**
	993	993	992			993	993	992			993	993	992		
Total Liabilities	10.43	8.17	4.73	**0**	**0**	11.35	8.4	4.78	**0**	**0**	11.46	8.12	4.17	**0**	**0**
	993	993	992			993	993	992			993	993	992		
Common Equity	4.37	8.89	9.9	**0**	0.25	5.96	8.89	10.24	**0**	0.11	5.61	7.96	10.95	**0**	**0**
	993	993	992			993	993	992			993	993	992		
Net Loans	6.25	5.75	2.87	0.24	**0**	7.92	5.56	2.17	**0**	**0**	7.95	5.26	1.76	**0**	**0**
	993	993	992			993	993	992			993	993	992		
Risk-Weighted Assets	5.96	5.43	4.41	0.30	0.09	9.4	5.54	1.83	**0**	**0**	10.62	5.25	0.29	**0**	**0**
	991	988	990			990	990	989			992	990	987		
LT borrowing	1.87	0.9	-0.42	**0**	**0**	1.74	0.87	0.26	**0**	**0**	1.58	0.89	0.11	**0**	**0**
	992	993	992			993	993	991			993	993	991		
ST borrowing	0.71	0.34	0.15	0.09	0.40	0.8	0.46	-0.68	0.12	**010**	1.02	0.33	-0.57	**0**	**0**
	993	993	992			993	993	992			993	993	992		
Retained Earnings (internal capital)	1.09	2.56	2.27	**0.02**	0.64	1.53	3.18	1.47	**0**	**0.01**	1.71	3.24	1.17	**0**	**0**
	993	993	992			993	993	992			993	993	992		
Tier1 (external capital)	4.79	8.60	10.09	**0**	0.08	4.19	8.11	12.18	**0**	**0**	5.58	7.61	10.95	**0.01**	**0**
	991	988	990			990	990	989			992	990	987		

Table 6. Balance sheet 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 and the average growth rate. In the right hand side panel, we provide test results 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. We report the p-values of these equality of means tests and use a bootstrap procedure to account for the fact that the classificiation in quintiles is based on estimated targets.. Differences in the observations are due to differences in data availability.

Adjustment mechanisms (Observations, Means-**%**)	Group 1		Group 2		Group 3		Group 4		Test for equality of mean p-values					
	Above target for leverage: k*<k **Above** target for Tier1RWA: k*<k		**Below** target for leverage: k*>k **Below** target for Tier1RWA: k*>k		**Above** target for leverage: k*<k **Below** target for Tier1RWA: k*>k		**Below** target for leverage: k*>k **Above** target for Tier1RWA: k*<k		Group 1 vs. 2	Group 3 vs. 4	Group 2 vs. 4	Group 2 vs. 3	Group 1 vs. 4	Group 1 vs. 3
	(1)		(2)		(3)		(4)		(5)	(6)	(7)	(8)	(9)	(10)
ΔLeverage	1321	-1.17	1886	1.09	1082	-0.76	673	0.4	**0**	**0**	**0**	**0**	**0**	**0**
ΔTier1RWA	1321	-0.59	1886	0.73	1082	0.51	673	-0.63	**0**	**0**	**0**	0.55	**0**	**0**
groLeverage	1321	-7.76	1886	13.11	1082	-4.76	673	4.39	**0**	**0**	**0**	**0**	**0**	**0**
groTier1RWA	1321	-3.81	1886	7.38	1082	5.69	673	-4.36	**0**	**0**	**0**	0.33	**0.01**	**0**
Total Assets	1321	15.27	1886	0.42	1082	13.57	673	5.12	**0**	**0**	**0.02**	**0**	**0**	**0**
Total Liabilities	1321	11.26	1886	5.86	1082	8.22	673	7.98	**0**	0.69	**0**	**0**	**0**	**0**
Common Equity	1321	5.73	1886	10.30	1082	7.21	673	8.04	**0**	0.34	**0.04**	**0**	**0**	**0**
Net Loans	1321	7.60	1886	3.55	1082	4.57	673	6.42	**0**	**0**	**0**	**0.01**	**0.01**	**0**
Risk-Weighted Assets	1315	8.28	1880	3.94	1080	3.28	670	8.09	**0**	**0**	**0**	0.73	0.16	**0**
LT borrowing	1321	1.97	1886	0.23	1081	1.13	673	0.48	**0**	**0**	**0**	**0**	**0**	0.20
ST borrowing	1321	0.86	1886	0.03	1082	-0.07	673	0.70	**0**	**0**	**0**	0.48	0.58	**0**
Retained Earnings (internal capital)	1321	1.72	1886	3.07	1082	1.31	673	2.78	**0**	**0.03**	0.46	**0.09**	**0**	0.54
Tier1 capital (external capital)	1315	5.26	1880	10.81	1080	7.99	670	5.72	**0**	**0**	**0**	0.51	**0**	**0**

