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Bank capital and balance sheet management during times of distress: international evidence

by Samuel Da Rocha Lopes, Daniel Foos, Aaron Janowski, Stefan W Schmitz, Mariana Tomova and Julieta Yung

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Samuel Da Rocha Lopes (European Banking Authority), Daniel Foos (Deutsche Bundesbank), Aaron Janowski (Deutsche Bundesbank), Stefan W. Schmitz (Austrian National Bank), Mariana Tomova (European Commission) and Julieta Yung (Federal Deposit Insurance Corporation)[1]

1. Introduction

1.1 Motivation

There is a substantial body of empirical literature on the relationship between bank capitalisation and the evolution of bank assets. These papers aim at estimating the impact of capital requirements on lending, as a proxy for the social costs of capital regulation. Yet, this literature does not yield consistent or strong results (see Appendix 1). An increase of capital requirements does not in general lead to either a reduction or an increase in bank lending. The heterogeneity across sample periods, banks, countries and banks' business models is substantial. The modelling choice between an approach where capital is considered exogenous in the short run (quantity-based approach, see Section A1.1 in Appendix 1) and an approach where capital is considered endogenous in the short run (opportunity-based approach, see Section A1.2 in Appendix 1) significantly influences the resulting analyses and conclusions. In most models that follow the quantity-based approach, capital is exogenous in two dimensions. First, these models assume that the capital level at the end of period *t-1* can be used to identify the direction of causation from capital in *t-1* to loan growth in period *t*; capital in *t-1* has an impact on loan growth in *t*, but loan growth in *t* has no impact on capital in *t-1*. Second, they assume that banks cannot adjust the capital level in period *t*. Both assumptions are revisited in this report. Consequently, banks would adjust to shocks by adjusting asset growth. These assumptions can have an impact on how the interaction between bank capital and balance sheet management (lending) is modelled.

We study what the regulatory/supervisory and the managerial literature on bank balance sheet and capital management imply for modelling capital management. Based thereon, we test the assumption that capital is exogenous in the short run (up to six months) rather than endogenous with Quantitative Impact Study (QIS) data. The underlying models need to encompass that banks are steering their capitalisation as part of their overall profit maximising strategy and business model, conditional on market conditions (ie price elasticities of assets/liabilities and the tax shield on debt). The models should also encompass capital constraints and shocks that shift outcomes off the desired path, such as shocks to asset volatility and valuations that might entail losses.

Our empirical analysis studies (1) whether banks take active measures to adapt Common Equity Tier 1 (CET1) capital in any period *t*, and, if so, how this relates (2) to available capital at the beginning of period *t* (the end of period *t-1*), (3) to bank-specific distress (substantial unexpected losses) in period *t*, and (4) to asset growth in period *t*. The empirical analysis yields results that are highly relevant for understanding banks' short-run behavioural adjustments to exogenous shocks and the interaction between banks and the real economy. The study aims at an audience beyond academia in economics,

[1] The work stream was led by Daniel Foos and Stefan W Schmitz. This project has benefitted greatly from discussions with Michael Straughan, Sebastian de-Ramon and William B Francis (all Bank of England), and from comments made at meetings of the Basel Committee's Research Group (RES). Our collaboration with Bryan Hardy (Bank for International Settlements) has greatly facilitated econometric estimates on the BIS premises. Martin Birn provided excellent Secretariat support.

including policy makers, regulators and experts on evaluating capital requirements. By challenging the notion that bank capital is largely exogenous in the short run, it provides valuable insights for both microprudential and macroprudential policy making.[2] Furthermore, the results help in improving evaluations of capital requirements. It also advances the modelling of second-round effects in macroprudential analysis and stress testing, as it requires these models to consider the short-run endogeneity of capital (as in the opportunity-based approach in Section A1.2 in Appendix 1).

1.2 Research questions

The general research question addressed in this project is: *How do banks manage their equity capital in the short run and what effects does this have on their asset and liability structure, explicitly considering periods of bank-specific distress?*

Specifically, we study the following related research questions:

- Do banks that plan to grow their balance sheets raise capital to achieve that growth objective (capital is endogenous) in the short run? Or is banks' balance sheet growth constrained in the short run by a given capitalisation (capital exogenous)?
- How do banks manage their balance sheets to adjust their CET1 ratios towards their estimated targets in the short run?
- How can the short-run endogeneity of capital be captured in a tractable, econometric model of bank balance sheet management?
- What relevant lessons can be learnt from the literature on bank capital and balance-sheet management?
- What macro-financial implications can be drawn from the analysis?

1.3 Overview of this report

The section "**Related literature**" brings together insights from publications on the supervisory requirements on bank capital management, studies on their practical implementation at the bank level and the academic empirical literature on bank capital management, especially in the presence of shocks.[3] It lays the foundations for the central empirical issue of the report that focuses on obtaining a better understanding of how banks manage their capital and their balance sheets during times of bank-specific distress.

From the review of the supervisory documents, we conclude that banks are required to manage capital in an active, forward-looking manner under business as usual and under distress, in the long-run and in the short-run, and to have capital plans in place that contain management action on capital under distress.

From the review of studies on banks' capital management in practice, we conclude that banks forecast their future capital requirements under business as usual and under distress in line with the respective supervisory requirements regarding capital management. We also find that banks' short-run

[2] Regarding the research focus and the results, the study links well with past projects of the Research Group (eg BCBS WPs 30, 31, 33 and 35), the FAME database and the QIS database at the BCBS Secretariat.

[3] The academic literature on active bank capital management is small relative to the large body of literature that assumes that bank capital is exogenous in the short run (Appendix A1.1).

adjustment to deviations from capital plans under distress takes place via a broad set of options, with changes of CET1 capital often contributing a significant share to the adjustment.

From the empirical economic literature on bank capital management, we conclude that banks under distress actively adjust capital in the short run through retained earnings and several other measures (such as asset sales, NPL reduction, revaluation of assets, changes to Accumulated Other Comprehensive Income[4] and regulatory adjustments as well as equity issuances). The combination of these measures is the outcome of an optimisation problem in which a bank aims at minimising its adjustment costs to adapt its balance sheet structure to an exogenous shock. Banks govern and implement their adjustment strategy via changes of funds transfer pricing and internal hurdle rates which affect the bank's pricing on the asset side (eg loan spreads) and on the liability side (eg deposit rates); the respective quantities adjust endogenously. The marginal adjustment costs across adjustment measures should be roughly equal in the optimum. They are likely to be influenced by bank-specific and macroeconomic variables. This has two implications for the empirical analysis: First, the combination of measures is likely to be bank-specific and to depend on the macroeconomic environment. An empirical strategy can exploit these variations in the cross section and in the time dimension. Second, focussing on one measure in isolation can be misleading. Instead, banks choose their specific combination of measures in a simultaneous and endogenous manner. An empirical strategy should therefore focus on models that can take these interdependencies into account.

The study empirically tests the following three hypotheses: (1) bank management actively adjusts CET1 capital in period *t*, also under distress; (2) banks that want/can grow assets more in period *t* and (3) are more capital constrained at the beginning of period *t* (at the end of period *t-1*), more actively increase their CET1 capital. The empirical strategy consists of two steps: the first step estimates banks' CET1 constraints in each period. The second step employs this estimate in testing the three hypotheses.

The section "**Sample composition and descriptive statistics**" describes the QIS data set and provides descriptive statistics of the main variables.

The section "**How do banks manage their balance sheets to adjust their CET1 ratios towards their estimated targets in the short run?**" presents the first step of our empirical strategy, in which we estimate the target capital-asset ratios for a global sample of banks based on their own characteristics, macroeconomic conditions, and the anticipation of Basel III regulatory changes to capital. Ideally, that data could be generated from asking banks what they regard as their capital constraint, whether they perceive their CET1 position to be less than, or greater than, their individual CET1 target (or derive that information from their publications). For our large international sample and for the period covered (2013–2019), this is infeasible. Hence, we employ the estimates of target capital ratios (k^*) to measure banks' CET1 constraints, to determine whether the bank's capital-asset ratio exceeds or falls below its target. We describe the methodology for this estimation (Section 4.1), discuss our results (Section 4.3) and offer concluding remarks (Section 4.4).

We find that banks' capital-asset ratios converge to target ratios at a speed of about 25% per year, on average, during the 2014–2019 period. Additionally, we note that banks that are larger, less liquid, more profitable, have higher trading activity and risk density, less engaged in lending, and are headquartered in a country experiencing GDP growth and inflation, tend to reduce their capital-asset ratios in the future. These associations are not always statistically significant, but the direction is not driven by our sample choices and is robust to including time fixed effects, controlling for economic and financial conditions, and correcting for small-sample bias. Moreover, when full Basel III implementation implies a lower CET1 ratio than currently reported by banks, we find that reported capital-asset ratios decrease, on average, at a pass-through rate of around 18% per semester. A further analysis of balance sheet management of capital-asset deviations suggests a statistically significant reduction in the rate of CET1

[4] See, also, the separate complementary report Da Rocha Lopes et al (forthcoming).

growth of about 0.9% on average for banks that have 1% excess capital, as well as a 0.6% increase in the growth rate of their RWA.

The section **"The endogeneity of management action on capital"** presents the second step of our empirical strategy. It tests the three hypotheses above. To do so, we introduce two key variables that measure banks' management action on capital and bank-specific distress. For the first variable, we explain how we define "banks actively adjusting CET1", which we refer to as management action on capital (MAC) for our study (Section 5.1). Our MAC metric aims at measuring active management action on capital in any period t – eg to what extent does the bank take action to actively increase the level of CET1 capital in period t (and not only the total capital ratio)? For the second variable, we define metrics to capture bank-specific periods of distress (Section 5.2). We test the three hypotheses mentioned above in econometric models in a panel data setting (Section 5.3).

The section investigates the following research questions:

- Do banks with higher asset growth and tighter capital constraints undertake more management action on capital?
- Can banks actively adjust their CET1 capital in the short run also under distress?
- Do banks that take more management action on capital also exhibit higher asset growth?

We start our analysis by employing a single-equation approach to address the first three research questions: The findings indicate that (1) a bank's growth rate of risk-weighted assets (RWA) and (2) its capital-constraint are significantly related to its management action on capital, and (3) bank-specific distress does not prevent banks from taking management action on capital. Capital is endogenous in the short run, as banks facing profitable growth opportunities are more likely to undertake management actions on capital. However, the single-equation approach cannot address the simultaneity bias associated with the feedback effect of management actions on capital on asset growth.

Hence, we employ a simultaneous-equations approach, which incorporates an additional equation to account for the feedback effect of management actions on capital on RWA growth. While the results for the first three research questions remain largely consistent, additional findings reveal that banks engaging in more management actions on capital experience higher RWA growth rates. These results are robust across various measures of capital constraints and financial distress as well as subsamples.

We refer a reader to a separate complementary report "**Accumulated other comprehensive income filters, HTM security holdings and bank capital: a cross-country study**" that presents an example of bank capital management through the changes in balance sheet composition, focusing on investment securities holdings, Held-to-Maturity (HTM) and Available-for-Sale (AFS). It had been shown in the prior literature that the re-allocation of these security investments has been impacted by the prudential filter (referred in this section as "AOCI filter") and its removal under Basel III **(BCBS 2011)**. In the empirical analysis presented in this complementary report, we expand the literature by using the global sample of banks, incorporating both vendor and supervisory confidential data (QIS), as well as documenting practices across jurisdictions in timing of the AOCI filter through the survey responses provided by RES members in 2023.

Our empirical analysis shows that global banks reallocated their security holdings during the study sample period, increasing their HTM security holdings. The timing of this reallocation of banks' balance sheet investment securities is consistent with timing of the AOCI filter phasing out, based on a 2023 RES survey. This example of HTM security asset holdings re-allocation illustrates the triggers for banks' actions and decision-making in managing regulatory capital, and related changes in their balance sheet composition, as a response to regulatory actions (AOCI filter removal), accounting rules and changes in interest rate environment.

2. Related literature

This section brings together insights from the supervisory requirements on bank capital and balance sheet management, their practical applications at the bank level and the academic empirical literature on bank capital and balance sheet management, especially in the presence of shocks. It addresses the question: What does the regulatory/supervisory and the managerial literature on bank balance sheet and capital management imply for bank capital and balance sheet optimisation? Thereby, it lays the foundations for the central hypothesis of the report which seeks to understand how banks manage their capital-asset ratios during times of distress. This section is organised as follows. In Section 2.1, we examine the supervisory requirements regarding the capital planning process. In Section 2.2, we summarise survey findings regarding the actual implementation of bank capital planning processes. Finally, in Section 2.3, we review the economic literature that studies banks' adjustment process to capital shocks empirically.

2.1 Supervisory requirements regarding banks' capital management

The **Basel Committee on Banking Supervision** (BCBS) requires banks to perform forward-looking capital planning and management in the form of a *capital adequacy assessment* in which they "demonstrate that chosen internal capital targets are well founded and that these targets are consistent with their overall risk profile and current operating environment" (BCBS, 2019a, 2019b).[5,6]

BCBS (2014) reviews common features of banks' capital planning processes and finds four elements of good practice. Accordingly, capital planning has (a) to be embedded in a proper governance setup, (b) to state a capital policy that is based on a risk inventory, (c) must plan in a forward-looking view, and (d) has to cover actions to preserve capital under adverse conditions.

Basel jurisdictions expect banks to conduct an adequate assessment of all relevant risks, how these risks are monitored and managed, as well as a statement on which risks are tolerated with less attention. "Leading practice among the banks observed is… that a sound capital policy also details the range of strategies management is able to employ to address anticipated and unexpected capital shortfalls." (BCBS, 2014, p 3). Next, banks must identify triggers and limits for risk metrics. Most jurisdictions expect banks to implement a forward-looking view using scenario analyses and stress testing. The management framework for preserving capital has to define actions to maintain capital in advance of the considered adverse condition and expects banks to update plans swiftly. Moreover, most supervisors emphasise the responsibility of the senior management and the board of directors for the prioritising and quantifying of the capital actions. Those actions include reductions in or cessation of common stock dividends, equity raises and/or balance sheet reductions.

The European **Single Supervisory Mechanism (ECB, 2018 and 2021)** expects banking institutions to assess and define management buffers above their regulatory and supervisory minima and internal capital needs to allow them to sustainably follow the institutions' strategies also under stressed conditions. The Single Supervisory Mechanism (SSM) expects banks to consider all material risks affecting the relevant regulatory ratios and/or their economic capital over the planning period of at least three years. The SSM expects banks to have in place a consistent capital allocation mechanism determining the capital needs of entities and business units. The capital plan is based on a credible baseline scenario as well as adverse scenarios. The plan must be consistent with the institution's business strategy, funding strategy and liquidity planning, risk appetite, recovery plan and the internal liquidity adequacy assessment

5 See the Supervisory Review Process' four key principles (SRP 20.5): www.bis.org/basel_framework/chapter/SRP/20.htm.

6 In this section, we focus on the BCBS, the Single Supervisory Mechanism and the US Board of Governors, as examples. As all BCBS members ought to apply the Basel approach in some form, all of them will feature fundamentally similar requirements, as shown by the examples in this section.

process. Funding plan targets are aligned to the business strategy and multi-year financial planning. The capital and funding plans must also incorporate foreseeable changes of regulation and accounting. Capital planning is a key element of the internal capital adequacy assessment process. The SSM expects banks to capture all the loan pricing components and to monitor ex-post profitability of product pricing decisions. A liquidity cost-benefit allocation mechanism encompasses a funds transfer pricing mechanism that allows calculating the correct net income component of profitability for business lines/units, products and customers.

The US **Board of Governors** (2020) stipulates similar requirements for banks' capital planning. All large Bank Holding Companies (BHCs) must have a capital policy in place that includes capital planning, capital issuance, capital usage and distributions as well as the strategies for addressing potential capital shortfalls. The capital plan must include sources of capital and planned capital action over the planning horizon of nine quarters under business as usual and stressed conditions. Responsibility for capital planning and capital policy is assigned to the board of directors. The supervisor reviews the capital plans of the banks, including an assessment of the assumptions underpinning the capital plan and whether the capital plan addresses potential future stressed conditions.

2.2 Banks' capital management in practice

In 2018, the UK Prudential Regulatory Authority (PRA) conducted a survey (**Bajaj et al, 2018**) to study bank capital budgeting, capital allocation and funds transfer pricing (FTP) based on a survey of banks in the United Kingdom. It finds that banks' capital and funding plans are largely in line with the respective supervisory requirements. Banks manage both sides of their balance sheets – including capital – actively and in a forward-looking manner. Internal prices are the primary means to govern asset and liability generation and to incentivise the decentralised decisions to reach the bank's strategic objectives.

The survey shows that there is a wide range of capital allocation methods in the banking business in place and that the approaches vary in their level of complexity.[7] One common approach is to assess whether profits meet an internal target rate of return – a hurdle rate, which is set by the management and derived from the desired return on equity. Another common approach is to apply regulatory capital metrics for capital allocation, which are either risk-based (risk-weighted assets (RWA) usage under a targeted minimum Common Equity Tier 1 (CET1) capital ratio) or leverage based using mostly the regulatory or the economic capital framework.

The survey finds that banks translate their strategic plans into detailed capital budgets.[8] A bank's strategic plan sets out the strategy such as where to grow, which businesses to downsize and where to make strategic investments to secure future, profitable growth. A capital budgeting process deploys the available equity capital to business lines consistent with this plan. The deployment of equity capital resources also needs to be consistent with other strategic management tools such as a bank's risk appetite and a framework that sets hard limits on balance sheet and RWA consumption, among others. Capital allocation allows banks to assess the relative performance across different business lines against the amount of equity capital allocated. Its outcomes are important for the monitoring of performance against the strategy. Gaps between the expected and actual performance prompt banks to review their strategies.

[7] The authors define capital allocation as the method that banks use to determine the notional amount of equity capital needed to support a particular business line.

[8] Capital budgeting is the process of deploying banks' equity capital to support banks' strategic objectives. Capital allocation and capital budgeting are two of the core components in the bank-wide strategic management process. Effective practices for capital allocation and budgeting contribute to securing the safety and soundness of individual banks and allow banks to recognise the levels of risk being taken and deploy equity capital where shareholders' returns can be made.

The survey finds that all banks manage their assets and liabilities via FTP processes, which complement banks' capital allocation approaches to price their products.[9] The prices of a bank's products reflect the cost of its financial resources including equity capital and debt. Internal debt funding cost is determined by the bank's FTP process.

Cadamagnani et al (2015) describe the FTP process and the role of the Treasury in more detail. Their survey shows a trend towards using a blended cost of funding curve when estimating a transfer pricing curve. The maturity of the assets and liabilities are often subject to uncertainty and risk; the actual, behavioural maturities differ from the contractual maturities. Most banks estimate the expected actual maturities and use those in setting internal transfer prices.

When setting strategy, banks also produce a forward-looking risk appetite statement. The risk appetite includes equity capital metrics and is used to develop the business and capital plans. This risk appetite is often based on risk weights as risk measures: When a business line uses less RWAs than budgeted, then this 'surplus' may be reallocated to other business lines. In contrast, when a business line exceeds its RWAs budget, reductions in its balance sheet and/or risk may be required.

The last, publicly available benchmarking of recovery plans in the Euro area **(ECB, 2020)** contains a horizontal overview of key characteristics of recovery plans of 93 Significant Institutions.[10] The exercise shows that banks pro-actively plan for recovery measures to cover potential deviations from capital plans. Banks include an average of 27 options to actively manage their capital in the face of shocks, which include capital raisings (about 40% of the recovery capacity), earnings retention (8%), entity disposals (20%), asset sales (8%), risk reduction (15%) and cost saving measures. The use of instruments differs across banks: For 26 of them, capital raisings cover more than 50% of the capital gap, for two of them, 100%.

The BCBS Research Group conducted two surveys in 2017 and 2018 that included questions regarding bank balance sheet management under shocks.

The first survey **(BCBS, 2018)** is part of the Committee's semi-annual Basel III monitoring exercise for the end-2016 reporting date. The sample consists of 148 banks (84 large internationally active banks with CET1 capital of more than €3 billion and 64 smaller banks). The sample provides broad international coverage with 24 banks from the Americas, 69 banks from Europe and 55 banks from the rest of the world. It includes questions regarding individual bank's adjustment to new regulatory constraints to contribute to the assessment of new regulation on bank balance sheet management. Specifically, one question asks how banks would reach their new leverage ratio requirement calibrated at 3%, with an additional 1% G-SIB add-on (assuming they were not already meeting the target). Banks responded that they use a broad set of complementary measures. Banks would adjust to a leverage ratio shortfall predominantly by adjusting factors summarised under the category "Other" (marginal contribution 31% of the shortfall) and by capital increases, including retained earnings (marginal contribution 22% of the shortfall).[11] Another question asked banks for the marginal contributions of various options to increase the target management CET1 capital buffer based on stress test results. Banks adjust largely via capital increases (marginal

9 FTP is part of the process of setting retail and commercial interest rates and is a mechanism designed to account for the cost of funds faced by banks as well as the associated liquidity, interest rate and currency risks associated with lending and taking deposits. FTP is an internal process typically carried out by the bank's treasury function, acting as a central risk management hub for all business lines.

10 Of the 93 banks, 13 have total assets below €30 billion, 45 €30–100 billion, 19 €100–300 billion and 16 above €300 billion. The analysis is based on the recovery plan standardised reporting templates submitted in the 2019 cycle.

11 Reducing trading book exposure, interbank lending, other business lending, sovereign bonds, financial or non-financial corporate bonds and non-core assets contributed around 5% each. The rest—such as reducing real estate lending or small and medium-sized enterprise (SME) lending or increasing securitisations—contributed less than 5% each.

contribution 34% of the shortfall), lower non-core assets (10%) and operating costs (which would then also translate into higher retained earnings, 9%).[12]

The second survey **(BCBS, 2019c)** was conducted as part of the Committee's semi-annual Basel III monitoring exercise for the end-2017 reporting date. The sample consists of 128 banks (86 large internationally active banks with Tier 1 capital of more than €3 billion and 42 smaller banks). The sample provides broad international coverage with seven banks from the US, 44 banks from Europe and 77 banks from the rest of the world. Regarding the question on how banks would reach their new leverage ratio requirement, the responses corroborate the results of the first survey: increasing capital, including retained earnings (34%), reducing interbank lending (8%), reducing trading book exposure (7%) and non-core assets (7%) account for more than half of the adjustment.[13] The analysis finds that bank adjustments are heterogeneous, indicating that there is little sign of herding. Banks with lower risk-density place more weight on the most common measures, like capital increases. More profitable banks report higher contributions of capital increases. Also, regarding the other question on bank balance sheet management, the second survey confirms the findings of the first one. It asks banks for the marginal contributions of various options to increase the target management Tier 1 capital buffer as a consequence of stress test results. The 89 banks that are subject to some capital stress tests respond that stress test results impact their capital planning or other business decisions. In the aggregate, capital increases account for the largest share of the adjustment (37%), followed by lower non-core assets (7%), lower operating costs (7%), reduced other business lending (6%) as well as reduced trading book (4%).

A better understanding of banks' capital management is important, as recent data show that the level of capital increased strongly since the introduction of Basel III. There is substantial heterogeneity across banks, time and region. The recent Basel III Monitoring Report **(BCBS, 2024)** showed that (i) Group 1 banks increased their CET1 capital from the end-June 2011 to end-December 2022, by 134% from €1,660 billion to €3,886 billion, that (ii) there are regional differences (Rest of the World: +200%, Europe: +74%, the Americas: +94%) and (iii) there are differences in the manner Group 1 banks increased their capital (ie, equity issuances, retained earnings and asset growth as well as asset valuations). On average, the dividend payout ratio was higher in Europe than in the Rest of the World and in the Americas. It was particularly low during the Covid-19 distress period. In Europe, CET1 raised was particularly high in the first half of the sample period. In the Americas and in the Rest of the World, it was particularly high during and after the Covid-19 distress period. The main drivers of the evolution of the CET1 ratio differ substantially across regions. In Europe, the reduction of risk-weighted assets (either risk weight and/or assets), retained earnings and CET1 raised contributed to the increase of the CET1 ratio from H1 2011 to H1 2023. In the Americas, "Other changes to CET1" had the largest impact followed by CET1 raised and retained earnings.[14] In the rest of the World, retained earnings constitute by far the most important contribution to the increase of the CET1 ratio, while risk-weighted assets had a significantly negative impact.

Eidenberger et al (2014) study bank balance sheet management during the post-2008 period of deleveraging in the Euro area. They base their analysis on the aggregate balance sheet of the full sample of the Monetary Financial Institutions (MFI) sector, which corresponds to the sum of the harmonised balance sheets of all the MFIs resident in the Euro area from January 1999 to February 2014. The leverage ratio – capital in per cent of total assets – increased from 5.2% in January 1999 to 5.9% in August 2002.

12 Additional measures, such as closing business lines, reducing other business lending, trading book exposure and interbank lending account for about 5% each. Further options, such as reducing non-performing loans (NPLs), financial or non-financial or government bonds, SME business lending, corporate lending, residential or commercial real estate lending and securitisations accounted for less than 5% each.

13 Additional measures, such as reducing sovereign bonds, other business lending, operating costs and NPLs account for about 5% each. The remainder is widely spread among other measures, including securitisations and closing business lines.

14 Other changes include changes in regulatory adjustments to CET1 and any other changes in CET1 capital between two reporting dates that are not reported separately.

Thereafter, it decreased to 5.3% immediately after the Lehman collapse. From then, it rose steadily to 8% by February 2014. The latter period features a substantial adjustment triggered by two shocks, the financial crisis and the ensuing regulatory tightening (ie Basel III, the introduction of bank resolution regimes).

The authors decompose the evolution of the leverage ratio into 12 asset categories and eight liability categories.[15] They compare the decompositions across the periods June 2003 to October 2008 and October 2008 to February 2014.[16] In the first period, the leverage ratio decreased from 5.6% to 5.2%. While capital and reserves increased by 55%, total assets expanded faster by 67%. The increase in capital compensated for the expansion of assets to about 80%; without the parallel increase of capital, the leverage ratio would have dropped to 3.3%.[17] In the second period, the leverage ratio increased by 2.7 percentage points. The decrease of total assets contributed 0.2 percentage points (or 12%) and the increase of capital 2.5 percentage points (or 88%). The largest contributions to the decrease of total assets stemmed from interbank loans, external assets, MFI bonds as well as write-offs, reclassifications and exchange rate adjustments. Remaining assets, government bonds and loans to general government increased. On the liability side, capital increased by almost 40%.

Overall, they find that the increase of capital contributes the lion's share to the improvement of the leverage ratio after Lehman's failure, that banks have a broad range of options to adjust to external shocks and that the largest contributions on the asset side stem from external assets and interbank loans and MFI securities.

2.3 Empirics of bank capital management

Berger et al (2008) examine whether the high capital cushions of US BHCs in 2007 were the result of previous years of high profitability, or active capital management. They find that banks chose capital levels substantially above their minimum requirements which for "well-capitalised" banks amounted to 6% Tier 1 capital and 10% total regulatory capital (Tier 1 plus Tier 2) during the observation period 1992 to 2006. The leverage ratio requirements were between 3% and 4%. The averages across the 67 BHCs with assets exceeding $10 billion amounted to 9.38% (Tier 1 ratio), 11.97% (Total risk-based capital ratio) and 7.63% (Tier 1 leverage ratio).

The authors study three competing, but not mutually exclusive hypotheses, to explain the large excess capital ratios. The first regards earnings retention. Banks retain profits as a precaution to protect against the potential costs and difficulties associated with the issuance of equity capital under short notice and, especially, under stress **(Myers, 1984)**. In addition, shareholders may favour a relatively constant dividend policy. The second hypothesis focuses on economic capital. Banks choose higher capital ratios when their earnings are more volatile, uninsured market counterparties are more risk-averse, charter values are higher to protect future profits **(Marcus, 1984)** and/or total assets are lower (possibly reflecting lower diversification, lower scale economies, higher expected cost of raising new equity and the lack of a too-

[15] Asset categories in the data set include the following: Loans to general government; loans to households, non-financial corporates and non-MFIs; securities general government; securities non-MFIs; securities MFIs; external (outside the Euro area) assets; interbank assets; fixed assets; share and other equities; money market fund shares; write-offs, reclassifications, exchange rate adjustments; remaining assets. Liability categories in the data set: Capital and reserves; deposits liabilities non-MFIs; deposit liabilities general government; debt securities issued; external (from outside the Euro area) liabilities; interbank liabilities; money market fund shares; remaining liabilities.

[16] October 2008 was the first data point after the Lehman collapse; February 2014 the last available data point. To ensure that the pre-crisis period is as long as the post-crisis period (five years and four months), the starting point of the pre-crisis period was set to June 2003.

[17] The composition of the increase of assets was dominated by loans to households, non-financial corporates (NFCs), non-MFIs (30%), external assets (21%) and interbank assets (19%). The composition of the expansion of liabilities featured a similar structure with deposits from non-MFIs (27%), external liabilities (17%) and interbank liabilities (22%). The increase of capital contributed 5% to the expansion of liabilities.

big-to-fail (TBTF) guarantee). The third hypothesis refers to acquisition plans. Banks considering mergers and acquisitions are likely to hold excess capital. To acquire a bank with a price-to-book value above 1, banks need to hold more capital (above the combined target capitalisations of the acquirer and the acquired banks). Supervisors are likely to link their permissions for large mergers to the expected capitalisation of the resulting pro forma bank considering the costs and uncertainties of the process.

To investigate the competing hypotheses in more detail, the authors employ a partial adjustment model to study banks' excess capital. Their data is an unbalanced panel of 4,563 annual observations for 666 publicly traded BHCs from 1992 to 2006. They define a "do-nothing capital ratio" as the hypothetical capital ratio at the end of year *t*. It consists of the capital level at the end of the previous year (with a constant number of shares, ie no share buybacks) plus retained earnings, net income in year *t* minus the USD dividend of last year *(t-1)*, irrespective of the actual share buybacks and the actual USD dividend in year *t*.[18] The actively managed part of banks capital ratio adjustment is the difference between the actual capital level and the "do-nothing capital ratio". We build on the concept of a "do-nothing capital ratio" in our definition of what we call "Management Action on Capital" in Section 5.1. Their partial adjustment model yields an adjustment speed driven by the banks' actively managed part of its capital. A low estimate of the speed of adjustment suggests that banks adjust more slowly and manage capital more passively; a high estimate suggests the opposite. Banks with lower initial capital levels adjusted faster. For the Tier 1 capital ratio, banks with lower or no rating(s) also adjusted faster. Somewhat counter-intuitively, banks experiencing higher supervisory pressure adjusted more slowly. The variable adjustment speeds ranged from 28% to 41%. Undercapitalised banks adjusted almost 50 percentage points faster for the Tier 1 capital ratio (32 percentage points faster for the leverage ratio and 24 percentage points faster for the total capital ratio). The authors conclude that banks actively manage their economic capital targets and their speeds of adjustment to these targets based on profit maximisation, eg due to funding cost optimisation, protection of their charter values, to cushion against higher asset risk and the exploitation of TBTF subsidies.

De Jonghe and Öztekin (2015) build on **Berger et al (2008)** to study the adjustment to capital targets of about 20,000 banks from 64 countries over the period 1994–2010. They find that banks adjust to negative capital shocks predominantly through increasing equity (rather than reducing assets). They use the calculated target ratio to determine the exogenous capital deficit/surplus relative to it. Following positive equity shocks, banks lever up by slower than average capital increases (ie reducing earnings retention, but not an outright reduction of capital) and substantial asset expansion. The latter includes but is not dominated by loans; other earning assets and particularly nonearning assets (incl. cash) dominate. This suggests that banks with (too) high capitalisation maintain capital for future profitable investments. In contrast, undercapitalised banks increase their capital ratios much more rapidly than well-capitalised banks, and much more so by raising external capital. These banks expand assets (loans and non-earning assets). For very large banks, asset growth is not significantly different between undercapitalised banks and banks close to their target capital ratios. Heterogeneity across countries is high. More stringent capital requirements, better supervisory monitoring, more developed capital markets and high inflation are associated with higher adjustment speeds. During times of crisis, the adjustment speed is significantly higher than in normal times.

