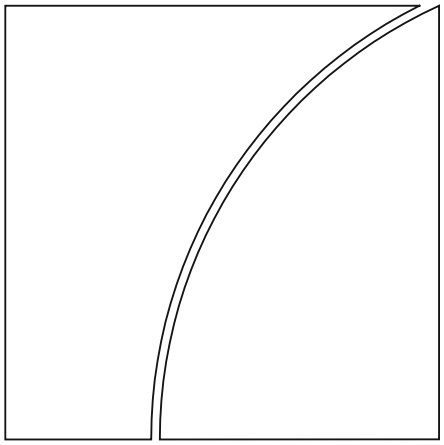
Basel Committee
on Banking Supervision



Evaluation of the impact and efficacy of the Basel III reforms

December 2022

BIS

This publication is available on the BIS website (www.bis.org).

ISBN 978-92-9259-622-4 (online)

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Glossary

AT1	Additional Tier 1
ASF	Available stable funding
BCBS	Basel Committee on Banking Supervision
BIS	Bank for International Settlements
bp	basis point(s)
CAPM	Capital asset pricing model
CCoB	Capital conservation buffer
CCP	Central counterparty
CCyB	Countercyclical capital buffer
CDS	Credit default swap
CET1	Common Equity Tier 1
CoCos	Contingent convertible debt instruments
CPMI	Committee on Payments and Market Infrastructures
CPSS	Committee on Payment and Settlement Systems (since 2014 renamed as CPMI)
DID	Difference-in-differences
D-SIB	Domestic systemically important bank
EDF	Expected default frequency
EU	European Union
EUR	Euro
FOLTF	Failing or likely to fail
FSB	Financial Stability Board
GAAP	Generally Accepted Accounting Principles
GDP	Gross domestic product
GFC	Global Financial Crisis
G-SIB	Global systemically important bank
HLBA	Historical Look-Back Approach
HQLA	High-quality liquid assets
IFRS	International Financial Reporting Standard
IMF	International Monetary Fund
IOSCO	International Organization of Securities Commissions
LCR	Liquidity Coverage Ratio
NSFR	Net Stable Funding Ratio
OBS	Off-balance sheet
OCI	Other comprehensive income
PD	Probability of default
PoNV	Point of non-viability
RSF	Required stable funding
RWA	Risk-weighted asset

SME	Small and medium-sized enterprise
SRS	Supervisory Reporting System
TBTF	Too-big-to-fail
TLAC	Total loss-absorbing capacity

Executive Summary

1. Beginning in 2009, the Basel Committee on Banking Supervision (the Committee) developed a set of new regulatory standards, commonly referred to as the Basel III reforms, in response to the Global Financial Crisis (GFC) of 2007–09. These reforms aimed to strengthen the regulation, supervision and risk management of banks. By improving the banking sector's resilience and ability to absorb shocks arising from financial and economic stress, the reforms were intended to reduce the risk of spillovers from the financial sector to the real economy. The reforms that have been implemented so far include revised definitions of capital and minimum risk-based capital requirements, a minimum leverage ratio requirement to complement the risk-based capital requirements, and two liquidity requirements: the Liquidity Coverage Ratio (LCR) and the Net Stable Funding Ratio (NSFR).

2. This report provides the Committee's first holistic evaluation of the impact and efficacy of the Basel III reforms. It sets out evidence that the overall resilience of the banking sector has increased since the implementation of the Basel reforms. Moreover, the analyses show greater improvements for institutions that were more heavily impacted by the reforms, suggesting that the reforms were an important driver of this increased resilience. Greater resilience did not come at the expense of banks' cost of capital, as banks more heavily impacted by the reforms also saw a greater decrease in their cost of capital. There is no robust evidence and only some indication that banks with lower initial CET1 ratios and LCRs had lower loan growth than their peers. As the overall intent of the reforms has been to strengthen the banking system and mitigate contagion to other parts of the financial system, the report also analyses market-based systemic risk measures, which showed improvement following implementation of the reforms.

3. As the Basel III reforms are multifaceted – including multiple minimum requirements for capital and liquidity – the report also investigates interactions among various elements of the reforms and provides an exploration of their complexity. While the report concludes that the framework does not suffer from redundant elements, it acknowledges increased complexity within the framework. The report does not find considerable evidence of the examined potential negative side effects of the reforms.

4. The scope of the evaluation is limited to those elements of Basel III that were implemented by 2019.[1] Empirical analysis of the reforms' indirect effects and other possible externalities (such as the impact of the reforms on market intermediation) are outside of the scope of this report. The evidence presented in the report is based on bank-level data that the Committee has been collecting, augmented with additional market and macroeconomic data.[2] The report considers other existing evidence from academic and jurisdictional studies, as well as qualitative analysis and a survey of Committee member and observer organisations, to assess potential side effects. The evaluation is primarily based on the period up to 2019 in order to assess the impact of the reforms immediately following their introduction.[3] This period was characterised by broadly stable economic conditions accompanied by low interest rates and accommodative monetary policies in most jurisdictions, ie the assessment is not informed by different macroeconomic environments across countries. The empirical methodology used in this report aims to clearly identify the stated effects, controlling for general trends and a variety of alternative explanations.

5. This report is the Committee's third evaluation of the impact of Basel III reforms. In July 2021, the Committee published its preliminary assessment of whether the Basel III reforms implemented prior to the

[1] The exploratory complexity analysis in Section 10 of the report takes into account the full Basel III finalisation package which will take effect from 1 January 2023, ie including the standards finalised in December 2017.

[2] The Committee's data collection consists of a semiannual data collection through the Basel III monitoring exercise and data from supervisory reporting systems (SRS).

[3] Whenever available, the report also presents descriptive data regarding the period after 2019 in the introduction of each chapter.

report had functioned as intended in light of the Covid-19 pandemic.[4] In October 2022, the Committee published an examination of several follow-up questions regarding the usability of capital and liquidity buffers, as well as potential sources of cyclicality in the Basel Framework.[5] Complemented by these two initial reports, this report takes a broader perspective and presents an in-depth analysis of the Basel III reforms since their implementation.

Results regarding banks' resilience and systemic risk

6. The Basel III reforms include revised definitions of capital and minimum risk-based capital requirements in order to enhance banks' loss-absorbing capacity. This has been achieved through the standardisation of capital instruments, driven by explicit criteria for Common Equity Tier 1 (CET1) and Additional Tier 1 (AT1) eligibility.

7. Banks have significantly increased their CET1 ratios since the publication of the Basel III reforms. CET1 ratios increased more for banks that were more heavily impacted by the implementation of the reforms, consistent with the improvement driven by the capital reforms. In line with the objectives of Basel III, this improvement in capital ratios was achieved largely through a substantial increase of capital in the banking system rather than through reductions in exposures or risk-weighted assets. With regard to AT1 instruments, the report does not arrive at robust empirical conclusions regarding their loss-absorption capacity.

8. With regard to the leverage ratio, for most banks the results are consistent with the new requirement's role as a complement and backstop to risk-based capital requirements. As with the risk-based capital ratios, the leverage ratio has, on average, increased; this is attributable primarily to the increase of Tier 1 (CET1 and AT1) capital. The analysis also indicates that the 2014 and 2017 amendments to the leverage ratio standard helped make the leverage ratio more comparable across jurisdictions with different accounting standards.

9. In addition to their capital positions, banks have also improved their liquidity positions. They have done so by increasing their levels of high-quality liquid assets (HQLA) and reducing their reliance on unstable, short-term funding sources. Banks that had larger LCR shortfalls when the reforms were introduced subsequently increased their LCRs more than banks that had smaller shortfalls or that had no shortfall. Banks have also increased the overall stability of their funding profiles, as measured by the NSFR, by increasing their available stable funding (ASF) more than their required stable funding (RSF). Banks that had larger NSFR shortfalls when the reforms were introduced subsequently increased their NSFRs more than banks with smaller shortfalls or no shortfall. This suggests that the LCR and NSFR requirements were drivers of the observed increases, even after accounting for general market trends.

10. Overall, the report confirms that the reforms coincided with improvements in capital and liquidity positions, particularly at the banks with the weakest capital and liquidity ratios. Furthermore, there is some indication that banks that had low capital ratios at the time of the reforms experienced a greater improvement in market-based resilience measures, which suggests that the observed effect is related to these reforms.

11. The Basel III reforms also aimed to broadly reduce systemic risk in the banking sector. The report finds that market-based measures of banking sector systemic risk have improved following the implementation of the Basel III capital and liquidity reforms, making the financial system less vulnerable to individual banks' distress. Further, higher risk-based capital and leverage ratios are associated with lower levels of systemic risk. Moreover, there is evidence that higher capital requirements for global systemically important banks (G-SIBs) decreased the market's perception of their levels of systemic risk. Overall, this suggests that enhancing banks' capital positions, an objective of the Basel III reforms,

4 See BCBS (2021).

5 See BCBS (2022b).

dampens the negative feedback effects between banks under stress and reduces negative spillovers to the real economy.

Results regarding banks' lending and capital costs

12. Overall, the report does not find considerable evidence of the examined negative side effects of the Basel III reforms. The analysis indicates that banks complying with the Basel III requirements lowered their costs of both debt and equity. This decrease was more pronounced for those banks with lower initial capital ratios, suggesting that market participants recognised the de-risking of banks resulting from Basel III by lowering the cost to banks of accessing capital markets.

13. In terms of lending to the real economy, there is no robust evidence and only some indication that banks with lower initial CET1 ratios and LCRs had lower loan growth than their peers. At the same time, the overall level of bank lending expanded in most jurisdictions. This suggests that, while the reforms may have limited lending by banks with weaker initial regulatory ratios, there is no indication that the reforms impaired the aggregate supply of credit to the economy.

Results regarding interactions and complexity within the Basel III framework

14. The Basel III framework is a multi-dimensional framework with several requirements for both capital and liquidity. The adoption of the Financial Stability Board (FSB) resolution framework has introduced another layer of loss-absorbing capacity outside the scope of the Basel Framework. Therefore, this evaluation also investigates the interactions of these multiple requirements and their impact on banks' resilience and lending.

15. Various analyses in the report suggest that the risk-based capital and leverage ratio requirements support each other given that they bind in different stages of economic cycles and across different business models, and cover different types of risk. Analysis of the interaction between the capital and liquidity frameworks reveals partially overlapping contributions – both improve banks' resilience, but in different ways. Further analysis of the interaction between the LCR and NSFR illustrates that both liquidity requirements help enhance banks' resilience, but the marginal benefit to resilience from increasing one ratio is dampened when the other ratio is also increased.

16. The analysis of interactions between Basel III and resolution frameworks focuses mostly on qualitative information and case studies given the extremely low number of large banks that have failed since the GFC and the very few observations for banks with Total Loss-Absorbing Capacity (TLAC) instruments. The report discusses how this interaction reinforces the resilience of the financial system by reducing the cost of a potential crisis.

17. While the more sophisticated and multi-dimensional framework introduced through Basel III addresses a variety of risks in order to enhance bank resilience, this comes at the cost of greater regulatory complexity. The report does not assess whether regulatory complexity could be reduced while maintaining banks' resilience.

1. Introduction

18. The Basel III reforms, developed by the Committee in response to the GFC, were finalised in December 2017.[6] Evaluating the impact of these reforms is an imperative of the Committee in its role as the primary global standard setter for the prudential regulation of banks.[7]

19. The GFC and, more recently, the Covid-19 pandemic revealed the importance of a resilient banking system in order to avoid spillovers from the banking sector to the real economy in times of stress, reducing systemic risk and averting public bailouts. The Basel III reforms address shortcomings of the pre-crisis regulatory framework and provide a regulatory foundation for a resilient banking system. They strengthen the microprudential regulation of individual banks and include macroprudential elements to address system-wide risks that can build up across the banking sector.[8] These reforms comprise capital and liquidity standards in a multi-dimensional framework with parallel regulatory requirements. Since finalising these reforms, the Committee has focused on their full, timely and consistent implementation.

20. The principles for the Committee's evaluation work are threefold. First, standards must be fully implemented before they are evaluated. This delimits the scope of the reforms evaluated in this report, which include risk-based and leverage capital requirements as well as the liquidity requirements adopted since 2010. The set of Basel III reforms finalised in 2017, which have yet to be implemented, are therefore excluded from this evaluation.[9] Second, evaluations should be based on rigorous conceptual and empirical analysis and should be agnostic to the outcome. As such, this report is not motivated by any policy agenda or proposal but rather is solely focused on the evidence and its accurate analysis, including acknowledgment of limitations and inconclusive evidence. Third, evaluations must reflect other relevant analyses and viewpoints. To this end, the core quantitative analysis presented in this report is complemented with qualitative analysis, surveys and jurisdictional studies, as well as references to relevant research and input from outreach discussions with stakeholders.

21. One key goal of the Committee's ex post evaluation of the Basel III framework is to assess the reforms in relation to their ex ante objectives. In particular, the evaluation seeks to address the question of whether the reforms have enhanced the resilience of and reduced systemic risk in the banking sector. Accordingly, the analyses in this report test for improvements that stem from the reforms both in terms of regulatory ratios and market-based measures of resilience and systemic risk. The evaluation also seeks to determine whether the reforms have had any side effects, particularly if those effects have negative economic consequences. For that, the analysis focuses on banks' behaviour in response to the reforms, mostly in terms of lending and the impact on banks' cost of equity and debt funding. And lastly, the analysis addresses the question of interactions across the different reforms in order to identify whether they amplify or dampen each other's impact.