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

This table reports coefficient estimates for a system of Seeming Unrelated regressions. In particular, we estimate a heterogeneous partial adjustment model for three different definitions of the capital ratio (Leverage, Tier1RWA and Total capital): $k_{i,j,t} - k_{i,j,t-1} = (\lambda_0 + \Lambda Z_{ij,t-1}) \times Gap_{i,j,t-1} + \varepsilon_{i,j,t}$.
The dependent variable is the change in the capital ratio, which is regressed on the gap (deviation between the estimated target and the lagged value of the capital ratio) and interactions of the gap with other variables captured by $Z_{ij,t-1}$. In column 2, we include as interaction variables: the marginal expected shortfall (MES), the delta Conditional Value-at-Risk (ΔCoVaR), the relative bank size to GDP (RelativeSize) and the natural logarithm of bank total assets (Size). In column 3, we use a composite indicator of these four dimensions, labelled SIFI-index. In Column 4, we add an interaction of the gap with an indicator that is one if either the Tier 1 RWA is below 8% or the Total Capital Ratio is below 10% (not Well-Capitalized), whereas in the last column we add the composite SIFI index and the Well Capitalized dummy jointly (as well as their interaction). All continuous variables are standardized before being interacted with the capital deviation to facilitate the economic magnitude interpretation.
The regression results are based on a sample of listed OECD banks over the 2001-2012 period. P-values based on robust standard errors, are obtained following a bootstrapping procedure to account for the estimated regressors (namely, estimated capital targets are used to obtain the gaps). Coefficients significantly different from zero at the 1%, 5% and 10% level are marked with ***/**/*. The letter a (b) following the p-values indicates the cases where that coefficient is significantly different from its analogue in panel a (b) at least at the 10% significance level.