Black et al (2016) study equity issuances of 1036 publicly traded US banks from 2001 to 2014. Over the entire period, 308 banks issued equity in private markets of which 196 were SEOs (Seasoned Equity Overing) and 179 PIPEs (Private Investments in Public Equity). The average amount of equity issued was 9.5% of the bank's book value of total equity for SEOs and 28.3% for PIPEs. They find that equity issuances increased strongly during the financial crisis. About one third of all private equity raisings in the sample period took place in 2008 and 2009. Before the financial crisis the average number of issuances

18 The definition of "do-nothing" capital is somewhat arbitrary. Instead of a fixed USD dividend, one can also justify, eg a fixed dividend pay-out ratio or a fixed dividend yield.

per annum was about 13, in 2008 and 2009 it was 61.[19] The authors estimate pooled logit regressions with fixed effects. They investigate the determinants of equity issuances and find that banks issuing SEOs are larger and more profitable, have lower total risk-weighted capital ratios, lower NPL ratios, lower shares of liquid assets and higher shares of brokered deposits than non-issuing banks. For PIPE issuers, the same holds true except that they are less profitable and have higher NPL ratios than non-issuing banks. The weakest banks (high NPLs, low and volatile profitability) issue via PIPE rather than TARP. In addition, the authors conclude that trading indicators also play a role in the choice of issuing instrument. Higher share turnover and asset transparency, lower price volatility and bid-ask spreads increase the likelihood of SEOs versus PIPE or TARP.

Couaillier (2021) studies how banks adjust to their capital targets. Instead of estimating banks' implicit targets, the author collects the announced capital targets of a sample of banks. The final dataset consists of an unbalanced panel of 1,171 observations from 70 banks. It covers banks from all countries in the Euro area except Lithuania, Latvia and Slovakia. The sample period is Q1 2014-Q4 2020. The author collects observations manually on banks' websites and financial communication documentation along four characteristics: (i) the value of the capital ratio target; (ii) the nature of the target: level of CET1 ratio or distance to capital requirements; (iii) the definition of the CET1 ratio: ie fully loaded or phased-in; and (iv) the horizon of the target (eg medium-term, next three years). Banks have progressively increased their targets until mid-2017, as the new regulatory framework and its implementation process were clarified and the European economy gradually recovered from the European sovereign debt crisis. They have since then mostly evolved in a stable interval, with the interquartile range staying between 12.5%-15%. In the long run, the distribution of the distances between actual CET1 ratio and the targets is centred on zero.

The estimations conducted by the author proceed in three steps. First, he regresses the announced target CET1 ratio on bank characteristics and macroeconomic variables. In the second step, the author estimates a partial adjustment model with a time- and bank-specific adjustment speed. Finally, in the third step, he examines whether the gap between actual capitalisation and the announced targets has information content regarding the changes of a set of balance-sheet and off-balance-sheet variables (ie CET1 ratio, CET1 outstanding (in euro), risk density, interest rates to NFCs and households (in quarterly difference), risk weighted assets (total and credit only), total original exposures, loans and debt securities exposures to NFCs, loans to households, exposure to general government (in quarterly growth)).[20] The author finds that: (1) targets are affected by capital requirements, but not one-to-one, and behave procyclically consistent with market pressure, (2) the impact on the target differs across types of capital requirements, (3) the distance between actual CET1 ratio and the target is a valuable predictor of balance-sheet adjustment,[21] suggesting that banks actively drive their capital *ratios* toward their announced targets, mostly through capital accumulation (2/3 of the adjustment via issued capital and earnings retention) but also through portfolio rebalancing. The latter largely focuses on changes of banks' NFCs debt portfolio and risk density; loans to NFCs play a minor role. Loans to households and general government are not significantly affected by the gap to the capital target. Finally, Couaillier finds that this adjustment occurs both above and below targets, but banks below target adjust faster.

Dinger and Vallascas (2016) examine whether poorly capitalised banks issue capital via Seasoned Equity Offerings (SEOs) to recapitalise. The impact of poor capitalisation on SOEs might be ambiguous: On the one hand, the debt overhang problem (**Myers, 1977**) or moral hazard in combination with risk-shifting behaviour (to debtors, the deposit guarantee scheme, or the government; **Gornall and Strebulaev, 2013**) suggest that poorly capitalised banks issue less capital and adjust via alternative measures (eg loan reduction). On the other hand, regulatory and market pressure provide incentives to

19 In addition, 152 equity injections from the TARP program took place in 2008 and 2009.

20 The analysis includes a broad set of variables that are supposed to capture bank-specific effects, macro-financial developments, Covid, monetary policy and fiscal measures to address the fall-out from Covid-19.

21 In contrast, "…the distance to capital requirement has relatively low statistical significance…" (Couaillier 2021, p 29).

increase capital (**Admati et al, 2012**; **Berger et al, 2008**). The authors' sample consists of 2,177 banks in 19 countries over the period from January 1993 to 30 June 2011. The data stems from Datastream and Worldscope data bases. The authors identify 3,530 SEOs (source: Thomson One Banker). They then exclude share offerings without effects on the capital structure, ie pure secondary offerings exchanging existing shares and withdrawn offerings. The final sample consists of 912 SEOs which amounts to a share of 5.18% of SEOs in bank-year observations. While SEOs are relatively rare, SEOs tend to be large relative to the issuing bank's book values. In their estimations, Dinger and Vallascas use a panel random effect logit specification.

The authors conclude that market mechanisms rather than capital regulation are the primary driver of the decision to issue by poorly capitalised banks. They infer this from the higher likelihood of SEOs in poorly capitalised banks. Riskier banks, banks with higher relative price to book values, lower profitability and larger banks are also more likely to raise capital. However, regulatory changes do not increase the likelihood of SEOs. Also, systemic shocks do not increase that likelihood. That effect is strongest for the largest banks (TBTF). Poorly capitalised banks raise more equity in normal times when they are subject to more stringent market discipline than well-capitalised banks. Compared to relying on retained earnings, SEOs allow poorly capitalised banks to adjust much faster and more reliably – future profits might underperform expectations and, hence, the bank might miss its recapitalisation target. Banks also prefer SEOs to decreases of their assets.

Krishnan et al (2010) examine whether SEO issuances by undercapitalised banks are different from those of well-capitalised banks. The sample consists of 276 public offers of seasoned equity made by US commercial banks and BHCs over the period 1983–2005. All American Depositary Receipts, secondary offers and SEOs that have warrants or are part of a unit offer, and shelf registration offers are excluded from the sample. The authors employ an event-study methodology for abnormal stock returns and use logistic regressions for examining the economic drivers of the issuance decision. Separate logistic regressions are estimated for the subsamples of undercapitalised (73) and well-capitalised (203) bank SEOs. The economic drivers of banks' equity issuance decisions include the market value to book value ratio (M/B), book assets, and an interaction term between M/B and the degree of undercapitalisation or overcapitalisation. The authors find evidence that both undercapitalised and well-capitalised banks experience similar and significantly negative stock price reactions to SEO announcements and have similar patterns of insider trading and similar economic drivers for the issuance decision. More specifically, post-SEO abnormal stock returns are found to be similar to benchmark returns (based on 3- and 4-factor Fama-French models) for both types of issuers in the long run, suggesting that investors understand the value implications of bank SEOs upon announcement.

Valencia (2010) investigates whether uncertainty about unexpected bank losses increases capitalisation, as theory predicts. The data are obtained from US commercial banks' Call Reports for the period 1995–2005 yielding 6,000 observations. The dependent variable is the bank's capital ratio, defined as capital over assets. It is measured as the mid-point of the sample period (in the year 2000). The main independent variable is uncertainty, which is conceptualised as the equivalent precautionary premium, ie the certain reduction in dividends (or alternatively, the certain increase in capital) that has the same effect on the banks' optimal decision as adding uncertainty. This is equivalent to the unexpected fluctuation in bank capital/return on loans. It is measured as the variance of the distribution of the yearly changes of a bank's relative capital ratio. The latter is defined as the change in period t of the bank's capital ratio – normalised by the industry capital ratio – relative to period t-1. To address reverse causality (ie better capitalised banks may choose more risk) the author derives the unexpected fluctuation in bank capital/return on loans for groups of banks, with groupings according to size/fed district/real estate loans to total loans/deposits to total liabilities/off-balance-sheet items to total assets. In the author's regressions, the impact of uncertainty on capitalisation is statistically significant and robust. In a counterfactual experiment, he finds that a decline in uncertainty to the lowest level during the observation period would reduce bank capital ratios by slightly over 1 percentage point. In line with **Dinger and**

Vallascas' (2016) observation that market discipline is lower under systemic stress, the author's data suggests that the intensity of this precautionary motive is stronger during recessions.

Bahaj et al (2016) study a bank's optimisation problem of simultaneously choosing a level of capital and the level of lending that maximises the expected return for shareholders. In the model, the bank can manage capital by retaining earnings and/or issuing capital. In addition, the authors consider government guarantees for deposits, bank capital requirements and the quality of the bank's legacy assets. When the quality of legacy assets is high and the bank faces profitable lending opportunities (ie high expected return on equity and low risk), the bank finances all loans that are profitable (ie have positive net present value). When legacy assets are of low quality, a debt overhang problem may result, banks may not reach the efficient level of lending. When new lending is also of sufficiently poor expected quality, the value of the government guarantee of deposits increases and acts as a subsidy. The bank may then even lend too much and issue negative net present value loans. The authors test the implications of their model using a sample of 18 UK banks and the over the period 1989–2007 with 589 quarterly observations. The authors use a local projection method to generate non-linear impulse response functions and find that the effect of an increase of bank-specific capital requirements on bank-specific lending growth differs between periods of high and low aggregate lending growth. In the former, the effect on lending is minimal, because banks meet the higher requirement by capital issuance; in the latter, a 25 basis points higher bank specific capital requirement implies a reduction of bank-specific lending of about 6%. Without differentiation between high and low aggregate credit growth, the impact of a bank-specific capital requirement on bank-specific lending growth is statistically insignificant.

Liu (2018) investigates the reasons why banks issue equity and finds evidence that banks do so as a strategy for assets expansion. The sample contains 2,141 banks and 16,297 bank-year observations over the period 1985–2015. There are 237 banks that issued equity during this period, while the rest did not issue common equity during the entire sample period. OLS regressions are estimated with dummy variables that capture pre-SEO and post-SEO effects on various bank-level outcome variables. Relative to a control group, US SEO banks increased not only their capital ratios but also assets and deposits in the years post-SEO. The newly raised funds are invested mainly in retail loans (consumer and mortgages).

Braouezec and Kiani (2021) address the question why banks decide to reach their target capital ratio by selling assets and/or issuing new equity shares. To answer this question, the paper develops a simple model in which each channel of adjustment is costly: that is, underwriting and dilution costs for equity issuance; and profit reduction and price impact for asset sales. The model assumes that the objective of the bank is to minimise the total adjustment cost subject to the target's constraint and then develops the bank's optimal strategy. The choice of the channel(s) of adjustment is formulated as an optimisation problem, which is in general non-linear. Depending upon the parameters, it may be more cost-efficient for the bank either to issue new shares or to sell the assets, or even to do both. The bank's optimal strategy is formulated in terms of two critical lower and higher thresholds (or spreads), c_l and c_h (with $c_l < c_h$), where the critical spread is defined as the total issuance cost divided by the gross proceeds. The paper shows that when the observed spread is lower than the lowest critical spread c_l, it is optimal for the bank to issue new shares only. On the other hand, when the observed spread is higher than the highest critical spread denoted as c_h, it is optimal to sell assets only. In between these two spread values, it is optimal for the bank to both issue new shares and sell a portion of assets. The model's predictions are shown to be consistent with the two European systemic banks' (Deutsche Bank and UniCredit) observed decisions to issue new shares in 2017.

Milne (2004) examines whether an inventory approach on bank capital can explain observed excess regulatory capital. The paper presents a continuous-time framework for modelling bank capital as a form of inventory decision. The author models bank capital management assuming illiquid assets, stochastic cash flow and fixed costs of equity issuance. Banks with sufficient franchise value (expected cash flow) maintain a buffer of capital that exceeds regulatory requirements. The desired buffer is a non-monotonic function of franchise value. Incentives for risk-taking depend upon this buffer, not the absolute level of capital. Capital requirements have little, long-run effect on bank risk-taking. Negative cash flow and higher capital requirements reduce bank lending and risk-taking, with the greatest impact on severely undercapitalised banks. The model determines the desired level of bank capital as a function of the minimum regulatory capital requirement, cash-flow uncertainty, franchise value, recapitalisation costs and the financing costs of both equity and deposits. The model shows that banks choose to hold buffers of excess regulatory capital to reduce the frequency of breaches of regulatory capital requirements.[22]

Lepetit et al (2012) examine whether a bank's decision to recapitalise to a target capital ratio is influenced by its ownership structure, particularly the separation between the voting rights and cash-flow rights of the bank's ultimate owner. The authors use a partial adjustment model framework in their estimations and build on the law and finance theory (La Porta et al, 1998 and 1999). The sample consists of 470 commercial banks across 17 Western European countries over the period 2002–2010. In the regressions, both active and passive changes in the capital ratio are used as dependent variables (both non-weighted Tier 1 and risk-based Tier 1 capital ratios). The authors find that the gap, or wedge, between voting rights and cash-flow rights significantly affects the bank's adjustment speed upwards and downwards towards a target capital ratio. When the ultimate owner's voting and cash-flow rights are identical, banks actively (as opposed to passively shift earnings to capital stock) and equally adjust capital upwards (ie raise equity) and downwards (ie repurchase equity) to reach their target capital ratio. However, a gap between voting and cash-flow rights of the ultimate owner makes banks reluctant to actively adjust their capital position upwards because they fear control dilution. Further investigation shows that such behaviour is more pronounced if the ultimate owner is a family or a state, or if the bank is headquartered in a country with weak shareholder protection.

Erel et al (2012) examine three questions: Do macroeconomic conditions affect non-financial corporates' (excl utilities)[23] abilities to raise capital? If so, what is the channel through which they operate? How do they affect firms' choices of securities, the structure of those securities and firms' access to the capital markets? The paper addresses these questions using a sample containing detailed information on publicly traded debt issuances, SEOs, syndicated loans and private placements in the US. The authors use a multinomial logit model of security choice and address the three research questions using a large sample of 21,657 publicly traded debt issues, 7,746 SEOs, 40,097 syndicated loans and 12,048 private placements of equity and debt for US corporations over the period 1971–2007. The regressions are estimated using a panel of monthly observations for all firms that had at least one type of security at any point during the sample period, a procedure that leads to 728,639 observations. In the multinomial logit models, the dependent variable captures six different types of security issuance: bank loan, public bond, convertible debt, SEO and private placements of equity and debt. The authors find that: (1) a borrower's credit quality significantly affects its ability to raise debt and equity capital during macroeconomic downturns, (2) for non-investment grade borrowers, equity and debt capital raising tends to be procyclical (ie they raise both types of capital under good macroeconomic conditions) while for investment-grade firms, it is countercyclical (they raise both types of capital under adverse macroeconomic conditions), (3) a recession lowers the likelihood of a firm issuing an SEO, relative to not issuing any security or issuing any other type of security, and (4) ceteris paribus, convertible bonds appear more likely to occur during poor economic times.

22 An inventory model of bank capital appears first in Baglioni and Cherubini (1994). Related analyses have been developed by Milne and Whalley (1999, 2004) and in discrete time by Calem and Rob (1996). Peura and Keppo (2004) extend the continuous time framework to take account of delays in raising capital. See, also, Korteweg and Strebulaev (2012).

23 While the sample does not include banks, we consider the findings regarding macroeconomic conditions and funding choices also informative for banks.

2.4 Conclusions

What does the regulatory/supervisory literature on bank balance sheet and capital management imply for bank capital and balance sheet management?

From our review of the supervisory documents, we conclude that banks are required to manage capital in an active, forward-looking manner under business as usual and under stress and to have capital plans in place that contain management action for capital under stress.

From our review of banks' capital management in practice, we conclude that banks forecast their future capital requirements under business as usual and under stress (broadly) in line with the respective supervisory requirements regarding capital management. We also find that banks' adjustment to deviations from capital plans under stress takes place via a broad set of options, with changes of capital contributing most to the adjustment. Banks govern and implement their adjustment strategy via changes of FTPs and internal hurdle rates which affect the bank's pricing on the asset side (eg loan spreads) and on the liability side (eg deposit rates); the respective quantities adjust endogenously.

From our review of the empirical economic literature, we conclude that banks actively adjust capital by capital increases, retained earnings and several other measures (such as asset sales, risk weight optimisation, NPL reduction) also under stress. The combination of these measures is the outcome of an optimisation problem in which a bank aims at minimising its adjustment costs to adapt its balance sheet structure to the exogenous shock. The marginal adjustment costs across adjustment measures are likely to be influenced by bank-specific and macroeconomic variables.

Combining the three strands of literature, we draw the following conclusions regarding the models in Section A1.1 in Appendix 1: first, the assumption – that banks' capital levels at the end of period *t-1* can be used to identify the direction of causation from capital in *t-1* to loan growth in period *t* – does not hold. The positive association between the two variables can be caused by two effects: first, banks increase capital more in period *t-1* when they (expect/plan to) increase their risk-weighted assets more in period *t*. Second, banks that have a capital surplus in period *t-1*, may find it easier to grow their risk-weighted assets in period *t*. Capital in period *t-1* and asset growth in period *t* are planned by the same bank staff/asset and liability committees at the same time. Balance sheets for period *t-1* are published well into period *t*, so that bank balance sheets can take into account even unexpected developments well into period *t*. The second assumption – that banks cannot adjust the capital level in the short run (period *t)* – is not supported by the literature, either.

These conclusions have two implications for our empirical analysis of balance sheet management. First, the forward-looking nature of the bank balance sheet and capital planning processes suggest a partial adjustment model for the adjustment of capital ratios to capital targets and to bank balance sheet management more broadly (Chapter 4). The combination of measures is likely to be bank-specific and depends on the macroeconomic environment. An empirical strategy can exploit these variations in the cross section and in the time dimension (panel data setting). Second, focussing on one measure of bank balance sheet adjustment (eg non-financial corporate loans) in isolation can be misleading. Instead, banks choose their specific combination of measures of asset-side and liability-side adjustments in a simultaneous and endogenous manner. An empirical strategy should therefore focus on simultaneous-equations models that take these interdependencies into account (Chapter 5).

3. Sample composition and descriptive statistics

This section describes the QIS data we employ for our empirical analysis. We obtain bank balance sheet and income statement data from all available banks under the Basel II/III frameworks around the world, assembled by the Basel Committee's Quantitative Impact Study (QIS).[24] The QIS database is based on a global sample of banks, which provide confidential data to their respective national supervisory agencies with the initial objective of evaluating the effectiveness of Basel III reforms. The database is maintained by the Basel Committee's Secretariat, allowing for a comprehensive view of banks' financials, including balance sheets, income statements and regulatory data, as well as capital and liquidity ratios and their constituent items.

The QIS database is particularly well suited to conduct this study because of both its global coverage, which ensures consistent measurements across jurisdictions, and the diligent data quality assurance conducted by banking supervisory authorities and centralised teams at the Basel Committee's Secretariat. Additionally, the QIS database incorporates selected confidential data unavailable in standard commercial datasets, offering unique insights into the adjustment process of banks to new regulatory requirements.

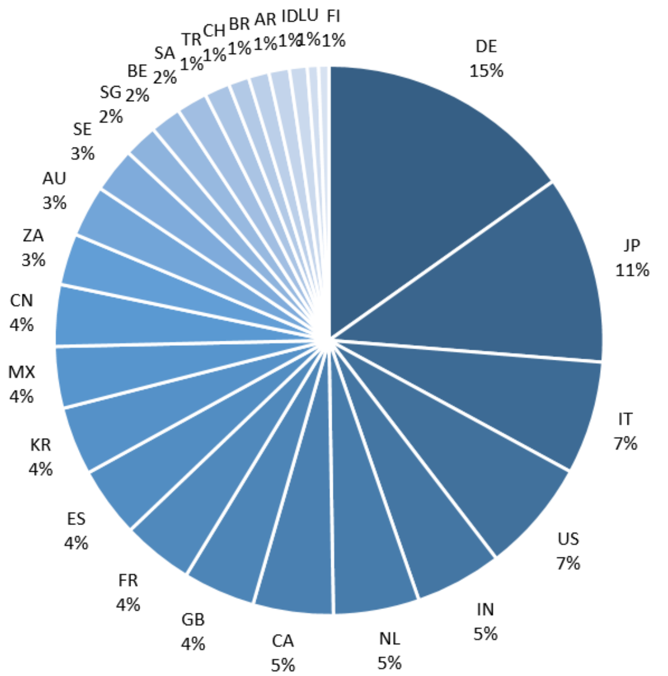
The data used in this study have semi-annual frequency, with reference to 31 December and 30 June reporting dates, with initial data range prior to data transformations and variable selection, between June 2013 and June 2019. The starting date is determined by the availability of necessary data, while the end date marks the end of the pre-Covid period, which we later extend to the most recently available post-Covid data for robustness analysis. Missing observations are filled with the average of pre- and post-Covid observations, increasing our sample size by approximately 5% and banks with less than three years of consecutive reported data are excluded. In additional analyses, presented in columns (3) and (4) of Table 3, we test our results for robustness regarding these sample choices to ensure they do not drive our results.

In total, our main dataset comprises 1,644 observations from 172 banks across 26 countries. The sample contains banks that vary along several dimensions: geographic composition, bank size and business model, supervisory approaches and it is therefore used for regular Basel III monitoring, including the report by the **Basel Committee on Banking Supervision (2020)**. Graph 1 illustrates the distribution of observations across jurisdictions. Most countries contribute between 3% and 7% of the observations, with Germany and Japan having a higher representation at 15% and 11%, respectively. It is worth noting that the latter countries contribute more *Group 2* banks to the QIS sample, which are smaller compared to the large, internationally active *Group 1* banks that account for 63% of the sample. European countries contribute the bulk of observations (48%), while 18% are from the Americas and 35% from the Rest of the World.

[24] Refer to www.bis.org/bcbs/qis/ for details on the QIS dataset.

Sample composition of global banks in the sample

Graph 1



Notes: We classify the 176 banks in our sample by country code, as reported by the respective supervisory agencies.

Source: QIS data; authors' calculations.

We also conduct a break-down of the banks in our sample according to their business model and legal form, as reported in the QIS database. Representing 62% of the observations, banks' business models are predominantly based on retail and commercial banking, whereas investment banks contribute 33% of the observations and the remainder of banks have other business models. Regarding legal form, Joint stock companies represent 84% of the observations, with 40% of them representing banks with a publicly available market capitalisation of equity. 9% of the observations constitute mutual or cooperative banks, and the remainder account for other legal forms.

Table 1 provides summary statistics for our entire sample of banks. First, we identify variables where the distribution of values indicates issues with data outliers and winsorise these at the 1% and 99% levels, which are typically used in the literature. The *reported CET1 ratio* represents the banks' Common Equity Tier 1 capital relative to its risk-weighted assets, using the regulatory standards in place at the respective reporting date.[25] With a mean of 14.8% and a median of 13.2%, the *reported CET1 ratio* is on average well above the 4.5% Basel III minimum Pillar 1 requirements.[26]

During the sample period (2013Q2–2019Q2), the Basel III standards were implemented and the stringency of calculation for banks' CET1 ratios increased. Therefore, we also consider the *full Basel III CET1 ratio* under national implementation. The *reported* capital-asset ratio reflects the regulatory framework in place at the corresponding reporting date during the Basel III transition phase, as the new requirements

[25] Thus, the *Reported CET1 ratio* considers the Basel III phase-in provisions for capital ratios at the respective reporting date, as explained in Box A of the December 2020 Basel III Monitoring Report (**BCBS, 2020**).

[26] Refer to the RBC20 under risk-based capital requirements at www.bis.org/basel_framework for the most up-to-date standards of the Basel III framework.

are gradually being phased in. Instead, the *Basel III fully-phased-in* capital-asset ratio is a variable unique to our dataset that reflects a fully-phased-in Basel III framework according to national implementation, even if the transition phase is still ongoing. During the transition phase, this ratio already reflects the definitions of CET1 capital and RWA as if the national adaption of the Basel framework were already fully phased in. Typically, the reported capital-asset ratios by banks during the transition phase are higher than the *fully phased-in Basel III* capital-asset ratios, which apply the more stringent definitions of CET1 capital and risk-weighted assets under full implementation of the Basel III framework.

Importantly, and as a novel contribution to this literature, we take into account the bank-specific implementation of the Basel III reform as an influencing factor for target capital-asset ratios. Specifically, the vector $X_{b,c,t-1}$ includes the difference between *reported* capital-asset ratios and *Basel III fully-phased-in* capital-asset ratios, which we label *Basel III reform gap*. The need for banks to adapt to the new Basel III requirements, representing a positive *Basel III reform gap*, has an impact on the target capital-asset ratio that we seek to account for. The greater the distance between the reported and the full Basel III capital-asset ratios, the larger the potential impact on the bank's future capital-asset ratios.

Descriptive statistics, main sample. (2013Q2–2019Q2) Table 1

Variable	Winsorised	N	Mean	SD	p5	p50	p95
Regulatory ratios							
reported CET1 ratio	No	1,644	0.148	0.0598	0.0924	0.132	0.252
full Basel III CET1 ratio	No	1,643	0.147	0.0612	0.0902	0.129	0.258
Basel III reform gap	No	1,643	0.00122	0.00980	-0.00731	0	0.0158
log of LCR	Yes	1,644	0.451	0.464	-0.0101	0.330	1.385
Bank financials							
log of assets	No	1,643	25.67	1.659	22.73	25.66	28.30
net income to assets	Yes	1,643	0.00374	0.00453	0	0.00266	0.0116
trading book to assets	Yes	1,633	0.0769	0.125	0	0.0199	0.367
lending to assets	No	1,635	0.573	0.217	0.0647	0.606	0.853
risk density	No	1,643	0.462	0.187	0.177	0.441	0.799
Macroeconomic variables							
log of HP-filtered real GDP	No	1,644	6.096	1.017	4.503	6.116	8.086
Inflation	Yes	1,644	0.0190	0.0242	-0.000775	0.0140	0.0567
change in log of market cap.	No	1,644	0.0295	0.0982	-0.148	0.0361	0.177
log of sov. CDS spread (5Y)	Yes	1,600	3.676	0.975	2.432	3.367	5.369

Table 1 also provides descriptive statistics for the potential determinants of banks' target capital-asset ratios we include in our model. Bank liquidity and capital ratios may be negatively related (**DeYoung et al, 2018**), and therefore we consider the Basel III Liquidity Coverage Ratio (*LCR*), as an additional potential factor for target capital-asset ratios.[27] It has a mean of 194% and a median of 139%, but due to its skewed distribution, the logarithmic transformation is applied before considering this variable in our econometric framework. Bank size, measured by total assets, is on average €140 billion.

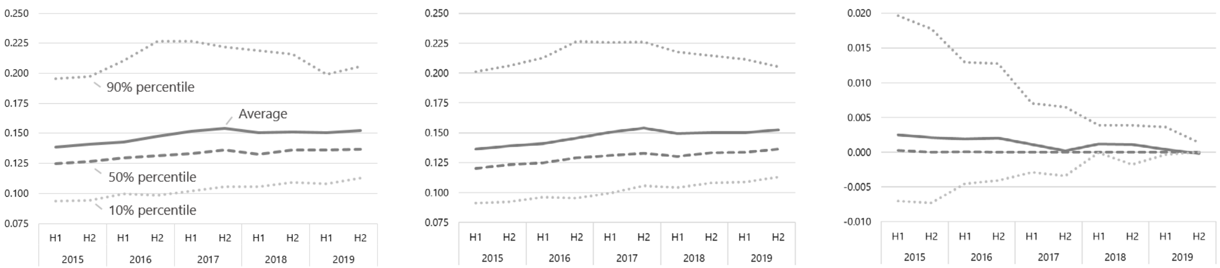
As robust profitability allows banks to build up capital, we also consider banks' *net income to assets*, which has a mean value of 3.7% and a median of 2.7%. The ratio of banks' *trading book to assets*,

[27] For a subset of banks, our dataset includes this variable even before public reporting of LCR was required.

banks' customer *lending to assets*, and banks' risk-weighted assets to total assets (*risk density*) are included in our analysis, because these are determinants of banks' business models that may potentially have an impact on their target capital-asset ratios. Finally, a set of macroeconomic factors (Hodrick-Prescott or *HP-filtered real GDP* and *inflation*) as well as market factors (change in stock *market capitalisation*, natural *logarithm of five-year sovereign Credit Default Swap or CDS spreads*), serve as country-specific controls.

Capital ratios during 2015–2019 Graph 2

Reported CET1 ratio | Full Basel III CET1 ratio | CET1 reform gap



Source: QIS data; authors' calculations.

4. How do banks manage their balance sheets to adjust their CET1 ratios towards their estimated targets in the short run?

In this section, we present the first step of our empirical analysis, in which we identify the balance sheet items associated with bank capital-asset deviations from their target. To this end, we employ a partial adjustment model of capital structure to estimate each bank's target capital-asset ratio using semimanual data for our global sample of banks. We can then determine whether the capital-asset ratio available in the bank exceeds or falls below its target and then explore which items in the banks' balance sheets can be associated with these deviations with a fixed effects model and a simultaneous system of equations.

We present the econometric framework in Section 4.1 and discuss our estimates of banks' target capital-asset ratios in Section 4.2, assessing their empirical validity with data on banks' reported target capital ratios. We then examine the lagged and contemporaneous relationship between capital-asset deviations and various items on banks' balance sheets in Section 4.3. Finally, in Section 4.4 we conclude by summarising our findings.

4.1 The partial adjustment model

The evolution of a bank's capital-asset ratio is a dynamic process that depends on the target capital ratio set by the bank, which is also influenced by other bank-specific and time-specific factors that we need to consider. Bank-specific factors include idiosyncratic shocks to banks' capital as well as strategies chosen by banks' management, while time-specific factors include changes in the regulatory and supervisory environment as well as macroeconomic factors. To model this process, we employ a *partial adjustment model*, in line with the literature estimating bank capital dynamics.[28] In this model, the capital-asset ratio, $k_{b,c,t}$, of bank b in country c at time t is modelled as follows:

[28] While this approach was initially used as a way of estimating firm leverage (eg **Flannery and Rangan, 2006**), some salient examples of applications to bank capital structure include **Berger et al (2008)**, **De Jonghe and Oztekin (2015)** and **de-Ramon et al (2022)**.

$$k_{b,c,t} = \lambda\, \hat{k}^*_{b,c,t} + (1-\lambda)\, k_{b,c,t-1} + \epsilon_{b,c,t}. \tag{1}$$

Equation (1) describes the evolution of a bank's capital-asset ratio at time t as a combination of last period's $(t-1)$ capital-asset ratio, $k_{b,c,t-1}$, and the desired target ratio at time t, $\hat{k}^*_{b,c,t}$, with the parameter λ determining each term's relative weight. λ can be interpreted as the speed at which a bank adjusts its capital-asset ratio over time, where $\lambda = 1$ would imply full adjustment to the target level within one period, and $\lambda = 0$ would imply no systematic adjustment over time. The error term in equation (1) is represented by $\epsilon_{b,c,t}$. It is important to stress that $\hat{k}^*_{b,c,t}$ is an unobservable variable that is not recorded systematically on bank's financial statements, such as balance sheets or income statements, and must hence be estimated.