22. The decade following the implementation of the initial set of Basel III reforms was free of a banking crisis of the same severity as the GFC. However, the Covid-19 pandemic was a severe shock across the globe with both public health and economic repercussions. The Committee conducted an initial

6 See BCBS, *Basel III: Finalising post-crisis reforms*, December 2017, www.bis.org/bcbs/publ/d424.htm.

7 See P Hernández de Cos, "Lessons from Covid-19 on Basel reforms and next steps", 11 May 2022, www.bis.org/speeches/sp220511.htm; "Evaluating the effectiveness of Basel III during Covid-19 and beyond", 20 April 2021, www.bis.org/speeches/sp210420.htm; and "Post-Basel III: time for evaluation", 24 October 2019, www.bis.org/speeches/sp191024.htm.

8 These micro- and macroprudential approaches to supervision are interrelated, as greater resilience at the individual bank level reduces the risk of system-wide shocks, but conflicts could also occur, especially during the downward phase of the credit cycle (see J Osiński, K Seal and L Hooduin, "Macroprudential and ,microprudential policies: toward cohabitation", *IMF Staff Discussion Note*, no 13/05, June 2013, www.imf.org/external/pubs/ft/sdn/2013/sdn1305.pdf.

9 See BCBS, *Basel III: Finalising post-crisis reforms*, December 2017, www.bis.org/bcbs/publ/d424.htm. Note that the exploratory complexity analysis in Section 10 of the report takes into account the full Basel III finalisation package.

assessment of whether the Basel III standards implemented to date had functioned as intended through the onset of the pandemic in its July 2021 report, *Early lessons from the Covid-19 pandemic on the Basel reforms* (hereafter the "July 2021 BCBS report").[10] In general, the report concluded that the banking sector is much better positioned to absorb shocks rather than amplify them, as it had done in the GFC. The Committee also has completed follow-up analyses of capital and liquidity buffers and aspects of cyclicality in the Basel Framework, looking at experience beyond the pandemic period and considering broader evidence. These analyses were set out in a subsequent report, *Buffer usability and cyclicality in the Basel Framework*, published in October 2022 (hereafter the "October 2022 BCBS report").[11] The report found some indication of a positive relationship between capital headroom and lending. Further, the report also indicated that temporary reductions in capital requirements supported lending during the pandemic.

23. This report takes a step back from the Covid-19 period and considers the impact of the Basel III reforms since their announcement. The analysis evaluates the capital and liquidity standards' individual contributions to and joint impact on the resilience of global banks. The report relies on the bank-level data that the Committee has collected since 2011 – the most complete and consistent source for bank regulatory ratios globally – and builds on prior reports and analyses. All of the Committee's evaluation reports complement the series of evaluations conducted by the FSB, to which the Committee has provided input.[12]

24. This report is organised into the following sections. It begins with a description of the Basel III regulatory landscape and standards which fall within the scope of the evaluation (Section 2) and of the data and methodology used throughout the report (Section 3). Evaluation of the reforms starts with an analysis of the impact of the reforms on bank resilience (Section 4) and on systemic risk (Section 5). This is followed by a closer look at the capital reforms (Section 6) and the liquidity reforms (Section 7), before turning to an investigation into possible side effects of these reforms on banks' lending, cost of capital and business models (Section 8). Lastly, the report examines interactions within and among the Basel III and resolution reforms (Section 9) and provides an exploratory consideration of complexity in the Basel III framework (Section 10). Supporting detail and analysis is set out in an accompanying Annex document.

2. Regulatory landscape: Basel III reforms and resolution framework

25. This section briefly describes the Basel III reforms in scope for this evaluation, including the motivation for their introduction and their intended outcomes, which are used as the basis for the empirical analyses conducted for the evaluation.

26. As a central element of the Committee's response to the GFC, the Basel III framework includes an initial set of reforms announced in 2010, a series of additions over the following years and a final package of reforms adopted in 2017. The standards in the scope of this evaluation focus on those reforms already implemented by most member jurisdictions. The initial set of reforms includes the revised definitions of capital, minimum risk-based capital requirements and the non-risk-based leverage ratio (referred to as the capital reforms) and two standards to address liquidity risk – the LCR and NSFR (referred to as the liquidity reforms). The report also considers the resolution framework established by the FSB in order to evaluate

[10] See BCBS (2021).

[11] See BCBS (2022b).

[12] For example, the FSB has analysed the effects of the too-big-to-fail (TBTF) reforms (see Financial Stability Board, *Evaluation of the effects of too-big-to-fail reforms*, 1 April 2021, www.fsb.org/wp-content/uploads/P010421-1.pdf) and the effects of financial regulatory reforms on small- and medium-sized enterprise (SME) financing (see Financial Stability Board, *Evaluation of the effects of financial regulatory reforms on small and medium-sized enterprise (SME) financing*, 29 November 2019, www.fsb.org/wp-content/uploads/P291119-1.pdf).

its interactions with the Basel III reforms. The specific details of these reforms and how they are expected to enhance bank resilience and reduce systemic risk are presented below.

27. This section first summarises the capital reforms (Section 2.1) and the liquidity reforms (Section 2.2). It then summarises the FSB resolution framework (Section 2.3) and sets out an explanation of reform announcement dates and how those are factored into the report's analysis (Section 2.4).

2.1 Capital reforms

28. The GFC revealed deficiencies in the definition of regulatory capital, its calibration and its implementation across jurisdictions. Tier 1 capital was the highest form of regulatory capital under Basel II and, in certain instances, included instruments that proved unable to absorb losses on a going-concern basis. The definition of regulatory capital also lacked regulatory adjustments (ie deductions from banks' own funds), which made it difficult to determine how much bank capital would be available for effective loss absorption under stressed conditions. Furthermore, the Basel II framework lacked measures to prevent banks from building up excessive leverage from on- and off-balance sheet sources. When credit risk materialised in financial markets during the GFC, banks with excessive leverage were forced to sell assets at significantly reduced prices to meet repayment maturities and maintain solvency, which exacerbated losses, downward pressure on asset prices, capital depletion and the subsequent credit crunch.

29. The reforms to the capital framework involved a standardisation of the definition of regulatory capital and a build-up, both in quantity and quality, of the capital instruments that count towards the minimum regulatory ratios. The revised definition of capital further differentiates qualifying instruments by their loss-absorption capacity and by their availability on a going- or gone-concern basis.

30. Basel III introduced CET1 as the highest-quality form of regulatory capital. CET1 consists of common shares issued by banks, retained earnings, other comprehensive income (OCI) and other reserves. These items are modified by a range of specified deductions and adjustments. The minimum CET1 requirement is set at 4.5% of risk-weighted assets (RWA).

31. CET1 is a component of Tier 1 capital, which also includes AT1 capital instruments. Basel III allows for a number of instruments to qualify as AT1, including instruments structured as contingent convertible debt instruments (CoCos) or preferred shares, depending on their conversion and writedown features. Total capital includes Tier 1 and Tier 2 capital, with the latter mainly composed of gone-concern instruments such as subordinated term debt, which must absorb losses before depositors and general creditors. The minimum Tier 1 and total capital requirements are set at 6% and 8% of RWA, respectively.

32. In addition to minimum risk-based capital requirements, the capital framework also includes several buffers that must be satisfied with CET1 capital. The capital conservation buffer (CCoB), set at 2.5% of RWA, is applicable to all banks. The G-SIB buffer currently ranges from 1% to 3.5% of RWA for the most systemically important banks. In addition, national authorities can set a buffer for domestic systemically important banks (D-SIBs).[13] The countercyclical capital buffer (CCyB) can range from 0% to 2.5% of RWA and is applicable to banks operating in jurisdictions that implement the buffer.[14]

33. In addition to the aforementioned requirements and buffers (which make up the Pillar 1 process), the Basel III framework sets out a supervisory review process whereby jurisdictions may establish bank-specific Pillar 2 requirements (and potential guidance) to address risks which are not sufficiently covered

[13] According to revisions to the Basel III framework finalised in 2017, beginning in January 2023, G-SIBs will also be subject to a leverage ratio buffer requirement that will be set at 50% of the bank's G-SIB buffer.

[14] The Basel III framework acknowledges that "national authorities can implement a range of additional macroprudential tools, including a buffer in excess of 2.5% for banks in their jurisdiction, if this is deemed appropriate in their national context. However, the international reciprocity provisions set out in this regime treat the maximum countercyclical buffer as 2.5%". (See BCBS, *The Basel framework*, RBC 30.9 footnote 2).

by Pillar 1. For example, Pillar 2 requirements may result from bank-specific outcomes of supervisory stress tests.

34. Overall, the capital buffer and Pillar 2 frameworks are intended to reduce capital shortfalls from several sources. While the CCoB and Pillar 2 requirements have a microprudential objective, the CCyB and the G-SIB and D-SIB buffers provide macroprudential features to the framework. Specifically, the CCyB is intended to protect the banking system against future potential losses when excess aggregate credit growth is associated with a build-up of system-wide risk. While the risk-based capital standard was broadly implemented by end-2013, there was a longer phase-in period for the buffers.

35. As a new requirement introduced by Basel III, the objective of the leverage ratio is to supplement the risk-based ratio with a simple, transparent and non-risk-based measure that can act as a backstop to risk-based capital requirements.[15] As such, it is expected to increase resilience for the minority of banks that are bound by the leverage requirements rather than the risk-based capital requirements. The leverage ratio is intended to restrict the build-up of excessive leverage throughout the credit cycle and avoid abrupt deleveraging, which could amplify a credit downturn. The leverage ratio is expressed as Tier 1 capital divided by a non-risk-weighted measurement of total on- and off-balance sheet exposures. The minimum Tier 1 leverage ratio requirement is set at 3%.[16] While the leverage ratio standard was not in effect as a Pillar 1 requirement until 2018, banks were expected to publicly report their leverage ratios starting in 2015.

36. The Basel III reform package also features revisions to the measurement of RWA in the risk-based capital framework (including adjustments made to the standards on credit risk, market risk, counterparty credit risk, securitisation risk, credit valuation adjustment risk and operational risk), a framework for measuring and controlling large exposures and the introduction of an output floor. The specific impact of these standards is not within the scope of this report, as many of these standards were only finalised as of December 2017 or later, or have yet to be implemented in most jurisdictions.[17]

2.2 Liquidity reforms

37. The role of banks in market intermediation and in the maturity transformation of short-term deposits into long-term loans makes them inherently vulnerable to liquidity risk. The GFC exposed a number of cases where banks did not hold enough sufficiently liquid assets to manage the impact of their short-term funding being withdrawn. Some assets that were considered high quality, such as certain asset-backed securities, saw large declines in price and a reduction in liquidity during the crisis, intensifying liquidity pressures throughout the financial system. Those pressures were also amplified by banks' increased reliance on short-term wholesale funding and unexpected outflows from supposedly stable counterparties in the run-up to the crisis. Sudden withdrawals of funding resulted in fire-sale scenarios, whereby banks' attempts to quickly sell assets in the absence of alternative funding led to significant haircuts and substantial losses, which also affected other banks that had to mark such positions to market. These factors contributed to widespread problems in many jurisdictions, including dried up inter-bank lending, bank failures and a contraction in the supply of bank credit to the real economy.

[15] See BCBS (2010b).

[16] Note that this does not include an additional G-SIB leverage ratio surcharge not yet due for implementation.

[17] The analysis of capital reforms in Section 6 includes 2017 amendments to the leverage ratio standard, and the exploratory complexity analysis in Section 10 takes into account the full Basel III finalisation package. In some jurisdictions, the large exposures framework was not in place by 2020; as such, it is not included in the scope of this report.

38. The Basel III framework introduced two liquidity requirements: the LCR[18] and the NSFR.[19] These ratios reflect the dichotomy between acute short-term shocks and longer-term asset and liabilities mismatches, as discussed in the academic literature.[20] They also provide a common definition and hierarchy for liquid assets, similar to the standardisation of capital instruments.

39. The LCR aims to ensure that banks have a large enough stock of HQLA to meet their obligations in a significant stress scenario (combining idiosyncratic and market-wide shocks) lasting 30 calendar days. An asset can be included in the stock of HQLA if it is unencumbered, meets certain fundamental and market-related criteria, and can be easily and immediately converted into cash at little or no loss of value. The LCR sets the required ratio of HQLA to total net cash outflows over a 30-day stress scenario period to at least 100% in normal times.

40. The NSFR aims to ensure that banks have stable funding profiles relative to the composition of their assets and off-balance sheet activities over a longer time period, reducing the risk of prolonged strains in funding conditions. The NSFR sets the required ratio of the amount of ASF over a one-year horizon to the amount of RSF to at least 100%.

41. The LCR and NSFR are complemented with specific principles to strengthen liquidity risk management and supervision[21] as well as a set of liquidity risk monitoring tools to measure other dimensions of a bank's liquidity and funding risk profile.[22] Along with Pillar 3 reporting for liquidity, these elements of the framework provide assurance that supervisors have a broader view of liquidity risks, including risks not specifically or fully covered by the LCR or the NSFR, such as intraday liquidity risk.[23] Although the LCR was implemented in most jurisdictions in 2015, the NSFR was not implemented in most jurisdictions until after 2019.

2.3 Resolution framework

42. Although separate from the Basel III reforms, the resolution framework established by the FSB in 2015 is another regulatory development designed to limit the cost of a crisis in the global banking system and mitigate "too-big-to-fail" (TBTF) risks. Applicable only to G-SIBs, this framework is intended to facilitate orderly resolution without creating severe systemic disruptions or exposing taxpayers to the risk of loss. The framework gives power and tools to national resolution authorities. It also requires banks to conduct recovery and resolution planning and to meet TLAC requirements in parallel with the Basel III capital requirements. TLAC requirements can be met by a portion (up to 67%) of instruments that are eligible to satisfy minimum regulatory capital requirements, plus debt liabilities and other TLAC-eligible instruments that meet certain criteria.[24] The required TLAC ratios are set separately from those of the Basel III capital framework (ie TLAC/RWA and TLAC/leverage exposure are to be greater than 18% and 6.75%, respectively, as of January 2022). The Basel Framework's TLAC holdings standard took effect in 2019.[25]

[18] See BCBS, *Basel III: The Liquidity Coverage Ratio and liquidity risk monitoring tools,* January 2013, www.bis.org/publ/bcbs238.pdf.