Panel A:	ΔLeverage				
Gap(i,t-1)	0.361***	0.332***	0.364***	0.373***	0.376***
	(0.00863)	(0.00851)	(0.00856)	(0.00774)	(0.00934)
Gap(i,t-1) * MES(i,t-1)		0.00951			
		(0.00968)			
Gap(i,t-1) * ΔCoVaR(i,t-1)		0.0308***			
		(0.00685)			
Gap(i,t-1) * RelativeSize(i,t-1)		-0.0636***			
		(0.0132)			
Gap(i,t-1) * Size(i,t-1)		-0.0425**			
		(0.0187)			
Gap(i,t-1) * SIFI-index(i,t-1)			-0.0249***		-0.0227***
			(0.00904)		(0.00774)
Gap(i,t-1) * RegulatoryPressure(i,t-1)				-0.227***	-0.225***
				(0.0258)	(0.0303)
Gap(i,t-1) * SIFI-index(i,t-1) * RegulatoryPressure(i,t-1)					-0.00240
					(0.0245)
Observations	4,243	4243	4,243	4,243	4,243
Adjusted R-squared	0.598	0.629	0.600	0.609	0.611
Panel B:	ΔTier1RWA				
Gap(i,t-1)	0.213***	0.216***	0.218***	0.212***	0.218***
	(0.00836),a	(0.00837),a	(0.00811),a	(0.0100),a	(0.0109),a
Gap(i,t-1) * MES(i,t-1)		0.0363***			
		(0.0101),a			
Gap(i,t-1) * ΔCoVaR(i,t-1)		0.00318			
		(0.00952),a			
Gap(i,t-1) * RelativeSize(i,t-1)		-0.00476			
		(0.00917),a			
Gap(i,t-1) * Size(i,t-1)		-0.0119			
		(0.0122)			
Gap(i,t-1) * SIFI-index(i,t-1)			0.0176**		0.0165**
			(0.00718),a		(0.00781),a
Gap(i,t-1) * RegulatoryPressure(i,t-1)				-0.000565	-0.0148
				(0.0210),a	(0.0217),a
Gap(i,t-1) * SIFI-index(i,t-1) * RegulatoryPressure(i,t-1)					0.0120
					(0.0257)
Observations	4,243	4,243	4,243	4,243	4,243
Adjusted R-squared	0.218	0.223	0.221	0.218	0.220
Panel C:	ΔTotalCap				
Gap(i,t-1)	0.252***	0.259***	0.260***	0.249***	0.259***
	(0.00934),ab	(0.0112),ab	(0.00968),ab	(0.0112),ab	(0.0109),ab
Gap(i,t-1) * MES(i,t-1)		0.0288**			
		(0.0130)			
Gap(i,t-1) * ΔCoVaR(i,t-1)		0.0149			
		(0.0118)			
Gap(i,t-1) * RelativeSize(i,t-1)		-0.0141			
		(0.0116),a			
Gap(i,t-1) * Size(i,t-1)		-0.00384			
		(0.0132),a			
Gap(i,t-1) * SIFI-index(i,t-1)			0.0232***		0.0245***
			(0.00774),a		(0.00746),a
Gap(i,t-1) * RegulatoryPressure(i,t-1)				0.0171	0.00480
				(0.0255),a	(0.0275),a
Gap(i,t-1) * SIFI-index(i,t-1) * RegulatoryPressure(i,t-1)					-0.00975
					(0.0271)
Observations	4,243	4,243	4,243	4,243	4,243
Adjusted R-squared	0.282	0.285	0.286	0.282	0.286

Table 8: Balance sheet adjustments by SIFIs: leverage or regulatory driven?

This table reports the coefficient estimates for the regression model (7a) in panel A and regression model (7b) in panel B. In panel C, we report an extension of regression model (7b). Using a sample of listed OECD banks over the 2001-2012 period, we assess the relation between the annual growth rates of diverse balance sheet items and their capital shortfall (positive gap, undercapitalized) or their capital surplus (negative gap, overcapitalized) vis-à-vis its target capital ratio. We jointly assess the impact of deviation from the leverage target and the regulatory capital target ratio. 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), total liabilities (Liabilities), Cash and marketable securities and Liquid Assets. Growth rates variables are scaled by average total equity, total assets and total liabilities. The gap is computed using two definitions of capital ratio (Leverage and Tier1RWA). SIFI-index$_{i,t-1}$ is an aggregate systemic risk 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, are obtained following a bootstrapping procedure to account for the estimated regressors (namely, estimated capital targets are used to obtain the gaps). *, ** and*** indicate statistical significance at the 10%, 5% and 1% levels respectively. The letter y following the p-values indicates the cases where that coefficient is significantly different at the 10% significance level from its analogue (with the other capital definition) in the same panel in the same column.