To this end, we model the capital-asset ratio as a function of its previous value and of vector $X_{b,c,t-1}$, which represents potential factors that determine target capital ratios.[29] $X_{b,c,t-1}$ includes N bank-specific characteristics (such as size, liquidity, profitability and the Basel III implementation status) and macroeconomic controls (including country-specific GDP growth and inflation), all referring to time $t-1$, with controls for bank-specific fixed effects:

$$k_{b,c,t} = \lambda \sum_{n=1}^{N} \zeta_n x_{n,b,c,t-1} + (1-\lambda) k_{b,c,t-1} + v_{b,c,t}. \tag{2}$$

Similarly to equation (1), the coefficient $(1-\lambda)$ in equation (2) represents the stickiness of bank capital-asset ratios in the one-period adjustment process, whereas λ represents the speed of adjustment towards the target capital-asset ratio. The bank-specific characteristics and macroeconomic controls are included in the n-element vector $X_{b,c,t-1}$, denoted by $x_{n,b,c,t-1}$ and weighted by the parameter ζ_n. Furthermore, $v_{b,c,t} = \varphi_b + \epsilon_{b,c,t}$ is a composition of the bank-specific fixed effects (φ_b) and the idiosyncratic, serially uncorrelated shocks $(\epsilon_{b,c,t})$. Note that $k_{b,c,t}$ does not refer to absolute amounts of capital, but capital-asset ratios, where the Common Equity Tier 1 (CET1) is set in relation to the risk-weighted assets (RWA).

To estimate this equation, we employ a two-step system generalised method of moments (system GMM) estimator (**Blundell and Bond, 1998**) as the previous-period capital ratio $k_{b,c,t-1}$ is an endogenous regressor, following the specification proposed by **de-Ramon et al (2022)**.[30] This estimation method avoids dynamic panel bias (**Nickell, 1981**) and takes into account the endogeneity of regressors, as well as idiosyncratic errors that are heteroskedastic and correlated within but not across cross-sectional units. Dynamic panel estimators are particularly suitable for unbalanced panels where the number of units (banks) exceeds the number of time periods (**Bond, 2002**), as it is the case for our sample of banks. To account for potential small-sample bias, we adjust standard errors applying the finite-sample correction (**Windmeijer, 2005**) and correspondingly perform corrections to the covariance matrix estimate.

System GMM allows for the endogenous variable to be instrumented using its first difference, which is then instrumented by its own lagged values. However, dynamic panel estimations are weakened by having too many instruments (**Roodman, 2007**). Therefore, we limit the lags to $t-1$ and $t-2$, as suggested by the appropriate econometric tests we perform, and collapse the instruments for each bank over time in order to avoid overidentification issues.

[29] A more detailed explanation of this equation and related derivations are shown in Appendix A2.1.

[30] Technically, we employ the Stata command xtabond2 developed by **Roodman (2009)** to estimate the model described in equation (2). Therefore, individual banks' fixed effects (φ_b) must be recovered from the disturbance term $(v_{b,c,t})$. Appendix A2 provides a detailed description and formulation of this procedure. The Stata output is then used to determine the stickiness of bank capital, accounted for by the dependency between capital ratios and their lagged values $(1-\lambda)$, as well as the adjustment speed λ. With the permission of the authors, we adapted and modified Stata code from **de-Ramon et al (2022)** to align with our specification.

The vector $X_{b,c,t-1}$, which represents bank-, country- and time-specific determinants of banks' target capital-asset ratios, is treated as an exogenous regressor and therefore instrumented via the instrumental variables (IV) approach. The factors that contribute to banks' target capital-asset ratios have been investigated by **Brewer et al (2008)** and **Gropp and Heider (2010)**, among others, who emphasise the importance of bank size, profitability, risk, market-based variables and country-specific factors. In our estimates, we test various specifications of vector $X_{b,c,t-1}$ that take these categories into account.

Our application of the partial adjustment model allows us to estimate the unobserved target capital-asset ratio $\hat{k}^*_{b,c,t}$, using our estimates of the adjustment speed λ in a one-period model and subsequently we derive percentage capital-asset ratio deviations from its target ($\hat{Z}_{b,c,t}$), as defined in equation (3):

$$\hat{Z}_{b,c,t} = 100 \times \left[\left(\frac{k_{b,c,t}}{\hat{k}^*_{b,c,t}}\right) - 1\right]. \tag{3}$$

According to this formula, $\hat{Z}_{b,c,t} > 0$ represents a capital-asset ratio surplus and $\hat{Z}_{b,c,t} < 0$ represents a capital-asset ratio shortage relative to the target, with $\hat{Z}_{b,c,t} = 0$ indicating a capital-asset ratio that is exactly at its target ratio.

4.2 Results

This section presents the estimation results of the partial adjustment model. As described in Section 4.1, we estimate equation (2) using the two-step, system GMM estimator (**Blundell and Bond, 1998**). Further details on the methodology can be found in Appendix 2.

4.2.1 Baseline estimation results

The main estimation results for the partial adjustment model are presented in Table 2. As expected, the lagged dependent variable, *reported CET1 ratio*, shows a positive and highly significant coefficient estimate in all four specifications. The coefficient estimates are between 0.82 and 0.93 and indicate that there is a strong stickiness of bank capital-asset ratios in the one-period adjustment process, as we would expect given the high costs of altering bank capital each period. This coefficient estimate implies an average speed of adjustment of 7–18% semi-annually across all banks and it is robust to, for example, removing the *Basel III reform gap* variable for concerns of potential correlation with the dependent variable.[31] In that case, the speed of adjustment is 11%, suggesting that the speed of adjustment is not being driven by the new variable we introduce in our specification. The closest study to ours that estimates an average global speed of adjustment for bank capital is **De Jonghe and Oztekin (2015)**. They consider banks across 35 countries for the 1994–2010 period and find the average annual speed of adjustment to be 29%, broadly in line with our findings of an annual speed within the range of 15–39%.[32]

We conduct Hansen tests for overidentification and test for autocorrelation of the error term to corroborate the validity of our model across different specifications. "AR1" and "AR2" in Table 2 refer to the Arellano-Bond test for first differences in the residuals at lag 1 and 2, respectively. With a value of zero, we reject the null at lag 1, and with values greater than 0.10 we fail to reject the null at lag 2, suggesting no autocorrelation in the residuals. The Hansen tests, which yield a Chi-square value below one, suggest

[31] To further address concerns of potential correlation of the Basel III reform gap variable with the dependent variable, which by construction uses dependent variable $k_{b,c,t-1}$, we conduct tests on the correlation between the Basel III reform gap variable and the reported CET1 capital ratio. Since our dataset is in a panel format, we employ within, between and pooled correlation test approaches: The results show that correlation is not material: within correlation coefficient (by bank id groups) is 0.12, between correlation is -0.11, pooled correlation with time fixed effects is -0.02, Spearman correlation (overall) is -0.11.

[32] Since our estimate of λ is semi-annual, we convert to yearly with the formula $(1 + \lambda)^2$.

that we cannot reject the null hypothesis that all the restrictions for overidentification are valid.[33] We therefore do not find any evidence of these econometric issues in our model and its subsequent variations, making the results valid for interpretation.

In the baseline model (1), a key variable in vector $X_{b,c,t-1}$ is the *Basel III reform gap*. Recall that the *Basel III reform gap* variable captures the increase in regulatory conservatism, or strictness, under the new nationally applied framework. Once the fully loaded rules become effective, the reported capital ratio must decrease at banks that have shown a positive gap before the new rules become effective. New rules often become effective after a long period of transitional arrangements that can allow for a stepwise phase-in of stricter rules, such as an increase of regulatory deductions from capital. A positive gap may also indicate that the equity or the risk weights are stricter under the fully loaded rules. Ultimately, this variable represents "phasing-in" of Basel capital requirements and gradual removal of transitional arrangements. Our results show a highly significant negative coefficient estimate on the gap variable in all four regression specifications. This suggests that, if full Basel III implementation implies a lower CET1 ratio than currently reported, we would expect lower future reported ratios, with a pass-through rate into capital-asset ratios of around 18%. In other words, banks with a larger *Basel III reform gap* are expected to exhibit lower reported capital-asset ratios in the future, all else equal.

Of the other explanatory variables, coefficient estimates for banks' size (*log of assets*) are negative, as expected, and statistically significant in several specifications. This is consistent with the notion that larger banks tend to have relatively lower capital ratios, as identified in the literature (eg, **Berger et al, 2008**; **De Jonghe and Oztekin, 2015; de-Ramon et al, 2022**). Although not tested directly, this result is also consistent with the notion that market perceptions of too-big-to-fail implied guarantees suggests that larger banks can have lower capital ratios because they face less of a penalty from the market for operating at lower capital levels (**Couaillier, 2021**). Other bank-specific controls, such as our proxies for liquidity (*LCR*), bank complexity (ratio of *trading book to assets*) and economic impact (ratio of consumer *lending to assets*) are show relatively stable coefficients across different model specifications, although not statistically significant in general. This also tends to be consistent with the results from **De Jonghe and Oztekin (2015)** who study a large set of global banks. Their liquidity proxy is in their case negative, but also statistically insignificant and their proxy for economic impact is negative as in our specification.

We expect loan growth to be more prominent in institutions that have a higher buffer relative to their regulatory capital thresholds, because a larger capital buffer provides banks with greater flexibility and confidence to extend additional credit, as they are better positioned to absorb potential losses and meet regulatory requirements. This observation is supported by recent empirical work based on the Basel Committee's independent analysis of a global panel dataset of banks. While data limitations may apply, this study found some indication of a positive relationship between capital headroom and lending.[34] The *trading book to assets* ratio accounts for banks' trading activities as one specific aspect of their business model and suggests, in our case, that banks with relatively larger trading activity have on average lower capital-asset ratios in the future, although this relationship is not statistically significant. In terms of profitability, as expected, we find the ratio of *net income to assets* to be negatively related to future capital-asset ratios, although again, this is not statistically significant. In unreported results, we explore different measures of profitability, such as return on equity, and our main results remain robust to using this variable. Finally, we consistently find that higher economic growth and inflation are associated with lower future capital-asset ratios; as expected, higher price inflation incentivises banks to have less capital.[35]

33 Unlike the Sargan test, which is used for one-step GMM, the Hansen test is applied in the context of two-step system GMM and may be sensitive to the number of instruments used.

34 "Capital headroom" is defined as the surplus of a bank's capital resources above all minimum regulatory requirements and buffers. See **Basel Committee on Banking Supervision (2022)**.

35 Higher inflation may lead to increased lending activity as banks seek to capitalise on higher nominal interest rates, which can further reduce their capital ratios.

Table 2 reports results for our baseline regression and several different variations of the baseline regression specification. Compared with the results for the baseline regression model presented in column (1), we include *risk density* as an additional regressor in the alternative regression model presented in column (2) to account for the ratio of banks' risk-weighted assets to total assets. A negative coefficient would suggest that banks with a higher risk density have lower future capital-asset ratios, but the estimate is not statistically significant. The regression model presented in column (3) incorporates time fixed effects, with the caveat that the number of instruments increases. In the context of system GMM, an excessive number of instruments can overfit the model and weaken the validity of the Hansen test. Despite this increase, all our main results remain robust. In column (4) of Table 2, we report results for a regression model that uses additional controls for financial conditions (market capitalisation) and country risk (credit default swaps five-year spread).[36] We do not find these variables to be significant determinants of capital-asset ratios. However, our key results remain consistent: The speed of adjustment of bank capital-asset ratios is about 25% on average per year. Additionally, better capitalised banks have a lower Basel III reform gap. Lower future capital-asset ratios are, all else equal, associated with banks that are larger, less liquid, more profitable, have higher trading activity, are less engaged in lending and are headquartered in countries with higher growth and inflation.

[36] These macroeconomic data are not available for four banks in our sample, thus the number of observations is slightly lower.

Baseline results for the dependent variable: *reported CET1 ratio* Table 2

	(1)	(2)	(3)	(4)
t-1: reported CET1 ratio	0.857***	0.822***	0.926***	0.917***
	(0.105)	(0.134)	(0.210)	(0.171)
t-1: Basel III reform gap	-0.178***	-0.172***	-0.189***	-0.188***
	(0.055)	(0.056)	(0.059)	(0.067)
t-1: log of assets	-0.001**	-0.001*	-0.000	-0.000*
	(0.000)	(0.001)	(0.000)	(0.000)
t-1: log of LCR	0.002	0.002	0.001	0.002
	(0.003)	(0.003)	(0.003)	(0.002)
t-1: net income to assets	-0.052	0.177	-0.134	-0.134
	(0.189)	(0.407)	(0.290)	(0.334)
t-1: trading book to assets	-0.012	-0.013	-0.008	-0.008
	(0.008)	(0.008)	(0.017)	(0.017)
t-1: lending to assets	-0.014	-0.013*	-0.008	-0.009
	(0.009)	(0.007)	(0.022)	(0.017)
t-1: risk density		-0.014		
		(0.016)		
t-1: log of HP-filtered real GDP	-0.002	-0.001	-0.001	-0.001
	(0.001)	(0.001)	(0.003)	(0.003)
t-1: inflation	-0.066*	-0.051**	-0.036	-0.052***
	(0.036)	(0.022)	(0.082)	(0.017)
t-1: change in log of market cap.				-0.001
				(0.003)
t-1: log of sov. CDS spread (5Y)				0.000
				(0.004)
Time Fixed Effects (semi-annual)	No	No	Yes	No
Observations	1,644	1,644	1,644	1,592
Number of banks	172	172	172	168
Number of instruments	11	12	21	13
AR1	0.000	0.000	0.000	0.000
AR2	0.362	0.358	0.292	0.313
Hansen	0.496	0.538	0.617	0.556

Notes: We report 2-step system GMM coefficient estimates where the dependent variable's lag, CET1 reported ratio, is instrumented via GMM and all lagged bank-specific and macroeconomic controls are instrumented via IV. Standard errors are reported in parentheses, where *** p<0.01, ** p<0.05, * p<0.1, and adjusted for small sample bias and with the **Windmeijer (2005)** finite-sample correction. AR(1) and AR(2) refer to the Arellano-Bond tests for autocorrelation in the residuals, and Hansen refers to the chi-square value for the overidentification test.

4.2.2 Robustness checks

We test the robustness of the baseline regression results presented in column (1) of Table 2 by examining different regional subsamples and using alternative sample selections with respect to as varying time periods or the treatment of missing values. Results are presented in Table 3, where columns (1) and (2) represent, respectively, region-specific results for Europe and the Rest of the World (RoW); whereas columns (3) and (4) reflect regression results based on different methods for preparing the data used in the estimations, and column (5) reports regression results for an extension of the historical data to include the period 2020–2022.

Columns (1) and (2) of Table 3 reports regression results for Europe and RoW, with the main results remaining fairly consistent.[37] While for Europe, the stickiness of capital ratios of 89.6% is similar to the baseline world-wide sample's estimate of 85.7%, it is substantially lower in the RoW at 70.8%. Furthermore, the coefficient estimate for the *Basel III reform gap* variable is negative in both subsamples, despite not being significant for the RoW. It is worth noting that for this latter subsample, the Arellano-Bond test indicates second-order autocorrelation in the residuals. While we aim to compare the same model across regions, a more rigorous examination of the region might require the inclusion of additional or different variables to improve the model's validity.

Column (3) of Table 3 reports regression results for the full sample of 214 global banks, compared to the baseline sample of 172 banks used in Table 2 and columns (1) and (2) from Table 3, which excluded banks with less than three years of consecutive reported data. To preserve sample size, despite data gaps, we implement the forward orthogonal transform proposed by **Arellano and Bover (1995)**. This method subtracts the average of all future available observations of a variable from each contemporaneous observation, rather than differencing the data. All essential results are confirmed, with estimated coefficients remaining similar in magnitude and direction to the baseline specification, suggesting that this data choice does not influence our results.

Column (4) of Table 3 presents estimates based on the baseline sample but excludes interpolated values, reducing our available number of observations. Again, we find our results to be robust to this data choice.

While our baseline sample ends in H2 2019, the regression results reported in column (5) of Table 3 are based on an extended sample that spans up to H2 2022. The years 2020–2022 were marked by the Covid-19 pandemic, which involved unprecedented government interventions in the banking sector. It is therefore unlikely that the partial adjustment model will be applicable for this period in a similar way as to the relatively stable period of 2013–2019. Therefore, we exclude this period in estimating from our baseline specification. In addition, there are significant data gaps in the years 2020–2022, such as missing financial statements or incomplete reporting due to the impact of the Covid-19 pandemic, which we need to interpolate. The significantly lower coefficient estimate for the lag of the *reported CET1 ratio* compared to the baseline model reflects the unique circumstances during the Covid-19 pandemic. Specifically, the stickiness of capital was lower during this period. We believe this phenomenon warrants further analysis, which is beyond the scope of this work.

We also consider different alternatives to our model, which are not reported in this table. These alternatives included incorporating the country yield curve spread as a proxy for economic conditions, the government debt to GDP ratio and different variations of GDP growth, such as the country's estimated output gap. In all these cases, results did not materially change. However, the validity of the model was sometimes compromised due to the need to reduce the number of observations because of sampling restrictions and the introduction of more instruments into the setup.

Additionally, we accounted for CET1 requirements, following the literature on how banks adjust their balance sheets in response to changes in the regulatory environment. Although we found a positive relationship between CET1 requirements and capital-asset ratios, as expected, this variable was difficult to interpret within our context due to the different jurisdictions included in our sample. Similarly, the loan loss reserves as a percentage of gross customer loans was a limited variable in our sample but also suggested a negative relationship with capital-asset ratios.

[37] We chose the regions Europe and RoW as subsamples so that the number of banks and observations is large enough to allow for robust model performance. .

Robustness checks for the dependent variable: *reported CET1 ratio*					Table 3
	(1)	(2)	(3)	(4)	(5)
	region: EUR	region: RoW	full sample	no interpolation	data extension
t-1: reported CET1 ratio	0.896***	0.708***	0.886***	0.851***	0.703***
	(0.130)	(0.090)	(0.156)	(0.074)	(0.076)
t-1: Basel III reform gap	-0.307***	-0.098	-0.113***	-0.307***	-0.205***
	(0.068)	(0.066)	(0.041)	(0.063)	(0.060)
t-1: log of assets	-0.000	-0.000	-0.001**	-0.001	-0.001**
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
t-1: log of LCR	-0.001	0.010***	0.002	0.004	0.007**
	(0.002)	(0.003)	(0.003)	(0.002)	(0.003)
t-1: net income to assets	-0.371	0.556**	0.008	-0.108	0.274*
	(0.252)	(0.239)	(0.259)	(0.158)	(0.165)
t-1: trading book to assets	-0.030	0.005	-0.009	-0.006	-0.015**
	(0.024)	(0.005)	(0.011)	(0.006)	(0.006)
t-1: lending to assets	-0.017	-0.009	-0.010	-0.006	-0.020***
	(0.017)	(0.006)	(0.013)	(0.005)	(0.007)
t-1: log of HP-filtered real GDP	-0.000	-0.001	-0.001	-0.001	-0.003***
	(0.003)	(0.001)	(0.002)	(0.001)	(0.001)
t-1: inflation	-0.064**	-0.068*	-0.059	-0.031	-0.107***
	(0.032)	(0.041)	(0.051)	(0.036)	(0.024)
Observations	782	862	1,776	1,342	2,370
Number of banks	84	88	214	172	179
Number of instruments	11	11	11	11	11
AR1	0.000	0.000	0.000	0.000	0.000
AR2	0.893	0.0495	0.297	0.456	0.287
Hansen	0.619	0.954	0.546	0.617	0.0695

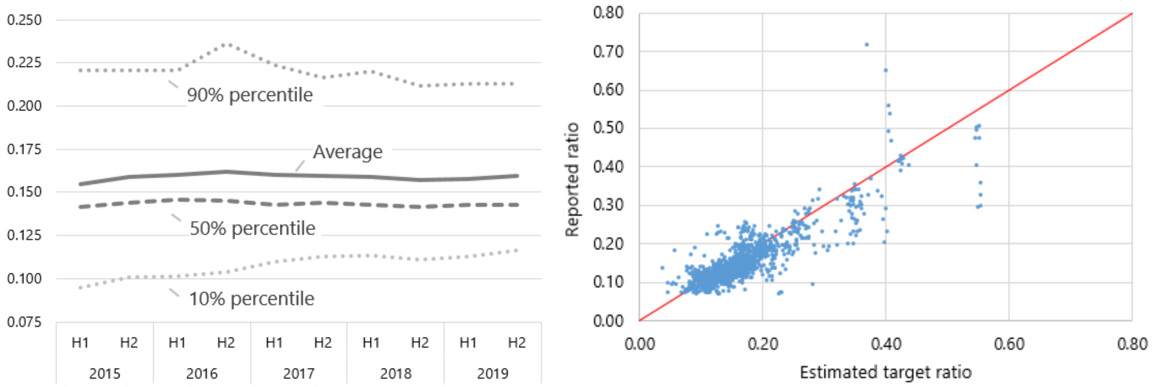
Notes: We report 2-step system GMM coefficient estimates where the dependent variable's lagged value, reported CET1 ratio, is instrumented via GMM and all lagged bank-specific and macroeconomic controls are instrumented via IV. Standard errors are reported in parentheses, where *** p<0.01, ** p<0.05, * p<0.1, and adjusted for small sample bias with the **Windmeijer (2005)** finite-sample correction. AR(1) and AR(2) refer to the Arellano-Bond tests for autocorrelation in the residuals, and Hansen refers to the chi-square value for the overidentification test. Columns (1) and (2) focus on banks in the European and rest of the world (RoW) regions, respectively. Columns (3) and (4) present results of the baseline specification where banks are not excluded if more than three consecutive years of observations are missing, or if no missing observation is interpolated. Column (5) reports results for a regression that extends the sample period to include the period 2020–2022.

4.2.3 Estimation of target capital-asset ratios

Our application of the partial adjustment model is the first step in our econometric estimation and allows us to derive the banks' target capital-asset ratios from the estimated regression parameters. Appendix 2 provides a detailed description of the methodology used for this purpose, with the extraction of bank-specific fixed effects being a particular challenge that we carefully address. Graph 3 and Table 4 below illustrate the distribution of the estimated bank-specific target capital-asset ratios.

The left-hand chart in Graph 3 shows the distribution of the bank-specific target capital-asset ratios for each semester of the sample period in box plots. Interestingly, unlike the *reported CET1 ratios* (Graph 2), we do not observe a positive trend throughout our sample period. The estimated values are within plausible ranges. The very high estimated values correspond to banks that, due to their specific business models and ownership structures, achieve high capital ratios. The right-hand chart in Graph 3 supports this point by comparing the estimated target capital ratios (horizontal axis) to the reported capital ratios (vertical axis) in a scatter plot. As expected, there is a strong positive correlation, which is close to a 45-degree line, such that banks with a high target capital ratio also report relatively high capital ratios. However, it is also apparent that in a majority of cases, the target ratios are higher than the reported ratios. This observation is based on the trend during the sample period, where many banks were actively trying to increase their capital ratios in response to regulatory pressures and market expectations. These cases are located below the diagonal line in Graph 3, while banks whose capital target has already been reached, or exceeded, are shown on or above the diagonal line.

Distribution of estimated capital targets during 2015–2019 (left) and capital targets plotted with reported capital ratios (right) Graph 3



Source: authors' estimations based on QIS data.

Table 4 shows the distribution of the estimated target capital ratios numerically. The mean of 15.9% and median of 14.3% fall within what we consider as plausible estimates. A comparison with the reported numbers also yields the expected result: The reported capital ratios are, on average, 4.8% lower than the estimated target ratios, and reported capital is, on average, €1.6 billion lower than the estimated target.

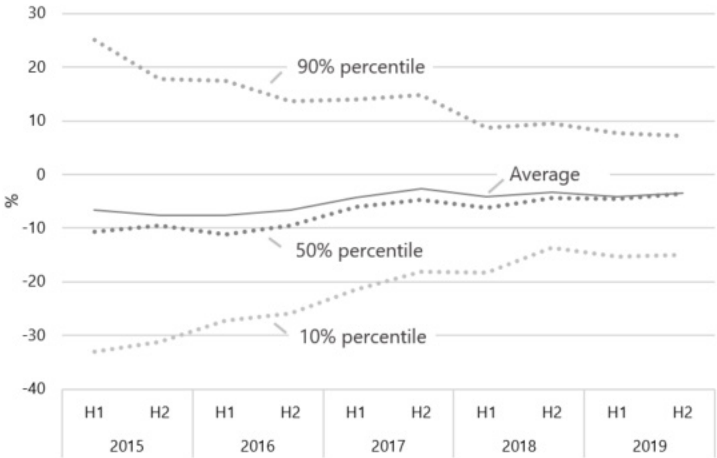
Descriptive statistics of target capital ratios Table 4

Variable	N	Mean	SD	p5	p50	p95
CET1 target ratio	1,644	0.159	0.0652	0.0963	0.143	0.282
Deviation of reported capital ratio from target ratio in %	1,644	-4.771	20.39	-29.88	-6.221	22.76
Deviation of reported capital from target in bn €	1,643	-1.605	6.081	-12.300	-0.3216	3.326

Graph 4 shows the deviation of the reported ratio from the target ratio over time. We note that banks' actual capital ratios converge towards their target during the Basel III implementation phase for a wide range of banks. The deviation from target was reduced both by banks operating below and above target. This indicates that risks from low capitalisations were reduced as well as inefficiencies from high capitalisations.

Distribution of deviation of reported capital ratio from target ratio in % during 2015–2019

Graph 4



Source: authors' estimations based on QIS data.

4.2.4. Benchmarking the targets with reported data

To assess the empirical validity of our estimated capital target ratio, we compare them to what banks report as their target ratios in publicly available documents. Since our data, and therefore the names and identifiers of all the banks in our sample, are confidential, we cannot directly compare the estimated and the actual (ie reported or publicly announced) bank target capital-asset ratios at the level of individual banks. Instead, we can do so with respect to the mean values of the estimated and actual target capital-asset ratios for the two samples (the BCBS QIS dataset used for the estimations and a sample of internationally active banks).

To this end we create a list of banks, similar to our confidential sample, and collect individual bank-level data for the target capital-asset ratios from public sources that we later aggregate for comparison purposes. In line with Couaillier (2001) we construct an original dataset of all the publicly announced CET1 bank target capital-asset ratios for all global banks from Group 1 of the BCBS QIS sample (79 banks) and for some global banks from Group 2 (16 banks). In addition to the announced CET1 target capital-asset ratios we collect information on: (I) the definition of the target capital-asset ratios, (ii) the time horizon of the target, (iii) the minimum regulatory capital requirement, (iv) the type of document in which the target was announced, and (v) the type of economic analysis model used for internal capital planning.

It is worth acknowledging that this is not a straightforward exercise, and it therefore presents its own set of challenges and limitations. First, not all banks publicly announce their targets for the CET1 capital-asset ratios (for example, 40% of Group 1 banks do not publicly announce capital-asset targets during our sample period). Second, for the Group 1 banks that do publicly announce targets for the CET1 capital-asset ratio, in approximately 39% of the bank-year observations, the targets are defined in relation to the prudential regulatory requirement. For example, the bank might announce that it targets the minimum requirement or a buffer above the minimum requirement. However, in many cases, the minimum regulatory requirement is either not disclosed or only partially disclosed (ie omitting capital buffers or Pillar 2 requirements), because in some jurisdictions, banks are not allowed to reveal their regulatory requirements in full. Third, the sample composition for the estimated and announced target ratios is not exactly the same as the confidential BCBS QIS sample, especially for Group 2 banks. This discrepancy arises because the data collection exercise for the publicly announced targets does not encompass the entire BCBS QIS sample in particular regarding Group 2 banks. Fourth, the time horizons of the estimated and the publicly announced targets differ. Our estimated targets refer to the steady state or long-term target that banks project given their own characteristics, macroeconomic conditions and anticipation of Basel III regulatory changes during the 2014–2019 period, while the time horizon of the publicly announced targets can differ not only across banks but also for the same bank across time periods. For example, in some cases banks announce targets as part of their medium-term or strategic business plans, which have as a horizon the period of validity of the plan (which have three to four years span on average), in other cases banks announce annual targets or guidance for the next year with a more limited time horizon of about one year. For approximately 29% of Group 1 banks (or 23 banks) the announced target capital-asset ratios were a longer-term target, ie with a horizon of more than 1 year. For 14% of the Group 1 banks (or 11 banks), the announced target capital-asset ratios in the beginning of the period of analysis 2014–2019 was the expected at the time full Basel III capital requirement at the end of the transition period which coincides with the end of our period of analysis.

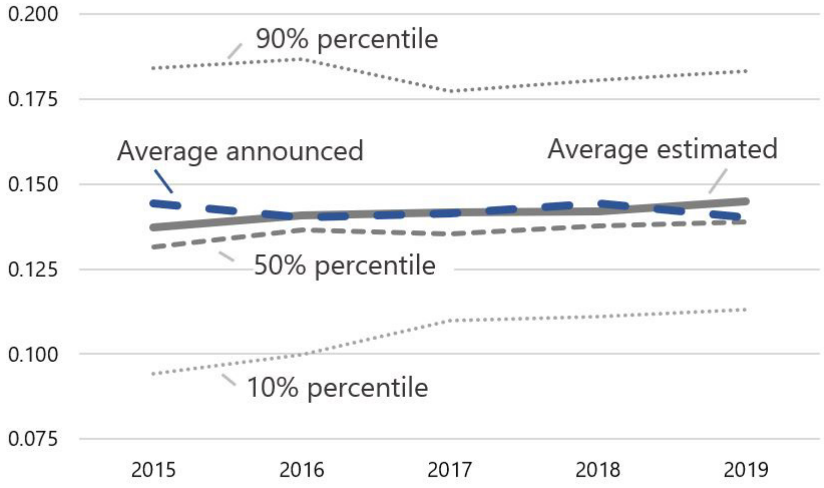
Lastly, the definitions of the targets differ across jurisdictions and sometimes within the same jurisdiction across banks or in time. In some cases, banks define their targets in terms of full application of Basel III rules, while in other cases, the targets are defined in terms of transitional rules or national application of the Basel III rules. Some of the banks in one country, for instance, define their CET1 targets in terms of the national application of Basel III rules, which is much more restrictive than the internationally applicable rules, while three of the six Group 1 banks in another country define their capital targets excluding unrealised gains on securities, even though they reported target CET1 ratios both with and without this item.[38]

With these caveats in mind, we consider the publicly announced target capital-asset ratios to be a lower bound of the actual and the estimated bank capital target ratio. This assumption is justified because banks may have incentives to set higher internal targets than those publicly announced to ensure compliance with regulatory requirements and to maintain a buffer for unexpected losses. Furthermore, more than 54% of Group 1 banks (or 43 banks) defined their target capital-asset ratios as a lower bound (ie the capital-asset ratio is expected to be "at least" a given percentage, or to be "above the prudential requirements at all times", or "to exceed" a given percentage). Only two Group 1 banks publicly announced target capital-asset ratios that were defined as an upper bound beyond which capital would be returned to shareholders.

We aggregate these publicly announced targets to benchmark our model estimates. Graph 5 compares the estimated and publicly announced target capital-asset ratios for Group 1 banks. The means of our estimated and publicly announced target capital-asset ratios for the 2014–2019 period are, respectively, 14.1% and 14.2% for Group 1 banks and 15.9% and 15.3% for the entire sample of banks. As we had anticipated, the publicly announced targets are in general lower than our estimated targets in particular for the full sample of banks. For Group 1 banks the estimated targets are lower than the announced targets in the beginning of the period of analysis, namely 2014 and 2015, when they started the transition period of adjustment towards the new Basel III risk-based capital standard. Towards the end of the period of analysis, in 2018–2019, the average estimated target capital-asset ratios for Group 1 banks tend to be higher than the average publicly announced targets. Our estimates reflect the stylised fact that, for the entire sample, the reported ratios and the publicly announced targets are generally higher than those for the Group 1 banks.

[38] The definition of targets can also vary due to differences in the treatment of AOCI prudential filters across jurisdictions (Da Rocha Lopes et al, forthcoming) and the degree of transparency of banks regarding the OCI exclusion from capital.