[19] See BCBS, *Basel III: the Net Stable Funding Ratio,* October 2014, www.bis.org/bcbs/publ/d295.pdf.

[20] Bai et al (2018) and Berger and Bouwman (2009) are examples of this literature.

[21] See BCBS, *Principles for sound liquidity risk management and supervision,* September 2008, www.bis.org/publ/bcbs144.pdf.

[22] See BCBS, *Basel III: The Liquidity Coverage Ratio and liquidity risk monitoring tools,* January 2013, www.bis.org/publ/bcbs238.pdf.

[23] See BCBS, *Monitoring tools for intraday liquidity management,* April 2013, www.bis.org/publ/bcbs248.pdf.

[24] See Financial Stability Board, *Total Loss-Absorbing Capacity (TLAC) principles and term sheet*, November 2015, www.fsb.org/2015/11/total-loss-absorbing-capacity-tlac-principles-and-term-sheet/.

[25] Some member jurisdictions implemented additional frameworks, for example the Minimum Requirement for Own Funds and Eligible Liabilities in the EU.

2.4 Reform implementation dates

43. It is important to consider the timing with which the reforms were introduced in order to appropriately measure their impact. To that end, this report uses the term "global announcement date" to refer to the date by which a final standard has been initially published by the Committee.[26] In the process of jurisdictional implementation of the internationally agreed standards, each jurisdiction typically releases a proposal for the new domestic rule, followed by the publication of a final rule. This report refers to the publication date of a proposed rule as the "jurisdictional announcement date". A standard typically goes into effect in a jurisdiction sometime after the publication of a final rule. Jurisdictional announcement dates are the main consideration for this evaluation because banks and market participants typically adjust their actions in relation to the new standards at that point rather than delaying until the publication or implementation of a final rule. Annex A.1 contains a table showing the global and jurisdictional announcement dates based on the Committee's Basel III implementation progress updates.[27]

3. Tools for the evaluation: Data and methodology

44. Most of the following sections rely on a common data set as well as a common empirical methodology to identify the impact of the introduction of Basel reforms. Where warranted, some sections apply variations to this empirical methodology; in these cases, the variations are explained in detail in the respective section. This section sets out the details of both the data (Section 3.1) and the common methodology (Section 3.2) generally used throughout the report.

3.1 Data availability and quality assessment

45. This report is based on three main data sources: (i) the Committee's data from its data collection exercise[28] and Basel III implementation progress updates; (ii) external data, including vendor data and country-specific macroeconomic data; and (iii) an internal survey that was conducted across Committee member and observer organisations (hereafter referred to as the "BCBS member survey"). More details on the data as well as summary statistics are provided in Annex A.2.

46. The Committee's data collection exercises (hereafter referred to as the Committee's data) comprise bank-level data collected through the Basel III monitoring exercise and data from supervisory reporting systems (SRS). It includes semiannual (end-June and end-December) data since 2011 for 377 banks from 26 jurisdictions.[29] The data collection is designed to assess the impact of Basel III reforms on a representative sample of major financial institutions selected by supervisors in each country. Most analyses in this report use data for the period from 2011 through 2019, which was characterised by broadly stable economic conditions accompanied by low interest rates and accommodative monetary policies in most jurisdictions. The focus on the pre-pandemic period rules out confounding effects from pandemic-related measures. Where available, descriptive data that includes the period after 2019 is provided in the introduction of relevant sections of the report. Unlike public data sets, the Committee's data monitor

[26] See www.bis.org/publ/bcbs189_dec2010.htm and www.bis.org/publ/bcbs188.htm.

[27] See BCBS, *RCAP on timeliness: Basel III implementation dashboard*, www.bis.org/bcbs/implementation/rcap_reports.htm.

[28] The Committee's global panel data is the source for all the Basel III Monitoring Reports (See BCBS, *Basel III monitoring report*, www.bis.org/bcbs/publ/d541.htm for the most recent report. The full archive of reports going back to 2012 can be found at the Committee's website at www.bis.org/bcbs/qis/index.htm, and the data can be accessed via dashboards at www.bis.org/bcbs/dashboards.htm).

[29] Note that some data were not collected from banks for H1 2020 due to the Covid-19 pandemic.

banks' regulatory metrics before the regulation is applicable in the individual jurisdictions. The database includes two sets of banks, namely Group 1 and Group 2, with the latter including smaller banks.[30] Additionally, the Committee collects jurisdiction-specific information, including announcement and adoption dates for each standard, through its Basel III implementation progress updates, as described in Section 2.4.

47. The Committee's data provide information on banks' regulatory ratios and risk exposures, funding structure, profitability and asset composition, including average risk weights. To measure bank lending, this report aggregates data collected on lending to retail clients, small and medium enterprises (SME), and non-financial corporate borrowers.[31] The Committee's data allow for a detailed analysis of regulatory ratios and requirements, including not only Pillar 1 requirements, but also capital buffers as applicable.

48. In addition to the Committee's data, the data set used for this report includes vendor-provided bank data, country-specific macroeconomic data and market-based indicators.[32] The vendor bank data include bank balance sheet and profitability variables, which are generally available since 2005, but only for a subset of the larger banks. Macroeconomic data are sourced from the International Monetary Fund (IMF), Bank for International Settlements (BIS), Bloomberg and Datastream. Market-based indicators in the data set include credit default swap (CDS) spread data from Markit, bank rating data from Fitch and expected default frequency (EDF) data from Moody's. In addition, the data set also includes bank probability of default (PD) measures from the BIS Quarterly Review (Goel et al (2019)) as well as systemic risk measures developed in academic literature and estimated using data from DataStream.[33]

49. The resulting data panel provides a detailed picture of internationally active banks' financial positions through the lens of the Basel Framework. It is thus uniquely suited to evaluating changes in bank resilience and behaviour in light of the introduction of Basel III reforms. However, the data set has some limitations that should be noted. For most variables, the sample is not a balanced panel, meaning observations are not available for all banks in all periods. Moreover, some variables have outliers, which may be the result of reporting errors or bank mergers, and may not be representative of the whole banking sector. Hence, many variables were winsorised before running empirical analyses, as described in Annex A.2. In addition, to ensure that the report's analyses are not heavily influenced by outlier banks with extremely specialised business models, the sample has been restricted to banks with total assets of at least EUR 1 billion and with loans to retail clients, SME and non-financial corporate borrowers exceeding 0.5% of total assets at their earliest date of appearance in the data set. Following these adjustments, the data set appears to be well suited to the evaluation of the Basel III reforms, but is limited for the NSFR and TLAC, given fewer observations for those standards following their more recent jurisdictional announcement.

50. The third source of data is a set of responses to an internal BCBS member survey, which was directed to Committee member and observer agencies. The survey included several questions to evaluate the potential side effects of the Basel III reforms, interactions between regulatory requirements, and complexity in the regulatory framework. In total, 27 Committee member and observer agencies responded to the survey in July 2021.

[30] Group 1 banks are those that have Tier 1 capital of more than EUR 3 billion and are internationally active. All other banks are considered Group 2 banks.

[31] These metrics represent total on- and off-balance sheet exposures as measured by the leverage ratio exposure measure values, not including derivatives.

[32] The Committee's global panel data and additional market and macro indicators also were used in the October 2022 BCBS report.

[33] The four systemic risk measures considered are two variants of delta conditional value at risk (ΔCoVaR and Exposure-ΔCoVaR), marginal expected shortfall (MES), and SRISK.

3.2 Methodology

51. The empirical analyses of the impact of the Basel III reforms are primarily conducted via panel fixed-effects regressions. In these regressions, the analyses relate the outcome variable (eg resilience measures, lending growth or cost of capital) to the bank-specific impact of the reforms. In doing so, the analyses aim to rule out general trends as an explanation for the association between the reforms and the outcome. However, as the impact of the reforms across banks is not random, further explanatory variables are included to help mitigate omitted variable bias in regression estimates ("control variables"). The panel fixed-effects regression analyses studying resilience, lending and cost of capital in this report adhere to the following general structure:

$$y_{i,t} = \alpha_i + \theta_t + \gamma \cdot Macro_{c,t-1} + \sum_{\tau>0} \beta_\tau \cdot D_\tau \cdot Impact_i + \varepsilon_{i,t},$$

where $y_{i,t}$ is the value of the outcome variable of interest for bank i at time t; α_i are bank-specific regression intercepts ("bank FE") as required by the fixed-effects estimator; θ_t are (optional) time dummy variables ("time FE") that are meant to filter out time period-specific effects largely unrelated to the Basel reforms; $Macro_{c,t-1}$ are (optional) lagged country-specific (or global) macroeconomic control variables for country c to account for the influence of macroeconomic dynamics such as GDP and interest rates; and D_τ $Impact_i$ are sets of regressors that capture the effect per each unit of Basel reform impact at time τ relative to the jurisidictional announcement date. $\varepsilon_{i,t}$ are the regression error terms.[34]

52. The impact of the Basel reforms is captured through an event window that estimates the reform effect for each period after the "reform event" (which occurs at $\tau = 0$) in the relevant jurisdiction. The "jurisdictional announcement date", ie when a jurisdiction releases a proposal for the new domestic rule (as explained in Section 2.4), is taken as the event date. τ is a time index showing the time distance relative to the jurisdiction-specific reform event. D_τ are dummy variables that are equal to one in the relevant time period τ after the reform event (eg D_2 is equal to one in the year that is two years after the reform event, etc). While the standalone use of D_τ dummies would estimate the average reform effect across all banks for each period after the reform event, the measurement of this effect would be contaminated by any country-specific trends affecting banks which are not controlled for by the macroeconomic variables. This concern is mitigated by estimating the difference in reform effect between more and less impacted banks, multiplying each D_τ by the bank-specific measure of the impact of the reform, $Impact_i$. Specifically, $Impact_i$ is the reform-related key regulatory ratio (eg CET1 ratio for the risk-based capital reforms, LCR and NSFR for the liquidity reforms, etc) at the time of the reform event (ie for $\tau = 0$), multiplied by negative one, as the impact of imposing these requirements on banks' behaviour is greater when the banks' ratios are lower. In the regressions, the time-specific event-window coefficients β_τ will reveal any time patterns in the outcome variable's response to the impact of the reform event. The relevant window of observation is usually within the first five years of the announcement date, or for $\tau < 5$, as banks have generally adjusted to the reforms by that time.

53. Although market measures are available at a higher frequency than the semiannual Committee data, the focus of the evaluation is on the persistent effects rather than the immediate market reaction. This longer-term effect is well estimated with semiannual data. In addition, the expected market anticipation of jurisdictional proposed standard publication limits the usefulness of a narrow observation window around the announcement. However, as noted earlier, the impact of the Basel reforms is not randomly assigned to banks. Consequently, the more and less heavily impacted banks may not be comparable, and will have different regulatory ratios. While the regressions can rule out generally applicable macroeconomic trends as an explanation, alternative explanations based on differences between banks, eg differences between degree of international activity, are possible. The gradual

[34] Standard errors are clustered at the bank level.

introduction of some standards and relevant transition periods also pose identification challenges (eg some banks may respond to the impact of the reforms as soon as they gain knowledge of their development and in advance of a jurisdictional announcement date).

54. The analysis of systemic risk discussed in Section 5 uses a similar event-window methodology. However, the smaller sample size of publicly traded, systemically important banks used in that analysis is insufficient for estimating the reform impact measures of the primary model. Instead, the specification identifies a reform effect by comparing the period when the reforms have been announced against the period when the reforms are not yet proposed. Also, to improve statistical power, that analysis does not include a year-specific estimate and only a single coefficient is estimated for the periods after the announcement date.

55. In addition to the methodologies described above focusing on the introduction of reforms, another panel regression methodology is applied to study the dynamics of capital ratios and liquidity measures as well as the interactions among Basel III reforms. In particular, the capital and liquidity analyses in Sections 6 and 7 relate the impact of the evolution of CET1 ratios and LCRs respectively on those ratios' subcomponents. These analyses differentiate between banks that are more heavily affected (eg lower CET1 ratios or LCR shortfalls) and those less heavily affected by the reforms in order to gain understanding of what types of actions such firms may have undertaken, without inferring causality. The regression analysis of interactions within the Basel III framework, presented in subsection 9.3.2, is based on a standard panel data model because, in addition to each individual reform, the analysis also includes interaction terms in the regressions, the estimation of which does not allow for the inclusion of jurisdictional announcement dates.

56. Finally, this report's assessment of the complexity of the Basel Framework in Section 10 is based on a range of methodologies given that the topic is not suitable for evaluation via a standard panel regression model. More details on the empirical approaches used to assess complexity are available in subsection 10.1.

4. Impact of the Basel III reforms on bank resilience

57. In the GFC, problems in the banking sector created a financial crisis which produced a wider economic crisis. In many jurisdictions, the high cost of bank rescues by taxpayers increased calls for reforms and led to the introduction of the Basel III reforms (BCBS (2010b)). At the time of the publication of the draft standard in 2009 (BCBS (2009)), there was a general debate on the benefits and potential costs of the reform package. Ex ante impact assessments conducted by the Committee and FSB implied the potential for the reforms to have considerable long-term net benefits (BCBS (2010a)).

58. In the years following the introduction of the Basel III reforms, economic conditions generally have been favourable. Over the sample period ending in 2019, the IMF Global Economic Outlook shows an average annual increase in global GDP of 3.1%, with loan growth averaging an even more robust annual increase of 3.9%, according to BIS data.

59. The Covid-19 pandemic has been the only global crisis since the introduction of the reforms. The July 2021 BCBS report indicated that the banking system remained resilient through the pandemic, strengthened by substantial increases in bank capital and liquidity. Both improvements helped banks to complement and support monetary and fiscal authorities' efforts to maintain economic activity during the pandemic.