Panel A: Asymmetries in banks' capital structure adjustments

Dependent variable. Growth in:	Equity	Tier 1 Capital	Retained Earnings	Assets	RWA	Loans	Liabilities	Cash and marketable securities	Liquid Assets
LevGap(i,t-1) * I(LevGap(i,t-1)>0)	-0.0134	-0.0907	0.108	-3.886***	0.00169	-0.198***	-0.380***	-0.233	-0.273
	(0.102)	(0.105)	(0.0774)	(0.104)	(0.0912)	(0.0417)	(0.0618)	(0.303)	(0.325)
LevGap(i,t-1) * I(LevGap(i,t-1)<0)	-0.330	-0.215	-0.573**	-0.461*	-0.301	-0.266**	-0.349**	1.472**	2.011***
	(0.267)	(0.254)	(0.233)	(0.265)	(0.213)	(0.117)	(0.148)	(0.664)	(0.768)
Tier1Gap(i,t-1) * I(Tier1Gap(i,t-1)>0)	1.306***	2.261***	0.0883	-0.132	-0.353**	-0.518***	-0.365***	1.249**	1.491***
	(0.230)	(0.217)	(0.177)	(0.166)	(0.140)	(0.0919)	(0.119)	(0.502)	(0.572)
Tier1Gap(i,t-1) * I(Tier1Gap(i,t-1)<0)	0.0984	0.234	-0.191	-0.261	-1.278***	-0.297*	-0.452*	-1.129	-1.857
	(0.372)	(0.377)	(0.313)	(0.269)	(0.287)	(0.168)	(0.232)	(0.906)	(1.153)
SIFI-index(i,t-1)	-0.0606***	-0.0737***	-0.0486***	-0.0213***	-0.0542***	-0.0515***	-0.0557***	0.0654***	0.0570***
	(0.00633)	(0.00579)	(0.00458)	(0.00821)	(0.00470)	(0.00349)	(0.00548)	(0.0179)	(0.0182)
Observations	4,339	4,231	4,339	4,339	4,231	4,339	4,339	4,230	3,081
R-squared	0.032	0.075	0.041	0.395	0.109	0.145	0.105	0.009	0.010
Number of bank_id	562	549	562	562	549	562	562	555	409

Panel B: Asymmetries and the effect of systemic importance in banks' capital structure adjustments

Dependent variable. Growth in:	Equity	Tier 1 Capital	Retained Earnings	Assets	RWA	Loans	Liabilities	Cash and marketable securities	Liquid Assets
LevGap(i,t-1) * I(LevGap(i,t-1)>0)	0.0964	-0.0243	0.157**	-4.098***	0.0170	-0.202***	-0.371***	-0.330	-0.385
	(0.0990)	(0.111)	(0.0781)	(0.104)	(0.102)	(0.0432)	(0.0634)	(0.320)	(0.340)
LevGap(i,t-1) * I(LevGap(i,t-1)<0)	-0.340	-0.230	-0.587**	-0.461*	-0.341*	-0.257**	-0.331**	1.495**	2.043***
	(0.279)	(0.252)	(0.241)	(0.251)	(0.207)	(0.120)	(0.154)	(0.677)	(0.766)
LevGap(i,t-1) * I(LevGap(i,t-1)>0) * SIFI-index(i,t-1)	-0.350***	-0.257**	-0.173**	0.649***	-0.126	0.0324	0.0117	0.273	0.205
	(0.110)	(0.118)	(0.0828)	(0.125)	(0.100)	(0.0484)	(0.0693)	(0.286)	(0.309)
LevGap(i,t-1) * I(LevGap(i,t-1)<0) * SIFI-index(i,t-1)	0.140	0.0530	0.0710	-0.515**	-0.141	0.110	0.404**	-0.0629	-0.231
	(0.319)	(0.290)	(0.251)	(0.238)	(0.181)	(0.117)	(0.167)	(0.687)	(0.658)
Tier1Gap(i,t-1) * I(Tier1Gap(i,t-1)>0)	1.169***	2.182***	0.0367	0.128	-0.347**	-0.512***	-0.362***	1.376***	1.726***
	(0.212),y	(0.217),y	(0.166)	(0.158),y	(0.142),y	(0.0905),y	(0.119)	(0.497),y	(0.571),y
Tier1Gap(i,t-1) * I(Tier1Gap(i,t-1)<0)	0.357	0.516	-0.121	-0.844**	-1.379***	-0.309*	-0.415*	-1.225	-1.935*
	(0.385)	(0.340)	(0.324)	(0.345)	(0.260),y	(0.176)	(0.251)	(0.900),y	(1.052),y
Tier1Gap(i,t-1) * I(Tier1Gap(i,t-1)>0) * SIFI-index(i,t-1)	0.610***	0.0929	0.153	-0.973***	-0.194	-0.0360	-0.250**	-0.739	-1.267**
	(0.232),y	(0.225)	(0.182)	(0.155),y	(0.161)	(0.0942)	(0.117),y	(0.518)	(0.568),y
Tier1Gap(i,t-1) * I(Tier1Gap(i,t-1)<0) * SIFI-index(i,t-1)	0.184	0.425	0.0357	-0.345	0.0252	-0.106	-0.208	0.0759	0.467
	(0.365)	(0.416)	(0.299)	(0.341)	(0.292)	(0.168)	(0.247),y	(1.006)	(1.061)
SIFI-index(i,t-1)	-0.0635***	-0.0687***	-0.0479***	-0.0179**	-0.0482***	-0.0522***	-0.0536***	0.0727***	0.0757***
	(0.00835)	(0.00679)	(0.00468)	(0.00903)	(0.00568)	(0.00372)	(0.00567)	(0.0199)	(0.0241)
Observations	4,339	4,231	4,339	4,339	4,231	4,339	4,339	4,230	3,081
R-squared	0.038	0.079	0.043	0.413	0.111	0.145	0.108	0.010	0.012
Number of bank_id	562	549	562	562	549	562	562	555	409