Average target capital-asset ratios of Group 1 banks | Graph 5



Source: Banks web sites and authors' calculations.

Notes: The average "estimated targets" capital-asset ratios are estimated with the baseline partial adjustment model using QIS data. The "announced targets" are the average publicly reported targets for a sample of banks that publicly announce their target capital-asset ratios.

4.3 Balance sheet adjustments to capital-asset ratio deviations

Banks can take many different approaches to addressing deviations of their capital-asset ratios from their target capital ratios. These deviations can result from regulatory or supervisory changes, aggregate or idiosyncratic shocks, or changes in risk perception related to bank fundamentals. Banks with capital ratios that deviate from their targets can decide whether to actively adjust the capital ratios through capital increases, a reallocation of their portfolio of assets, or changes in regulatory risk, among other options. To further analyse bank capital management, we examine how banks adjust different balance sheet items so as to move towards their target capital-asset ratios. Similar to **Francis and Osborne (2012)** and **de-Ramon et al (2022),** we estimate the following fixed effects model for each bank balance sheet item j:

$$\Delta ln\left(BS_{j,b,c,t}\right) = \gamma_{j,b} + \alpha_j \hat{Z}_{b,c,t-1} + \tau_j \, \Delta ln\left(BS_{j,b,c,t-1}\right) + \sum_{n=1}^{N} \beta_{j,n} \Delta x_{n,b,c,t} + \epsilon_{j,b,c,t}, \tag{4}$$

where $\hat{Z}_{b,c,t-1}$ is our bank-specific measure of capital-asset ratio deviations from the estimated capital-asset target ratio (surplus or shortfall) at time $t-1$ calculated using equation (3) and $\Delta\, ln\left(BS_{j,b,c,t}\right)$ represents the log change in bank balance sheet item j. From the denominator side of capital-asset ratio deviations, we focus on growth in total assets, growth in reported RWA, as well as two components of a bank's assets: growth in total loans (excluding loans to financial institutions) and Held-to-Maturity (HTM) security holdings.[39] From the numerator side, we consider (reported) CET1 capital. $\Delta x_{n,b,c,t}$ are a set of (changes in) bank- and country-specific characteristics, including real GDP and inflation for each country in the sample, and LCR, 5-year CDS spreads and the ratio of trading assets to total bank assets. We also include the change in the ratio of Accumulated Other Comprehensive Income (AOCI) as a proportion of full Basel III CET1 capital as a control variable for the HTM dependent variable.

[39] While we refer to the securities as Held-to-Maturity (HTM), it should be noted that this asset class also includes Amortised Cost securities under IFRS 9 classification for banks following IFRS starting in 2018 (BCBS 2025 for additional details).

In line with **de-Ramon et al (2022),** we expect positive and statistically significant associations between growth of total assets, total loans, RWA and capital-asset deviation in the preceding period, implying that balance sheet growth and lending activity increase in response to a (positive) capital-asset deviation. As growth in HTM securities represents a growth in this specific asset class, we expect a similarly positive and significant association between a capital-asset deviation and growth in HTM. The relation between capital-asset deviation and CET1 capital is expected to be negative, indicating that the capital growth is lower at banks with (positive) capital-asset deviation relative to estimated capital targets.

For the entire sample (H1 2014–H2 2019) we find that banks with capital-asset ratios that exceed their target ratios (a positive capital-asset ratio deviation), are on average more likely to reduce their Tier 1 capital growth as well as increase their risk-weighted asset growth in the next period by means of closing their capital-asset ratio deviations from the target (Table 5). The coefficient estimate on RWA is consistent with the notion that banks that need to increase their capital-asset ratios to achieve a higher target ratio may do so by reducing their regulatory risk, ie, the average risk weight of their assets. We find a statistically significant reduction in the rate of CET1 growth of about 0.088% on average for banks that have 1% excess capital-asset ratios (measured in percentage units). In terms of banks' management of their assets, we find a statistically significant increase in the growth rate of RWA (0.059%).

Fixed effects: Capital-asset deviations and growth in different balance sheet items — Table 5

VARIABLES	$\Delta ln(assets)$	$\Delta ln(RWA)$	$\Delta ln(loans)$	$\Delta ln(HTM)$	$\Delta ln(CET1)$
$\hat{Z}_{b,c,t-1}$	7.60e-07	0.00059***	9.57e-05	0.00244**	-0.00088***
	(0.000143)	(0.000203)	(0.000365)	(0.00103)	(0.000182)
Δ real GDP	-2.567***	-3.307***	-0.751	2.097	-3.018***
	(0.667)	(0.917)	(0.931)	(6.8972)	(0.669)
Δ Trading book to assets	0.103	-0.117*	-0.833***	0.962	-0.174**
	(0.103)	(0.0609)	(0.256)	(0.647)	(0.0700)
Δ LCR	0.00318**	-0.0006	0.00118	-0.0564	-0.00011
	(0.00138)	(0.0011)	(0.00371)	(0.0826)	(0.00143)
Δ 5-year CDS	-0.000349	-0.00045**	-0.0002	0.000747	-0.00063***
	(0.000217)	(0.000175)	(0.00016)	(0.00192)	(0.000188)
Δ Inflation rate	-0.434	-0.320	-0.888	7.204*	0.103
	(0.478)	(0.444)	(0.692)	(3.650)	(0.353)
Δ AOCI to CET1				-0.120	
				(0.180)	
Constant	0.0242***	0.0345***	0.0163*	0.179	0.0358***
	(0.00623)	(0.0843)	(0.00917)	(0.126)	(0.00596)
Observations	1,419	1,419	1,410	561	1,419
R-squared	0.049	0.080	0.048	0.034	0.104
Number of banks	168	168	168	72	168
Countries	24	24	24	16	24

Notes: The fixed effects regression $\Delta ln(BS_{j,b,c,t}) = \gamma_{j,b} + \alpha_j \hat{Z}_{b,c,t-1} + \tau_j\, \Delta ln(BS_{j,b,c,t-1}) + \sum_{n=1}^{N} \beta_{j,n} \Delta x_{n,b,c,t} + \epsilon_{j,b,c,t}$ is estimated separately for each balance sheet item j listed in the columns. $\hat{Z}_{b,c,t-1}$ represents the estimated bank capital-asset ratio deviation in the previous period, and $\Delta x_{n,b,c,t}$ is a vector of the change in control variables listed in subsequent rows. Robust standard errors are reported in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

We do not find a statistically significant relationship with lending growth. The increase of growth rate in HTM securities is significantly positive and higher in magnitude compared to RWA (0.244%) in response to 1% increase in capital-asset deviation (measured in percentage units) in the prior period. Three points related to the latter finding are worth mentioning. First, due to sample size limitations, we have fewer than half the banks relative to our benchmark regressions (72 banks), reducing the total number of observations, so comparison to other regression results in our table should be viewed with caution. Second, during our sample period, HTM holdings experienced significant growth due to regulatory changes in the accounting treatment of other unrealised losses and gains on securities. The removal of these prudential filters between 2014 and 2018 could have led banks to pre-emptively reallocate their security holdings from AFS to HTM, which were treated differently under current capital regulation and accounting standards. Given the complexity of this topic, the re-allocation of investment security holdings for bank capital management, in response to changes in prudential capital regulation and increased interest rate volatility, is further studied in (refer to BCBS 2025 for additional explanations).

Segmenting banks into Group 1 and Group 2 based on a convention used by the Basel Committee,[40] we find that the results for CET1 are similar in magnitude to those in the main sample: (-0.093% in Group 1, $p<0.001$ and -0.0804% for Group 2, $p<0.1$). However, results for HTM regressions are materially different in Group 1 and Group 2 segments: for banks in Group 1, HTM holdings increase by 0.253% in response to 1% increase capital-asset deviation in the prior period; it declines by 0.670% for Group 2. The difference can be due to the differences in accounting standard implementation for these security types. We note the limitations of this analysis due to a smaller sample size for HTM, which decreases further when segmented by Group 1 (66 banks) and Group 2 (six banks). Alternatively, we segmented banks by the broad geographic areas, Europe (EU), and Rest of the World and Americas (RWAM) combined, to examine regional variations in the main results. The EU subsample includes 83 banks from 11 countries, and RWAM subsample includes 85 banks from 13 countries. For the EU subsample, the results for growth in risk-weighted assets and CET1 capital in response to 1% increase in capital-asset deviation in the preceding semester hold: positive and significant increase in growth of RWA by 0.101% and negative and significant growth in CET1 by 0.102%. For RWAM subsample, only CET1 growth is significant (negative) but smaller in magnitude at 0.07%.[41]

Next, we account for the endogeneity of capital-asset ratio deviations and balance sheet items by expanding our analysis to a system of simultaneous equations estimated via **Zellner and Theil (1962)** three-stage least squares (in the spirit of **Jacques and Nigro, 1997** and **Siemienowicz et al, 2018**). In our system of two simultaneous equations the growth in balance sheet item j and our measure of capital-asset ratio deviations are modelled as a contemporaneous function of each other and their own lags, along with corresponding controls:

$$\begin{aligned} \Delta ln\left(BS_{j,b,c,t}\right) &= \gamma_j^{BS} + \alpha_j^{BS}\hat{Z}_{b,c,t} + \tau_j^{BS}\,\Delta ln\left(BS_{j,b,c,t-1}\right) + \sum_{n=1}^{N}\beta_n^{BS}\Delta x_{n,b,c,t} + \epsilon_{j,b,c,t} \\ \hat{Z}_{b,c,t} &= \gamma_j^{Z} + \alpha_j^{Z}\,\Delta ln\left(BS_{j,b,c,t}\right) + \tau_j^{Z}\hat{Z}_{b,c,t-1} + \sum_{n=1}^{N}\beta_n^{Z}\Delta x_{n,b,c,t} + \theta_{j,b,c,t}. \end{aligned} \tag{5}$$

The system of equations (5) includes the same variables from the fixed-effects regression in equation (4), but it now treats capital-asset ratio deviations as endogenous and estimates all parameters simultaneously. We expect the impact of capital-asset deviation $\hat{Z}_{b,c,t}$, on the growth rates of balance sheet items the first equation of the system (5), $\Delta ln\left(BS_{j,b,c,t}\right)$, to be similar to those in a one-directional model (4), although in this setting the capital-asset deviation is contemporaneous rather than lagged by one semester. The second equation in system (5) accounts for the simultaneous feedback effect from the growth rates of the balance sheet items on contemporaneous capital-asset deviation.

40 Group 1 banks are those with Tier 1 capital of more than €3 billion and are internationally active. The rest of the bank are considered Group 2 banks (eg, BCBS, Basel III Monitoring Report, March 2024). Group 1 and Group 2 designations are noted at the latest available date and do not adjust throughout our sample period.

41 Results of subsample analysis are not tabulated for brevity.

Table 6 reports results for the simultaneous equations model for each pair of capital-asset ratio deviations and balance sheet item j. Two columns refer to one set of simultaneous equations, and the respective dependent variables are listed in the column titles. As expected, and similar to our one-directional model (4), an increase by 1% (unit) in capital-asset deviation is associated with a significant decrease in the growth rate of CET1 (by -0.112%) and an increase in the growth rate risk-weighted assets (by 0.117%). Growth in total assets and lending are not statistically significantly associated with capital-asset deviation, and the same is true for growth in HTM securities holdings. In the second model of system (5), we find that a bank's capital-asset deviation is relatively persistent, with statistically significant coefficients $\hat{z}_{b,c,t-1}$ ranging from 0.635 to 0.733 across different specifications. Moreover, when considering capital-asset deviation as dependent variable, we find it is positively and significantly associated with the growth rate of total assets and, in particular, the growth rate of growth of HTM security holdings. Conversely, capital-asset deviation is negatively and statistically significantly associated with the growth rate of lending for the entire sample. We find material differences in estimations for Group 1 and Group 2 subsamples, namely for growth rate in lending in the first equation of the system (5): it is negatively and significantly associated with 1% increase in capital-asset deviation for banks in Group 1 (-0.101%), and positively and significantly associated with 1% increase in capital-asset deviation for banks in Group 2 (0.113%). We do not find that these differences hold in geographic region segmentation (EU and RWAM). While these findings are not surprising given the differences between Group 1 and Group 2 banks, further analysis is needed to understand the underlying causes of the responses of the lending growth in these two groups.[42]

[42] The estimations by Group 1 and Group 2 segments, as well as EU and RWAM segments are not tabulated for brevity.

System of simultaneous equations: Capital-asset ratio deviations and growth in different balance sheet items Table 6

VARIABLES	$\Delta ln(assets)$	$\hat{Z}_{b,c,t}$	$\Delta ln(RWA)$	$\hat{Z}_{b,c,t}$	$\Delta ln(loans)$	$\hat{Z}_{b,c,t}$	$\Delta ln(HTM)$	$\hat{Z}_{b,c,t}$	$\Delta ln(CET1)$	$\hat{Z}_{b,c,t}$
$\hat{Z}_{b,c,t}$	0.000178		0.00117***		-8.79e-05		0.00203		-0.00112***	
	(0.000158)		(0.000173)		(0.000305)		(0.00143)		(0.000180)	
$\hat{Z}_{b,c,t-1}$		0.682***		0.635***		0.687***		0.676***		0.733***
		(0.0172)		(0.0743)		(0.0310)		(0.0370)		(0.118)
$\Delta ln(BS_{j,b,c,t})$		49.92**		63.94		-126.8***		22.10**		60.13
		(21.19)		(88.15)		(42.11)		(10.04)		(152.1)
$\Delta ln(BS_{j,b,c,t-1})$	-0.199***		0.0483*		-0.0963***		0.124***		-0.0264	
	(0.0271)		(0.0287)		(0.0282)		(0.0408)		(0.0291)	
Δ Inflation rate	-0.880***	112.2***	-0.544**	112.7*	-0.959**	-8.875	6.879**	-1.680	0.0564	81.08**
	(0.225)	(37.47)	(0.245)	(58.91)	(0.429)	(72.65)	(2.941)	(120.5)	(0.255)	(32.94)
Δ real GDP	0.0384	-63.16*	-0.262	-42.43	0.0638	-74.63	-2.614	85.05	-0.325	-47.77
	(0.230)	(35.96)	(0.251)	(49.71)	(0.442)	(64.35)	(1.991)	(70.44)	(0.262)	(52.46)
Δ LCR	0.00571	2.624***	-0.00981**	3.325***	0.0120*	4.440***	0.0247	1.468	0.00284	2.951***
	(0.00356)	(0.566)	(0.00388)	(0.824)	(0.00673)	(1.086)	(0.0867)	(2.851)	(0.00405)	(0.522)
Δ TB to assets	0.0927	-27.33***	-0.0427	-17.58	-0.765***	-120.7***	1.284**	-32.56	-0.159**	-13.49
	(0.0637)	(10.20)	(0.0694)	(12.46)	(0.122)	(37.47)	(0.572)	(22.11)	(0.0724)	(22.76)
Δ 5-year CDS	-0.000336***	-0.0319**	-0.000381***	-0.0193	-0.000140	-0.0549***	0.00120	-0.0944***	-0.000746***	-0.00630
	(7.39e-05)	(0.0133)	(8.07e-05)	(0.0413)	(0.000140)	(0.0209)	(0.000841)	(0.0298)	(8.41e-05)	(0.105)
Δ AOCI to CET1							-0.401	4.576		
							(0.292)	(10.26)		
Constant	0.0171***	-1.813***	0.0157***	-2.001	0.0133***	0.647	0.113***	-4.482***	0.0159***	-2.062
	(0.00256)	(0.507)	(0.00279)	(1.369)	(0.00483)	(0.870)	(0.0243)	(1.479)	(0.00293)	(2.558)
Observations	1,249	1,249	1,249	1,249	1,239	1,239	487	487	1,249	1,249
R-squared	0.071	0.567	-0.004	0.458	0.048	-0.430	0.057	0.353	-0.008	0.617
Banks	168	168	168	168	168	168	69	69	168	168
Countries	24	24	24	24	24	24	16	16	24	24
Log likelihood	-2888	-2888	-2837	-2837	-3570	-3570	-1835	-1835	-3040	-3040
RMSE	0.0631	9.895	0.0686	11.07	0.119	17.39	0.339	9.832	0.0718	9.305
Chi-squared	95.22	1742	99.45	1389	61.96	543.5	35.28	828.8	108	1964

Notes: The 2-equation system $\Delta ln(BS_{j,b,c,t}) = \gamma_j^{BS} + \alpha_j^{BS}\hat{Z}_{b,c,t} + \tau_j^{BS}\,\Delta ln(BS_{j,b,c,t-1}) + \sum_{n=1}^{N}\beta_{j,n}^{BS}\Delta x_{n,b,c,t} + \epsilon_{j,b,c,t}$ and $\hat{Z}_{b,c,t} = \gamma_j^{Z} + \alpha_j^{Z}\,\Delta ln(BS_{j,b,c,t}) + \tau_j^{Z}\hat{Z}_{b,c,t-1} + \sum_{n=1}^{N}\beta_{j,n}^{Z}\Delta x_{n,b,c,t} + \theta_{j,b,c,t}$ is estimated separately for each balance sheet item j listed in the left-hand side of each column. $\hat{Z}_{b,c,t-1}$ is the estimated bank capital-asset deviation in the previous period, and $\Delta x_{n,b,c,t}$ is a vector of the change in control variables listed in subsequent rows. Robust standard errors are reported in parentheses. *** p<0.01, ** p<0.05, * p<0.1. How are robust SEs estimated?

4.4 Conclusions

The results from a partial adjustment model of bank capital structure estimated with a two-step GMM estimator suggest that, during the 2014–2019 period, the capital-asset ratios of our global sample of banks converge towards their target ratios at a speed of about 25% per year, consistent with previous findings in the literature. We find that banks with capital-asset ratios that are higher than the capital-asset ratios under the fully loaded Basel III rules are expected to report lower capital-asset ratios in the future, with an average pass-through rate (adjustment speed) of 18% per semester. On average, we note that banks that are larger, less liquid, more profitable, have higher trading activity and risk density, less engaged in lending and are headquartered in a country experiencing GDP growth and inflation, tend to reduce their capital-asset ratios in the future. These associations are not always statistically significant, but the direction is not driven by our sample choices and is robust to including time fixed effects, controlling for economic and financial conditions, and correcting for small-sample bias.

We estimate the target capital-asset ratios of each bank and find them to be, on average, higher than the banks' reported capital-asset ratios, regardless of the banks' current levels of capitalisation. We note the convergence towards target during the Basel III implementation phase for a wide range of banks. When we study the relationship between the capital-asset ratio deviations from target ratios and the growth in different balance sheet items using a simultaneous equations model, we find that banks with capital-asset ratios above their target capital-asset ratios have both a higher growth in their RWA, including their HTM holdings, and a reduction in growth of their CET1, as they transition to their desired target capital ratio.

5. The endogeneity of management action on capital

In this section, we study whether management action on capital is endogenous in the short-run (defined as a period of six months), including periods of bank-specific distress. This section is organised as follows. In Section 5.1, we define management action on capital (MAC) for the study of the endogeneity of capital. MAC aims at measuring management action on capital – eg to what extent does the bank take actions to actively increase the level of CET1 (and not only the CET1 ratio)? This means that we are interested in whether the bank is taking steps to increase the absolute amount of CET1 capital, rather than just improving the CET1 ratio by reducing risk-weighted assets or other means. The introduction of MAC in our empirical framework allows us to separate active management of the level of capital from adjustments of the capital target, risk density and/or assets and passive adjustments of the level of capital via higher earnings without significantly altering the payout ratio. This means that we are distinguishing between actions taken by management to actively manage capital levels and situations where capital levels increase due to higher earnings, without making substantial changes to the proportion of earnings distributed to shareholders as dividends. In Section 5.2, we define periods of bank distress. Sections 5.1 and 5.2 define the two key variables – Management Action on Capital and Distress Index – which we employ in our regression analysis in Section 5.3.

Section 5.3 addresses the following research questions:

– Do banks with higher asset growth undertake more management action on capital?

– How does bank-specific distress affect management action on capital?

– Do banks that take more management action on capital also exhibit higher asset growth?

Section 5.3.1 is devoted to addressing first question. Specifically, we examine the role of several balance sheet items on the asset side as explanatory variables for management action on capital. Including the bank-specific distress variable in our regression models allows us to address the second question as well. Section 5.3.2 we test for all three research questions in a comprehensive approach. We study the endogeneity of bank balance sheet policy in a simultaneous-equations model. Building on the results in the single-equation approach, we introduce an additional equation that models the impact of MAC on the balance sheet items on the asset side.

5.1 Definitions of management action on capital (MAC)

Our key measure of management action on capital is *MAC_3*. It is defined as the first difference of CET1 adjusted for the passive component of retained earnings (see the formula in Table 7). This measure of management action on capital aims at separating the active generation of additional capital based on a targeted management decision from the passive generation of additional capital that simply results from management allowing higher earnings feeding into CET1. This aligns our definition with **Berger et al (2008)**[43]. We base our approach on the corporate finance literature on dividend smoothing.[44] Under this view, banks aim at smoothing dividend payout ratios. We include share buybacks in our payout ratio. We then define a "do-nothing payout ratio" as a payout ratio that remains broadly constant over time. Specifically, this corresponds to the bank-specific average payout ratio across the sample period, meaning that the bank does not make significant changes to the proportion of earnings distributed to shareholders as dividends. We define management action on retained earnings (*MAC_ret_earnings*) as significant deviations of at least 20% from that average payout ratio: *MAC_ret_earnings* is 0 when the bank's payout ratio in the period is between 80% and 120% of its own average across the sample period. If the bank incurs losses, management action on capital is defined as the amount of the drop in CET1 that is fully or partially compensated by other measures on CET1, zero otherwise. We report significant changes to the payout ratio during periods of distress separately. This allows us to evaluate how effectively our definition of management action on retained earnings captures the bank's response to financial distress.

The main motivation for our detailed definition of *MAC_3* is that previous studies on bank reactions to capital shocks show that banks use several measures to increase capital (incl. sales of assets and participations, adjustments of their distribution policies, CET1 issuances). The discussion in the literature survey of Section 2.2 showed that banks have substantial room for manoeuvre in the management of their P&L and balance sheets across several components (within the boundaries of the law, accounting standards, internal and external audits, as well as bank supervision and market discipline). The QIS data set does not and cannot capture all of these. Theoretically, the change of CET1 within any period should be largely equal to capital issuances plus retained earnings adjusted for changes of AOCI (all other comprehensive income) and of the sum of regulatory adjustments.[45] However, when we compare the first difference of CET1 with the sum of its components, we find a significant unexplained portion of the changes in CET1. This discrepancy suggests that there are additional factors or measurement errors that are not captured by the components that are included in QIS data, leading to an incomplete explanation of the changes in CET1. We find that this varies systematically with bank distress, as do changes of AOCI[46] and of the sum of regulatory adjustments (Table 10). Hence, we suggest that *MAC_3* is

43 Berger et al (2008) define management action on capital as deviations from the "do-nothing capital ratio". The latter is the hypothetical capital ratio at the end of year t. It consists of the capital level at the end of the previous year (with a constant number of shares, aka no share buybacks) plus retained earnings, net income in year t minus the USD dividend of last year (t-1), irrespective of the actual share buybacks and the actual USD dividend in year t. The actively managed part of banks' capital ratio adjustment is the difference between the actual capital level and the "do-nothing capital ratio".

44 For example, Lintner (1956) found that past dividends contribute statistically and economically significantly to current dividend payout ratios. The author also showed that firms have long-term targets for their dividend payout ratios and adjust to that in a partial manner. Over the last almost 60 years, the role of share buybacks in capital return policies has increased, but Lintner's main results still hold (Leary, Michaely, 2011).

45 See Table A3.4 for the calculation of shocks to AOCI *(ΔAOCI)*, to the sum of regulatory earnings (*ΔReg_Adj*) and the unexplained component of increases in CET1 (*ΔCET1 unexplained)*

46 Regarding the role of AOCI in bank capital management, see also our separate complementary report "AOCI capital filters and amortized cost securities: international evidence", BCBS Working Paper, forthcoming.

a comprehensive definition of management action on capital, as it accounts for these systematic variations. Accounting standards, bank regulation and supervision limit the leeway banks have in this respect. However, there remains some flexibility for banks to manoeuvre within these constraints. For example, banks can adjust their risk-weighted assets, modify their asset portfolios, or engage in capital optimisation strategies. As we show, banks make use of this remaining leeway to manage their capital levels effectively.

We use two alternative definitions of management action on capital for robustness checks. First, *MAC_1L* is defined as the reported issuance of CET1 plus current and lagged management action on retained earnings.[47] Second, we define *MAC_2* as net capital issuance of CET1, additional Tier 1 and the gross issuance of Tier 2 capital (Tier 2 net issuance is unavailable) plus the management action component of retained earnings (if profits are positive). We include the issuance of AT and Tier 2 in the definition of management action on capital, because these issuances free up CET1 capital during the sample period.[48] Table 7 provides an overview of our various definitions of management action on capital. Table A3.1 to Table A3.3 in the appendix displays the descriptive statistics and correlations for the variables in Section 5.

Definitions and formulas of management action on capital — Table 7

Variable	Definition	Formula
MAC_retained_ earnings	Management action on retained earnings: Deviation from the "do nothing payout ratio" by at least ±20% of profits after tax (PaT)	*= PaT×(0.8×Payout_ratio_Mean - Payout_ratio) if Payout_ratio < 0.8 ×Payout_ratio_Mean* *= PaT×(1.2×Payout_ratio_Mean - Payout_ratio) if Payout_ratio > 1.2 ×Payout_ratio_Mean* *= 0 if PaT < 0* *= 0 if (Payout_ratio < 1.2 * Payout_ratio_Mean) & (Payout_ratio > 0.8 * Payout_ratio_Mean)*
*MAC_1L**	CET1 issued plus lagged management action on retained earnings	*= CET1_ISSUED + MAC_ret_earnings* + L.MAC_ret_earnings
*MAC_2**	CET1 issued plus net issuance of additional Tier 1 (AT1_NET_ISSUED) and gross issuance of Tier 2 (T2_ISSUED)	*= CET1_ISSUED + AT1_NET_ISSUED + T2_ISSUED*
MAC_3	First difference of CET1 (D.CET1) adjusted for the passive component of retained earnings	*= D.CET1 - CET1_ret_earnings + MAC_ret_earnings if (D.CET1 > 0) or ((D.CET1 ≤ 0) & (PaT > 0))* *= D.CET1 - PaT if (D.CET1 ≤ 0) & (PaT ≤ 0) & (D.CET1 > PaT)*
CET1_D_unexpl	Unexplained component of ΔCET1 after accounting for retained earnings, capital issued (CET1_ISSUED), changes of AOCI (AOCI_D) and changes of the sum of regulatory adjustments (Reg_Adj_D)	*CET1_D_unexpl= D.CET1 - CET1_ret_earnings - CET1_ISSUED - AOCI_D + Reg_Adj_D*

47 Distribution decisions are often taken well into the following period. Hence, it is likely that bank management not only reduces the payout ratio for the current period but also that for the previous period in the face of distress. That is even more likely given the time lag between observable risk drivers (eg, a recession) and their manifestation in banks' P&L and balance sheets.

48 Gross issuances are provided in the QIS data set and we correct for redemptions of additional Tier 1 and Tier 2 capital. However, the reporting of redemptions is sketchy. Hence, the difference between net and gross issuance is small. For the period of investigation, that makes good sense. The capital categories additional Tier 1 and Tier 2 were only introduced with Basel III and phased-in over several years. As a rule, additional Tier 1 issuances are perpetual. Though, regulation allows for redemptions after a minimum of five years and after supervisory approval. Similarly, Tier 2 issuances mostly have maturities of five or more years. Since banks had to build-up these new capital tiers with the introduction of Basel III, we would not have expected significant redemptions during our sample period.

5.2 Definition of periods of bank distress and a distress index

As the QIS database is maintained on an anonymised basis, we cannot easily match outside data with the QIS data. Hence, our definition of bank distress is based solely on QIS data. Distress to profits is the main metric. We regard banks as under distress when their profits are significantly negative. The dummy variable for *s_prof_neg* is 1 when a bank incurs a loss of more than 5% of its CET1 capital. Its frequency is 2.2% in our sample.[49]

The definition is neutral with respect to the source of the distress, inter alia, operational risk, credit risk or market risk. The calibration links the distress periods directly to CET1 – rather than, eg NPLs – so that banks are likely to be under some pressure to adjust their balance sheets. The distress variable is a dummy variable with a value 1 in a distress period and 0 otherwise. Table 8 presents the definitions of periods of distress.

For robustness checks, we construct a continuous distress index, $Distress\_I_{i,t}$., using the following steps:

1. First, we calculate the current first difference of profits after tax (ΔPaT) and subtract the bank-specific mean first difference of profits: ($\Delta PaT_{i,t} – mean\_\Delta PaT_i$).
2. Next, we divide this difference by the bank-specific standard deviation of first differences: $(\Delta PaT_{i,t}–mean\_\Delta PaT_i)/std\_\Delta PaT_i$.
3. Then, we calculate $Distress\_I\_sqd_{i,t}$ to capture the non-linear relationship between shocks to profits and its consequences on the balance sheet structure while maintaining the sign of the shock. This is done by squaring the distress index and multiplying it by the sign of the original distress index: $Distress\_I_{i,t}{}^2 * sgn(Distress\_I_{i,t})$
4. Finally, we normalise the range between -1 and 1 to make it more intuitive and tractable. This is achieved by subtracting the minimum index value from the current index value and then dividing by the difference between the maximum and minimum index values across the sample: $(Distress\_I\_sqd_{i,t}–Distress\_I\_sqd_{min})/(Distress\_I\_sqd_{max}–Distress\_I\_sqd_{min})$.

In this normalised index, the largest negative shock in the sample period features an index value of 1 and the smallest one an index value of -1. Table 8 presents the definition of a distress index and its non-linear version. Accounting for non-linearities is important because the impact of profit shocks on the balance sheet may not be proportional.

Definition of the distress index and its non-linear version — Table 8

Distress Intensity	Definition
Distress_I_pct	*Distress_I = (PaT_D_pct - PaT_D_pct_Mean)/PaT_D_pct_Std* *Distress_I_pct = (Distress_I - Distress_I_max)/(Distress_I_min - Distress_I_max)*
Distress_I_sqd_pct	*Distress_I_sqd = Distress_I×Distress_I×sign((PaT_D_pct - PaT_D_pct_Mean)/PaT_D_pct_StD)* *Distress_I_sqd_pct = (Distress_I_sqd - Distress_I_sqd_max)/(Distress_I_sqd_min - Distress_I_sqd_max)*

We check the plausibility of defining periods of bank distress using three indicators (1) a real GDP shock in the reporting bank's home country, (2) a stock price shock, and (3) a CDS spread shock. These choices reflect broader economic conditions, market perceptions of financial stability and the cost of

[49] We used several alternative measures, which include changes of risk density, higher losses (up to 7.5% of CET1) and AOCI, to check for the robustness of our main conclusions presented in Sections 4.3 and 4.4.

insuring the bank's debt, respectively, providing a comprehensive view of bank distress factors. The shocks are defined as follows: [50]

1. A real GDP shock occurs when real GDP growth is below the mean for the respective country and there is an output gap.
2. A stock price shock is defined as a decrease in the banks' minimum stock price during the period compared to the previous one.
3. A CDS spread shock is defined as increase in the banks' maximum CDS spread during the period compared to the previous period exceeding one standard deviation.

Table 9 presents the relative frequencies of periods of distress with shocks to GDP, stock prices and CDS spreads.

Relative frequencies of periods of distress per bank when (1) a real GDP shock occurs in the period in the country in which the reporting bank is domiciled, (2) a stock price shock, and (3) a CDS spread shock occurs for the respective bank in the same period

Frequencies (in %) Table 9

	N/Y	GDP↓	stock price↓	CDS spread↑	Shock freq
s_prof_neg	N	15%	15%	13%	
	Y	10%	***86%***	***31%***	2.2%

Source: Authors' own calculation based on QIS data.