60. This section of the report assesses the impact of the introduction of the reforms on the resilience of individual banks. Resilience in this context means that banks can withstand a negative shock – from whatever source – and recover quickly and comprehensively from it. Resilient banks maintain a sound capital and liquidity base. Furthermore, banking resilience is reflected in market participants' trust that

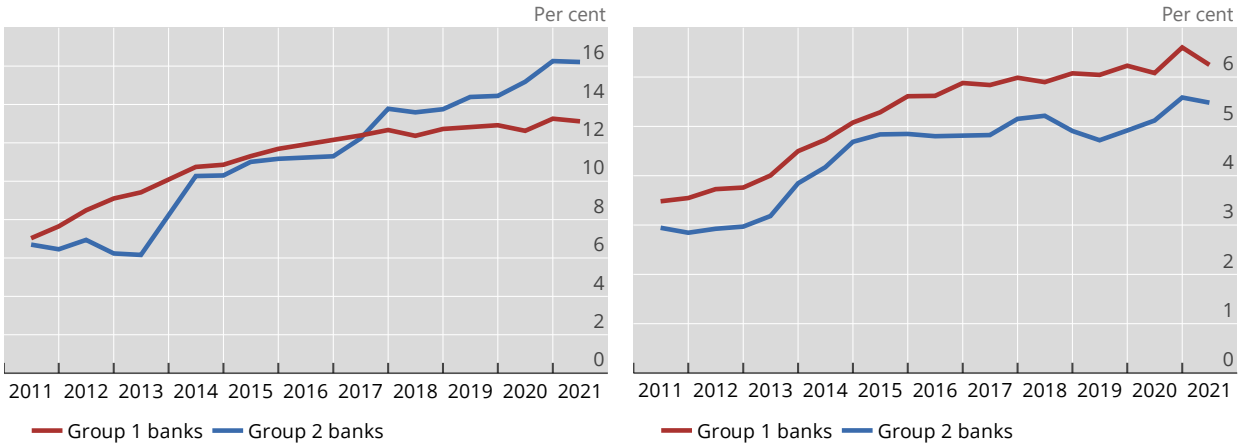
banks can withstand adverse conditions. Therefore, in addition to investigating changes in banks' regulatory capital and liquidity ratios (Section 4.1), this section investigates how changes in market-based measures of bank solvency relate to the Basel III reforms (Section 4.2). Resilient banks are a critical part of a financial system's resilience, a concept that is addressed further in Section 5.

4.1 Impact of the Basel III reforms on regulatory measures of capital and liquidity adequacy

61. The Basel III reforms coincided with a significant improvement in banks' regulatory capital and liquidity ratios. Graph 1.1 shows that over the period 2011–21, the weighted average CET1 ratios of a balanced data set of banks in the Basel III monitoring exercise improved from around 7% to around 13%, with a proportional improvement in the leverage ratio from around 3.5% to around 6.5%. Both measures suggest an improvement in banks' ability to absorb losses on their assets. As the report shows in Section 6, this improvement mainly reflects an increase in capital, but also partly stems from a reduction in RWA or exposures for some banks. Meanwhile, the LCR and NSFR introduced by Basel III show sharp improvement through 2021 in Graph 1.2.[35]

Weighted average capital ratios

Balanced data set — Graph 1.1

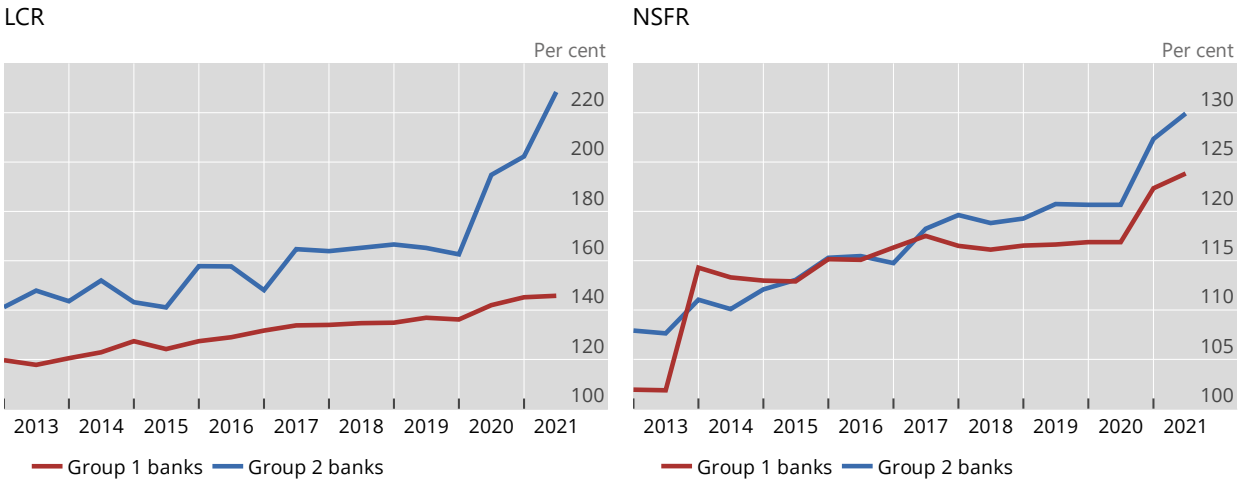


Source: Basel Committee on Banking Supervision.

[35] The recent rise in LCR levels is in part due to the substantial increase in financial system liquidity given the policy responses of national governments and central banks to the Covid-19 stress.

Weighted average liquidity ratios

Balanced data set — Graph 1.2



Source: Basel Committee on Banking Supervision.

62. The Basel III framework introduced a non-risk-based leverage ratio to act as a credible supplementary "backstop" measure to the risk-based capital requirements. The leverage ratio, relative to the risk-based Tier 1 ratio, is binding only for a smaller proportion of banks, in line with its "backstop" function as intended by the Committee.[36]

63. Having demonstrated an overall improvement in regulatory ratios over time, the next analysis seeks to connect these improvements to the Basel III reforms. The Basel III reforms required banks with lower capital and liquidity ratios to make greater adjustments to their operations in order to fulfil the new requirements and hence likely had a more significant impact on these banks.[37] Therefore, this analysis measures each reform's impact using a bank's respective regulatory ratio at the jurisdictional announcement date, multiplied by negative one so that a higher value of the regression coefficient corresponds to a greater impact of the reform. The regressions demonstrate the extent to which regulatory ratios improved for each percentage point of impact in the time after the jurisdictional announcement dates. Details of the data and regression specification are set out in Section 3.1 and Section 3.2, respectively.

64. Table 1 presents the results of these regressions, with each column representing the results corresponding to the regression of a given regulatory ratio. In column (1), the results show that a lower CET1 ratio at the time of the jurisdictional announcement date is associated with a larger increase in the CET1 ratio thereafter. The effect is statistically significant and economically sizeable, as the marginal impact of a 1-percentage-point lower initial CET1 ratio accumulates to a CET1 ratio impact of about 18 basis points over the following five years. It is important to note that the model specification (with time fixed effects) controls for the very strong positive trend of CET1 ratios, as seen in Graph 1.1, meaning that this marginal impact of 18 basis points is to be seen as in addition to the general trend.

[36] See BCBS, *Basel III monitoring report*, September 2022, www.bis.org/bcbs/publ/d541.pdf.

[37] Given limitations to data on bank-specific CET1 requirements, actual CET1 ratios are used here as a proxy for CET1 ratios in excess of requirements (ie CET1 headroom). Annex A.3 demonstrates that CET1 ratios and headroom are significantly positively related.

Reform impact on regulatory ratios in percentage points, by years since jurisdictional announcement date

Table 1

Dependent variable	Regulatory Ratio			
	(1)	(2)	(3)	(4)
Reform considered	CET1	Leverage	LCR	NSFR
One year after	0.081***	–0.008	0.086***	–0.016
(τ = 1)	(0.028)	(0.016)	(0.028)	(0.011)
Two years after	0.095**	–0.041**	0.227***	–0.020
(τ = 2)	(0.044)	(0.021)	(0.046)	(0.018)
Three years after	0.149***	–0.049*	0.308***	–0.048*
(τ = 3)	(0.056)	(0.026)	(0.056)	(0.026)
Four years after	0.158**	–0.040	0.363***	–0.050
(τ = 4)	(0.061)	(0.031)	(0.067)	(0.036)
Five years after	0.176***	–0.029	0.420***	–0.074
(τ = 5)	(0.061)	(0.038)	(0.070)	(0.047)
R^2 (within)	0.304	0.350	0.106	0.272
Observations	2,714	2,767	2,265	2,565
Number of banks	197	202	195	192

The table shows the regression coefficients for CET1 ratio, leverage ratio, LCR and NSFR when the regulatory ratios are considered as dependent variables. The data set used is taken from the Basel Committee on Banking Supervision and described in more detail in Section 3.1; the methodology is presented in Section 3.2. $Impact_i$ is measured by the individual regulatory ratio at the jurisdictional announcement date. Controls are the lagged GDP growth, lagged implied volatility (VIX/V2X) and the lagged policy rate. Bank and time fixed effects are included. Robust standard errors, clustered at the bank level, are reported in parentheses. The symbols *, ** and *** denote significance at the 10%, 5% and 1% level.

Source: Basel Committee on Banking Supervision.

65. Similarly, column (3) of Table 1 shows that the marginal impact of a 1-percentage-point lower LCR at the jurisdictional announcement date is associated with an LCR improvement that is 42 basis points greater than the general trend in the five years following the jurisdictional announcement date. In tandem with the results in column (1), these results suggest that the reforms have improved resilience not only at the system-wide, aggregate level, but have had a particularly strong impact on banks with relatively weak initial CET1 ratios and LCRs.

66. However, columns (2) and (4) show no such relationship between the reform impact and subsequent improvement for the leverage ratio and NSFR. Although Graphs 1.1 and 1.2 show that both ratios improved significantly after 2011, the result from the regression analysis indicates that this trend did not differ much between banks with weak leverage ratios and NSFRs and those with strong ratios. Of note, as finalised by the Committee, both the leverage ratio and the NSFR were planned to go into effect at later dates than were the CET1 ratio and LCR requirements. Furthermore, as noted earlier, the leverage ratio was intended to serve as a backstop to the risk-based capital ratios.

67. The relationships in Table 1 are statistically robust and largely unchanged by the inclusion of country-specific time effects. The results are generally stronger using data closer to the global announcement dates in Table A4.1 in Annex A.4. The latter results are consistent with an earlier adjustment to the Basel III reforms or with the influence of other factors, such as supervisory actions, over this period. Table A4.2 in Annex A.4 shows that conclusions are largely unaffected when including the impact of all reforms as explanatory variables simultaneously instead of one at a time. Consistent with these results, Annex A.5 sets out a supplementary analysis showing that internationally active Japanese banks (to which the Basel III reforms applied) improved their CET1 ratios by more than did other Japanese banks (which were not subject to the Basel III reforms) in the years following the reforms. The evidence that banks took action to improve their regulatory ratios following the jurisdictional announcement of the reforms suggests that bank resilience has improved since the introduction of Basel III.

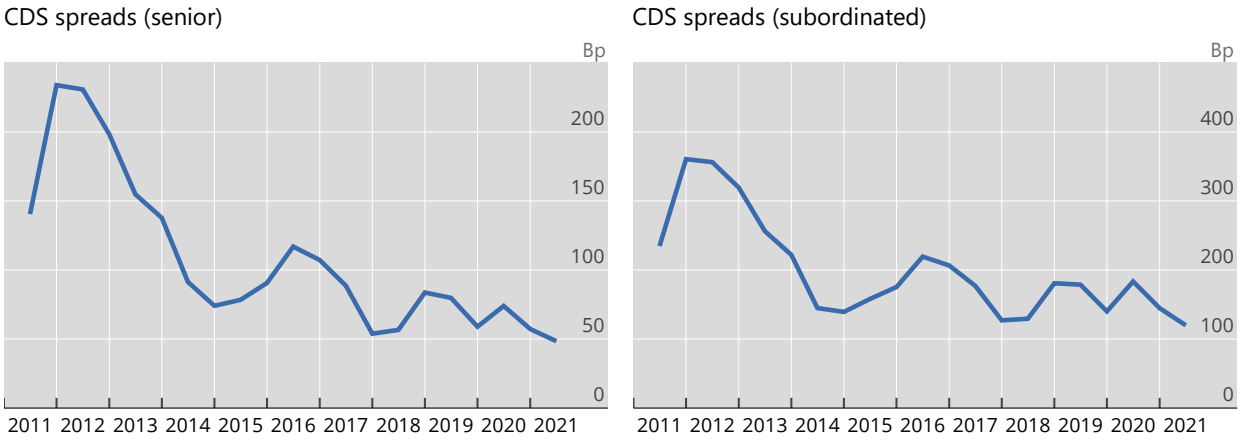
68. In the next section, the analysis is expanded to seek evidence that actions taken by banks also improved market-based measures of bank resilience.

4.2 Impact of the Basel III reforms on market-based measures of bank resilience

69. Improvements in banks' resilience following the introduction of the Basel III reforms should be reflected in market participants' perceptions of resilience. To confirm this, this study considers changes in market-based measures of bank resilience, such as CDS spreads. In addition to senior and subordinated CDS spreads, this study analyses estimates of banks' PDs and Moody's EDFs. As these risk measures are not directly targeted by the reforms, they potentially offer an independent validation of the reforms' efficacy.

70. The expectation is that these market-based bank resilience measures have improved (ie have decreased) following the jurisdictional announcement dates of the reforms. As Graphs 2.1 and 2.2 show, this trend is clearly visible over the period in which the Basel III reforms were implemented. All market-based resilience measures improved (decreased) sharply during this period. These observations are consistent with improved bank resilience after the introduction of Basel III. However, it should be noted that CDS spreads have not fallen to the level they had been at prior to the GFC.