Panel C: Asymmetries and the effects of systemic importance and capital buffers in banks' capital structure adjustments

Dependent variable. Growth in:	Equity	Tier 1 Capital	Retained Earnings	Assets	RWA	Loans	Liabilities	Cash and marketable securities	Liquid Assets
LevGap(i,t-1) * I(LevGap(i,t-1)>0)	0.112	-0.00655	0.152**	-4.208***	0.0131	-0.175***	-0.336***	-0.279	-0.274
	(0.0851)	(0.105)	(0.0726)	(0.110)	(0.100)	(0.0432)	(0.0626)	(0.326)	(0.334)
LevGap(i,t-1) * I(LevGap(i,t-1)<0)	-0.293	-0.0602	-0.602**	-0.399	-0.332	-0.292**	-0.328**	1.806**	2.722***
	(0.307)	(0.279)	(0.281)	(0.268)	(0.224)	(0.129)	(0.165)	(0.756)	(0.844)
LevGap(i,t-1) * I(LevGap(i,t-1)>0) * SIFI-index(i,t-1)	-0.325***	-0.227*	-0.178**	0.622***	-0.145	0.0318	0.00795	0.271	0.220
	(0.109)	(0.117)	(0.0821)	(0.123)	(0.0991)	(0.0475)	(0.0689)	(0.287)	(0.310)
LevGap(i,t-1) * I(LevGap(i,t-1)<0) * SIFI-index(i,t-1)	0.173	0.179	0.0535	-0.483*	-0.115	0.0897	0.412**	0.246	0.366
	(0.326)	(0.309)	(0.270)	(0.261)	(0.198)	(0.123)	(0.170)	(0.759)	(0.756)
LevGap(i,t-1) * I(LevGap(i,t-1)>0) * RegulatoryPressure	0.122	0.111	-0.0182	1.159***	-0.128	-0.351**	-0.549**	-0.540	-1.267
	(0.677)	(0.691)	(0.461)	(0.299)	(0.350)	(0.165)	(0.215)	(1.102)	(1.275)
LevGap(i,t-1) * I(LevGap(i,t-1)<0) * RegulatoryPressure	-0.562	-1.290*	0.191	0.504	0.129	0.0732	-0.134	-1.956	-4.119**
	(0.886)	(0.783)	(0.795)	(0.612)	(0.541)	(0.379)	(0.516)	(1.861)	(1.884)
Tier1Gap(i,t-1) * I(Tier1Gap(i,t-1)>0)	1.084***	2.071***	0.00253	0.0747	-0.115	-0.455***	-0.301**	1.945***	2.477***
	(0.206),y	(0.212),y	(0.162)	(0.170),y	(0.160)	(0.0967),y	(0.123)	(0.604),y	(0.624),y
Tier1Gap(i,t-1) * I(Tier1Gap(i,t-1)<0)	0.270	0.292	-0.0124	-0.730**	-1.422***	-0.269	-0.387	-1.658*	-2.941***
	(0.404)	(0.348)	(0.340)	(0.363)	(0.280),y	(0.200)	(0.269)	(0.973),y	(1.107),y
Tier1Gap(i,t-1) * I(Tier1Gap(i,t-1)>0) * SIFI-index(i,t-1)	0.620***	0.104	0.134	-0.978***	-0.156	-0.0355	-0.259**	-0.611	-1.040*