The definitions of periods of distress are consistent with (1) periods of shocks to a bank's stock price and, to a somewhat lesser degree, with (2) shocks to the bank's CDS spread.[51] The relative frequencies of significant declines in a bank's stock prices increase markedly during periods with distress to its profits. In a period of distress with negative profits (*s_prof_neg*), the frequencies increase from 15% to 86%, The results are similar for a bank's CDS spreads. The frequencies of strong increases of a bank's CDS spread increases strongly in periods with distress to its profits.[52] distress with negative profits (*s_prof_neg*), the frequencies increase from 13% to 31%.

The definition of distress is not consistent with real GDP shocks for the period in the country in which the reporting bank is domiciled. This might be because the specific sample of banks for this analysis (which includes listed banks with market data on CDS spreads) is tilted towards internationally active banks. The effects of shocks to domestic GDP might be reduced by international diversification. In addition, shocks to GDP typically affect profits with some time lag.

For our empirical analysis, we employ *s_prof_neg* as the definition of distress. With a bank loss of at least 5% of CET1 and frequency of 2.2%, it is rare to qualify as "distress". As banks are unlikely to plan for such losses, the distress would call for a management reaction. As such, it lends itself to the study of our research questions: What does such management action looks like? What does it imply for the structure and dynamics of bank balance sheets, in terms of capital, assets and risk density? In addition, the

[50] See Table A3.4 for the calculation of shocks to GDP, stock prices and CDS spreads.

[51] These main conclusions are robust with respect to several alternative measures of bank distress which include changes of risk density, higher losses (up to 7.5% of CET1) and AOCI.

[52] Funding costs (eg CDS spreads) are likely to increase during periods of distress which affects – at given yields of assets – the profitability of generating balance sheet assets and the optimisation problem regarding management action on capital.

conditional frequencies of exceptionally strong declines of stock prices and exceptionally large increases of CDS spreads suggest that the definition captures distress well. Both negative stock price and CDS effects should provide further incentives for management to take action to return the bank's capital-asset ratios to the envisaged capital plan.

A common assumption in the academic literature, which is summarised in in Appendix 1 is that banks cannot raise capital in times of distress. Table 10 reports the relative frequencies of shocks to several components of CET1 changes, including management action on capital, conditioned on distress periods.[53]

Relative frequencies of shocks to several components of CET1 change: management action on capital, changes of AOCI (*ΔAOCI*), changes of regulatory adjustments *(ΔReg_Adj*) and changes of the unexplained component of increases of CET1 *(ΔCET1 unexplained*) versus bank distress

Frequencies (in %) Table 10

	s_prof_neg	
	N	Y
MAC_1L	42%	***67%***
MAC_2	41%	***59%***
MAC_3	21%	***72%***
MAC Payout R (< 80% of mean)	*42%*	***85%***
MAC Payout R (> 120% of mean)	*24%*	***3%***
ΔAOCI↑	41%	***56%***
ΔReg_Adj↓	26%	21%
ΔCET1 unexplained↑	73%	***95%***

Source: Authors' own calculation based on QIS data.

If anything, management action on capital is more likely during periods of bank-specific distress under our central definition of distress (*s_prof_neg*).[54] However, as the univariate analysis is only indicative, this observation will be revisited in the multivariate setting below. The results presented in Table 10 suggest that across all definitions of management action on capital – *MAC_1L, MAC_2* and *MAC_3* – their observed relative frequencies are higher under distress (right-hand column Y). For *MAC_1L*, the relative frequency increases from 42% to 67%; for *MAC_2*, from 41% to 59%; and for *MAC_3*, from 21% to 72%. The relative frequency of management action on capital, in the form of lower payout ratios, increases from 42% to 85%. Inversely, that of management action in terms of a payout ratio above 120% of the bank-specific mean decreases from 24% to 3%. From the univariate analysis we conclude that modelling management action on capital under distress is a worthwhile exercise.

As shown in Table 10, the relative frequencies of large increases of AOCI *(ΔAOCI*) and of unexplained components of changes in CET1 *(ΔCET1 unexplained*) lend empirical support to using the comprehensive definition of management action on capital, *MAC_3*, in our econometric analysis. In both cases, the relative frequencies increase under distress. The relative frequency of large changes of regulatory adjustments decreases somewhat under bank distress.

[53] For the definition of shocks to these components, see Table A3.4.

[54] This conclusion is robust with respect to several alternative measures of bank distress which include changes of risk density, higher losses (up to 7.5% of CET1) and AOCI. That likelihood often increases with the severity of the distress.

The analysis in this section suggests that banks take management action on capital more frequently under distress than under business-as-usual: Management action on capital is costly for banks; the issuance of capital is likely to meet shareholder resistance as it dilutes them, reduces the return on equity and increases their risk exposure to the bank. Significant deviations of balance sheet structure from the banks' projected path is costly too: eg the opportunity costs of lower than planned loan growth amount to the loss of profit from the foregone profitable lending opportunities; these amount to the (target capital ratio)×(risk weight of the exposure)×(target return on equity). If the opportunity costs of foregone lending opportunities exceed the costs of management action on capital (ie the cost of equity), the bank takes management action on capital. Significantly lower payout ratios are also costly for banks. In sum, it is worthwhile to study this optimisation problem empirically, by accounting for bank-specific distress, rather than simply assuming that management action on capital would not be possible under distress.

We draw the following conclusions for from Section 5.2:

Empirical and theoretical models of bank balance sheet management should include active management action on capital. The available level of capital should be conceptualised as endogenous, meaning it should be treated as an optimisation problem rather than an exogenous constraint. Balance sheet dynamics are likely to differ between normal times and times of distress. The often positive correlation between capital growth and (risk weighted) assets growth in normal times is consistent with banks' forward-looking capital plans and consistent with bi-directional causality: banks can grow (risk weighted) assets because they have raised capital; and banks raise capital, if they want to exploit profitable lending opportunities and grow (risk weighted) assets (See the literature review in Chapter 2). A regression of (risk weighted) asset growth on lagged capital might capture reverse causality meaning that instead of capital levels influencing asset growth, it is possible that changes in asset growth are influencing capital levels. An empirical analysis of bank capital and bank balance sheet management should address this concern. In Section 5.3, we present such a model, conditional on limitations of the QIS database noted previously.

5.3 The endogeneity of management action on capital and asset growth

In this section, we study the endogeneity of capital using both single-equation and simultaneous-equations model approaches. We investigate the following questions: *Do banks with higher asset growth undertake more management action on capital? How does bank-specific distress affect management action on capital? Do banks that take more management action on capital also exhibit higher asset growth?*

First, we examine the determinants of management action on capital (Section 5.3.1). As defined in Section 5.2, we employ *MAC_3* as our primary definition of management action on capital. The variable *s_prof_neg*, which identifies events where the bank incurs a loss equal to or lower than -5 % of CET1, serves as our main indicator of periods of bank-specific distress. Capitalisation surplus/shortage, measured by the distance to target (*Z_w*), can be influenced by changes in risk density, the level of CET1 capital, total assets and the target. Hence, with *Z_w* as dependent variable it is difficult to separate arithmetic changes in *Z_w* due to its components from behavioural effects. Consequently, distinguishing between changes in *Z_w* that result from deliberate management actions and those that occur due to arithmetic adjustments in its components becomes challenging. By choosing *MAC_3* as the dependent variable, we explicitly capture the endogeneity of capital. The variable *Z_w*, estimated in Section 4, is an important input, as it allows us to proxy for the distance between available and target capital. Banks that are further below their target capital ratio are more capital constrained which can have an impact on management action on capital. Section 5.3.2 introduces an additional equation in a simultaneous-equations model framework that captures the impact of *MAC_3* on different items on the asset side of banks' balance sheets.

5.3.1 What determines management action on capital? (Single-equation approach)

The regression model specified in equation (5.1) aims to explain a bank's *MAC_3* by (a) its potential capital constraints, (b) the change in its risk density, (c) its profitability, (d) a bank-specific distress dummy and (e) the respective balance sheet items on the asset side (equation 5.1). Our main hypothesis is that the growth rate of various balance sheet items is systematically and significantly positively associated with management action on capital. The coefficient $\beta_{M,j}$ in equation 5.1 is significantly positive. However, it is important to note that the single-equation approach can lead to biased and inconsistent coefficient estimates for the right-hand side variables affected by *MAC_3*, due to the use of contemporaneous values. This simultaneity bias is a limitation of the single-equation approach and justifies the use of a simultaneous-equations approach, which we will employ in section 5.3.2. The regression model for the single-equation approach is equation (5.1):

$$MAC\_3\_CET1\_w_{b,t} = \gamma_{M,j} + \beta_{M,j} LOG\_BS\_w_{j,b,t} + \tau_{M1,j} L.Z\_w_{b,t} + \tau_{M2,j} RD\_D\_w_{b,t} + \tau_{M3,j} ROA\_w_{b,t} + \tau_{M4,j} s\_prof\_neg_{b,t} + \epsilon_{j,b,t} \qquad (5.1)$$

The dependent variable *MAC_3_CET1* is defined as *MAC_3* for CET1 capital and is winsorised at the 1% and 99% levels to *MAC_3_CET1_w*. In the econometric analysis, we also include observations *without* management action on capital. Otherwise, we would not be able to test our main hypothesis. The values of the dependent variable for these observations are the changes of *CET1* between *t* and *t-1* where management action on capital is 0. However, we also estimated the main specification in Table 11 for the smaller subset of all observations which actually feature management action on capital. The lagged value of the gap between the bank's capital ratio and its target ratio (*L.Z*_w) measures its potential capital constraint. Bank capital targets are estimated in Section 4 (using a partial adjustment model). The change in risk density (*RD_D_w*) is the winsorised first difference of the variable RD, which is the ratio of risk-weighted assets over total accounting assets. The profitability of the bank is measured by its Return on Assets (*ROA_w*) in period t. The variable *s_prof_neg* is a dummy variable defined as 1 in a period of bank-specific distress (according to the definition *s_prof_neg* in Table 9 in Section 5.2) and 0 otherwise.

We test for the impact of the growth rate of several balance sheet items on the asset side (*LOG_BS_D_w*) on management action on capital: (1) risk weighted assets (*LOG_RWA_D_w*), (2) total accounting assets (*LOG_ASSETS_D_w*), (3) lending to the non-financial sector (corporates, retail and sovereigns) (*LOG_LENDING_NF_D_w*), (4) lending to non-financial corporates (*LOG_NFC_D_w*), (5) lending to the non-financial private sector (retail lending and NFC) (*LOG_RETAILNFC_D_w*), (6) other exposure (eg equity and other non-credit obligation assets) (*LOG_OthExp_D_w*), (7) total trading book exposures (*LOG_TBExp_D_w*), (8) total leverage ratio exposures (*LOG_LRExp_D_w*), (9) sovereign exposure [55] (*LOG_SovExp_D_w*), (10) retail exposure [56] (*LOG_RetExp_D_w*) and (11) corporate exposure [57] (*LOG_CorpExp_D_w*). For the descriptive statistics and the correlations of all variables in Sections 5.2 and 5.3, see Table A3.1 to Table A3. in the appendix.

We estimate a fixed-effects panel regression model. The sample period is H2 2013 to H2 2019. However, due to the use of lagged variables in the regression, the dependent variable is derived from H1 2014 to H2 2019. The results are reported in Table 11 in columns (1) to (11) for each of the balance sheet items on the asset side. Standard errors are cluster-robust with country clusters. Column (12) reports the results for column (1) without the *RD_D_w* as robustness check for (1).

55 Sovereign exposures include public sector entities (PSEs), PSEs guaranteed by sovereigns, PSEs not guaranteed by sovereigns, MDBs and other sovereign exposure.

56 Retail exposure includes residential real estate, exposures to small and medium enterprises (SME), qualifying revolving retail exposures and other retail exposure.

57 Corporate exposure includes non-financial and financial corporates, SME exposures, commercial real estate and other corporate non-financial exposure.

Regression results for the determinants of management action on capital – dependent variable *MAC_3_CET1_w* Table 11

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
L.Z_w	**-0.000959*** **	**-0.000928*** **	**-0.000798*** **	**-0.000756*** **	**-0.000746*** **	**-0.000818*** **	**-0.000777*** **	**-0.000878*** **	**-0.000796*** **	**-0.000775*** **	**-0.000749*** **	**-0.00103*** **
	(0.000129)	(0.000138)	(0.000174)	(0.000187)	(0.000184)	(0.000180)	(0.000168)	(0.000205)	(0.000174)	(0.000186)	(0.000170)	(0.000121)
RD_D_w	**-0.442*** **	**0.716*** **	**0.234** **	**0.211* **	0.180	0.205	**0.310** **	0.162	**0.226* **	**0.174* **	0.183	
	(0.108)	(0.107)	(0.101)	(0.105)	(0.107)	(0.121)	(0.120)	(0.117)	(0.121)	(0.102)	(0.111)	
ROA_w	**-5.318*** **	**-5.627*** **	**-5.138*** **	**-4.172*** **	**-4.765*** **	**-4.124*** **	**-5.252*** **	**-3.103** **	**-4.879*** **	**-3.837*** **	**-4.819*** **	**-5.430*** **
	(1.210)	(1.115)	(1.400)	(1.226)	(1.266)	(1.410)	(1.404)	(1.245)	(1.366)	(1.348)	(1.252)	(1.174)
s_prof_neg	**0.0445** **	**0.0405** **	**0.0389** **	**0.0451*** **	**0.0420*** **	0.0321	**0.0402** **	**0.0425* **	0.0313	**0.0418** **	**0.0412** **	**0.0409** **
	(0.0167)	(0.0166)	(0.0162)	(0.0143)	(0.0143)	(0.0240)	(0.0168)	(0.0224)	(0.0195)	(0.0172)	(0.0151)	(0.0163)
LOG_RWA_D_w	**0.633*** **											**0.553*** **
	(0.0600)											(0.0579)
LOG_ASSETS_D_w		**0.616*** **										
		(0.0759)										
LOG_LENDING_NF_D_w			**0.128*** **									
			(0.0359)									
LOG_NFC_D_w				**0.0449** **								
				(0.0200)								
LOG_RETAILNFC_D_w					**0.0954*** **							
					(0.0276)							
LOG_OthExp_D_w						**0.0174** **						
						(0.00824)						
LOG_LRExp_D_w							**0.269*** **					
							(0.0594)					
LOG_TBExp_D_w								0.00216				
								(0.00442)				
LOG_SovExp_D_w									0.0217			
									(0.0169)			
LOG_RetExp_D_w										**0.0871*** **		
										(0.0303)		
LOG_CorpExp_D_w											**0.0679*** **	
											(0.0199)	
Constant	-0.00315	-0.00137	0.00262	0.000183	0.00188	0.000470	0.00303	-0.00426	0.00346	-0.00147	0.00277	-0.00118
	(0.00483)	(0.00447)	(0.00516)	(0.00466)	(0.00481)	(0.00539)	(0.00548)	(0.00524)	(0.00510)	(0.00523)	(0.00473)	(0.00446)
Observations	1,272	1,272	1,259	1,227	1,250	1,234	1,263	985	1,250	1,180	1,259	1,272
Banks	158	158	158	155	157	157	158	127	157	149	158	158
Countries	26	26	26	26	26	26	26	26	26	26	26	26
Degree of freedom	24	24	24	24	24	24	24	24	24	24	24	24
r2 overall	0.408	0.388	0.167	0.129	0.148	0.119	0.210	0.119	0.120	0.145	0.141	0.384
r2 within	0.388	0.371	0.108	0.0785	0.100	0.0706	0.181	0.0537	0.0613	0.0923	0.0941	0.359
r2 between	0.453	0.439	0.487	0.411	0.407	0.344	0.202	0.338	0.364	0.360	0.353	0.472

The results reported in Table 11 show that management action on capital is significantly higher for banks that are more capital constrained at the beginning of the period, ie those with a greater shortfall relative to their target capital ratio (*L.Z_w*). This result is robust across all specifications involving different balance sheet items. The average deviation from the target across banks and time is -4.78% (Table 4). Hence, if a bank's gap to its target is one percentage point lower, ie only -3.78%, its management action on capital relative to CET1 is between 8 and 10 basis points lower across specifications, ceteris paribus. As management action on capital is costly, banks undertake it only when and to the extent needed.

When combined with the growth rate of risk weighted assets (column 1 of Table 11), the coefficient estimate of the change in risk density (*RD_D_w*) is significantly negative. Summary statistics show that the average *RD_D* is about -0.0024 (-0.24 percentage points). Let us assume a decrease of the bank's risk density of 1 percentage point. This would affect management action on capital via two channels: directly via *RD_D_w* and indirectly via *LOG_RWA_D_w*. The direct effect would – somewhat counterintuitively – increase the bank's management action on capital by +0.442% of CET1 capital. However, that effect is overcompensated by the second one. Holding total assets constant, a reduction in risk density would imply a negative growth rate of RWAs. Here, the reduction of risk density would lead to a decrease in management action on capital by -0.633% of CET1 capital. Hence, the overall effect of a reduction of risk density (*RD_D_w*) by 1 percentage point is plausible, as it leads to a decrease of *MAC_3_CET1_w* by about 0.2% of CET1 capital. We re-estimated the specification on column (1) without *RD_D_w*. The results are included in Table 11 in column (12). Thew coefficient estimates of the target capital ratio (*L.Z_w*), profitability (*ROA_w*), shocks (*s_prof_neg*) remain basically unchanged; that of the growth of risk weighted assets (*LOG_RWA_D_w*) decreases to 0.553.

When combined with unweighted exposures – such as total assets growth, leverage ratio exposure growth, and growth rates of specific exposure categories (all without risk weighting) – a decrease in risk density significantly decreases management action on capital (columns 2, 3, 4, 7, 9 and 10). The effect is highest for *LOG_ASSETS_D_w* with a coefficient estimate of 0.7 (column 2). A decrease of risk density by 1 percentage point reduces management action on capital by 0.7% of CET1 capital. For other balance sheets items, such as lending to NFCs (column 4) or lending to the retail exposure (column 10), the effect is lower. A decrease in risk density by 1 percentage points reduces management action on capital by about 0.2% of CET1.

Higher profitability (*ROA_w*) significantly reduces management action on capital in all specifications. If a bank's return on assets increases by 10 basis points, eg from 1% to 1.10%, its management action on capital decreases by 53 basis points of CET1 in column (1). Banks that are highly profitable can fund growth through "normal" retained earnings and do not need to take costly management action on capital.

The coefficient estimate of the distress dummy (*s_prof_neg*) is significantly positive across most specifications, except columns (6) and (9).

Banks that grow, tend to increase capital to fund that growth. A higher growth rate of risk-weighted assets (*LOG_RWA_D_w*) is associated with significantly more management action on capital (column 1). An increase in the growth rate of RWAs by 1 percentage point increases management action on capital by 63 basis points of CET1 capital, assuming risk density is held constant (*RD_D_w* = 0). Holding risk density constant means that the increase in RWA is driven solely by total assets. Hence, the results should be comparable to those in column 2 for *LOG_ASSETS_D_w*. The coefficient estimate of *LOG_ASSETS_D_w* is significant, meaning that an increase in the growth rate of assets by 1 percentage point increases management action by 62 basis points.

The coefficient estimate for total exposure (*LOG_LRExp_D_w*) (column 7) is significant as well, but about 50% lower than that for *LOG_ASSETS_D_w*. The estimated coefficients for the following balance sheet items are also significant: lending to the non-financial sector (*LOG_LENDING_NF_D_w*) (column 3), to non-financial corporates (*LOG_NFC_D_w*) (column 4) and to the private non-financial sector

(*LOG_RETAILNFC_D_w*) (column 5), other exposures (*LOG_OthExp_D_w*) (column 6), retail exposures (*LOG_RetExp_D_w*) (column 10) and corporate exposures (*LOG_CorpExp_D_w*) (column 11). For these balance sheet items, the coefficients are much lower than for total assets, ranging from 0.2 to 0.13. We attribute this to compositional effects, ie an increase in retail lending (column 10) might be accompanied by a decrease in other balance sheet components, thereby increasing RWAs less than proportionally.

The explanatory power (overall R^2s) of the model is highest for the most comprehensive balance sheet components: risk-weighted assets (RWA, column 1) and totals assets (column 2). Notably, the within R^2s for the smaller components of bank balance sheets are much lower. We attribute this to compositional effects where the impact of the growth of one component on capitalisation may be offset by a decrease of others. For the between R^2s, the picture is different. Except for leverage ratio exposure (column 8), the between R^2 are similar to those reported in columns 1 and 2.

We conducted the following robustness checks with the results reported in Appendix 4 in Table A4.1 to Table A4.8):

1. Alternative measure of capital constraint (Table A4.1): A bank's shortfall/surplus relative to its target capital ratio (*L.Z_w*) is based on the estimated target CET1 ratio. We replace *L.Z_w* with the lagged observed CET1 ratio *L_CET1r_RWA_w* as proxy for capital constraints. The results are reported in Table A4.1 in Appendix 4. The estimated coefficients for the main variables – the balance sheet components – are very similar. Except, that they become significantly positive for sovereign exposures (*LOG_SovExp_D_w*), too. The estimated coefficients of changes of risk density (*RD_D_w*) are now significant for all balance sheet components (versus seven out of 11 in main specification). They are also somewhat higher. The coefficient estimates of profitability (*ROA_w*) are broadly in line with the main specification but are somewhat higher, too. The estimated coefficients of the distress variable *s_prof_neg* remain significant for the most comprehensive balance sheet items RWA, total assets and leverage ratio exposure (columns 1, 2 and 7). The within R^2s are very similar to the main specification. The between R^2s are lower for all balance sheet items which suggests that *L.Z_w* is a better proxy for capital constraints across banks and banking systems.

2. We then replace the distress dummy variable *s_prof_neg* with a continuous distress index *Distress_I_sqd_pct* (for its construction see Table 8 in Section 5.2). The results are reported in Table A4.2 in Appendix 4. The estimated coefficients for the balance sheet components are basically identical. The results for *L.Z_w* remain significant but are somewhat lower throughout. Those for *RD_D_w* hardly change. Those of *ROA_w* are again significant for all balance sheet items and are marginally higher. The estimated coefficients of the new distress variable *Distress_I_sqd_pct* are insignificant for all balance sheet components. The overall R^2s remain broadly unchanged. As further robustness check we included an interaction variable for growth constrains (*Growth_c_w*) which is the interaction term between *L.Z_w* and *LOG_RWA_D_w*. The coefficient is significantly negative (-0.00252) for the respective balance sheet item RWAs. That suggests that banks that feature higher RWA growth and are further below their CET1 target take more management action on capital. The coefficient estimates of all other variables remain unchanged as does the R^2. The interaction term is insignificant for all other balance sheet items.

   The robustness checks for the variables *L_CET1r_RWA_w* and *Distress_I_sqd_pct* show that the results are robust.

3. In addition, we estimated the main specification in Tabell 11 for a subset of observations (results available upon request); namely, only observations with management action on capital. That reduces the number of observations by about one-third. The results are broadly similar. The coefficient estimates of the balance sheet items are almost identical, except that the one for sovereign exposure becomes significant as well. The coefficient estimates for *L.Z_w* are significant for all balance sheet items and of almost identical magnitude. The coefficient estimates for

RD_D_w are significant for the three comprehensive balance sheet items only (RWA, total assets and leverage exposure). The coefficient estimates for *ROA_w* are significant for all balance sheet items and somewhat higher than for the broader sample of observations. The distress variable *s_prof_neg* is significant for seven out of 11 balance sheet items (versus nine out of 11 in Table 11).

The next set of robustness checks focuses on regression results for several subsamples of our entire QIS bank sample.

4. We estimate all models for the subsamples of large, internationally active banks (Group 1) and smaller banks (Group 2). The results are reported in Table A4.3 and Table A4.4 in Appendix 4.

For Group 1 banks, the estimated coefficients of *L.Z_w* are broadly unchanged. Banks with tighter capital constraints take more management action on capital. Changes in risk density (*RD_D_w*) are less important than for the overall sample. They are significant for growth of RWAs (*LOG_RWA_D_w*) and total assets (*LOG_ASSETS_D*_w) (columns 1 and 2), but not for the other balance sheet items (two out of 11). In the full sample, they are significant for seven out of 11 balance sheet items. For the *ROA_w* and *s_prof_neg* the results are broadly unchanged. The coefficient estimates of the balance sheets items yield the same results for all but for other exposure (*LOG_OthExp_D_w)*) and lending to the non-financial corporates (*LOG_NFC_D_w*) (columns 4 and 6) which cease to be significant. The R^2 are higher than for the full sample of all banks with values around 50% for RWAs and total assets (columns 1 and 2).

For Group 2 banks, the estimated coefficients of *L.Z_w* are broadly unchanged, except that they are now much higher for the growth rate of the trading book (*LOG_TBExp_D_w*, column 4). Changes of risk density play a more important role than in the entire sample. The coefficient estimate is now significant in 11 out 11 cases (rather than seven out of 11). Profitability is less important, as it is significant in 2 out of 11 cases (versus 11 out of 11 in the full sample). The distress dummy *s_prof_neg* is now significant for all balance sheet items and roughly twice as high as in the full sample. The estimated coefficients of the balance sheet items are broadly unchanged. The R^2 are lower than for the full sample of all banks with values around 30% for RWAs and total assets (columns 1 and 2).

Comparing the results for Group 1 and Group 2 banks yields the following results. The estimated coefficients of capital constraints *L.Z_w* are lower for Group 1 banks. Changes of risk density have less of an effect for Group 1 banks, while return on assets has a more pronounced impact on their management action on capital. The estimated coefficients of the balance sheet items are broadly similar (with the above-mentioned exceptions). While shocks have positive effects on management action on capital for both groups, the magnitude is higher for Group 2 banks. The R^2 are higher for Group 1 than for Group 2 banks.

The main results are robust across Group 1 and Group 2 banks, especially for risk weighted assets (*LOG_RWA_D_w*) and total assets (*LOG_ASSETS_D*_w).

5. We then estimate the specifications for the subsamples of EU banks and banks in the Rest of the World and the Americas (RWAM). Combining the Rest of the World and the Americas yields a sample size that is broadly comparable with that of the EU banks.

For EU banks (Table A4.5), the estimated coefficients of *L.Z_w* are broadly unchanged compared to the overall sample. Changes of risk density (*RD_D_w*) play a more important role; 10 out of 11 are significant (versus seven out of 11 for the full sample). However, for RWAs it ceases to be significant. The coefficient estimates are higher, too. Profitability is significant for all balance sheet items, but the coefficients higher. The coefficient estimates of the various balance sheet items are lower, except that of sovereign exposure (*LOG_SovExp_D_w*) which becomes significant while that of non-financial corporate lending *(LOG_NFC_D_w*) ceases to be significant (columns 4 and 9). The distress dummy is significant for all balance sheet items. The R^2 are lower for the most comprehensive balance sheet items, but somewhat higher for the others than in the sample of all banks.

For RWAM banks (Table A4.6), the estimated coefficients of *L.Z_w* are broadly unchanged. Changes in risk density (two out of 11 are significant) play less of a role compared to the full sample (seven out of 11). They are significant and have similar levels for risk weighted assets (*LOG_RWA_D_w*) and total assets (*LOG_ASSETS_D_w*). The coefficient estimates for profitability (*ROA_w*) are somewhat lower but remain significant for all balance sheet items. The distress dummy is significant for only three out of 11 balance sheet items (RWAs, total assets and corporate exposure, columns 1, 2 and 11). For RWAs and total assets, the R^2 are also higher than in the sample of all banks and in the EU sample.

The differences between the Europe and the RWAM samples are pronounced. Changes of risk density and profitability are more important in the EU (10 and 2, respectively, out of 11) versus the RWAM sample (2 and 10, respectively, out of 11). While distress is significantly positive for all balance sheet items in the EU, it is significantly positive in the RWAM sample for 3 balance sheet items only. The estimated coefficients of the various balance sheet items are much lower in the EU than for RWAM banks. For example, for the risk weighted assets and total assets they are 0.373 and 0.367 in the EU, but 0.743 and 0.771 for RWAM banks.

The main results are robust across Europe and RWAM banks, especially for risk weighted assets (*LOG_RWA_D_w*) and total assets (*LOG_ASSETS_D_w*).

6. The comprehensive measure of management action on capital is appropriate for the reasons highlighted in Section 5.1. However, to check for robustness, we also estimate all regression specifications using two narrow measures of management action on capital, *MAC_1L_w* and *MAC_2_w*. For these, a significant number of observations are 0. In many semesters, banks neither issue capital nor substantially adjust from their pay-out policies. The low volatility leads to problems in the econometric analysis. Hence, we restrict the sample for these two dependent variables to periods with non-zero management action on capital.

For *MAC_1L_w* (Table A4.7), the explanatory value of the model is basically nil. Capital constraints and changes of risk density play no role (0 out of 12) as determinants of management action on capital. Profitability is significantly positive for four balance sheet items. The distress dummy is not significant. Also, the estimated coefficients of the various balance sheet items are mostly insignificant. They are significantly positive but very small for two balance sheet items (sovereign exposure (*LOG_SovExp_D_w*) and leverage ratio exposure (*LOG_LRExp_D_w*)). The goodness of fit is low with R^2s close to 0%.

For *MAC_2_w* (Table A4.8), the results are similar to those using *MAC_1L_w* as the dependent variable. The estimated coefficients of *L.Z_w* are insignificant. Risk density is significant in one out of 11 balance sheet items. Profitability is significantly positive for five balance sheet items. Distress is not significant. Also, the estimated coefficients of the various balance sheet items are mostly insignificant. They become significantly positive for sovereign exposure (*LOG_SovExp_D_w*) and significantly negative for retail exposure (*LOG_RetExp_D_w*). The goodness of fit is low with R^2s below 1%.

Furthermore, we estimated the coefficients also for the subsample of all observations with positive *MAC_1L_w* and *MAC_2_w* (results available upon request). For the former, the results remain basically unchanged. For the latter, *L.Z_w* is now significantly negative for all balance sheet items and risk density is significantly positive for six out of 11 balance sheet items including RWAs, total assets and leverage exposure.

We conclude that for narrow measures of management action on capital higher the growth rates of balance sheet items are insignificant.

The single-equation approach shows that we cannot reject our main hypothesis. The growth rate of several balance sheet items, particularly risk weighted assets, is systematically and significantly positively associated with management action on capital for the comprehensive measure of management action on capital. Banks that encounter profitable growth opportunities undertake more management action on capital. The single-equation approach does not allow for the determining the direction of causation. Either banks that take management action on capital grow more, or banks that grow more take more management action on capital. We employ a simultaneous-equations approach in Section 5.3.2 to account for the potential simultaneity of management action on capital and RWA growth.

The main results using the single-equation approach are robust across several proxies for capital constraints and distress, as well as across several subsamples. Specifically, banks with tighter capital constraints, higher increases of risk density and lower profitability take more management action on capital. Banks under distress take more management action on capital. As in the univariate analysis in Section 5.2, the hypothesis that it is always impossible for banks to take management action on capital under distress is rejected.