Mean market-based resilience measures, 2011–21 Graph 2.1

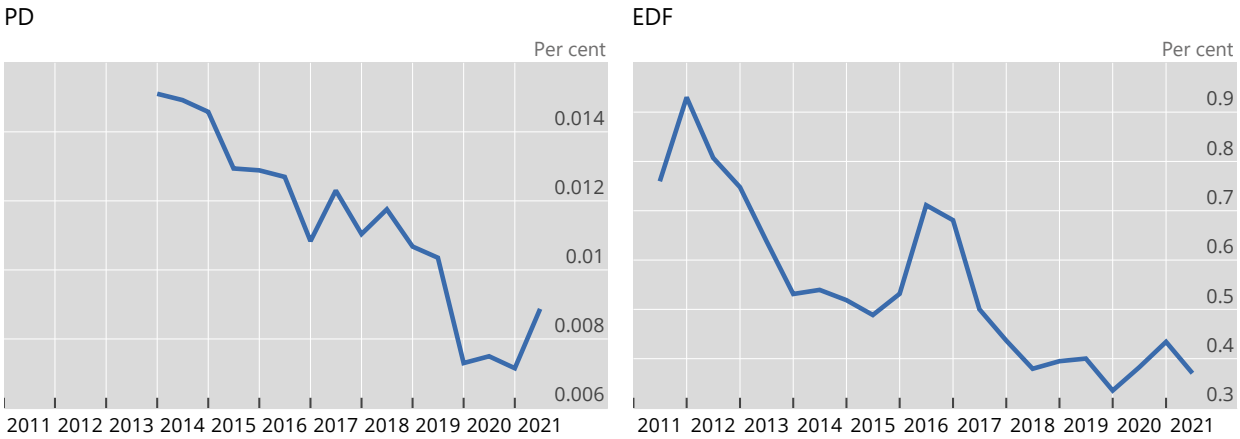


Note: This graph is generated using a balanced data set of publicly listed banks from the Committee data. Averages are taken of measures winsorised at the 1st and 99th percentiles. "Bp" refers to basis points.

Source: Markit.

Mean market-based resilience measures, 2011–21

Graph 2.2



Note: This graph is generated using a balanced data set of publicly listed banks from the Committee data. Averages are taken of measures winsorised at the 1st and 99th percentiles.

Source: Markit.

71. The regression methodology applied in Section 4.1 above can be used to link improvements in market-based measures of bank resilience with the Basel III reforms, specifically by regressing the CDS spreads, EDFs and PDs on regulatory ratios (multiplied by negative one) at the jurisdictional announcement date for each Basel III reform. As before, controls are added to the regression for macroeconomic effects, bank-specific effects and time-specific trends. The availability of market-based resilience measures is significantly lower than that of regulatory ratios and therefore the sample is limited to only 42 to 72 (mostly large and capital markets-oriented) banks. The regression results are set out in Table 2.

Reform impact on market-based resilience measures as dependent variable (bp), by years since jurisdictional announcement date

Table 2

Dependent variable	CDS (senior)				EDF			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Reform considered	CET1	Leverage	LCR	NSFR	CET1	Leverage	LCR	NSFR
One year after (τ = 1)	–1.604	0.098	–0.115	0.013	–0.236	–0.429	0.004	0.063
	(1.074)	(1.610)	(0.093)	(0.078)	(0.590)	(0.805)	(0.033)	(0.042)
Two years after (τ = 2)	–4.596***	–2.986	–0.159	–0.074	–0.532	–0.296	0.075	–0.030
	(1.690)	(2.176)	(0.154)	(0.133)	(1.140)	(0.940)	(0.065)	(0.070)
Three years after (τ = 3)	–5.238**	–2.862	–0.120	–0.020	–0.488	0.594	0.118	–0.048
	(2.097)	(2.859)	(0.202)	(0.161)	(1.474)	(1.236)	(0.090)	(0.108)
Four years after (τ = 4)	–5.819**	–1.614	–0.281	–0.164	–0.619	1.744	0.056	–0.148
	(2.494)	(4.106)	(0.256)	(0.209)	(1.718)	(1.403)	(0.110)	(0.176)
Five years after (τ = 5)	–7.127**	–5.006	–0.328	–0.152	–2.048	–1.096	0.066	–0.354***
	(2.835)	(4.729)	(0.304)	(0.296)	(2.155)	(1.584)	(0.127)	(0.131)
R^2 (within)	0.760	0.745	0.752	0.750	0.342	0.371	0.347	0.347
Observations	685	613	664	667	1,251	1,179	1,197	1,233
Number of banks	46	42	44	45	72	68	69	71

The table shows the regression coefficients for CET1 ratio, leverage ratio, LCR and NSFR when CDS spreads (senior) are considered as dependent variable in columns (1)–(4), while columns (5)–(8) display the coefficients for EDF as dependent variable. The data set used is taken from the Basel Committee on Banking Supervision and described in more detail in Section 3.1; the methodology is presented in Section 3.2. $Impact_i$ is measured by the individual regulatory ratio at the jurisdictional announcement date. Controls are the lagged GDP growth, lagged implied volatility (VIX/V2X) and the lagged policy rate. Bank and time fixed effects are included. Robust standard errors, clustered at the bank level, are reported in parentheses. The symbols *, ** and *** denote significance at the 10%, 5% and 1% level.

Source: Basel Committee on Banking Supervision.

72. In Table 2, column (1) shows that the impact of jurisdictions' announcements of the CET1 reforms is associated with a statistically significant decline in senior CDS spreads. For each percentage point lower a bank's CET1 ratio is at the time of the jurisdictional announcement date, the bank experiences a further reduction in CDS spreads of around 7 basis points after five years, in addition to the general trend shown in Graph 2.1. This result is statistically and economically highly significant.[38] By contrast, columns (2) to (4) do not show a statistically significant relationship between the change in senior CDS spreads and the bank-specific impact of the reform after the jurisdictional announcement dates for leverage ratio, LCR and NSFR. The result is very similar when using CDS spreads on subordinate bank debt, as shown in columns (1) to (4) of Table A4.4 in Annex A.4, with the decline per unit of the initial CET1 ratio being even greater for subordinated CDS spreads.

73. Columns (5) to (8) of Table 2 present the regression results with Moody's EDFs as the dependent variable. The coefficients for the market-based indicators after the jurisdictional announcement dates for all measures are insignificant and small, except in the case of the NSFR after five years. Additional regression results with the estimated PD as the dependent variable display significant results only for the leverage ratio, which had a negative impact on PDs, as shown in Table A4.4 in Annex A.4.

74. In summary, these results show that average bank-specific resilience, as measured by market-based indicators, improved after 2011. Regression analyses partly attribute this effect to the Basel III capital reforms: banks with lower initial CET1 ratios experienced a greater improvement in resilience. That said, the analysis finds no evidence that liquidity reforms had a direct impact on bank resilience.

75. The fact that this study does not find compelling evidence of a connection between reform impact and resilience improvements for the liquidity reforms could relate to the relatively limited availability of market-based resilience measures (often less than 50 banks). With regard to the NSFR, it should also be noted that this requirement was introduced at a later date than other reforms and that the observation period may therefore not be sufficient. Moreover, the observation period did not include any sustained periods of severe liquidity stress, so it was generally not possible to observe how market-based measures evolved against any deficient or rapidly diminishing liquidity ratios. As data limitations lead to large standard errors, it is not possible to rule out potentially *economically* significant relationships between reforms and bank resilience.

4.3 Conclusions

76. This section empirically assesses the impact of Basel III regulatory reforms on banks' resilience, looking both at regulatory ratios and market-based resilience measures. The results point to a clear improvement in resilience, as measured by regulatory metrics. Empirically, the study finds that the weighted average capital ratios have almost doubled since 2011 and that the weighted average liquidity ratios have risen by around 25 percentage points. In addition, banks with lower CET1 risk-based capital ratios and LCRs at the time of the reforms generally experienced greater increases in these ratios. This suggests that the observed average increase in regulatory ratios is related to these reforms. Note that in many jurisdictions, only book value indicators of resilience are available due to the large number of unlisted banks, given the presence of cooperative and mutual banks. It is also important to note that banks usually maintain positive capital headroom, ie capital above the regulatory requirements. In fact, analysis set out in Annex A3 shows a positive correlation between CET1 ratios and CET1 headroom over the period. This can be interpreted to mean that individual banks did not reduce their capital headroom during the introduction of the reforms, which is further evidence of the positive impact of the reforms on resilience.

[38] The July 2021 BCBS report found a similar negative relationship between CET1 ratios and CDS spreads during the early days of the Covid-19 pandemic.

77. The study finds a significant average improvement in resilience as measured by market-based indicators. Banks' CDS spreads, EDFs and PDs have fallen since 2011. This finding is consistent with the reforms affecting not only regulatory ratios but also market perceptions of individual banks' resilience. Furthermore, there is some indication that banks with low capital ratios at the time of the reforms experienced a greater improvement in market-based resilience measures, which suggests that the observed average decline in CDS spreads is related to these reforms. At the same time, the evidence on liquidity reforms' contribution to resilience as measured using market-based indicators is weak.

5. Impact of the Basel III reforms on systemic risk

78. This section evaluates the impact of the reforms on the resilience of the banking system as a whole and expands the perspective on individual banks' resilience taken in Section 4. Typically, systemic risk is decomposed into (i) a cross-sectional dimension concerning the interdependencies between financial institutions and (ii) a time dimension, which is linked to the financial cycle and refers to the accumulation of risk over time.[39] This section focuses primarily on the first dimension, and thus the structural elements of systemic risk, rather than any cyclical vulnerabilities in the financial system.

79. The analyses that follow use a range of well established market-based measures to study the relationship between selected Basel III reforms and systemic risk. In general, there are various ways of measuring systemic risk.[40] Market-based measures of systemic risk are distinct from accounting-based measures (eg the G-SIB score). While the latter are less affected by, for instance, short-term market fluctuations and are available for most banks, the market-based measures used in this report provide an external view on systemic risk.

80. This section first sets out the concept of systemic risk and the approach used in the analysis (Section 5.1). The trends of market-based systemic risk measures before and after the Basel III reforms are described in Section 5.2. Section 5.3 sets out an analysis of the relationship between regulatory ratios and market-based measures of systemic risk. Lastly, Section 5.4 examines how changes in regulatory ratios are related to market-based systemic risk measures for both G-SIB and non-G-SIB banks.

5.1 Motivation and approach

81. Systemic risk is defined as the risk that an individual institution under stress will adversely impact a substantial part of the financial system, which, in turn, may result in market stress, potentially negatively impacting functions and services provided by the financial system to the broader economy.[41] Typically, as described by De Bandt and Hartmann (2000), systemic risk involves systemic events (eg bad news or an idiosyncratic failure in the system leading to failures or distress more broadly). Importantly, the concept of systemic risk is somewhat different from but related to systematic risk, which relates to how all institutions are exposed to a common set of risks.

82. Sources of systemic risk include convergence in risk-taking (ie related to institutions' individual choice to be exposed to similar risks), financial contagion (ie spillover of losses between institutions through contractual relationships) and amplification mechanisms (ie the risk that small shocks have a large

[39] For example, see Caruana (2010).

[40] For example, see Adrian and Brunnermeier (2016) and Acharya et al (2017).

[41] This definition is consistent with the FSB/IMF/BCBS October 2009 report *Guidance to assess the systemic importance of financial institutions, markets and instruments: initial considerations, a report to the G-20 finance ministers and central bank governors*.

aggregate impact on the system, such as in the case of fire sales, liquidity market freezes or bank runs).[42] Banks with levels of usable capital or liquid assets that are not sufficient to cover short-term liabilities may cause harmful shocks to other financial institutions and the system as a whole. For example, undercapitalised banks are more likely to face bank runs and illiquid banks are more likely to engage in fire sales; both are more likely to impose spillover losses on counterparties. In contrast, better capitalised banks and banks with higher liquidity buffers are expected to be more resilient (see Section 4) and consequently contribute to a reduction in systemic risk.

83. Against this background, this study aims to shed light on the effectiveness of the requirements introduced by Basel III to mitigate some of the channels of interdependence between individual banks and the financial system. The interdependencies between different banks are captured by looking at co-movements of the market prices of their equities, focusing on the correlation of bank returns during extreme events. Some studies have already tried to address a similar question regarding how the Basel III reforms enhance bank resilience measured via market price-based indicators, but these have focused more narrowly on specific markets or single aspects of the reforms.[43]

84. Market prices tend to capture various channels of systemic risk, including direct channels (eg contagion via direct lending and borrowing or derivative transactions) and more pronounced indirect channels (eg systemic risk-taking, loss and distress amplification, such as through deleveraging, and changes in market sentiment). There is a growing body of literature showing that market-based risk measures correctly reflect the impact of stress events, are sensitive to market sentiment and are related to some key bank characteristics such as capitalisation, leverage, size and complexity.[44] Therefore, it can be expected that these measures should react to changes in regulatory policies targeting these key bank characteristics.

85. This study uses four well-established market-based indicators to study the relationship between selected Basel III reforms (ie CET1 ratio, Tier 1 ratio, leverage ratio and LCR)[45] and systemic risk: (i) ΔCoVaR, (ii) Exposure-ΔCoVaR, (iii) Marginal Expected Shortfall (MES) and (iv) SRISK. All measures are targeted at measuring a bank's level of systemic risk. Banks with higher values in these measures typically exhibit higher levels of systemic risk. Since these measures are not a direct target of the Basel III reforms, they can provide insights on the market's view of the ultimate impact of the reforms.