	(0.234),y	(0.238)	(0.186)	(0.153),y	(0.160)	(0.0898)	(0.112),y	(0.537)	(0.544),y
Tier1Gap(i,t-1) * I(Tier1Gap(i,t-1)<0) * SIFI-index(i,t-1)	0.173	0.318	0.0935	-0.325	-0.0347	-0.0813	-0.204	-0.240	-0.264
	(0.361)	(0.433)	(0.296)	(0.353)	(0.296)	(0.175)	(0.248),y	(1.006)	(1.122)
Tier1Gap(i,t-1) * I(Tier1Gap(i,t-1)>0) * RegulatoryPressure	-0.0429	0.0241	0.211	0.112	-0.726	-0.118	0.0176	-2.371*	-2.556*
	(0.834)	(0.735)	(0.556)	(0.427),y	(0.470)	(0.262)	(0.356)	(1.411)	(1.521)
Tier1Gap(i,t-1) * I(Tier1Gap(i,t-1)<0) * RegulatoryPressure	-0.848	0.527	-1.268	-1.018	0.569	-0.611	-0.182	-0.0731	5.421
	(2.462)	(1.774)	(1.632)	(1.240)	(0.924)	(0.816)	(1.014)	(3.018)	(3.531),y
SIFI-index(i,t-1)	-0.0614***	-0.0667***	-0.0478***	-0.0193**	-0.0509***	-0.0524***	-0.0542***	0.0684***	0.0680***
	(0.00835)	(0.00702)	(0.00495)	(0.00906)	(0.00575)	(0.00383)	(0.00578)	(0.0203)	(0.0240)
Observations	4,339	4,231	4,339	4,339	4,231	4,339	4,339	4,230	3,081
R-squared	0.041	0.084	0.044	0.417	0.117	0.148	0.110	0.012	0.016
Number of bank_id	562	549	562	562	549	562	562	555	409

Table 9: Non-linearities in the speed of adjustment: asymmetry and joint stance of the leverage and regulatory capital gap

This table analyzes whether the speed of adjustment depends on the sign of the gap (i.e., is asymmetric) and whether the stance of the regulatory capital ratio affects the speed of adjustment of the leverage ratio (and vice versa). To that end, we estimate the following equation:

$$\mathrm{k}_{i,j,t} - \mathrm{k}_{i,j,t-1} = \mathrm{Gap}_{i,j,t-1} * \left[\beta_1 \cdot I\left(\mathrm{Gap}_{i,j,t-1} > 0\right) + \beta_2 \cdot I\left(\mathrm{Gap}_{i,j,t-1} < 0\right) + \beta_3 \cdot I\left(\mathrm{Gap}_{i,j,t-1} > 0\right) \cdot I\left(\mathrm{otherGap}_{i,j,t-1} > 0\right) + \beta_4 \cdot I(\mathrm{Gap}_{i,j,t-1} < 0) \cdot I\left(\mathrm{otherGap}_{i,j,t-1} > 0\right)\right] + \varepsilon_{i,j,t}$$