5.3.2 The endogeneity of capital and RWA growth (simultaneous-equations approach)

In this section, we take the endogeneity of management action on capital and RWA growth into account and study the issue within a simultaneous-equations model presented in equation (5.2). Based on the results of the main specification (with the independent variable *LOG_RWA_D_w*) in the single-equation approach, we introduce a second equation that models the impact of management action on the growth of RWAs. Our main hypothesis is that the growth rate of RWAs is systematically and significantly positively associated with management action on capital and that management action on capital is systematically and significantly positively associated with the growth rate of RWAs. The coefficients $\beta_{M,j}$ and $\beta_{BS,j}$ in equation 5.2 are significantly positive.

$$MAC\_3\_CET1\_w_{b,t} = \gamma_M + \beta_M LOG\_RWA\_D\_w_{b,t} + \tau_{M1} L.Z\_w_{b,t} + \tau_{M2} RD\_D\_w_{b,t} + \tau_{M3j} s\_prof\_neg_{b,t} + \tau_{M4} ROA\_w_{b,t} + \epsilon_{b,t}$$

$$LOG\_RWA\_D\_w_{b,t} = \gamma_{BS} + \beta_{BS} MAC\_3\_CET1\_w_{b,t} + \tau_{BS1} L.LOG\_RWA\_D\_w_{b,t} + \tau_{BS2} L.Z\_w_{b,t} + \tau_{BS3} TRADINGBOOK\_TA\_w_{b,t} + \tau_{BS4} LCR\_w_{b,t} + \tau_{BS5} RGDP\_HP\_D_{c,t} + \tau_{BS6} YC\_SLOPE\_noi\_w_{c,t} + \tau_{BS7} CDS5Y\_D\_w_{c,t} + \Theta_{b,t} \qquad (5.2)$$

Regression results for a simultaneous-equations system with the dependent variables *LOG_RWA_D_w* (growth rate of RWAs) and *MAC_3_CET1_w* (management action on capital)

Table 12

	(1)		(2)		(3)	
VARIABLES	LOG_RWA_D_w	MAC_3_CET1_w	LOG_RWA_D_w	MAC_3_CET1_w	LOG_RWA_D_w	MAC_3_CET1_w
MAC_3_CET1_w	**0.674*** **		**0.558*** **		**0.465*** **	
	(0.0967)		(0.0908)		(0.0814)	
L.Z_w	**0.00116*** **	**-0.00133*** **	**0.00118*** **	**-0.00143*** **		
	(0.000126)	(0.000113)	(0.000130)	(0.000113)		
L.LOG_RWA_D_w	0.000849		0.00155		0.0427**	
	(0.0152)		(0.0175)		(0.0205)	
RGDP_HP_D	0.0647		-0.0599		0.149	
	(0.149)		(0.167)		(0.194)	
TRADINGBOOK_TA_w	-0.0139		-0.0230**		-0.0256**	
	(0.00928)		(0.0104)		(0.0111)	
LCR_w	-0.000804		-0.000973		-0.00311***	
	(0.000886)		(0.000872)		(0.00107)	
CDS5Y_D_w	**-0.000180** **		**-0.000250*** **		**-0.000394*** **	
	(8.21e-05)		(7.94e-05)		(8.87e-05)	
YC_SLOPE_noi_w	-0.234		**-0.435** **		**-0.440** **	
	(0.200)		(0.199)		(0.176)	
LOG_RWA_D_w		**1.040*** **		**0.960*** **		**0.704*** **
		(0.104)		(0.106)		(0.105)
RD_D_w		-0.116		-0.0647		0.0971
		(0.135)		(0.139)		(0.138)
ROA_w		**-2.781*** **		**-3.102*** **		**-5.004*** **
		(0.564)		(0.562)		(0.612)
Distress_I_sqd_pct		-0.0103				
		(0.0188)				
s_prof_neg				**0.0254** **		0.0107
				(0.0107)		(0.0125)
L.CET1r_RWA_w					**0.257*** **	**-0.289*** **
					(0.0509)	(0.0444)
Constant	0.0229***	-0.0108	0.0243***	-0.0137***	-0.0140*	0.0426***
	(0.00345)	(0.00992)	(0.00361)	(0.00275)	(0.00755)	(0.00674)
Observations	965	965	996	996	1,105	1,105
R-squared	0.348	0.215	0.339	0.273	0.305	0.338
Small-sample statistics	Yes	Yes	Yes	Yes	Yes	Yes
Banks	128	128	129	129	129	129
Countries	16	16	16	16	16	16
F statistic (eq1)	29.59		26.90		20.87	
F statistic (eq2)		142.2		115.7		75.29
Log likelihood	3898	3898	3582	3582	3467	3467
Parameters	15	15	15	15	15	15
Degrees of freedom	1915	1915	1977	1977	2195	2195

Table 12, column (2) reports the results for the main specification that we also applied in producing the results reported in Table 11, column (1). Additionally, the table presents the results for two robustness tests. In in column (1), the distress index *Distress_I_sqd_pct* replaces the dummy variable *s_prof_neg*; in column (3), the observed variable *L.CET1r_RWA* replaces the estimated one (*L.Z_w*) as a measure of capital constraints.

The regression for the determinants of *MAC_3_CET1_w* in column (2) yields very similar results as that in Table 11, column (1). The first part of our main hypothesis is not rejected: the coefficient β_M of *LOG_RWA_D_w* is significantly positive. The estimated coefficients of *L.Z_w* and *ROA_w* are significantly negative. The distress dummy is significantly positive. The change in risk density (*RD_D_w*) is no longer significant. The coefficient estimate of *LOG_RWA_D_w* remains significantly positive but is higher with a value of 1.04 (compared to 0.633 in Table 11). The R^2 is lower. The orthogonality condition holds, meaning that the change in risk density, profitability and bank-specific distress directly affect management action on capital and only impact the growth rate of RWAs through their influence on management action on capital.

These results suggest that banks which encounter profitable growth opportunities take the necessary management action on capital to fund that growth. Conversely, banks that are less capital constrained take less action on capital, as do banks that are more profitable. The latter can fund higher growth out of "normal" retained earnings (reflecting a "do nothing" strategy discussed in Section 5.1). The F statistics indicate that the model adequately captures the relationships between the variables. Its value of 115.7 for the second equation suggests that the regression specification is well-suited. We also estimated the MAC_3_CET1_w equation with the interaction term *Growth_c_w* (*L.Z_w*LOG_RWA_D_w*). The estimated coefficient is insignificant while the other coefficient estimates remain broadly unchanged (results available upon request).

The regression for the determinants of the growth rate of RWAs (*LOG_RWA_D_w*) includes several bank-specific variables, such as the measure of capital constraints (*L.Z_w*) and the share of the trading book in total assets (*TRADINGBOOK_TA_w*). The latter captures alternative, profitable investment opportunities or hedging activities. Higher liquidity as measured by the LCR indicates a lack of profitable growth opportunities, as it suggests an allocation of deposit inflows to safer but lower-yielding High-Quality Liquid Assets (HQLA).[58]

We control for aggregate demand for bank assets by including the change in the Hoddrick-Prescott-filtered real GDP (*RGDP_HP_D*), the slope of the yield curve (*YC_SLOPE_noi_w*), the lagged dependent variable (*L.LOG_RWA_D_w*) and the change of the five-year CDS spread of the country in which the bank is headquartered (*CDS5Y_D_w*). Higher economic growth is associated with higher loan demand. A steeper yield curve implies that longer-term rates are higher relative to short-term rates, likely increasing the financing costs for longer-term investments and decreasing the demand for loans to fund them. Furthermore, the change of the five-year CDS spread reflects market perception of the macro risk of the country in which the bank is headquartered. Higher macro risk can be associated with lower investment and demand for bank assets. In addition, higher sovereign risk often translates into higher marginal bank funding costs. Banks that face higher marginal funding costs are likely to charge higher internal fund transfer prices. Hence, they are likely to charge more for assets, which also affects demand for its assets. Finally, we include the other endogenous variable in the system of equations, the management action on capital (*MAC_3_CET1_w*). The orthogonality condition holds, meaning that the variables controlling for aggregate demand directly affect the growth rate of RWAs, as do the LCR and the share of the trading book in total assets. These variables impact management action on capital only through their influence on the growth rate of RWAs.

[58] Note that throughout the sample period, LCRs were generally well above the regulatory minima.

The main result is that the second dependent variable, *MAC_3_CET1_w,* is significantly positive. The second part of our main hypothesis is not rejected: the coefficient β_{BS} of *MAC_3_CET1_w* is significantly positive. Banks that take more management action on capital exhibit higher growth in risk-weighted assets (RWA). The measure of capital constraints is also significantly positive, indicating that banks with a smaller gap to their target can grow more. An increase of the country CDS spread (*CDS5Y_D_w*) decreases the RWA growth rate. The coefficient estimate of the share of the trading book in total assets is significantly negative. A flatter yield curve increases RWA growth. Real GDP growth, the LCR and the lagged growth rate of RWAs do not exhibit significant estimated coefficients. The F test (eq 1) of 26.90 suggests that the specification is reasonable.

As in Section 5.3.1, we conduct a similar set of robustness checks:

1. The measure of capital constraints (*L.Z_w*) is estimated in Section 4. To check for the robustness of the results, we replace it by the observed variable lagged CET1 ratio (*L.CET1r_RWA_w*).

   The results for *MAC_3_CET1_w* reported in column (3) of Table 12 are similar to those in column (2). The estimated coefficients of capital constraints (*L.CET1r_RWA_w*) and profitability (*ROA_w*) are significantly negative. The change in risk density (*RD_D_w*) remains insignificant. The distress dummy is now insignificant. The coefficient estimate of *LOG_RWA_D_w* remains significantly positive.

   The results for *LOG_RWA_D_w* in column (2) confirm the main result that banks that take more management action on capital can grow RWAs more. Banks with a higher CET1 ratio, a lower share of the trading book, lower funding costs and lower LCRs also grow more. Higher RWA growth in the previous period and a flatter yield curve increase RWA growth.

2. We replace the distress measure *s_prof_neg* with the continuous distress index *Distress_I_sqd_pct* in column (1).

   The results for *MAC_3_CET1_w* reported in column (1) of Table 12 confirm those in column (2) in terms of significance and magnitude. *Distress_I_sqd_pct* is not significant, though. Banks in distress find it no more difficult to take management action on capital than other banks. The results for *LOG_RWA_D_w* in column (1) are very similar than those in column (2).

3. As in Section 5.3.1, we estimated the equations in Table 12 for the subset of observations with management action on capital different from 0, only (results available upon request). The estimated coefficients are almost identical across all three columns.

4. We then estimate the same simultaneous-equations system for the subsamples of large, internationally active banks (Group 1) and smaller banks (Group 2), as well as for banks in Europe (EU) and the Rest of the World and the Americas (RWAM). Results are presented in Table 13.

Regression results for a simultaneous-equations system with the dependent variables *LOG_RWA_D_w* (growth rate of RWAs) and *MAC_3_CET1_w* (management action on capital) for subsamples of the full sample [Group 1 (1), Group 2 (2), EU (3) and RWAM (4)] Table 13

	(1)		(2)		(3)		(4)	
VARIABLES	LOG_RWA_D_w	MAC_3_CET1_w	LOG_RWA_D_w	MAC_3_CET1_w	LOG_RWA_D_w	MAC_3_CET1_w	LOG_RWA_D_w	MAC_3_CET1_w
MAC_3_CET1_w	**0.235****		**1.142*****		**0.583*****		**0.567*****	
	(0.117)		(0.184)		(0.103)		(0.196)	
L.Z_w	**0.000654*****	**-0.00105*****	**0.00234*****	**-0.00194*****	**0.00151*****	**-0.00147*****	**0.000883*****	**-0.00120*****
	(0.000157)	(0.000131)	(0.000321)	(0.000304)	(0.000173)	(0.000174)	(0.000214)	(0.000143)
L.LOG_RWA_D_w	0.00493		-0.00932		-0.00430		-0.00692	
	(0.0247)		(0.0442)		(0.0320)		(0.0187)	
RGDP_HP_D	-0.169		0.520		**-1.345****		0.00344	
	(0.216)		(0.727)		(0.651)		(0.142)	
TRADINGBOOK_TA_w	**-0.0305****		0.00224		**-0.0676*****		-0.0126	
	(0.0129)		(0.0317)		(0.0246)		(0.0107)	
LCR_w	-0.00515		0.000115		-0.00144		0.000886	
	(0.00465)		(0.00134)		(0.00105)		(0.00273)	
CDS5Y_D_w	**-0.000538*****		-1.88e-05		-0.000148		**-0.000296***	
	(0.000123)		(0.000104)		(9.14e-05)		(0.000156)	
YC_SLOPE_noi_w	**-0.673****		0.0879		**-1.051*****		-0.0787	
	(0.276)		(0.443)		(0.344)		(0.352)	
LOG_RWA_D_w		**1.102*****		**0.913****		**0.708*****		**1.124*****
		(0.105)		(0.366)		(0.146)		(0.132)
RD_D_w		**-0.310****		-0.255		0.247		-0.211
		(0.126)		(0.578)		(0.207)		(0.160)
ROA_w		**-5.534*****		-1.536		**-4.882*****		**-2.318*****
		(0.799)		(0.999)		(1.004)		(0.656)
s_prof_neg		**0.0288****		0.0238		0.0185		0.0213
		(0.0143)		(0.0183)		(0.0153)		(0.0131)
Constant	0.0271***	-0.00686*	0.0212*	-0.0193***	0.0417***	-0.00936**	0.0201***	-0.0185***
	(0.00801)	(0.00369)	(0.0112)	(0.00536)	(0.00880)	(0.00389)	(0.00520)	(0.00404)
Observations	713	713	283	283	433	433	563	563
R-squared	0.289	0.310	-0.191	0.176	0.204	0.193	0.441	0.344
Small-sample statistics	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Banks	86	86	43	43	60	60	69	69
Countries	15	15	11	11	7	7	9	9
F statistic (eq1)	13.97		10.66		19.04		10.54	
F statistic (eq2)		57.77		46.61		59.34		81.04
Log likelihood	2324	2324	1297	1297	1503	1503	2187	2187
Parameters	15	15	15	15	15	15	15	15
Degrees of freedom	1411	1411	551	551	851	851	1111	1111

The results for the Group 1 sample are reported in Table 13, column (1). The main coefficients of *MAC_3_CET1_w* and *LOG_RWA_D_w* remain significantly positive. The former is lower for Group 1 banks than for the full sample; the latter is of similar magnitude. For *MAC_3_CET1_w*, the other coefficient estimates are also similar to those in Table 12, column (2) in terms of significance and magnitude. The coefficient estimate of *L.Z_w* is also of similar magnitude, while that of *ROA_w* is higher. The slope of the yield curve (*YC_SLOPE_noi_w*) remains significantly negative. So does the change of the CDS spread (*CDS5Y_D_w*), but with a higher coefficient estimate. The distress dummy remains significantly positive.

The results for the Group 2 sample are reported in Table 13, column (2). Again, the main coefficients of *MAC_3_CET1_w* and *LOG_RWA_D_w* remain significantly positive. The former is higher for Group 2 banks than for the full sample; the latter is of similar magnitude. For *MAC_3_CET1_w*, the coefficient of capital constraints (*L.Z_w*) remains significant but higher than for Group 1 banks. The other bank-specific variables – *RD_D_w*, *ROA_w* and the distress dummy are not significant anymore. For *LOG_RWA_D_w*, the coefficient of *L.Z_w* is significant and much higher than in Table 12, column (2). The R^2 for the RWA equation is negative which might be due to the lower number of observations.

For the European sample (Table 13 column 3), the coefficients are similar to those in Table 12 (2). Again, the main coefficients of *MAC_3_CET1_w* and *LOG_RWA_D_w* remain significantly positive and of similar magnitude. In the MAC_3_CET1_w equation, the coefficients of *L.Z_w* and of *ROA_w* remain significant. In the RWA equation, higher real GDP growth, a higher trading book share in total assets and a steeper yield curve reduce RWA growth. The distress dummy is not significant.

For the RWAM sample (column 4), the main results hold as well: more management action on capital is associated with higher RWA growth and the growth of RWAs is an important determinant of management action on capital. The coefficients of *MAC_3_CET1_w* and of *LOG_RWA_D_w* are similar in magnitude to Table 12 column (2). The estimated coefficients for *CDS5Y_D_w* and the yield curve are no longer significant. The distress dummy is not significant.

5. Across the two equations as well as across most of the specifications and subsamples, the relative impact is plausible and consistent with the findings of a partial adjustment to capital targets in Section 4 (Partial adjustment model): management action on capital of about 100 basis points of CET1 can compensate for a capital shortfall vis-à-vis the bank's target of about 20 basis points at the end of the previous period (Table 12, column (2)). Yet, banks with larger shortfalls take more management action on capital. A 1% shortfall translates into management action on capital of about 14 basis points of CET1, but a higher growth rate of RWAs almost fully translates into higher management action on capital (with the coefficient of *LOG_RWA_D_w* in the vicinity of 1). Banks that face profitable growth opportunities, take management action on capital *and* accept temporary deviations from target, ie the adjustment to target remains partial. In the RWA equation, the ratios of the coefficients of *L.Z_w* and *MAC_3_CET1_w* in the RWA equation are quite stable in the vicinity of 4 to 5 (adjusted for the denomination of *MAC_3_CET1_w* in decimals versus *L.Z_w* in per cent) across all columns (in Table 12 and Table 13.

The results from the simultaneous-equations approach show that, in the full sample and across several robustness checks, our hypothesis is not rejected. Banks with higher RWA growth undertake more management action on capital and banks that take more management action on capital exhibit higher RWA growth. This result also is found to hold across two robustness checks and for the subsample of Group 1 banks and the regional subsamples (Europe versus RWAM). The results for the Group 2 banks might be somewhat less reliable, as the number of observations is lower.

5.4 Conclusions

The first main hypothesis claims that the growth rate of risk weighted assets is systematically and significantly positively associated with management action on capital. The single-equation approach does not reject this hypothesis for the comprehensive measure of management action on capital. Capital is found to be endogenous in the short run, in the sense that banks facing profitable growth opportunities undertake more management action on capital. Specifically, they do so more when they are more capital constrained. This main result is robust across several proxies for capital constraints and distress, as well as subsamples of banks. Banks with tighter capital constraints, higher increases of risk density (except for RWA growth), lower profitability and banks under distress engage in more management action on capital. However, the single-equation approach does not allow us to assess causal relationship between management action on capital and RWA growth. Hence, we test our hypotheses in a two-equation simultaneous- equations model.

The simultaneous-equations approach takes into account the simultaneity of management action on capital and RWA growth. It adds an equation on the feedback from management action on capital to RWA growth to the single-equation approach. The results for the equation with *MAC_3_CET1_w* as the dependent variable remain largely consistent with the single-equation approach. The second main hypothesis, which claims that banks that want or can grow assets more actively increase their CET1 capital, is not rejected. The results for the second equation with *LOG_RWA_D_w* as the dependent variable show that banks that take more management action on capital feature higher RWA growth. The result is found to be robust across alternative measures of capital constraints and distress and various subsamples.

The findings have profound implications for regulatory and supervisory policy. As management action on capital in period *t* is systematically and positively associated with higher RWA growth in period *t*, the assumption that banks cannot adjust their CET1 levels in the short run overstates the impact of increasing capital requirements on credit growth in the short run. The finding that banks that feature higher growth also take more management action on capital suggest that the associated between lagged CET1 ratios and RWA growth is subject to reverse causality. Banks that do not face profitable growth opportunities do not increase their CET1 levels rather being unable to grow because of capital constraints.

Nevertheless, our empirical analysis suggests that more research is required. First, more research is required on the measurement of management action on capital and its components. Our analysis and the literature suggest that banks use a broad set of tools to management capital. Hence, we use a comprehensive measure *MAC_3_CET1_w* as our dependent variable. Measures based on CET1, additional Tier 1 and Tier 2 capital issued are too narrow. They cannot account for changes of CET1 in most periods in our sample. Furthermore, the unexplained part of changes of CET1 are systematically related to distress periods (Table 10). In a companion paper (Da Rocha Lopes et al, forthcoming) we find that banks indeed use the re-allocation of the investment security holdings that fall under accounting measurement as Held-to-Maturity (HTM) or Amortised Cost (AC) securities as tools to manage capital. Alternative approaches to measure management action on capital could focus on the analysis of bank communication on management action on capital (eg quarterly reports).

Second, to better model bank asset growth, more data is needed to control for aggregate and bank-specific demand in the equation of RWA growth in the simultaneous-equations model. In particular, additional data on bank asset pricing (eg, loan rates) would enhance the robustness of the results. The nature of the quantitative impact study (QIS) data used in this study limits the options for linking the balance sheet dynamics of international banks to demand in various markets.

Third, the specification of the regression equation of management action on capital is very parsimonious in the sense that it includes only a limited number of variables. In particular, more data on regulatory and supervisory capital requirements, as well as observed bank-specific capital targets, would improve both measures of capital constraints we use. Forth, more data on bank asset quality would enhance the specification. A richer model would account for mergers and acquisitions. Finally, our sample contains a large set of banks from many different countries and 11 semesters of consecutive observations. A longer time series would improve the robustness of the results.

6. Summary and conclusions

The research presented in this report provides a comprehensive analysis of how banks manage their equity capital in the short run, particularly during periods of distress. The report investigates the endogeneity of bank capital and examines its effects on balance sheet management, specifically the asset and liability structure of banks. The findings challenge the conventional assumption in several papers cited in Appendix 1, Section A1.1 that bank capital is largely exogenous in the short run, meaning that banks cannot adjust their capital level in period *t* in response to distress, capital targets and/or growth opportunities in period *t*. In contrast, our findings highlight the active forward-looking role of bank management in adjusting capital levels to meet these challenges.

A comprehensive literature review finds that banks actively adjust their capital levels, inter alia during periods of distress, using a broad set of measures. This review combines insights from supervisory requirements on bank capital and balance sheet management, their practical applications at the bank level and the academic empirical literature on bank capital and balance sheet management, including in periods of distress. The literature review shows that banks actively manage their capital levels in a forward-looking manner, even during periods of distress. This active management helps banks mitigate the impact of shocks and maintain balance sheet stability. The findings suggest that bank capital ratios in periods *t-1* and growth rates of assets in *t* are interdependent, as bank management determines the capital level at the end of period *t-1* inter alia as a function of its asset growth targets. The final decisions regarding bank balance sheet management for period *t* and profit distribution for period *t-1* are often taken well into period *t*. The empirical literature also finds that banks can and do adjust their capital levels in period *t* in response to unexpected growth opportunities and/or shocks in the same period. Based on these findings from the literature, we formulate our main research question and test it with a global data set.

We use a global data set that is representative along several dimensions: geographic composition, bank size and business model. This data set, used for regular Basel III monitoring by the Basel Committee, includes semi-annual data from June 2013 to June 2019, comprises 1,644 observations from 172 banks across 27 countries. It is particularly well-suited for this study, due to its global coverage, consistent measurements across jurisdictions, and high data quality assured by national banking supervisory authorities and the Basel Committee's Secretariat. Additionally, it includes selected confidential data not available in standard commercial datasets, providing unique insights into bank capital and balance sheet management during the transition to new regulatory requirements.

We employ a two-step approach to address our main research question: *How do banks manage their equity capital in the short run and what effects does this have on their asset and liability structure, explicitly considering periods of bank-specific distress?* First, we apply a partial adjustment model of bank capital ratios to estimate each bank's target capital-asset ratio, then a simultaneous equation model to estimate the dynamics between management action on capital and growth of balance sheet items.

The results of the partial adjustment model show that most banks operated below their estimated capital targets during the Basel III implementation phase, creating a positive impetus for increasing capital levels. This aligns with the results of the Basel III monitoring exercise, which observed a general trend towards higher capital ratios. However, some banks had estimated capital ratio targets below their reported capital ratios, using their room for manoeuvre either to increase their Risk-Weighted Assets (RWA) more quickly, or to reduce the growth rate of their Common Equity Tier 1 (CET1) capital. This indicates a strategic approach to capital management, where banks balance their growth opportunities with the desire to restore capital ratios to the target levels. Accordingly, we note the convergence towards target capital ratios during the Basel III implementation phase. The deviation from target capital ratios was reduced both by banks operating below and above target, indicating that the risks from low capitalisations were reduced as well as inefficiencies from high capitalisations.

In the simultaneous equation approach, we analyse how various measures of management action on capital are related to asset growth. These measures include, inter alia, retained earnings, asset sales, NPL reduction, revaluation of assets, changes to Accumulated Other Comprehensive Income, regulatory adjustments and equity issuances. Considering these measures of management action on capital helps us to solve the identification problem, as we separate active management of capital from passive adjustments by considering significant deviations in bank average payout policies. Our approach is motivated by the observation that unexplained changes of capital (ie, actual changes in CET1 capital in a period minus its reported components like retained earnings, capital issued etc) are systematically associated with periods of distress and by the above-mentioned empirical literature on bank reactions to distress.

Our findings show a significant and simultaneous relationship between management action on capital and growth in balance sheet items. Banks experiencing higher growth rates in various balance sheet items tend to engage in management action on capital more frequently and to a larger extent. This is particularly evident for banks facing profitable growth opportunities and tighter capital constraints. Additionally, less profitable banks rely more on active capital measures due to limited capacity for capital management via retained earnings. At the same time, banks that take more management action on capital also exhibit higher growth in risk-weighted assets. The results hold across several robustness tests and subsamples.

Existing studies such as those discussed in Appendix A1.1 treat bank capital as fixed in the short run (depending on the individual study). Our findings suggest that some of these studies tend to underestimate the ability of banks to adjust to changes in their operating environment such as changes to regulatory requirements or bank-specific distress. This is because banks adopt a proactive approach that helps them maintain balance sheet stability under distress. It also enables them to capitalise on profitable growth opportunities and navigate regulatory landscapes. By recognising these complex dynamics including the endogeneity of capital, regulators can better understand and more effectively evaluate policy options.

While we are confident that our main findings are robust across several perspectives, more research is required to corroborate the results. First, more research is required on the measurement of management action on capital and its components. Second, more data is needed to control for aggregate and bank-specific demand in the analysis of bank asset growth. Third, a richer model of management action on capital should include more variables, such as regulatory and supervisory capital requirements, observed bank-specific capital targets and bank asset quality. Fourth, a longer time series would improve the robustness of the results. Finally, more research is needed to understand the impact of mergers and acquisitions on bank capital management.

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Appendix 1: The role of the assumption of exogeneity versus endogeneity of capital for estimates of the relationship between bank capitalisation and the evolution of bank assets

This Appendix summarises more than 100 estimates reported in the literature regarding the impact of changes of actual bank capital and required bank capital on bank lending to the private non-financial sector and corresponding lending rates.[59] The Appendix is structured along the following lines. First, it discusses the findings on the impact of changes in bank capital requirements[60] or actual capital (largely exogenous, independent variable) on the level or growth rate of bank lending (endogenous, dependent variable). For brevity, we refer to this approach as *quantity approach*. It looks at short-term[61] and long-term effects, the sensitivity of the estimates with respect to the methods chosen, normal versus crisis times, subcategories of lending to the private non-financial sector, and permanent increases versus temporary releases of capital requirements. Second, the Appendix provides an overview over studies on the impact of changes of bank capital requirements/actual bank capitalisation on bank lending rates. For brevity, we refer to this approach as *opportunity cost approach*. The final section summarises and concludes the Appendix.

A1.1 Quantity approach: capital and lending to the private non-financial sector[62]

A1.1.1 Short-term effects

The majority of studies finds a negative short-term relationship between increasing *capital requirements* and *loan growth* with a wide range of estimates from +5 to -9 percentage points.[63] Likewise, BIS MAG (2015) finds a negative relationship between *capital requirements* and *loan volume* (average across countries -1.4%).[64] The ECB (2015) found some adverse impacts on loan supply, although it regarded the economic significance as limited, because the respective estimated coefficients were small.

59 The literature review builds on the FRAME repository at the BIS of studies on the impact of bank regulation which documents significant heterogeneity across quantitative impact estimates, notably regarding the effects of capital (regulation) on loan growth. The repository covers 83 studies and 139 quantitative impact estimates from 15 countries and regions. (www.bis.org/frame/cap_liq/overview.htm). It standardises estimates to ensure comparability across studies. It does so by reporting the impact of either a 1 ppt increase of the respective capital ratio (transition effect) or by a 1 ppt higher ratio (long-term effect). In addition, we look at surveys by the BCBS and the ECB as well as other studies that are not included in the FRAME repository or the two surveys.

60 The reviewed studies focus mostly on permanent increases of Pillar 1 capital requirements, but also include one study on dynamic provisioning in Spain before the global financial crisis of 2007–09, two on macroprudential buffers and one on the impact of Pillar 2 requirements and on releases of buffers. We have included studies that refer to banking systems that are comparable to that of the EA around 2021; ie the review excludes studies that focus on bank behaviour prior to the 1990s or on banks in developing countries. The introduction of Too-Big-To-Fail policies has partly removed the implicit public guarantee of large banks and enhanced the interaction between capitalisation and funding costs (G 20 (2020), FSB (2021).

61 While in our own econometric analyses, we test for short-term exogeneity of capital over a relatively short interval (6 months), other studies also consider longer periods of up to four years.

62 We focus on the *private non-financial sector* because the literature does. From the point of view of economic growth such a narrow focus is not justified for the following reasons: (i) lending to the public sector can be growth enhancing, too (eg public infrastructure investment), (ii) the statistical delineation between the public and the private sector is based on ownership structure; this puts a particular loan, say for railroad network expansion, into the public sector in one country and in the private sector in another although the impact on growth is similar, (iii) high loan growth is not necessarily growth- or welfare enhancing and not a supervisory policy objective per se.

63 Gropp et al (2019), Kolcunová and Malovaná (2019), de-Ramon, Francis and Harris (2016), Francis and Osborne (2012), ECB (2015).

64 BCBS (2010).

Higher *actual capitalisation* seems to increase *loan growth* also in the *short-term,* with a majority of estimates being positive and some as high as to +4 percentage points.[65]

A1.1.2 Long-term effects

The results on the long-term effects of an increase of *capital requirements* on the *level* of bank lending are inconclusive with a wide range of estimates from +3 to -10 percentage points for a standardised + 100 basis points of higher capital requirements.[66] Regarding the impact of a 100 basis points higher *actual capitalisation* on *loan growth*, the majority of studies finds a positive relationship of up to +4 percentage points.[67]

A1.1.3 Aggregate and macroeconomic effects

The estimates of the impact of capital requirements on lending do not allow for conclusions regarding aggregate and macroeconomic effects.[68] Most quantity-based studies are microeconomic in nature and report relative results – some banks gain market share at the expense of others. The studies then conclude that these effects constitute social costs. Though, few of the studies investigate welfare effects in dept. bank lending can have positive or negative effects on welfare (eg excessive bank lending is a frequent cause of financial crises, higher diversification of funding sources increases the resilience of NFCs to banking shocks). Furthermore, few studies consider credit substitution among banks or by other sources of funding such as leasing, factoring, bond issuance, promissory notes, NFC lending, internal funding or lending by banks that are not affected by the measures.

A1.1.4 Methods

Results are sensitive to the methods, the simulation or empirical models chosen:[69] If these consider that the Modigliani-Miller (MM) theorem partly holds also for banks, price effects and credit substitution effects, they are more likely to yield positive effects of capital requirements on lending.[70] On the contrary, short-term bank-level and, especially, loan-level partial-equilibrium models find mostly negative results. Both approaches estimate "reduced-form" supply equations without prices, although higher capital requirements increase banks' WACC, and struggle with bank-level supply/demand identification. Hence, pilot studies employ simultaneous equations models for demand and supply identification and product-

[65] Labonne and Lame (2014), Olszak et al (2014), Aiyar, Calomiris and Wieladek (2014), Aiyar et al (2014), Aiyar, Calomiris and Wieladek (2016), Behn, Haselmann and Wachtel (2016), Bernanke, B S and C Lown (1991), Berrospide and Edge (2010), Bridges et al (2014), Dell'Arriccia, Laeven and Suarez (2017), Gambacorta and Shin (2018), Iyer et al (2014), Kapan and Miniou (2018), Kim and Sohn (2017), Roulet (2018).

[66] Corbae and D'Erasmo (2014), Covas and Driscoll (2014), De Nicolo, Gamba and Lucchetta (2014), Fraisse, Le and Thesmar (2020), Batiz et al (2018), Behn, Haselmann and Wachtel (2016).