86. The first two systemic risk measures (ΔCoVaR and Exposure-ΔCoVaR) both build on the concept of value-at-risk (VaR), which is a common measure of risk. In general, the VaR provides the potential loss of a specific bank (or the whole financial system) over a given time period that is not exceeded with a certain probability (eg 95% or 99%). ΔCoVaR provides an estimate of how much the potential loss of the entire financial system increases when a specific bank is in distress. Exposure-ΔCoVaR is a similar measure, but reverses the conditioning; it estimates the increase in a single bank's potential loss given a system-wide distress. MES applies the same direction of conditioning as Exposure-ΔCoVaR, but is based on the expected shortfall measure. Specifically, MES is defined as a bank's expected equity loss when the overall financial market declines substantially over a given horizon and incurs a loss greater than its VaR. Finally, in contrast to the first three measures, SRISK takes a more structural approach. It measures the amount of capital that a bank is expected to need to raise in order to function normally if there is another financial crisis. More details on these systemic risk measures are provided in Annex A.6.

42 See Benoit et al (2017).

43 For example, Gehrig and Iannino (2021), as well as Busch et al (2021).

44 See de Mendonça and da Silva (2018), as well as Laeven et al (2016).

45 The NSFR was introduced later than the LCR, resulting in a shorter post-reform time period, and is therefore not considered in the baseline analysis in this section. However, the NSFR was considered in robustness checks and yielded similar results as the LCR.

87. There are several caveats to this approach based on market-based indicators. Market prices reflect a multitude of factors; they capture fundamentals but may also reflect general market conditions and sentiment, among other factors. This makes it difficult to attribute changes in market prices to specific transmission channels of systemic risk impacted by the Basel III reforms. As market prices tend to be rather volatile, it can be difficult to establish statistically significant results. Furthermore, systemic risk involves measuring negative externalities; while market-based measures try to take this into account, it is not obvious that the market prices used to construct these measures can fully account for such negative externalities. Finally, data limitations do not allow one to directly look at banks' bilateral exposures or their exposures to common asset classes.[46]

5.2 Comparison of pre-reform trends of systemic risk measures with post-reform trends

88. This section investigates how post-reform trends of market-based systemic risk measures compare with their pre-reform counterparts. The expectation is that following the reforms, bank returns should be less sensitive to the adverse events of other banks or the financial system as a whole.

89. This main regression for analysing systemic risk uses panel data with the same time period and event-window methodology used in Section 4 on resilience (as described in subsection 3.2), with small variations necessary due to the smaller sample of less heterogeneous publicly traded banks. The impact of the reforms on market-based systemic risk measures is estimated using a reform-event time dummy ($Reform_{c,t}$).[47] This dummy variable takes the value of one for all periods following the jurisdictional announcement date associated with the relevant reform (ie risk-based capital ratios, leverage ratio and the LCR) in a bank's home jurisdiction. The dummy variable is equal to the value zero for all pre-reform time periods. GDP growth and implied volatility (measured by the volatility index VIX or V2X) are used as macroeconomic variables ($Macro_{c,t-1}$) to control for country-specific factors and general market conditions. The model reads as follows:

$$y_{i,t} = \alpha_i + \gamma\, Macro_{c,t-1} + \beta\, Reform_{c,t} + \varepsilon_{i,t},$$

where i denotes the individual bank, c the country, and t the time period. $y_{i,t}$ is the dependent variable of interest, ie one of four market-based measures of systemic risk (ie ΔCoVaR, Exposure-ΔCoVaR, MES and SRISK).[48] α_i are bank-specific fixed effects and $\varepsilon_{i,t}$ is the error term.

90. Table 3 reports the results of how post-reform trends of market-based systemic risk measures differ from their pre-reform counterparts. The table shows that the coefficients of interest, β, on the reform-event time dummies ($Reform_{c,t}$) are significantly negative across all specifications. Significantly negative coefficients suggest that the introduction of the Basel III risk-based capital, leverage and LCR reforms is associated with a reduction in market-based systemic risk.[49]

[46] See Roncoroni et al (2021).

[47] Here the coefficient on the reform-event dummy shows the *average effect* (β) across all post-event periods, whereas the formulation used in Section 4 identifies *individual effects* for each event-window period separately (β_τ).

[48] SRISK, calculated in euros, is scaled by total assets for ease of interpretation.

[49] To give a sense of the magnitude and economic significance, ΔCoVaR, Exposure ΔCoVaR and MES decrease between roughly 45% and 55% after the introduction of risk-based capital ratios, between 32% and 42% after the introduction of the leverage ratio, and between 30% and 40% after the introduction of the LCR.

Regression of systemic risk measures on reform-event time dummies Table 3

Variables	ΔCoVaR	ΔCoVaR	ΔCoVaR	Exposure-ΔCoVaR	Exposure-ΔCoVaR	Exposure-ΔCoVaR
RBC Reform	–0.626***			–0.984***		
	(0.0715)			(0.130)		
Leverage Reform		–0.361***			–0.807***	
		(0.0597)			(0.136)	
LCR Reform			–0.373***			–0.774***
			(0.0519)			(0.116)
R^2	0.313	0.175	0.215	0.202	0.196	0.216
Observations	1,197	1,197	1,197	1,199	1,199	1,199
Number of banks	68	68	68	68	68	68

Variables	MES	MES	MES	SRISK/Total Assets	SRISK/Total Assets	SRISK/Total Assets
RBC Reform	–1.249***			–0.0107***		
	(0.190)			(0.00342)		
Leverage Reform		–0.998***			–0.00708**	
		(0.230)			(0.00329)	
LCR Reform			–0.821***			–0.00640**
			(0.133)			(0.00257)
R^2	0.157	0.146	0.126	0.169	0.129	0.129
Observations	1,204	1,204	1,204	942	942	942
Number of banks	68	68	68	54	54	54

The table shows the regression coefficients for $Reform_{c,t}$, either concerning the risk-based capital (RBC) reforms, the LCR reform or the leverage ratio reform, when one of our four systemic risk measures is considered as dependent variable. The data set used is taken from the Basel Committee on Banking Supervision and described in more detail in Section 3.1. Controls are the lagged GDP growth and lagged implied volatility (VIX/V2X), but not the lagged policy rate. Fixed effects are included at the bank level. Robust standard errors, clustered at the country level, are reported in parentheses. The symbols *, ** and *** denote significance at the 10%, 5% and 1% level.

Source: Basel Committee on Banking Supervision.

91. This finding is robust to the addition of a reduced set of bank-level controls selected to limit losses in the number of observations.[50] However, the findings are not robust to the inclusion of time fixed effects (see Table A7.1 in Annex A.7 for results of the specification where time fixed effects are added to the above model). These time fixed effects are intended to capture any time-period specific influences that are unrelated to the Basel III reform dates. The lack of significance may indicate that factors other than the Basel III reforms and the controls considered in the analysis could be responsible for changes in systemic risk. It may also indicate that the reform timing is so highly correlated across jurisdictions that separating the effects of the Basel reforms from other time series variation is difficult.

92. Since systemic risk is most relevant during periods of stress, the analysis above is extended to investigate whether and how pre-reform trends in systemic risk differ from their post-reform counterparts during crises. Crisis periods are identified as periods where the six-month average of the Financial Stress Index (FSI) created by the US Department of Treasury's Office of Financial Research (OFR) is above zero.

[50] With the reduced set of controls, the study was able to run regressions on a sample size that is only one bank less than the full sample without controls. The reduced set of controls includes total assets, net loans to assets, asset liquidity and deposit to assets.

The sample period for this specific analysis is expanded to the first half of 2020 in order to capture the Covid-19 period. The results reported in Table A7.2 in Annex A.7 find that systemic risk increased less during crisis periods, including the Covid-19 stress period, after the introduction of capital and liquidity reforms.[51]

93. Overall, these analyses provide robust evidence that the systemic risk measures analysed in this study have declined following the introduction of the Basel III reforms and that their increase has been less pronounced in periods of stress. This provides tentative evidence that interconnectedness within the financial system has been reduced since the introduction of the reforms. The following analysis builds on this and examines the relationship between regulatory ratios and systemic risk in order to test the expectation that increases in regulatory ratios are associated with lower levels of market-based systemic risk.

5.3 Impact of regulatory ratios on systemic risk

94. To analyse the relationship between regulatory ratios and systemic risk, the next analysis adjusts the regression model explained in Section 5.2 by including banks' key regulatory ratios (CET1 ratio, Tier 1 ratio, leverage ratio and LCR), $RegRatio_{i,t-1}$, instead of the reform-event time dummies, in the following model:

$$y_{i,t} = \alpha_i + \gamma\, Macro_{c,t-1} + \beta\, RegRatio_{i,t-1} + \varepsilon_{i,t},$$

where i denotes the individual bank, c the country, and t the time period. $y_{i,t}$ is the dependent variable of interest, ie one of four market-based measures of systemic risk (ie ΔCoVaR, Exposure-ΔCoVaR, MES and SRISK). α_i are bank-specific regression intercepts as required by the fixed-effects estimator. $\varepsilon_{i,t}$ is the error term.

95. Table 4 shows results that are significant with the expected negative sign for the CET1 and Tier 1 ratios across all four systemic risk measures. This indicates that higher risk-based capital ratios are generally associated with lower market-based measures of systemic risk, which is consistent with the literature.[52] For the leverage ratio, the results show significantly negative coefficients for ΔCoVaR, Exposure-ΔCoVaR and MES. This provides some evidence that lower bank leverage is in general associated with lower market-based measures of systemic risk. The impact of the leverage ratio on SRISK is not significant. Moreover, the relationship between the LCR and systemic risk measures is statistically insignificant for all four systemic risk measures.

[51] The significant public support measures introduced by authorities during the Covid-19 period may have helped limit the increase in systemic risk during that period, though it is difficult to disentangle the effect of the reforms from the impact of public support measures.

[52] For example, see Laeven et al (2016).

Regression of systemic risk measures on regulatory ratios Table 4

Variables	ΔCoVaR	ΔCoVaR	ΔCoVaR	ΔCoVaR	Exposure-ΔCoVaR	Exposure-ΔCoVaR	Exposure-ΔCoVaR	Exposure-ΔCoVaR
Tier 1 ratio	–0.0705***				–0.150**			
	(0.0159)				(0.0573)			
CET1 ratio		–0.0642***				–0.139**		
		–0.0642***				(0.0640)		
Leverage ratio			–0.0342***				–0.0345***	
			(0.00683)				(0.00884)	
LCR				–2.03e-05				–0.00155
				(0.000901)				(0.00151)
R^2	0.146	0.126	0.607	0.018	0.144	0.125	0.391	0.006
Observations	1,065	1,065	230	886	1,066	1,066	230	887
Number of banks	68	68	66	68	68	68	66	68

Variables	MES	MES	MES	MES	SRISK/Total Assets	SRISK/Total Assets	SRISK/Total Assets	SRISK/Total Assets
Tier 1 ratio	–0.175**				–0.00216***			
	(0.0719)				(0.000415)			
CET1 ratio		–0.175**				–0.00211***		
		(0.0801)				(0.000476)		
Leverage ratio			–0.0819***				–0.000612	
			(0.0126)				(0.000609)	
LCR				–0.00127				3.27e-05
				(0.00231)				(2.88e-05)
R^2	0.094	0.089	0.101	0.002	0.160	0.143	0.531	0.032
Observations	1,071	1,071	230	891	839	839	185	713
Number of banks	68	68	66	68	54	54	52	54

The table shows the regression coefficients for $RegRatio_{i,t-1}$, either concerning the Tier 1 or CET1 risk-based capital ratio, the leverage ratio or the LCR, when one of our four systemic risk measures is considered as dependent variable. The data set used is taken from the Basel Committee on Banking Supervision and described in more detail in Section 3.1. Controls are the lagged GDP growth and lagged implied volatility (VIX/V2X), but not the lagged policy rate. Fixed effects are included at the bank level. Robust standard errors, clustered at the country level, are reported in parentheses. The symbols *, ** and *** denote significance at the 10%, 5% and 1% level.

Source: Basel Committee on Banking Supervision.

96. During the period analysed, other events unrelated to the Basel III reforms may have occurred that impacted systemic risk and regulatory ratios. To account for this, interaction terms between banks' regulatory ratios and the reform-event time dummies are included in the above model to determine whether it was indeed the reforms that impacted systemic risk. These interaction terms provide evidence of whether the effect of the regulatory ratios on systemic risk differs between the pre- and post-reform periods. The results presented in Table A8 in Annex A.8 indicate that coefficients on the interaction terms are for the most part not statistically significant, suggesting it is difficult to attribute the decline in systemic risk solely to the impact of the Basel III reforms.

97. Overall, the analyses provide robust evidence that higher capital ratios are related to a decline in the systemic risk measures being analysed. This suggests that banks' capital strength contributes to lower systemic risk, rendering the financial system less vulnerable to the stress events of single banks. However, this decline in systemic risk measures cannot be attributed unambiguously to the Basel III reforms. In the next subsection, the analysis is expanded by considering the classification of some banks as G-SIBs.

5.4 Systemic risk and regulatory ratios for G-SIBs versus non-G-SIBs

98. This subsection explores the relationship between regulatory ratios and systemic risk for banks designated as G-SIBs versus those that have not been designated as such.[53] Given that G-SIBs are subject to additional capital buffers and greater supervisory scrutiny, this relationship could be expected to be different for these two groups of banks.[54]

99. For the analysis, the same regression model is applied as in Section 5.3, in addition to interacting the risk-based capital ratios ($RegRatio_{i,t-1}$) with a G-SIB dummy variable ($GSIB_i$) in the following model:

$$y_{i,t} = \alpha_i + \gamma\, Macro_{c,t-1} + \beta\, RegRatio_{i,t-1} + \gamma'\, RegRatio_{i,t-1}.GSIB_i + \varepsilon_{i,t},$$

where i denotes the individual bank, c the country, and t the time period. $y_{i,t}$ is the dependent variable of interest, ie one of four market-based measures of systemic risk (ie ΔCoVaR, Exposure-ΔCoVaR, MES and SRISK). α_i are bank-specific regression intercepts as required by the fixed-effects estimator. $\varepsilon_{i,t}$ is the error term. The G-SIB dummy variable is one for all G-SIBs in the sample.