I($\mathrm{Gap}_{i,j,t-1}$>0) corresponds to the situation when bank has capital shortfall, it takes value of one if the bank's actual capital is below the target capital ratio, and zero otherwise. I($\mathrm{Gap}_{i,j,t-1}$<0) corresponds to the situation when bank has capital surplus, is take one if the bank's actual bank capital is above the target capital ratio, and zero otherwise. I($\mathrm{otherGap}_{i,j,t-1}$>0) corresponds to the situation when bank has capital shortfall with respect to the other capital concept (i.e., Tier 1 capital gap in Panel A and the leverage ratio in the Panels B and C), it takes value of one if the bank's actual Tier 1 capital ratio is below the target Tier 1 capital ratio, and zero otherwise. In column 1, we estimate a constrained version of the above equation. We show results for a sample of listed OECD banks over the 2001-2012 period. We report results for three definitions of the capital ratio (Leverage, Tier1RWA and Total capital), corresponding with the three different panels A, B and C in the Table. All three equations in a column are estimated jointly as Seemingly Unrelated Regressions to account for possible dependencies in the residuals. P-values based on robust standard errors, are obtained following a bootstrapping procedure to account for the estimated regressors (namely, estimated capital targets are used to obtain the gaps). Coefficients significantly different from zero at the 1%, 5% and 10% level are marked with ***/**/*. The letter a (b) following the p-values indicates the cases where that coefficient is significantly different from its analogue in panel a (b) at least at the 10% significance level.

Panel A:	ΔLeverage	
Gap(i,t-1) * I(Gap(i,t-1)>0)	0.464***	0.515***
	(0.0120)	(0.0359)
Gap(i,t-1) * I(Gap(i,t-1)<0)	0.0942***	0.169***
	(0.0190)	(0.0282)
Gap(i,t-1) * I(Gap(i,t-1)>0) * I(other Gap(i,t-1)>0)		-0.0736*
		(0.0406)
Gap(i,t-1) * I(Gap(i,t-1)<0)* I(other Gap(i,t-1)>0)		-0.190***
		-0.042
Observations	4339	4339
Adjusted R-squared	0.332	0.334
Panel B:	**ΔTier1RWA**	
Gap(i,t-1) * I(Gap(i,t-1)>0)	0.236***	0.246***
	(0.0136),a	(0.0258),a
Gap(i,t-1) * I(Gap(i,t-1)<0)	0.249***	0.255***
	(0.0203),a	(0.0210),a
Gap(i,t-1) * I(Gap(i,t-1)>0) * I(other Gap(i,t-1)>0)		-0.0184
		(0.0254)
Gap(i,t-1) * I(Gap(i,t-1)<0)* I(other Gap(i,t-1)>0)		0.0207
		(0.0399),a
Observations	4339	4339
Adjusted R-squared	0.236	0.237
Panel C:	**ΔTotalCap**	
Gap(i,t-1) * I(Gap(i,t-1)>0)	0.313***	0.299***
	(0.0188),ab	(0.0234),ab
Gap(i,t-1) * I(Gap(i,t-1)<0)	0.220***	0.249***
	(0.0232)ab	(0.0260),a
Gap(i,t-1) * I(Gap(i,t-1)>0) * I(other Gap(i,t-1)>0)		0.0155
		(0.0247),a
Gap(i,t-1) * I(Gap(i,t-1)<0)* I(other Gap(i,t-1)>0)		-0.0840*
		(0.0502),ab
Observations	4339	4339
Adjusted R-squared	0.246	0.245