[67] Bernanke and Lown (1991), Peek and Rosengren (1997), Berrospide and Edge (2010), Cornett et al (2011), Carlson, Shan and Warusawitharana (2013), Iyer et al (2014), Dell'Arriccia, Laeven and Suarez (2017), Kim and Sohn (2017), Gambacorta and Shin (2018), Kapan and Miniou (2018), Roulet (2018), Buch and Prieto (2012).

[68] For a literature review on macroeconomic models see BCBS (2019d). It finds "…that most of the models show that Basel III leads to an increase in GDP, while some models show negative effects."

[69] BCBS (2016) Sections 2.6.2., 2.6.3. Malovana et al (2024) find that the estimated elasticities of lending to changes in capital requirements differ between sample sizes, publication (journal vs. working paper), type of credit as dependent variable and the monetary policy environment. Fidrmuc and Lind (2020) find that the impact of capital regulation on growth also depends on the authors affiliation with banking sector economists report more negative effects compared to public sector economists.

[70] BCBS (2021), p 39 Table 7. BCBS (2019d), p 11 Table 3.

/bank-level price data to control for bank-level demand.[71] Quantity-based studies are prone to the Lucas Critique and the "fallacy of composition" (treating the banking sector as representative agent).[72]

A1.1.5 Normal versus crisis times

In crisis times, the positive effect of bank capitalisation on loan growth seems to be stronger than in normal times.[73] BCBS (2019, Box A, p 10) estimates 500 regressions and finds that "[m]ost of the estimates for loan growth are negative and non-statistically significant. Only thirteen of the 500 loan growth estimates are negative and statistically significant at the 10% threshold. This contrasts with the positive effect during crises and emphasises the differential impact of bank capitalisation in normal and crisis times. This suggests that bank capitalisation does not have adverse effects on the real economy in normal times." (p 10) This is corroborated by a study of the Czech banking sector, which finds the relation to be particularly strong for publicly traded banks when compared to banks not publicly traded (ie cooperative savings banks).[74] The EU COM[75] looks at the correlation between bank market capitalisation ratios (year end 2011) and the subsequent change in the *level of loans* over the period 2011–2012 [during the EA sovereign debt crisis]. It finds "...that higher capitalised banks, far from being an impediment to the real economy, actually reinforce it by providing funding." (p 32)

A1.1.6 Subcategories of lending to the private non-financial sector

The impact of changes in capital requirements on loan growth differs across subcategories of lending.[76] This is also corroborated by a study[77] on O-SII buffers, which suggests that, in the short-term, the buffer requirement reduces the supply of credit by these banks to households and the financial sector, but not to the non-financial sector. Banks shifted their lending to less risky counterparts within the non-financial corporations. The effects on credit supply are short-lived and diffused in the medium-term (two years) and the adjustment takes place mostly via risk-weight optimisation. Kerbl and Steiner (2020)[78] find that Austrian banks that were subject to higher capital requirements (macroprudential buffers and/or Pillar 2 requirements) improved their credit quality (measured by probability of default and expected loss) more than others. One study focuses on *dynamic provisioning* in Spain before the financial crisis and estimates that the positive impact of higher shock absorption capacity on loan growth to NFCs is about +9 percentage points in bad times.[79]

A1.1.7 Endogeneity of capital and reverse causality

The heterogeneity of estimates can partly be attributed to the fact that the lagged capital ratio is not exogenous in the sense that it is independent of the current growth rate of lending, as assumed in the quantity-based studies: capital is a balance sheet residual (assets minus liabilities). While the latter are nominally fixed, bank management has considerable leeway in the valuation of the former [within the limits of the law, IFRS, market discipline and supervisory oversight]. Similarly, bank management actively

[71] These pilots are conducted in the Eurosystem Working Group on Stress Testing for three countries (Austria, the Netherlands and Belgium).

[72] de-Ramon, Francis and Harris (2016).

[73] BCBS (2019e) Graph 5.

[74] Kolcunová and Malovaná (2019).

[75] DG FISMA (2015).

[76] Forbes, Reinhardt and Wieladek (2017), Bridges et al (2014), de-Ramon, Francis and Harris (2016).

[77] Cappelletti et al (2019).

[78] Kerbl and Steiner (2020).

[79] Peydro et al (2017).

manages capital by its P&L-/provisioning policies, its pay-out policy, capital raisings, sales of assets, buy-backs of undervalued liabilities and its capital management across business lines and group entities. Hence, the estimates of the impact of capital on lending suffer from reverse causality: Banks that face profitable lending opportunities have stronger incentives to more actively manage/raise capital (eg via retained earnings) than banks that do not.

A1.1.8 Banks' adjustment strategies to increases of capital requirements

Hence, more recent studies investigate the effects of increases of capital requirements on banks' overall adjustment strategy, rather than only a single component, such as lending. They look at the contributions of different components of the adjustment strategy, such as capital management, asset sales, risk weight optimisation and lending.

These studies find that banks have various options to adjust, that there is substantial variation of adjustment strategies across banks, and that the lion's share of the adjustment takes place via increases of capital[80], and via reductions of interbank lending, of the trading book or of management buffers.

The studies also document systematic heterogeneity of adjustment strategies across banks. They find that banks with higher initial capital ratios, better asset quality, earlier recognition of expected losses, better prospects for profitable lending opportunities and stronger profitability feature higher lending growth under increasing capital requirements.[81] Another study found that the effects of TBTF reforms differ across size (G-SIBs versus D-SIBs).[82] Some studies also document heterogeneity across countries.[83]

The likelihood of issuing SEOs is higher in poorly capitalised banks and that such banks prefer SEOs to alternative capitalisation strategies.[84] A series of tests exploring the variation of capital regulation and market discipline show that market mechanisms rather than capital regulation are the primary driver of the decision to issue by poorly capitalised banks.

Banks achieve deleveraging primarily through equity growth (rather than asset liquidation).[85] In contrast, they achieve leveraging through higher pay-outs and substantial asset expansion. The speed of capital structure adjustment is heterogeneous across countries. Banks make faster capital structure adjustments in countries with more stringent capital requirements, better supervisory monitoring, more developed capital markets and high inflation. In times of crises, banks adjust their capital structure significantly more quickly.

Large bank holding companies choose target capital levels substantially above well-capitalised regulatory minima.[86] These targets increase with BHC risk but decrease with BHC size. BHCs adjust toward these targets relatively quickly and the adjustment speeds are faster for poorly capitalised BHCs, but slower (ceteris paribus) for BHCs under severe regulatory pressure.

80 Cohen and Scatigna (2016), De Jonghe, Dewachter and Ongena (2020), BCBS (2019c), Bahaj et al (2016), Beatty and Liao (2011), Eidenberger, Schmitz and Steiner (2014), BCBS (2016) as well as Fritsch and Siedlarek (2022).

81 ECB (2015), Beatty and Liao (2011), DG FISMA (2015), Schmitz, Kopp and Ragacs (2010).

82 FSB (2021).

83 In response to a homogeneous increase in capital requirements at the EU level - banks established in different countries may undertake regulatory capital inflation. This could be enhanced by the exercise of national discretion in the implementation of capital regulation, particularly in the context before the Banking Union and the Single Rulebook (Gropp et al (2021)).

84 Dinger and Vallascas (2016).

85 De Jonghe and Öztekin (2015) examine the dynamic behaviour of bank capital ratios using a global sample of 64 countries during the 1994–2010 period.

86 Berger et al (2008).

Fair value gains in AFS assets have consistently been used for earnings and capital management[87], in addition to capital issuances and retained earnings. The holdings of AFS assets are related to the intensity of this activity. It is prevalent in listed and non-listed banks, suggesting that the motivations go beyond the incentives provided by capital markets.

Consequently, recent ex-ante evaluations of capital measures (eg, those reported in BCBS 2019e) build on the opportunity cost approach which takes into account banks' scope of action in capital management.

A1.2 Opportunity costs approach: capital and lending rates

The results of the *opportunity cost approach*[88] are more conclusive and find that a 100 basis points increase of *capital requirements* implies an increase of the *lending rate* in a range of +2.5 to +10 basis points (with some Modigliani-Miller offset, ie the effect of additional capital requirements on the WACC is partly (40–50%) offset by lower costs of debt).[89] Studies that do not allow for a partial MM offset find somewhat higher effects in a range from +2.3 to +15 basis points. The studies also suggest that the delineation between private and social costs is important. Neglecting that the cost of the loss of the tax subsidy of debt that results from an increase of capital requirements are private costs, increases the costs in terms of higher lending spreads by about 25 to 30% (for tax rates of 20 to 25%).[90] In these papers, most estimates find that an increase in *actual bank capital* increases *lending rates* between +1 and +15 basis points. The reduction of loan growth is endogenous along the demand function.

Opportunity cost studies allow for macroeconomic conclusions, as the increases of funding costs of the real economy can be integrated in standard macroeconomic models. The increase in the lending spread can then lead to the redistribution of market shares among banks, ie to the substitution of borrowing within the banking sector and with other sources of funding (see Couaillier et al, 2022)[91]. But even then, marginal refinancing costs for private non-financial sector would increase somewhat.

[87] Barth et al (2012).

[88] Various papers are summarised in BCBS (2019) and include: BCBS (2010), Brooke et al (2015), Cline (2017), Barth and Miller (2018), Almenberg et al (2017), Fender and Lewrick (2016), Firestone, Lorenc and Ranish (2017), Federal Reserve Bank of Minneapolis (2017), Miles, Yang and Marcheggiano (2013), Santos and Winton (2013), Sutorova and Teply (2013), Elliott (2009), Slovik and Cournede (2011), Cosimano and Hakura (2011), King (2010), Dagher et al (2016), Boissay, Collard and Lewrick (2018), Batiz et al (2018), Covas and Driscoll (2014), Glancy and Kurtzman (2018), Benetton et al (2021, in the version of 2017), Schmitz, Kopp and Ragacs (2010). Basten (2021) studies the impact of the Swiss sectoral Counter Cyclical Capital Buffer (sCCyB) on mortgage rates. His results are in a similar range.

[89] Clark et al (2023) study the MM-offset under the Hamada (1969, 1972) framework, which assumes that the cost of equity adjusts to leverage rather than the cost of debt for 431 publicly traded US Bank Holding Companies from 1996 to 2019. The Hamada framework combines the MM theorem with the CAPM under the assumption of a zero-debt beta for a bank. They find that the offset increases with bank size: it amounts to 15% for banks with less than USD 50 billion of total assets, 17.7% for banks with USD 50 to USD 250 billion and 49.1% for those with total assets above USD 250 billion. The size-weighted average across the banks in the sample is 40%. Considering the tax effect reduces the MM offset somewhat. Miles et al (2013) employ the Hamada framework in their study of the largest UK banks.

[90] Admati et al (2013), Miles, Yang and Marcheggiano (2013), Kashyap, Stein and Hanson (2010).

[91] Over the long-term, within their main debt funding sources euro area NFCs shifted from MFI loans to trade credit, loans from the rest of the world and debt securities. The share of MFI loans fell from about 18% of NFC funding from 1999 to 2014 to 13% from 2015 to 2021.

A1.3 Summary and conclusions

The main conclusion that motivates the current project is that there are large differences regarding the estimated impact of exogeneous shocks on bank balance sheet dynamics between models that assume that capital is largely exogenous (A1.1) and those that assume that it is endogenous (A1.2).

In addition, the survey finds that (i) the long-term impact of higher capital requirements on the level of lending to the private non-financial sector is ambiguous, on loan growth it seems to be positive, (ii) the short-term effects on loan growth seem to be mostly negative with a wide range from +5 to -9 percentage points, (iii) the effects of higher capital requirements vary in magnitude, across subcategories of lending, across countries and across methods (iv) the long-term and short-term impact of higher actual capitalisation is less ambiguous and mostly positive, particularly during crisis times, (v) the impact of higher capital requirements and of higher actual capitalisation on lending rates is likely to be positive but small.

Appendix 2: Derivation of target capital-asset ratios from a partial adjustment model

A2.1 Modelling and estimating target capital-asset ratios

The unobserved target capital-asset ratio for bank b in country c at time t $\left(k^*_{b,c,t}\right)$ is expressed as:

$$k^*_{b,c,t} = \psi_b + \sum_{n=1}^{N} \zeta_n x_{n,b,c,t-1}, \qquad \text{(A2.1)}$$

where x is a vector of lagged explanatory factors with N bank characteristics and macroeconomic conditions for $n \in [1, N]$ that capture the significant determinants of bank target capital-asset ratios, ψ_b is a fixed effect for each bank that subsumes the country fixed effects and ζ is a vector of parameters.

The actual (observed) capital-asset ratio, $k_{b,c,t}$ is assumed to adjust towards its (desired) target capital-asset ratio slowly over time, such that the adjustment from one period to the next is only partial:

$$k_{b,c,t} - k_{b,c,t-1} = \lambda\left(k^*_{b,c,t} - k_{b,c,t-1}\right) + \epsilon_{b,c,t}, \qquad \text{(A2.2)}$$

with $\lambda \in [0,1]$ symbolising the speed of the adjustment process. While $\lambda = 1$ would indicate that banks reach their target capital-asset ratios within one period, making the adjustment process immediate; $\lambda = 0$ represents a random process independent from the bank's target capital-asset ratio; and $\epsilon_{b,c,t}$ is a random error. Equations (A2.1) and (A2.2) constitute a standard partial adjustment model of capital structure.

We can re-arrange equation (A2.2),

$$k_{b,c,t} = \lambda k^*_{b,c,t} + (1-\lambda)k_{b,c,t-1} + \epsilon_{b,c,t}, \qquad \text{(A2.3)}$$

and substitute equation (A2.1) for $k^*_{b,c,t}$ in equation (A2.3) in order to express bank's capital-asset ratio as a function of its past capital-asset ratio and its current desired target, as pre-determined by bank-specific characteristics and past macroeconomic conditions:

$$k_{b,c,t} = \lambda\psi_b + \lambda\sum_{n=1}^{N} \zeta_n x_{n,b,c,t-1} + (1-\lambda)k_{b,c,t-1} + \epsilon_{b,c,t}, \qquad \text{(A2.4)}$$

such that in equation (A2.4), λ regulates the degree of stickiness in the one-period adjustment process. equation (A2.4) can also be expressed as

$$k_{b,c,t} = \lambda\sum_{n=1}^{N} \zeta_n x_{n,b,c,t-1} + (1-\lambda)k_{b,c,t-1} + v_{b,c,t}, \qquad \text{(A2.5)}$$

where $v_{b,c,t} = \varphi_b + \epsilon_{b,c,t}$, is a composition of bank-specific fixed effects (φ_b) and the idiosyncratic, serially uncorrelated shocks $\left(\epsilon_{b,c,t}\right)$.

From equations (A2.4) and (A2.5), capital-asset ratio estimation can be expressed as follows:

$$\hat{k}_{b,c,t} = \hat{\lambda}\hat{\psi}_b + \sum_{n=1}^{N} \hat{\lambda}\hat{\zeta}_n x_{n,b,c,t-1} + \left(1-\hat{\lambda}\right)k_{b,c,t-1} = \hat{\varphi}_b + \sum_{n=1}^{N} \hat{\lambda}\hat{\zeta}_n x_{n,b,c,t-1} + \left(1-\hat{\lambda}\right)k_{b,c,t-1}. \qquad \text{(A2.6)}$$

Let us assume that capital-asset ratios $k_{b,c,t}$ reach their target, $k^*_{b,c,t}$, in the long run ($k_{b,c,t} \to k^*_{b,c,t_*}$, $t_* \gg t$). Therefore, the long-run estimates of the explanatory variables defined in equation (A2.1) can be obtained with the **Blundell and Bond (1998)** generalised method of moments (GMM) approach via the **Roodman (2009)** Stata command *xtabond2* of the model (A2.5), which yields the following output in Stata:

$$\hat{k}_{b,c,t} = \hat{A}_{0,xtabond2} + \sum_{n=1}^{N} \hat{B}_n x_{n,b,c,t-1} + \hat{A}_1 k_{b,c,t-1}, \tag{4}$$

where $\hat{A}_{0,xtabond2}$ is the constant from the levels equation in the system GMM estimation. $\hat{A}_1$ captures the autoregressive component of the endogenous dependent variable instrumented via system GMM, and $\hat{B}_n$ represents the coefficient estimates for the n strictly exogenous regressor in vector x instrumented via IV. Individual banks' fixed effects in this framework, φ_b, must therefore be recovered from the disturbance term, which also subsumes the idiosyncratic and serially uncorrelated shocks (**Roodman, 2009, p 100**).

Mapping equation (A2.6) to equation (A2.7), we obtain $1 - \hat{\lambda} = \hat{A}_1$ and $\hat{\zeta}_n = \frac{\hat{B}_n}{(1-\hat{A}_1)}$.; while from equation (A2.6) we note that fixed effects for the target capital-asset ratio are as follows:

$$\hat{\psi}_b = \frac{\hat{\varphi}_b}{\hat{\lambda}} = \frac{\hat{\varphi}_b}{(1 - \hat{A}_1)}. \tag{5}$$

We show how to recover $\boldsymbol{\hat{\varphi}_b}$ from the Stata xtabond2 output (A2.7) in the next Section A2.2.

A2.2 Deriving individual-bank fixed effects $\boldsymbol{\hat{\varphi}_b}$

The purpose of this section is to derive the individual-bank fixed effects from the Stata *xtabond2* output equation (A2.7) leading to the formulas in equation (A2.8) and formalise the expression of the constant $\hat{A}_{0,xtabond2}$ from the output of Stata *xtabond2*.

A2.2.1 OLS fixed effects using indicator (dummy) variables

Assume that the panel dataset consists of G banks, with each bank denoted by $b \in [1, G]$. Let d_b be an indicator variable for each bank ($d_b = 1$), where bank $b = 1$ is a reference bank, with $d_1 = 0$.

Then, if we consider a pooled OLS framework, the estimation of $\hat{k}_{b,c,t}$ as a function of N lagged characteristics $z_{n,b,c,t-1}$ for $n \in [1, N]$, (where $z_{n,b,c,t-1}$can represent lagged $(t-1)$ bank characteristics, as well as the lagged dependent variable $k_{b,c,t-1}$) can be expressed as follows:

$$k_{b,c,t} = \gamma_1 + \sum_{b=2}^{G} \gamma_b d_b + \sum_{n=1}^{N} \beta_n z_{n,b,c,t-1} + e_{b,c,t}, \tag{A2.9}$$

with individual fixed effects for bank b (φ_b) expressed as individual intercepts:

$$\hat{\varphi}_1 = \hat{\gamma}_1, \qquad if\ b = 1$$
$$\hat{\varphi}_b = \hat{\gamma}_1 + \hat{\gamma}_b \quad \forall\ b \in [2, G],$$

such that the estimated capital-asset ratio for each individual bank in equation (A2.9) can be expressed as:

$$\hat{k}_{b,c,t} = \hat{\varphi}_b + \sum_{n=1}^{N} \hat{\beta}_n z_{n,b,c,t-1}. \tag{A2.10}$$

Allowing for the panel dataset to be unbalanced, we let T_b be the number of periods for each bank b, such that $T_b \leq T$, where T is the maximum number of periods in the panel. We note that expression (A2.10) can be rearranged into an equivalent expression for $\hat{\varphi}_b$ by summing up both sides of equation (A2.10) and dividing by T_b:

$$\frac{1}{T_b} \sum_{t=1}^{T_b} \left(k_{b,c,t} - \hat{k}_{b,c,t}\right) = \frac{1}{T_b} \sum_{t=1}^{T_b} \left(k_{b,c,t} - \hat{\varphi}_b - \sum_{n=1}^{N} \hat{\beta}_n z_{n,b,c,t-1} \right) \tag{A2.11}$$

$$\Leftrightarrow \hat{\varphi}_b = \frac{1}{T_b}\sum_{t=1}^{T_b}\left(k_{b,c,t} - \sum_{n=1}^{N}\hat{\beta}_n z_{n,b,c,t-1}\right).$$

A2.2.2 Fixed effects and a constant in Stata xtabond2 (system GMM)

We can next formulate the expression for $\hat{\varphi}_b$, $\forall\, b \in [1, G]$ using output of Stata *xtabond2* equation (A2.7).

Let $\hat{A}_{0,xtabond2}$ indicate the constant obtained from Stata *xtabond2*, which is specific to that statistical software package. According to **Roodman (2009)**, $\hat{A}_{0,xtabond2}$ is imputed subject to a software package-specific constraint into predicted values of capital, $\hat{k}_{b,c,t(predict)}$, such that the following is true:

$$\sum_{b=1}^{G}\left[\sum_{t=1}^{T_b}\left(k_{b,c,t} - \hat{k}_{b,c,t\,(predict)}\right)\right] = 0, \tag{A2.12}$$

where $\hat{k}_{b,c,t\,(predict)}$ is the output of the Stata $xtabond2$ command $< predict\ xb, xb >$ in Stata $xtabond2$:

$$\hat{k}_{b,c,t(predict)} = \hat{A}_{0,xtabond2} + \sum_{n=1}^{N}\hat{B}_n x_{n,b,c,t-1} + \hat{A}_1 k_{b,c,t-1} \tag{A2.13}$$

Substituting the expression of $\hat{k}_{b,c,t(predict)}$ from (A2.13) into equation (A2.12) yields:

$$\sum_{b=1}^{G}\left[\sum_{t=1}^{T_b}\left(k_{b,c,t} - \left(\hat{A}_{0,xtabond2} + [\sum_{n=1}^{N}\hat{B}_n x_{n,b,c,t-1} + \hat{A}_1 k_{b,c,t-1}]\right)\right)\right] = 0$$

$$\Leftrightarrow \hat{A}_{0,xtabond2} = \frac{1}{\sum_{b=1}^{G}(T_b)}\left(\sum_{b=1}^{G}\left[\sum_{t=1}^{T_b}\left(k_{b,c,t} - [\sum_{n=1}^{N}\hat{B}_n x_{n,b,c,t-1} + \hat{A}_1 k_{b,c,t-1}]\right)\right]\right).$$

Next, we express estimated bank fixed effects $\hat{\varphi}_b$ similar to the general case as in equation (A2.11).

$$\hat{\varphi}_b = \frac{1}{T_b}\sum_{t=1}^{T_b}\left(k_{b,c,t} - (\underbrace{\sum_{n=1}^{N}(\hat{B}_n x_{n,b,c,t-1}) + \hat{A}_1 k_{b,c,t-1})}_{\hat{k}_{b,c,t}}\right) \tag{A2.14}$$

and add and subtract the constant term $\hat{A}_{0,xtabond2}$ in equation (A2.14) without loss of generality,

$$\hat{\varphi}_b = \frac{1}{T_b}\sum_{t=1}^{T_b}\left(k_{b,c,t} - (\underbrace{\sum_{n=1}^{N}(\hat{B}_n x_{n,b,c,t-1}) + \hat{A}_1 k_{b,c,t-1} + \hat{A}_{0,xtabond2}}_{\hat{k}_{b,c,t(predict)}} - \hat{A}_{0,xtabond2})\right)$$

$$\frac{1}{T_b}\sum_{t=1}^{T_b}\left(k_{b,c,t} - \hat{k}_{b,c,t(predict)} + \hat{A}_{0,xtabond2}\right) = \frac{1}{T_b}\sum_{t=1}^{T_b}k_{b,c,t} - \frac{1}{T_b}\sum_{t=1}^{T_b}\hat{k}_{b,c,t(predict)} + \hat{A}_{0,xtabond2}. \tag{A2.15}$$

We can now use equation (A2.15) to formulate bank-specific fixed effects $\hat{\psi}_b$ for the target capital $k^*_{b,c,t}$ from equation (A2.8) as follows:

$$\hat{\psi}_b = \frac{\frac{1}{T_b}\sum_{t=1}^{T_b}k_{b,c,t} - \frac{1}{T_b}\sum_{t=1}^{T_b}\hat{k}_{b,c,t(predict)} + \hat{A}_{0,xtabond2}}{\left(1 - \hat{A}_1\right)}.$$

Appendix 3: Management action on capital – supplemental tables

Descriptive statistics and correlations of the variables in Section 5

Table A3.1

VARIABLES	Winsorised	N	Mean	SD	Skewness	Kurtosis	p5	p50	p95
Management action on capital									
MAC_3_CET1_w	Yes	1,272	-0.0112	0.0702	0.336	6.938	-0.120	-0.0100	0.0932
MAC_1L_CET1_w	Yes	1,272	0.0168	0.0842	7.710	75.68	-0.0338	0.00150	0.0876
MAC_2_CET1_w	Yes	1,272	0.0298	0.0918	6.870	65.37	-0.0255	0.00524	0.131
Measures of distress									
s_prof_neg	No	1,272	0.0165	0.127	7.589	58.59	0	0	0
Distress_l_sqd_pct	No	1,240	0.496	0.0538	-4.114	39.87	0.442	0.501	0.534
Bank controls									
Z_w	Yes	1,272	-4.070	15.89	1.319	7.808	-26.52	-5.324	20.80
RD_D_w	Yes	1,272	-0.00240	0.0279	0.193	10.44	-0.0432	-0.00183	0.0327
ROA_w	Yes	1,272	0.00379	0.00408	2.053	11.30	0	0.00283	0.0111
TRADINGBOOK_TA_w	Yes	1,265	0.0789	0.127	2.485	9.441	0	0.0233	0.380
LCR_w	Yes	1,272	1.811	1.696	5.037	30.79	1.007	1.380	3.827
CET1r_RWA_w	Yes	1,272	0.144	0.0458	1.913	7.723	0.0956	0.131	0.237
Macro variables									
RGDP_HP_D	No	1,272	0.00813	0.00798	1.396	5.022	-0.00218	0.00738	0.0283
CDS5Y_D_w	Yes	1,232	-3.008	24.67	1.244	11.05	-43.76	-2.316	25.10
Balance sheet items									
LOG_RWA_D_w	Yes	1,272	0.00955	0.0671	0.562	5.993	-0.0936	0.00624	0.120
LOG_ASSETS_D_w	Yes	1,272	0.0137	0.0636	0.222	4.425	-0.0926	0.0136	0.119
LOG_LENDING_NF_D_w	Yes	1,259	0.0168	0.118	0.553	13.13	-0.128	0.0152	0.166
LOG_NFC_D_w	Yes	1,227	0.00719	0.235	0.784	20.96	-0.243	0.00798	0.258
LOG_RETAILNFC_D_w	Yes	1,250	0.0113	0.151	-0.179	20.38	-0.157	0.0136	0.163
LOG_OthExp_D_w	Yes	1,234	-0.00612	0.489	-1.050	12.84	-0.693	0.0128	0.643
LOG_LRExp_D_w	Yes	1,263	0.00840	0.0856	-0.819	9.319	-0.110	0.0120	0.130
LOG_TBExp_D_w	Yes	985	-0.0328	0.521	-0.227	10.89	-0.853	-0.00588	0.619
LOG_SovExp_D_w	Yes	1,250	0.0199	0.236	0.419	12.72	-0.262	0.0173	0.306
LOG_RetExp_D_w	Yes	1,180	0.0128	0.158	-1.737	20.17	-0.156	0.0173	0.183
LOG_CorpExp_D_w	Yes	1,259	0.00893	0.180	-0.865	14.48	-0.217	0.0124	0.249
Interaction									
LOG_RWA_D_w * L.Z_w									
Growth_c_w	Yes	1,272	0.172	1.571	3.854	50.54	-1.428	0.00702	2.176
Banks		163	163	163	163	163	163	163	163

Descriptive statistics and correlations of the variables in Section 5

Table A3.2

	L.Z_w	RD_D_w	ROA_w	s_prof_neg	Growth_c_w	LOG_RWA_D_w	LOG_ASSETS_D_w	LOG_LENDING_NF_D_w	LOG_NFC_D_w
L.Z_w	1								
RD_D_w	0,159647	1							
ROA_w	0,112599	0,041018	1						
s_prof_neg	0,026539	-0,01527	-0,35734	1					
Growth_c_w	0,116439	-0,10874	-0,06484	0,032788	1				
LOG_RWA_D_w	0,149512	0,431753	0,143892	-0,09962	-0,05407	1			
LOG_ASSETS_D_w	-0,01725	-0,37528	0,110878	-0,08745	-0,00904	0,607112	1		
LOG_LENDING_NF_D_w	-0,00902	-0,05797	0,026541	-0,06057	-0,09461	0,311702	0,396565	1	
LOG_NFC_D_w	-0,03661	0,039465	0,052667	-0,04444	-0,10744	0,251026	0,252536	0,636921	1
LOG_RETAILNFC_D_w	-0,0287	0,032511	0,027691	-0,05282	-0,09434	0,31757	0,319837	0,808472	0,821672
LOG_OthExp_D_w	-0,01338	-0,02176	-0,06244	0,004568	0,00813	0,072074	0,113248	-0,02243	0,152745
LOG_LRExp_D_w	-0,01809	-0,14341	0,057178	-0,12164	-0,0567	0,437739	0,633472	0,597409	0,397423
LOG_TBExp_D_w	-0,07434	-0,04986	0,054558	-0,00693	-0,0389	0,087147	0,139179	-0,08744	-0,01584
LOG_SovExp_D_w	-0,0218	-0,15011	-0,00127	-0,01184	-0,08615	0,073371	0,251221	0,620261	0,124635
LOG_RetExp_D_w	-0,00227	0,01351	-0,05621	-0,00137	-0,10425	0,271352	0,257931	0,599311	0,268605
LOG_CorpExp_D_w	-0,05207	0,025932	0,060049	-0,06378	-0,0616	0,264649	0,259551	0,51965	0,846702
MAC_3_CET1_w	-0,20667	0,031194	-0,25038	0,161072	-0,05283	0,459405	0,421366	0,208086	0,146981
MAC_1L_CET1_w	-0,03081	-0,02272	0,033468	0,07616	-0,01717	0,024688	0,053834	0,013783	0,003376
MAC_2_CET1_w	0,002157	0,011617	0,034647	0,079706	-0,01969	0,050192	0,035732	0,033311	0,014639

Descriptive statistics and correlations of the variables in Section 5

Table A3.3

	LOG_RETAILNFC_D_w	LOG_OthExp_D_w	LOG_LRExp_D_w	LOG_TBExp_D_w	LOG_SovExp_D_w	LOG_RetExp_D_w	LOG_CorpExp_D_w	MAC_3_CET1_w	MAC_1L_CET1_w	MAC_2_CET1_w
L.Z_w										
RD_D_w										
ROA_w										
s_prof_neg										
Growth_c_w										
LOG_RWA_D_w										
LOG_ASSETS_D_w										
LOG_LENDING_NF_D_w										
LOG_NFC_D_w										
LOG_RETAILNFC_D_w	1									
LOG_OthExp_D_w	0,065837	1								
LOG_LRExp_D_w	0,517581	0,280465	1							
LOG_TBExp_D_w	-0,02429	-0,11486	0,146188	1						
LOG_SovExp_D_w	0,219474	-0,00862	0,406407	-0,02065	1					
LOG_RetExp_D_w	0,649312	0,033768	0,440636	-0,00016	0,289431	1				
LOG_CorpExp_D_w	0,674309	0,082956	0,405965	0,009815	0,091913	0,179801	1			
MAC_3_CET1_w	0,212489	0,143053	0,284959	0,03913	0,061227	0,207296	0,15076	1		
MAC_1L_CET1_w	0,008747	0,029096	0,007743	0,017498	0,031668	-0,0221	-0,00339	0,175958	1	
MAC_2_CET1_w	0,019547	-0,00734	-0,00796	0,004862	0,037264	-0,01246	0,006851	0,129901	0,886687	1

Source: QIS, S&P Market Intelligence and own calculations.