Regression of systemic risk measures on regulatory ratios and G-SIB dummy with interaction terms

Table 5

Variables	ΔCoVaR	ΔCoVaR	Exposure-ΔCoVaR	Exposure -ΔCoVaR	MES	MES	SRISK/Total Assets	SRISK/Total Assets
Tier 1 ratio	–0.0503**		–0.0701		–0.0767		–0.00258***	
	(0.0196)		(0.0760)		(0.0980)		(0.000614)	
Interaction Tier 1 ratio G-SIB	–0.0528**		–0.212**		–0.262**		0.000845	
	(0.0188)		(0.0766)		(0.100)		(0.000637)	
CET1 ratio		–0.0387*		–0.0423		–0.0549		–0.00236***
		(0.0208)		(0.0751)		(0.0969)		(0.000719)
Interaction CET1 ratio G-SIB		–0.0680**		–0.264**		–0.327**		0.000499
		(0.0262)		(0.0931)		(0.122)		(0.000671)
R^2	0.157	0.143	0.187	0.185	0.129	0.138	0.164	0.144
Observations	1,065	1,065	1,066	1,066	1,071	1,071	839	839
Number of banks	68	68	68	68	68	68	54	54

The table shows the regression coefficients for $RegRatio_{i,t-1}$ and its interaction with $GSIB$, either concerning the Tier 1 or CET1 risk-based capital ratio, when one of our four systemic risk measures is considered as dependent variable. The data set used is taken from the Basel Committee on Banking Supervision and described in more detail in Section 3.1. Controls are the lagged GDP growth and lagged implied volatility (VIX/V2X), but not the lagged policy rate. Fixed effects are included at the bank level. Robust standard errors, clustered at the country level, are reported in parentheses. The symbols *, ** and *** denote significance at the 10%, 5% and 1% level.

Source: Basel Committee on Banking Supervision.

[53] An earlier Committee study of the G-SIB indicators revealed that G-SIBs and non-G-SIBs behave differently; see BCBS, "An examination of initial experience with the global systemically important bank framework", *BIS Working Papers*, no 34, February 2019, www.bis.org/bcbs/publ/wp34.pdf.

[54] The expected direction of this difference is ambiguous. It depends on whether the market's perception of G-SIBs as being inherently systemically riskier than their non-G-SIB peers outweighs the view that systemic risk is lower when large and complex institutions hold more capital.

100. Table 5 presents the coefficients on the risk-based capital ratios and the interaction terms that identify whether the effect of regulatory ratios on systemic risk differs between G-SIBs and non-G-SIBs. The results suggest that the negative relationship between CET1 and Tier 1 ratios and ΔCoVaR holds for both G-SIBs and non-G-SIBs. Moreover, the findings indicate that an increase in these regulatory ratios decreased the market's perception of systemic risk relatively more for a G-SIB than for a non-G-SIB. Regarding Exposure-ΔCoVaR and MES, the negative relationship shown in the previous subsection tends to be driven mainly by G-SIBs.

101. This result using market-based measures is largely in line with a complementary Committee study that analyses the impact of the G-SIB framework on bank behaviour using accounting-based measures (see Box 1). This study suggests that higher capital requirements for G-SIBs, including the G-SIB buffer, have had the expected impact on reducing systemic risk for these banks. This provides indicative evidence that the Basel III reforms led to a reduction of systemic risk.

Box 1

Effects of the G-SIB framework on bank behaviour

In a complementary study, the Committee analysed whether the effects of the G-SIB designation on bank behaviour have been consistent with the framework's objectives. Bank behaviour is captured through financial ratios based on banks' balance-sheet and income-statement data covering several broad categories (eg ratios that are proxies for the G-SIB indicators, but also ratios reflecting bank profitability, risk-taking, capitalisation and default measures). The sample is thus not limited by the availability of market data.

The analysis applies a difference-in-differences (DID) regression specification to annual observations on 105 banks from Standard & Poor's Global Market Intelligence database for the years 2005–18. This setup is, to a large extent, endogenous. As such, the results are indicative, rather than identifying causal relationships.

Using banks' individual G-SIB indicators as dependent variables, the regression results show a statistically significant reduction in asset growth (indicator for size), trading and available-for-sale securities (substitutability), and the share of Level 3 assets (complexity) for G-SIBs in response to their G-SIB designation relative to non-G-SIBs.

In terms of capitalisation and risk-taking, the regression results provide evidence that G-SIBs have issued more Tier 1 capital than non-G-SIBs, but the observable growth in the Tier 1 ratio has been smaller for G-SIBs than for non-G-SIBs. Despite the improvements in capitalisation, there is no statistically significant change in lending in response to a G-SIB designation and hence no evidence of a negative impact of the G-SIB framework on the real economy.

These empirical results suggest that overall, the G-SIB framework has achieved its intended objective of improving the resilience of G-SIBs and reducing systemic risk.

5.5 Conclusions

102. The analysis of the effects of the Basel III reforms on systemic risk expands the analysis of individual banks' resilience in Section 4 to focus on market-based measures of systemic risk which provide an external view from the market's perspective. The results show that market-based measures of systemic risk declined after the introduction of the Basel III capital and liquidity reforms, suggesting that banks and the financial system have become less vulnerable to the distress of individual banks and that interconnectedness within the financial system has been reduced following the capital and liquidity reforms. Furthermore, a deeper-dive analysis of stress periods shows that systemic risk increased less during crisis periods after capital and liquidity reforms were introduced.

103. The results also suggest that higher risk-based capital and leverage ratios are associated with lower systemic risk levels of banks across the entire sample period. This shows that banks' capital strength can help dampen negative feedback effects between banks under stress, thus reducing the probability of systemic distress due to the difficulties of a single bank, and position banks to be better able to continue to perform their intermediation functions.

104. Moreover, there is evidence that higher capital requirements for G-SIBs decreased the market's perception of systemic risk relatively more for G-SIBs than for non-G-SIBs. This suggests that the Basel III reforms, associated with greater supervisory scrutiny and higher capitalisation of G-SIBs, have helped to reduce the systemic risk posed most acutely by these banks.

6. Additional analysis of capital reforms

105. Sections 4 and 5 of this report examined and discussed the quantitative effects of the Basel III capital reforms on bank resilience and systemic risk. This section provides additional analyses on these reforms. The section starts with an examination of the evolution of capital ratios and their subcomponents (Section 6.1). Next, insights are provided into changes to banks' capital investor base (Section 6.2). This is followed by discussions of the efficacy of AT1 capital instruments (Section 6.3) and the leverage ratio (Section 6.4).

6.1 Impact of capital reforms on capital ratios and their subcomponents

6.1.1 Descriptive analyses of the evolution of capital ratios

106. Regulatory capital ratios improved significantly after 2011.[55] For a balanced data set of 110 Group 1 banks, Graph 3 shows that the weighted average CET1 ratio[56] and the weighted average leverage ratio nearly doubled from 2011 to 2021, which is in line with the evidence shown in Section 4. Additionally, the weighted average Tier 1 ratio and total capital ratio similarly increased from approximately 7% to approximately 15% and from approximately 8% to approximately 17%, respectively (see the left-hand panel of Graph 3).

107. The right-hand panel of Graph 3 shows that the main driver of the increases in the weighted average leverage ratio since the introduction of the Basel III reforms was the increase in the amount of Tier 1 capital.

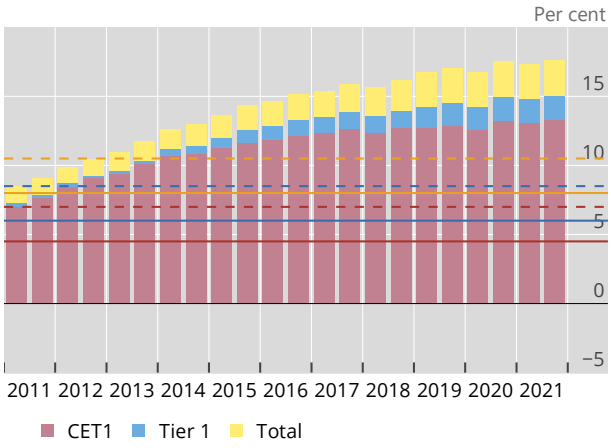
[55] The following conclusions are based on BCBS (2022a).

[56] The weighted average CET1 ratio for a balanced data set of Group 1 banks is measured as the sum of CET1 amounts for all Group 1 banks that are part of the Committee's data sample over the whole sample period, divided by the sum of their risk-weighted assets.

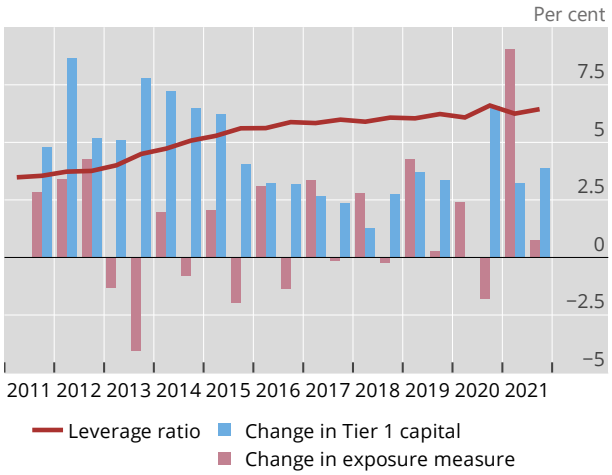
Evolution of capital ratios (expressed as weighted averages)

Group 1 banks, balanced data set — Graph 3

CET1, Tier 1 and total capital ratios[1]



Leverage ratio and determinants of changes



[1] The solid lines depict the relevant minimums, the dotted lines the minimums plus the capital conservation buffer.

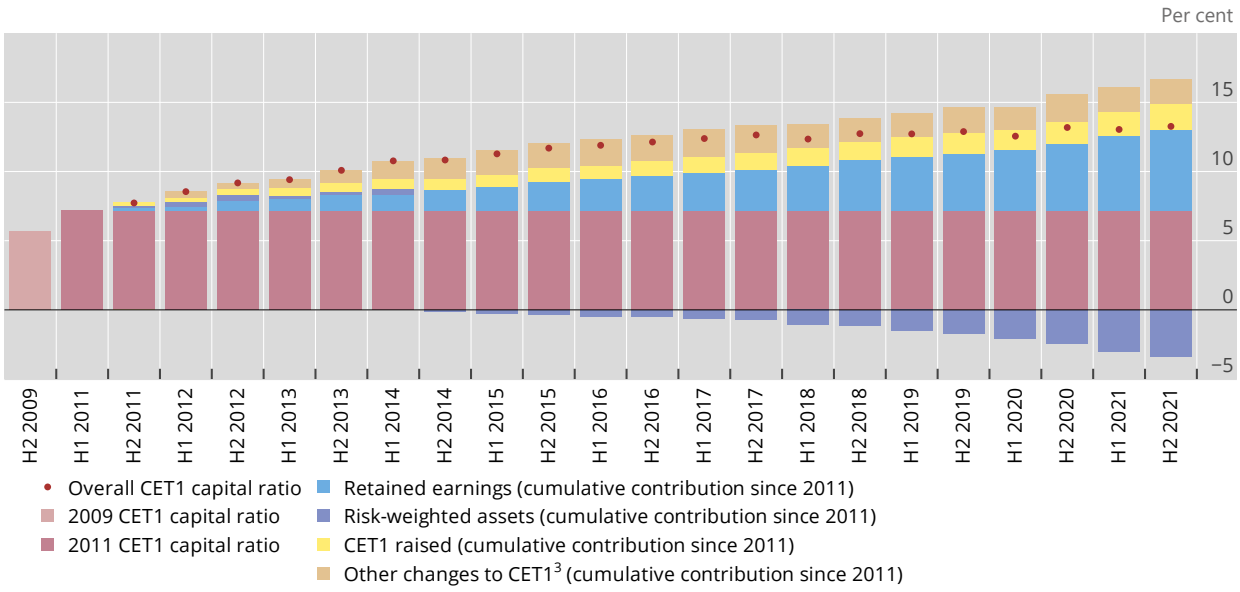
Source: Basel Committee on Banking Supervision.

108. Graph 4 decomposes the observed changes to the weighted average CET1 ratio for the same sample of Group 1 banks. The biggest driver of the increases in the weighted average CET1 ratio after the introduction of the Basel III reforms was retained earnings, followed by CET1 capital raises. However, after a slight decrease in RWA until 2014, increases in RWA started to limit the increases in the CET1 ratios, particularly after 2018.[57]

[57] Notice that increases in RWA have a negative impact on the CET1 ratio and are thus illustrated below the horizontal axis.

Evolution of CET1 ratios and their subcomponents[1]

Group 1 banks, balanced data set[2] Graph 4



[1] The graph shows the fully phased-in initial Basel III framework for the data points up to and including the end of 2018 and the actual framework in place at the reporting date for all data points thereafter. [2] Except for the ratio for H2 2009, which is based on the different sample of the Committee's comprehensive Quantitative Impact Study and therefore not fully comparable. [3] Other changes include changes in regulatory adjustments to CET1 capital and any other changes in CET1 capital between two reporting dates that are not reported separately.