Table 10: Speed of adjustment by SIFIs pre and post 2007

Table shows the estimation results on the effects of systemic risk and size on bank's adjustment speed (Eq. (6)) for a sample of listed OECD banks over 2001–2012 period taking into account that the effects may have changed since the onset of the global financial crisis starting in 2007. In panel A, we report the obtained regression coefficients. Capital gap is computed using three definitions of capital ratio (Leverage, Tier1RWA and Total capital), corresponding with the columns 1, 2 and 3, respectively. In all regression, $D_{2007-2012}$ is a dummy takes one during crisis time (2007–2012), and zero otherwise, and SIFI-index$_{i,t-1}$ is an aggregate systemic risk index (SIFI-Index) constructed based on the quintiles of the MES, ΔCoVaR, relative size and size. 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. The letter a (b) following the p-values indicates the cases where that coefficient is significantly different from its analogue in column 1 (2) at least at the 10% significance level. In panel B, we report the implied adjustment speeds in the pre and post crisis periods for small banks, average banks and SIFIs, corresponding respectively with cases where the standardized SIFI index takes on the value of -1, 0 and 1.

Panel A: regression results			
	ΔLeverage	ΔTier1RWA	ΔTotal Capital
Gap(i,t-1)	0.163***	0.147***	0.187***
	(0.0118)	-0.0108	(0.0149),b
Gap(i,t-1) * D(2007–2013)	0.224***	0.0985***	0.106***
	(0.0165)	(0.0126),a	(0.0185),a
Gap(i,t-1) * SIFI-index(i,t-1)	-0.0377***	-0.0213*	-0.0165
	(0.0118)	(0.0124)	(0.0121)
Gap(i,t-1) * SIFI-index(i,t-1) * D(2007–2013)	0.00656	0.0495***	0.0486***
	(0.0146)	(0.0154),a	(0.0157),a
Observations	4,243	4,243	4,243
Adjusted R-squared	0.618	0.228	0.291

Panel B: implied adjustment speeds			
ΔLeverage			
	SIFI = -1	SIFI = 0	SIFI = 1
2001-2006	0.201	0.163	0.125
2007-2013	0.418	0.387	0.356
ΔTier1RWA			
	SIFI = -1	SIFI = 0	SIFI = 1
2001-2006	0.168	0.147	0.126
2007-2013	0.217	0.245	0.274
ΔTotal Capital			
	SIFI = -1	SIFI = 0	SIFI = 1
2001-2006	0.204	0.187	0.171
2007-2013	0.261	0.293	0.325

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.

(A1) $$MES_{i,t}^{q} \equiv E\left(R_{i,t} | R_{M,t} \leq VaR_{R_{M},t}^{q}\right),$$

where R_i is one-day stock return for bank i, R_M is one-day market return[12], 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 [13]:

(A2) $$\mathrm{Prob}_{t-1}\left(\mathrm{R_M} \leq \mathrm{CoVaR}_{\mathrm{R_{M|i,t}}}^{\mathrm{q}} \mid \mathrm{R_{i,t}} = \mathrm{VaR}_{\mathrm{R_{i,t}}}^{\mathrm{q}}\right) = \mathrm{q}$$

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

[12] We refer to the broader stock market index, as market portfolio benchmark; so as to, catch bank's contribution to the economy stability.

[13] 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.

$\mathrm{CoVaR}_{R_{M|i,t}}^{q=\text{distress state}}$ 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 $\mathrm{CoVaR}_{R_{M|i,t}}^{q=\text{median}}$ 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 $\Delta\mathrm{CoVaR}_{R_{M|i,t}}^{q}$ of individual bank is defined as:

(A3) $$\Delta\mathrm{CoVaR}_{R_{M|i,t}}^{q} = \mathrm{CoVaR}_{R_{M|i,t}}^{q} - \mathrm{CoVaR}_{R_{M|i,t}}^{\text{median}}$$

MES and ∆CoVaR 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 ∆CovaR 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

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