Formulas for calculating large deviations to GDP, bank stock prices, bank CDS spreads, AOCI, the sum of regulatory adjustments and the unexplained component of changes of CET1

Table A3.4

Variable	Formula
C001 (GDP growth) & C005 (output gap)	1 if C001mean < C001_Mean & C005last < 0
X352 (stock price, min of period)	tbc
X318 (CDS spread; minimum of period)	1 if X318_D/L.X318 > (1)*(X318_D_pct_StD/X318_D_pct_Mean)
ΔAOCI (AOCI)	1 if D.AOCI_D/L.AOCI_D > (1)×(AOCI_D_pct_StD/AOCI_D_pct_Mean)
ΔReg_Adj (sum of regulatory adjustments)	1 if D.Reg_Adj_D/L.Reg_Adj_D < (-1)×(Reg_Adj_D_pct_StD/Reg_Adj_D_pct_Mean)
CET1_D_unexpl (unexplained component of ΔCET1 after accounting for retained earnings, capital increases, changes to AOCI and the sum of regulatory adjustments)	CET1_D_unexpl= D.CET1 - CET1_ret_earnings - CET1_ISS - AOCI_D + Reg_Adj_D 1 if CET1_D_unexpl/L.CET1_D_unexpl > (1)×(CET1_D_unexpl_pct_StD/CET1_D_unexpl_pct_Mean)

Components of regulatory adjustments to CET1 capital in the QIS data set (Reg_Adj) [pro domo: (1) better understand each of the positions in the table]

Table A3.5

Y534 = ΣB.2 Regulatory adjustments to Common Equity Tier 1 capital

Basel Framework reference	Item	Reporting date national impl.
CAP30.7–8	Deduction for goodwill net of related tax liability	
CAP30.7–8	Deduction for intangibles (excluding goodwill and mortgage servicing rights) net of related tax liability	
CAP30.9	Deduction for deferred tax assets arising from carryforwards of unused tax losses, unused tax credits and all other (net of pro rata share of any DTLs)	
CAP30.21	Deduction for investments in own shares (excluding amounts already derecognised under the relevant accounting standards)	
CAP30.21	Deduction for reciprocal cross holdings of common equity	
CAP30.13	Deduction for shortfall of provisions to expected losses (gross of any tax adjustment)	
CAP30.11–12	Cash flow hedge reserve to be deducted from (or added to if negative) Common Equity Tier 1 capital	
CAP30.15	Total cumulative net gains and (losses) in equity due to changes in the fair value of liabilities that are due to a change in the bank's own credit risk Amount to be deducted from (or added to if negative) capital (if gain report as positive; if loss report as negative)	
CAP30.16–17	Deduction for defined benefit pension fund assets	
CAP30.14	Deduction for securitisation gain on sale (expected future margin income) as set out in CAP30.14	
CAP50.14	Deductions for prudent valuation	
EU	Deductions for securitisation positions which can alternatively be subject to a 1,250% risk weight; of which:	
EU	for securitisation positions held in the trading book	
EU	Deductions for free deliveries which can alternatively be subject to a 1,250% risk weight	
EU	Deductions for positions in a basket for which an institution cannot determine a risk weight under IRB and can alternatively be subject to a 1,250% risk weight	
EU	Deductions for equity exposures under the IRB approach which can alternatively be subject to a 1,250% risk weight	
	Transitional regulatory adjustments to CET1 due to the introduction of ECL provisioning, reflecting the accounting treatment at the reporting date	
	Other CET1 deductions to be made before the threshold deductions (excluding adjustments reported in row 45)	
	Total Common Equity Tier 1 capital after the regulatory adjustments above	

Appendix 4: The determinants of Management Action on Capital: supplemental tables and figures

Regression results for the determinants of management action on capital – dependent variable *MAC_3_CET1_w*

Robustness check with *L.CET1r_RWA_w* instead of *L.Z_w* — Table A4.1

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
RD_D_w	**-0.381*** **	**0.827*** **	**0.338*** **	**0.281*** **	**0.288** **	**0.289** **	**0.431*** **	**0.280** **	**0.351*** **	**0.288*** **	**0.282** **
	(0.101)	(0.119)	(0.0990)	(0.0965)	(0.107)	(0.119)	(0.118)	(0.108)	(0.108)	(0.0979)	(0.102)
ROA_w	**-5.732*** **	**-5.941*** **	**-5.738*** **	**-4.987*** **	**-5.597*** **	**-4.871*** **	**-5.717*** **	**-4.189*** **	**-5.602*** **	**-4.811*** **	**-5.554*** **
	(1.067)	(1.070)	(1.132)	(1.044)	(1.105)	(1.115)	(1.148)	(1.183)	(1.114)	(1.126)	(1.096)
s_prof_neg	**0.0365** **	**0.0312** **	0.0241	0.0257	0.0144	0.0164	**0.0279* **	0.0162	0.00949	0.0172	0.0187
	(0.0142)	(0.0147)	(0.0167)	(0.0175)	(0.0235)	(0.0217)	(0.0158)	(0.0254)	(0.0221)	(0.0220)	(0.0195)
LOG_RWA_D_w	**0.657*** **										
	(0.0596)										
LOG_ASSETS_D_w		**0.635*** **									
		(0.0714)									
LOG_LENDING_NF_D_w			**0.140*** **								
			(0.0344)								
LOG_NFC_D_w				**0.0450** **							
				(0.0177)							
LOG_RETAILNFC_D_w					**0.0960*** **						
					(0.0226)						
LOG_OthExp_D_w						**0.0156** **					
						(0.00753)					
LOG_LRExp_D_w							**0.305*** **				
							(0.0601)				
LOG_TBExp_D_w								0.00644			
								(0.00431)			
LOG_SovExp_D_w									**0.0306* **		
									(0.0155)		
LOG_RetExp_D_w										**0.0884*** **	
										(0.0306)	
LOG_CorpExp_D_w											**0.0734*** **
											(0.0185)
L.CET1r_RWA_w	**-1.289*** **	**-1.225*** **	**-1.048*** **	**-1.042*** **	**-1.081*** **	**-1.028*** **	**-1.061*** **	**-1.426*** **	**-1.067*** **	**-1.164*** **	**-1.045*** **
	(0.164)	(0.155)	(0.149)	(0.160)	(0.160)	(0.157)	(0.142)	(0.200)	(0.159)	(0.176)	(0.157)
Constant	0.186***	0.178***	0.161***	0.158***	0.166***	0.157***	0.161***	0.199***	0.165***	0.172***	0.161***
	(0.0222)	(0.0210)	(0.0208)	(0.0225)	(0.0230)	(0.0214)	(0.0195)	(0.0277)	(0.0221)	(0.0251)	(0.0220)
Observations	1,425	1,425	1,411	1,377	1,403	1,386	1,415	1,107	1,400	1,325	1,411
Banks	158	158	158	155	157	157	158	128	157	149	158
Countries	26	26	26	26	26	26	26	26	26	26	26
Degree of freedom	24	24	24	24	24	24	24	24	24	24	24
r2 overall	0.192	0.187	0.0698	0.0497	0.0638	0.0390	0.104	0.0565	0.0473	0.0600	0.0569
r2 within	0.440	0.413	0.148	0.111	0.136	0.0973	0.230	0.0930	0.0997	0.134	0.126
r2 between	0.0712	0.0820	0.112	0.146	0.160	0.0360	0.0413	0.141	0.0787	0.139	0.0826

Regression results for the determinants of management action on capital – dependent variable *MAC_3_CET1_w*

Robustness check with *Distress_I_sqd_pct* instead of *s_prof_neg* Table A4.2

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
L.Z_w	**-0.000889*** **	**-0.000858*** **	**-0.000716*** **	**-0.000660*** **	**-0.000654*** **	**-0.000733*** **	**-0.000708*** **	**-0.000804*** **	**-0.000713*** **	**-0.000678*** **	**-0.000675*** **
	(0.000125)	(0.000137)	(0.000173)	(0.000182)	(0.000176)	(0.000177)	(0.000165)	(0.000202)	(0.000170)	(0.000178)	(0.000169)
RD_D_w	**-0.435*** **	**0.699*** **	**0.217** **	**0.199* **	0.162	0.189	**0.291** **	0.148	**0.213* **	0.163	0.171
	(0.112)	(0.108)	(0.0984)	(0.102)	(0.105)	(0.118)	(0.119)	(0.109)	(0.117)	(0.0990)	(0.109)
ROA_w	**-6.204*** **	**-6.420*** **	**-5.551*** **	**-4.809*** **	**-5.177*** **	**-4.532*** **	**-5.835*** **	**-4.133*** **	**-5.352*** **	**-4.512*** **	**-5.310*** **
	(1.277)	(1.160)	(1.411)	(1.381)	(1.301)	(1.454)	(1.441)	(1.433)	(1.350)	(1.418)	(1.332)
LOG_RWA_D_w	**0.623*** **										
	(0.0626)										
LOG_ASSETS_D_w		**0.610*** **									
		(0.0769)									
LOG_LENDING_NF_D_w			**0.127*** **								
			(0.0360)								
LOG_NFC_D_w				**0.0422** **							
				(0.0196)							
LOG_RETAILNFC_D_w					**0.0952*** **						
					(0.0275)						
LOG_OthExp_D_w						**0.0168* **					
						(0.00835)					
LOG_LRExp_D_w							**0.265*** **				
							(0.0593)				
LOG_TBExp_D_w								0.000564			
								(0.00408)			
LOG_SovExp_D_w									0.0206		
									(0.0167)		
LOG_RetExp_D_w										**0.0949*** **	
										(0.0298)	
LOG_CorpExp_D_w											**0.0636*** **
											(0.0202)
Distress_I_sqd_pct	-0.0167	-0.0114	0.0198	0.00131	0.0190	0.00722	0.00374	-0.0130	-0.00677	-0.0161	0.0148
	(0.0293)	(0.0248)	(0.0341)	(0.0324)	(0.0323)	(0.0375)	(0.0349)	(0.0420)	(0.0398)	(0.0406)	(0.0339)
Constant	0.00859	0.00726	-0.00561	0.00187	-0.00607	-0.00168	0.00356	0.00657	0.00855	0.00901	-0.00274
	(0.0166)	(0.0142)	(0.0190)	(0.0193)	(0.0182)	(0.0217)	(0.0199)	(0.0249)	(0.0216)	(0.0229)	(0.0195)
Observations	1,240	1,240	1,227	1,199	1,218	1,202	1,232	972	1,218	1,151	1,227
Banks	157	157	157	154	156	156	157	126	156	148	157
Countries	26	26	26	26	26	26	26	26	26	26	26
Degree of freedom	24	24	24	24	24	24	24	24	24	24	24
r2 overall	0.406	0.387	0.153	0.109	0.135	0.101	0.196	0.104	0.103	0.134	0.125
r2 within	0.388	0.375	0.104	0.0689	0.0954	0.0640	0.178	0.0439	0.0551	0.0931	0.0848
r2 between	0.458	0.441	0.457	0.368	0.384	0.283	0.169	0.321	0.311	0.298	0.323

Regression results for the determinants of management action on capital – dependent variable *MAC_3_CET1_w*

Robustness check with estimates for the subsample Group 1 banks

Table A4.3

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
L.Z_w	**-0.000825*** **	**-0.000811*** **	**-0.000732*** **	**-0.000702** **	**-0.000658** **	**-0.000774*** **	**-0.000725*** **	**-0.000717*** **	**-0.000732*** **	**-0.000673*** **	**-0.000705*** **
	(0.000156)	(0.000175)	(0.000229)	(0.000254)	(0.000242)	(0.000237)	(0.000216)	(0.000223)	(0.000224)	(0.000235)	(0.000223)
RD_D_w	**-0.456*** **	**0.685*** **	0.116	0.0764	0.0411	0.0224	0.205	0.0805	0.0597	0.0609	0.0425
	(0.134)	(0.150)	(0.0979)	(0.0761)	(0.0913)	(0.0896)	(0.131)	(0.0710)	(0.0962)	(0.0865)	(0.0833)
ROA_w	**-5.484*** **	**-5.902*** **	**-5.297*** **	**-4.013*** **	**-4.696*** **	**-4.012*** **	**-5.235*** **	**-4.356*** **	**-4.790*** **	**-3.724*** **	**-4.962*** **
	(1.254)	(1.203)	(1.122)	(1.066)	(0.974)	(1.148)	(1.036)	(1.358)	(1.169)	(1.201)	(1.127)
s_prof_neg	**0.0389** **	**0.0329* **	**0.0320* **	**0.0405** **	**0.0362** **	0.0260	**0.0348* **	0.0263	0.0250	**0.0342* **	**0.0362** **
	(0.0167)	(0.0165)	(0.0178)	(0.0153)	(0.0151)	(0.0256)	(0.0182)	(0.0233)	(0.0219)	(0.0171)	(0.0161)
LOG_RWA_D_w	**0.645*** **										
	(0.0669)										
LOG_ASSETS_D_w		**0.597*** **									
		(0.0978)									
LOG_LENDING_NF_D_w			**0.118** **								
			(0.0460)								
LOG_NFC_D_w				0.0461							
				(0.0286)							
LOG_RETAILNFC_D_w					**0.0922** **						
					(0.0330)						
LOG_OthExp_D_w						0.0136					
						(0.00970)					
LOG_LRExp_D_w							**0.257*** **				
							(0.0794)				
LOG_TBExp_D_w								0.0101			
								(0.00683)			
LOG_SovExp_D_w									0.0113		
									(0.0200)		
LOG_RetExp_D_w										**0.113** **	
										(0.0474)	
LOG_CorpExp_D_w											**0.0697** **
											(0.0293)
Constant	-0.00277	-0.000267	0.00233	-0.00184	0.000333	-0.00136	0.00259	-0.000245	0.00214	-0.00416	0.00219
	(0.00502)	(0.00472)	(0.00411)	(0.00399)	(0.00359)	(0.00444)	(0.00412)	(0.00559)	(0.00440)	(0.00467)	(0.00431)
Observations	887	887	875	858	868	857	881	817	866	823	877
Banks	104	104	104	104	104	103	104	99	103	99	104
Countries	23	23	23	23	23	23	23	23	23	23	23
Degree of freedom	22	22	22	22	22	22	22	22	22	22	22
r2 overall	0.471	0.417	0.179	0.138	0.166	0.116	0.221	0.118	0.125	0.167	0.153
r2 within	0.426	0.373	0.0970	0.0662	0.0950	0.0585	0.175	0.0535	0.0504	0.102	0.0902
r2 between	0.522	0.489	0.545	0.470	0.462	0.342	0.118	0.321	0.335	0.345	0.327

Regression results for the determinants of management action on capital – dependent variable *MAC_3_CET1_w*

Robustness check with estimates for the subsample Group 2 banks

Table A4.4

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
L.Z_w	**-0.00130*** **	**-0.00127*** **	**-0.000991*** **	**-0.000901*** **	**-0.000974*** **	**-0.000935*** **	**-0.000942*** **	**-0.00170*** **	**-0.000970*** **	**-0.000999*** **	**-0.000896*** **
	(0.000201)	(0.000183)	(0.000206)	(0.000218)	(0.000221)	(0.000234)	(0.000258)	(0.000259)	(0.000229)	(0.000254)	(0.000219)
RD_D_w	**-0.387*** **	**0.771*** **	**0.460*** **	**0.480*** **	**0.459*** **	**0.578*** **	**0.509*** **	**0.469* **	**0.525*** **	**0.453** **	**0.477*** **
	(0.106)	(0.0884)	(0.136)	(0.148)	(0.141)	(0.151)	(0.164)	(0.258)	(0.144)	(0.163)	(0.156)
ROA_w	**-4.632* **	**-4.635* **	-4.308	-4.063	-4.430	-3.852	-4.912	1.203	-4.701	-3.493	-4.086
	(2.523)	(2.300)	(3.389)	(2.830)	(3.148)	(3.332)	(3.632)	(1.519)	(3.235)	(2.886)	(2.843)
s_prof_neg	**0.0837*** **	**0.0862*** **	**0.0773** **	**0.0729** **	**0.0726** **	**0.0763** **	**0.0726* **	**0.122*** **	**0.0695** **	**0.0803** **	**0.0734** **
	(0.0266)	(0.0243)	(0.0329)	(0.0286)	(0.0319)	(0.0341)	(0.0362)	(0.0150)	(0.0321)	(0.0295)	(0.0288)
LOG_RWA_D_w	**0.610*** **										
	(0.0717)										
LOG_ASSETS_D_w		**0.676*** **									
		(0.0591)									
LOG_LENDING_NF_D_w			**0.139*** **								
			(0.0363)								
LOG_NFC_D_w				**0.0397** **							
				(0.0182)							
LOG_RETAILNFC_D_w					**0.0989** **						
					(0.0400)						
LOG_OthExp_D_w						**0.0291** **					
						(0.0113)					
LOG_LRExp_D_w							**0.284*** **				
							(0.0913)				
LOG_TBExp_D_w								-0.00974			
								(0.00985)			
LOG_SovExp_D_w									0.0410		
									(0.0235)		
LOG_RetExp_D_w										0.0479	
										(0.0310)	
LOG_CorpExp_D_w											**0.0587*** **
											(0.0173)
Constant	-0.00668	-0.00700	0.000712	0.00206	0.00219	0.00136	0.00141	-0.0219**	0.00364	2.76e-05	0.00172
	(0.0103)	(0.00910)	(0.0121)	(0.0107)	(0.0115)	(0.0121)	(0.0130)	(0.00857)	(0.0119)	(0.0114)	(0.0104)
Observations	385	385	384	369	382	377	382	168	384	357	382
Banks	54	54	54	51	53	54	54	28	54	50	54
Countries	17	17	17	17	17	17	17	17	17	17	17
Degree of freedom	15	15	15	15	15	15	15	12	15	15	15
r2 overall	0.306	0.347	0.159	0.128	0.135	0.147	0.197	0.139	0.132	0.129	0.140
r2 within	0.321	0.377	0.145	0.122	0.132	0.136	0.204	0.140	0.113	0.108	0.125
r2 between	0.382	0.373	0.352	0.287	0.295	0.288	0.363	0.142	0.350	0.344	0.343

Regression results for the determinants of management action on capital – dependent variable *MAC_3_CET1_w*

Robustness check with estimates for the subsample EU banks — Table A4.5

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
L.Z_w	**-0.00105*** **	**-0.00102*** **	**-0.000870*** **	**-0.000854*** **	**-0.000877*** **	**-0.000867*** **	**-0.000867*** **	**-0.00105*** **	**-0.000892*** **	**-0.000901*** **	**-0.000861*** **
	(0.000156)	(0.000150)	(0.000134)	(0.000141)	(0.000146)	(0.000152)	(0.000148)	(0.000183)	(0.000148)	(0.000156)	(0.000143)
RD_D_w	-0.00657	**0.856*** **	**0.530*** **	**0.518*** **	**0.497*** **	**0.504*** **	**0.645*** **	**0.450** **	**0.552*** **	**0.468*** **	**0.515*** **
	(0.154)	(0.0903)	(0.107)	(0.119)	(0.117)	(0.155)	(0.110)	(0.183)	(0.127)	(0.134)	(0.121)
ROA_w	**-7.407** **	**-7.609*** **	**-7.968** **	**-7.424** **	**-7.944** **	**-7.874** **	**-8.212** **	**-3.411** **	**-7.856** **	**-7.071** **	**-7.486** **
	(2.424)	(2.315)	(2.810)	(2.653)	(2.778)	(3.033)	(2.677)	(1.385)	(2.891)	(2.332)	(2.717)
s_prof_neg	**0.0433** **	**0.0405** **	**0.0336** **	**0.0350** **	**0.0321* **	**0.0337* **	**0.0337** **	**0.0636*** **	**0.0313* **	**0.0362** **	**0.0353** **
	(0.0159)	(0.0149)	(0.0148)	(0.0143)	(0.0154)	(0.0159)	(0.0144)	(0.0123)	(0.0146)	(0.0138)	(0.0146)
LOG_RWA_D_w	**0.373*** **										
	(0.110)										
LOG_ASSETS_D_w		**0.367*** **									
		(0.0960)									
LOG_LENDING_NF_D_w			**0.0981*** **								
			(0.0297)								
LOG_NFC_D_w				0.0238							
				(0.0172)							
LOG_RETAILNFC_D_w					**0.0536** **						
					(0.0225)						
LOG_OthExp_D_w						**0.0199** **					
						(0.00688)					
LOG_LRExp_D_w							**0.168*** **				
							(0.0508)				
LOG_TBExp_D_w								0.00227			
								(0.00662)			
LOG_SovExp_D_w									**0.0309* **		
									(0.0166)		
LOG_RetExp_D_w										**0.0434* **	
										(0.0216)	
LOG_CorpExp_D_w											**0.0354* **
											(0.0175)
Constant	-0.00250	-0.00124	5.94e-05	-0.000810	9.88e-05	0.000723	0.00106	**-0.0120** **	0.000313	-0.00179	-0.000662
	(0.00639)	(0.00593)	(0.00695)	(0.00667)	(0.00692)	(0.00743)	(0.00667)	(0.00453)	(0.00718)	(0.00618)	(0.00672)
Observations	555	555	551	536	549	547	549	372	551	524	549
Banks	74	74	74	71	73	74	74	52	74	70	74
Countries	12	12	12	12	12	12	12	12	12	12	12
Degree of freedom	11	11	11	11	11	11	11	11	11	11	11
r2 overall	0.307	0.317	0.252	0.235	0.239	0.239	0.272	0.217	0.241	0.233	0.245
r2 within	0.227	0.247	0.167	0.150	0.155	0.156	0.188	0.142	0.152	0.149	0.155
r2 between	0.550	0.521	0.513	0.513	0.529	0.451	0.548	0.424	0.512	0.504	0.520

Regression results for the determinants of management action on capital – dependent variable *MAC_3_CET1_w*

Robustness check with estimates for the subsample RWAM banks

Table A4.6

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
L.Z_w	**-0.000798*** **	**-0.000804*** **	**-0.000792** **	**-0.000722* **	**-0.000653* **	**-0.000843** **	**-0.000734** **	**-0.000797** **	**-0.000763** **	**-0.000666* **	**-0.000661* **
	(0.000179)	(0.000192)	(0.000331)	(0.000375)	(0.000357)	(0.000338)	(0.000289)	(0.000334)	(0.000319)	(0.000345)	(0.000312)
RD_D_w	**-0.576*** **	**0.622*** **	0.0672	0.0255	-0.00134	0.0311	0.0915	0.0211	0.0367	0.0211	-0.00596
	(0.135)	(0.136)	(0.0902)	(0.0904)	(0.0994)	(0.0929)	(0.106)	(0.0883)	(0.102)	(0.0906)	(0.0951)
ROA_w	**-4.704*** **	**-4.994*** **	**-4.123** **	**-2.992** **	**-3.651** **	**-2.694* **	**-4.199** **	**-3.039* **	**-3.718** **	-2.563	**-3.893** **
	(1.369)	(1.208)	(1.550)	(1.158)	(1.312)	(1.397)	(1.648)	(1.561)	(1.501)	(1.587)	(1.296)
s_prof_neg	**0.0293** **	**0.0261** **	0.0183	0.0209	0.0161	-0.00945	0.0279	0.00275	-0.00292	0.00835	**0.0289* **
	(0.0111)	(0.00967)	(0.0134)	(0.0129)	(0.0120)	(0.0102)	(0.0173)	(0.0129)	(0.0100)	(0.0117)	(0.0140)
LOG_RWA_D_w	**0.743*** **										
	(0.0398)										
LOG_ASSETS_D_w		**0.771*** **									
		(0.0420)									
LOG_LENDING_NF_D_w			**0.138** **								
			(0.0521)								
LOG_NFC_D_w				0.0630							
				(0.0384)							
LOG_RETAILNFC_D_w					**0.119** **						
					(0.0407)						
LOG_OthExp_D_w						0.0171					
						(0.0115)					
LOG_LRExp_D_w							**0.328*** **				
							(0.0773)				
LOG_TBExp_D_w								0.00295			
								(0.00657)			
LOG_SovExp_D_w									0.0141		
									(0.0233)		
LOG_RetExp_D_w										**0.120** **	
										(0.0526)	
LOG_CorpExp_D_w											**0.0952** **
											(0.0349)
Constant	-0.00433	-0.00419	0.00434	0.000594	0.00306	-0.000200	0.00353	0.000744	0.00552	-0.00218	0.00503
	(0.00680)	(0.00586)	(0.00718)	(0.00541)	(0.00636)	(0.00675)	(0.00845)	(0.00759)	(0.00687)	(0.00767)	(0.00608)
Observations	717	717	708	691	701	687	714	613	699	656	710
Banks	84	84	84	84	84	83	84	75	83	79	84
Countries	14	14	14	14	14	14	14	14	14	14	14
Degree of freedom	12	12	12	12	12	12	12	12	12	12	12
r2 overall	0.531	0.515	0.165	0.124	0.151	0.0932	0.233	0.0972	0.0952	0.138	0.137
r2 within	0.520	0.516	0.0962	0.0677	0.0980	0.0475	0.223	0.0323	0.0337	0.0901	0.0921
r2 between	0.463	0.398	0.586	0.505	0.463	0.340	0.0143	0.332	0.332	0.312	0.286

Regression results for the determinants of management action on capital – dependent variable *MAC_1L_CET1_w*

Robustness check with estimates for the independent variable *MAC_1L_CET1_w* instead of *MAC_3_CET1_w* — Table A4.7

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
L.Z_w	-3.74e-05	-3.37e-05	0.000124	0.000200	0.000195	0.000137	2.99e-05	2.61e-05	0.000115	0.000206	8.51e-05
	(0.000380)	(0.000385)	(0.000336)	(0.000332)	(0.000330)	(0.000382)	(0.000393)	(0.000440)	(0.000335)	(0.000336)	(0.000343)
RD_D_w	-0.0236	0.0694	0.0363	0.0243	0.0239	0.0407	0.0513	0.0758	0.0423	0.0349	0.0338
	(0.103)	(0.0808)	(0.0893)	(0.0946)	(0.0918)	(0.0967)	(0.0865)	(0.111)	(0.0870)	(0.0970)	(0.0904)
ROA_w	2.736	2.736	2.863	**3.429****	2.967	**3.170***	2.715	**3.699***	2.797	**3.112***	2.856
	(1.682)	(1.677)	(1.779)	(1.627)	(1.750)	(1.736)	(1.820)	(1.976)	(1.772)	(1.791)	(1.787)
s_prof_neg	0.00808	0.00800	0.00746	0.00575	0.00273	0.000657	0.00755	0.0197	0.00728	0.00301	0.00710
	(0.0355)	(0.0356)	(0.0409)	(0.0420)	(0.0424)	(0.0383)	(0.0394)	(0.0427)	(0.0406)	(0.0421)	(0.0410)
LOG_RWA_D_w	0.0542										
	(0.0468)										
LOG_ASSETS_D_w		0.0454									
		(0.0352)									
LOG_LENDING_NF_D_w			0.00543								
			(0.00628)								
LOG_NFC_D_w				0.00510							
				(0.00593)							
LOG_RETAILNFC_D_w					0.00655						
					(0.00747)						
LOG_OthExp_D_w						0.000275					
						(0.00332)					
LOG_LRExp_D_w							0.0241*				
							(0.0139)				
LOG_TBExp_D_w								0.00762			
								(0.00616)			
LOG_SovExp_D_w									**0.00864****		
									(0.00374)		
LOG_RetExp_D_w										-0.00865	
										(0.00594)	
LOG_CorpExp_D_w											0.00683
											(0.00744)
Constant	**0.0119****	**0.0120****	**0.0119****	**0.0109****	**0.0118****	**0.0117****	**0.0123****	0.00963	**0.0122****	**0.0125****	**0.0118****
	(0.00523)	(0.00512)	(0.00529)	(0.00478)	(0.00526)	(0.00499)	(0.00556)	(0.00669)	(0.00525)	(0.00554)	(0.00535)
Observations	919	919	904	870	893	882	909	669	899	848	903
Banks	154	154	154	151	153	154	154	119	153	145	154
Countries	26	26	26	26	26	26	26	26	26	26	26
Degree of freedom	25	25	25	25	25	25	25	25	25	25	25
r2 overall	0.000406	0.000275	9.73e-05	0.000541	0.000129	5.29e-05	5.47e-05	0.00170	0.000236	4.51e-05	7.96e-05
r2 within	0.0101	0.00955	0.00885	0.0129	0.0108	0.0110	0.00860	0.0182	0.00991	0.0118	0.00868
r2 between	0.000233	0.000341	0.000596	0.000317	0.000968	0.00147	0.000871	0.00347	0.000539	0.00205	0.000644

* The number of observations is smaller for *MAC_1L_w* than for *MAC_3_w*, because we restrict the sample to non-zero observations. Otherwise, the variation of the dependent variable is low and might influence the estimation.

Regression results for the determinants of management action on capital – dependent variable *MAC_2_CET1_w*

Robustness check with estimates for the dependent variable *MAC_2_CET1_w* instead of *MAC_3_CET1_w* Table A4.8

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
L.Z_w	-0.000165	-0.000153	-4.99e-05	5.55e-05	1.58e-05	8.87e-06	-0.000117	-6.36e-05	-6.83e-05	1.29e-05	-0.000105
	(0.000330)	(0.000338)	(0.000308)	(0.000301)	(0.000304)	(0.000346)	(0.000336)	(0.000366)	(0.000306)	(0.000312)	(0.000319)
RD_D_w	0.0911	0.164	0.152	0.135	0.141	0.155	0.166	**0.208***	0.162	0.157	0.148
	(0.105)	(0.101)	(0.104)	(0.111)	(0.106)	(0.111)	(0.102)	(0.122)	(0.101)	(0.112)	(0.104)
ROA_w	2.147	2.182	2.454	**3.205****	**2.621***	**2.799****	2.373	**3.601****	2.332	**2.770***	2.429
	(1.387)	(1.399)	(1.463)	(1.202)	(1.403)	(1.337)	(1.468)	(1.387)	(1.432)	(1.401)	(1.478)
s_prof_neg	0.00614	0.00504	0.0125	0.0107	0.00711	0.00644	0.00639	0.0205	0.0128	0.00820	0.0110
	(0.0341)	(0.0340)	(0.0410)	(0.0419)	(0.0423)	(0.0387)	(0.0380)	(0.0405)	(0.0410)	(0.0422)	(0.0406)
LOG_RWA_D_w	0.0531										
	(0.0424)										
LOG_ASSETS_D_w		0.0195									
		(0.0338)									
LOG_LENDING_NF_D_w			-0.00271								
			(0.00764)								
LOG_NFC_D_w				-0.00454							
				(0.00835)							
LOG_RETAILNFC_D_w					-0.00450						
					(0.0107)						
LOG_OthExp_D_w						0.00194					
						(0.00372)					
LOG_LRExp_D_w							0.0127				
							(0.0236)				
LOG_TBExp_D_w								0.00548			
								(0.00625)			
LOG_SovExp_D_w									**0.0115***		
									(0.00587)		
LOG_RetExp_D_w										**-0.0141***	
										(0.00750)	
LOG_CorpExp_D_w											0.000218
											(0.0110)
Constant	**0.0262*****	**0.0264*****	**0.0257*****	**0.0241*****	**0.0253*****	**0.0255*****	**0.0257*****	**0.0207*****	**0.0260*****	**0.0263*****	**0.0256*****
	(0.00426)	(0.00422)	(0.00426)	(0.00373)	(0.00424)	(0.00393)	(0.00449)	(0.00487)	(0.00421)	(0.00438)	(0.00440)
Observations	919	919	904	870	893	882	909	669	899	848	903
Banks	154	154	154	151	153	154	154	119	153	145	154
Countries	26	26	26	26	26	26	26	26	26	26	26
Degree of freedom	25	25	25	25	25	25	25	25	25	25	25
r2 overall	0.00107	0.000286	0.000307	0.000676	0.000309	0.000145	0.000278	0.00343	0.000794	0.000271	0.000195
r2 within	0.00976	0.00821	0.00770	0.0102	0.00821	0.00890	0.00885	0.0200	0.00933	0.0100	0.00757
r2 between	1.54e-05	0.000519	0.000435	0.000398	0.000516	0.00170	0.000860	0.00390	0.000220	0.000794	0.000635

* The number of observations is smaller for *MAC_2_w* than for *MAC_3_w*, because we restrict the sample to non-zero observations. Otherwise, the variation of the dependent variable is low and might influence the estimation.