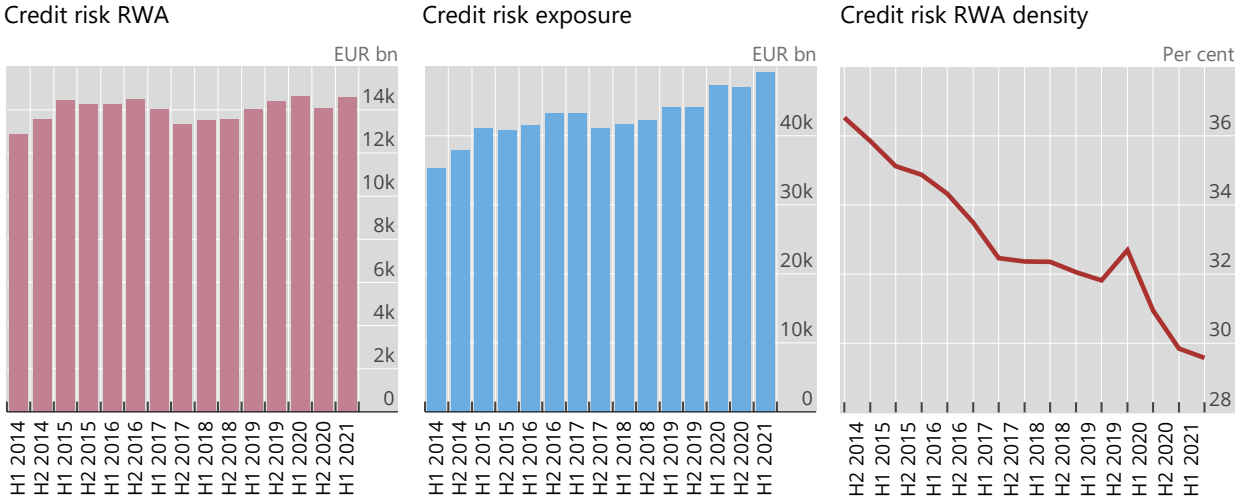
Source: Basel Committee on Banking Supervision.

109. The rise in banks' aggregated RWA was driven mainly by credit risk, which represents the majority of aggregated RWA. Additionally, other risks, such as operational risk, also impacted aggregated RWA. Graph 5 confirms that for credit risk exposures, aggregated RWA increased for a balanced data set of Group 1 banks (see left-hand panel), driven by the rise in the aggregated exposures (see central panel) but mitigated by a decrease in weighted average credit risk RWA density[58] (see right-hand panel).

[58] RWA density is defined as risk-weighted assets divided by leverage exposures. For this report, credit RWA density is defined as credit RWA divided by credit risk exposure at default.

Credit risk RWA, exposure and RWA density

Group 1 banks, balanced data set — Graph 5



Source: Basel Committee on Banking Supervision.

110. Several factors could explain the decrease in credit risk RWA density shown in the right-hand panel of Graph 5. It may be due to cyclicality in risk-based capital requirements, leading to a decrease in RWA density during periods of benign economic conditions. Decreases in the underlying risk of banks' credit exposures might be partly due to changes in the composition of banks' credit portfolios since 2011, as the share of sovereign exposures, which are assigned relatively low risk weights, increased. This increase was particularly acute in 2020–21 due to the governmental guarantees provided during the Covid-19 pandemic. By June 2021, sovereign exposures represented approximately 25% of banks' total credit risk exposures.

6.1.2 Regression analysis

111. This subsection performs several regressions to empirically assess how banks' CET1 ratios evolved after the Basel III capital reforms were announced. Changes in CET1 ratios are decomposed into three subcomponents: (i) change in CET1 capital amounts; (ii) change in leverage exposures (a proxy of exposures at default); and (iii) change in average RWA density.[59]

112. The regression analysis assesses how each of these subcomponents evolved differently between banks with CET1 ratios above and below the global median CET1 ratio (in the previous period), as shown in the following regression model:

$$Y_{i,t} = \alpha_i + \beta \cdot max\{\overline{CET1\ Ratio} - CET1\ Ratio_{i,t-1}, 0\} + \gamma \cdot max\{CET1\ Ratio_{i,t-1} - \overline{CET1\ Ratio}, 0\} + \theta_{c,t} + \varepsilon_{i,t},$$

where $Y_{i,t}$ refers to the logarithmic transformation (log transform) of each subcomponent of the CET1 ratio growth for bank i in reporting period t, ie log(CET1 amount), log(leverage exposure), or log(RWA density). The key variables, $max\{\overline{CET1\ Ratio} - CET1\ Ratio_{i,t-1}, 0\}$ and $max\{CET1\ Ratio_{i,t-1} - \overline{CET1\ Ratio}, 0\}$, are the CET1 ratios of bank i in the previous period relative to the global median of the CET1 ratio, α_i and $\theta_{c,t}$ refer to fixed effects, and $\varepsilon_{i,t}$ is the error term. The use of jurisdiction-time fixed effects $\theta_{c,t}$ controls for different trends across jurisdictions. In addition, bank fixed effects α_i capture time-independent differences across

[59] Using logarithmic transformation (log transform), the decomposition of CET1 ratio growth rates by subcomponents follows the equation:

log(CET1 ratio) = log(CET1 amount) – log(leverage exposures) – log(RWA density)

banks. By construction, 50% of the observations in each period have a CET1 ratio lower than the global median of the CET1 ratio.

113. Table 6 presents the results for these regressions. As the analysis in Section 4 suggests, there were significant CET1 ratio increases in response to the Basel III reforms; this analysis may indicate how the reforms influenced changes in subcomponents of CET1 ratios.

Contribution of CET1 ratio subcomponents to CET1 ratio growth rates — Table 6

	Growth in CET1 ratio	(=) Growth in CET1 amount	(–) Growth in total exposure (leverage exposure)	(–) Growth in average RWA density
	(1)	(2)	(3)	(4)
Deficit CET1 ratio relative to the global median	3.474***	2.171***	0.385	–1.687**
	(0.407)	(0.631)	(0.718)	(0.796)
Excess CET1 ratio relative to the global median	–1.312***	–0.430**	0.182	0.700***
	(0.167)	(0.180)	(0.145)	(0.171)
R^2	0.546	0.343	0.312	0.318
Observations	3,191	3,191	3,191	3,191

Standard errors are in parentheses and clustered at the bank level. The symbols *, ** and *** denote significance at the 10%, 5% and 1% level respectively. Jurisdiction-time fixed effects and bank fixed effects are included in all regressions.

Source: Basel Committee on Banking Supervision.

114. The regression results indicate that banks with a CET1 ratio below the global median in the previous period generally showed a significantly higher growth rate in their CET1 ratios and CET1 amounts than did banks with a CET1 ratio above the global median. The results also indicate that the growth rate in CET1 amount was the main driver contributing to the higher growth rate in CET1 ratios for those less capitalised banks in the previous period.[60] Combined with the results in Section 4, this is consistent with CET1 capital requirements leading to an improvement in CET1 levels. The results also suggest that banks with a CET1 ratio below the global median CET1 ratio had a lower growth rate in their average RWA density than did better capitalised banks in the previous period.[61] The results do not provide strong evidence that the capital reforms impacted banks' growth in exposures.

6.2 Changes to banks' capital investor base as a result of Basel III

115. A bank's investor base can affect contagion risk and the loss absorbency of capital instruments. More sophisticated investors with diversified portfolios can better absorb losses. Surveys of stakeholders conducted by the Committee and internal Committee studies have shown that banks' investor base for AT1 and Tier 2 capital instruments has changed since the GFC. Holdings of bank capital instruments by retail investors have declined in some jurisdictions, although this was mainly due to changes in local regulatory requirements or investor protection regulations (eg MiFID II in the EU) that are unrelated to Basel III. For example, some jurisdictions implemented measures to disallow or discourage the sale of banks' non-equity capital instruments to retail investors due to concerns regarding retail investors' ability to understand the underlying risks of those instruments. Basel III's stricter definition of eligible regulatory

[60] This is consistent with the result obtained by Cohen and Scatigna (2016).

[61] The results remain consistent with different CET1 ratio cutoff points to distinguish the banks in relative excess or deficit of CET1 ratio (ie the 25th percentile of the CET1 ratios as well as fixed 10% and 12% of CET1 ratio). However, the results for the growth in exposures and the growth in average RWA density are sensitive to the sample of banks selected.

capital did not lead to an exclusion of more sophisticated investors. On the contrary, the liquidity of these instruments has generally increased due to standardisation.

116. Separately, holdings of bank regulatory capital instruments by other banks and insurance companies have decreased over time. According to an internal Committee study, the share of bank equity instruments held by other banks and insurance companies fell from 13.3% in 2010 to 6.5% in 2019. Likewise, the share of bank non-equity capital instruments held by other banks and insurance companies fell from 23.1% in 2010 to 17.2% in 2019. This change is incentivised by the Basel III requirement that the holding of regulatory capital instruments issued by financial sector entities be subject to threshold-based deductions from regulatory capital.

117. These studies suggest that Basel III has reduced contagion risks between financial sectors. The shift observed towards more informed investors of bank capital instruments also may have improved the loss-absorption capacity of these instruments.

6.3 Assessment of the efficiency of AT1 instruments

6.3.1 AT1 eligibility criteria and instrument types

118. The requirements for qualification as AT1 capital were intended to contribute to an improvement in the quality and consistency of the capital base compared with hybrid capital instruments that qualified as Tier 1 capital under Basel II. The GFC showed that a large majority of these hybrid capital instruments did not absorb losses as expected. Under Basel III, the criteria for the classification as AT1 instruments include: (i) *perpetuity* – the instruments do not mature, although their terms and conditions may provide for the possibility of call options subject to prior supervisory approval but without terms in these call options providing incentives for the issuer to redeem them; (ii) *dividend/coupon discretion* – distributions must be at the full discretion of the issuer, paid out of distributable items, and cancellation of distributions does not constitute an event of default; and (iii) *possibility of conversion/write-off* – the instrument shall be either written off or converted into common equity at the option of the relevant authority upon the occurrence of a trigger event.

119. As a result of these qualification requirements, a significant proportion of instruments eligible as Tier 1 capital under Basel II failed to comply with the stricter definition of Tier 1 capital set out in Basel III. According to the Committee's calculations, approximately 80% of the value of "other Tier 1" capital under Basel II did not qualify as Tier 1 under Basel III.

120. The Basel III definition of AT1 provides room for banks to issue instruments eligible as AT1 that differ in their accounting classification, conversion or writedown features. These instruments notably include, among other forms of instruments, preferred shares and CoCos.

Preferred shares

121. At least three jurisdictions identify non-cumulative perpetual preferred shares as a significant proportion of AT1 capital instruments used by banks in their jurisdiction.

122. In the United States, preferred shares that qualify for AT1 capital must be accounted for as equity under US GAAP and thus do not entail writedown provisions. The terms of these preferred shares (including provisions governing dividend payments) have been largely standardised across banks since the finalisation of Basel III in the United States in 2013.

123. Regarding the loss absorption mechanism of preferred shares, the terms of preferred shares usually include triggers that prohibit dividend distributions or increases in indebtedness at the bank group level in the event that certain regulatory capital and liquidity coverage thresholds are breached.

CoCos

124. CoCos are instruments which are designed to absorb losses in a going-concern scenario through the cancellation of discretionary distributions, the conversion of the principal amount into common shares, or the writedown of the principal amount. When classified as liabilities for accounting purposes, the principal writedown or conversion to CET1 capital should occur no later than upon the occurrence of a trigger event. The minimum regulatory trigger event occurs when a bank has a CET1 ratio that reaches 5.125% or lower. The calibration of the trigger at a minimal 5.125% (ie 0.625 percentage points above the CET1 minimum ratio requirement of 4.5%) is linked to the last of the four stages of distribution restrictions under the combined buffer requirement.

6.3.2 Experiences with the loss-absorption capacity of AT1 instruments

125. Under the Basel III standards, AT1 instruments are intended to provide going-concern loss absorption and they thus serve to achieve two goals: (i) supporting a timely recapitalisation of banks in the aftermath of a crisis and (ii) helping to reduce the need for taxpayer bailouts of TBTF banks to protect depositors and creditors from undue losses.

126. Examples of AT1 instruments' loss-absorption capacity in stress periods are scarce and mixed. Most Committee member jurisdictions have reported no instances to date of AT1 instruments having to absorb losses on a going-concern basis. Other Committee member jurisdictions provided a limited number of examples where AT1 instruments absorbed losses on a going-concern basis or where the contractual or regulatory triggers were activated. In two cases, the activation of the trigger event resulted in the write-off or conversion of AT1 instruments, which allowed banks to improve their CET1 capital ratios. Furthermore, some suspensions of coupons on AT1 instruments were also observed, including for one internationally active bank.

127. Committee member jurisdictions presented two cases of banks whose financial situations raised questions regarding a potential absorption of losses by AT1 instruments. One of these cases involved resolution, and the decision from the relevant authorities was grounded primarily on liquidity difficulties. The solvency requirements were met when the bank was declared to be failing or likely to fail (FOLTF), but nonetheless, within the resolution procedure,[62] the resolution authority imposed the writedown and conversion of capital instruments before the quantitative AT1 trigger was hit, suggesting that the bank needed capital resources. In another case, the breach of the combined buffer requirements was addressed without the need for loss absorption or reduction of AT1 coupons because a recapitalisation was completed before the coupons' next payment date. Regarding distributions, in these cases, the banks were still able to pay out coupons on AT1 instruments despite deterioration in their financial positions, as payouts on AT1 instruments are linked to distributable items, not just current profits.

6.3.3 Remuneration of AT1 capital instruments

128. In responses to surveys conducted by the Committee, investors have reported that they would react negatively to AT1 coupon cancellation and would expect coupon cancellation to occur only in exceptional circumstances (eg when other alternatives for capital-raising and preservation are exhausted). Investors note that coupon cancellations would send a strong message to the market about the non-viability of the issuing bank, which would result in a steep increase in pricing and low market demand for AT1 and other instruments issued by that bank. In addition, from the issuers' perspective, the benefit received from the absence of distribution would be limited given the small proportion of AT1 instruments in banks' capital stack. In this sense, some market participants consider AT1 instruments as fixed income instruments that effectively have no downside risk of coupon payment cancellation. However, the higher

[62] See Single Resolution Board (2017), Article 5.

yields on these instruments relative to senior debt indicates that market participants do perceive some risks associated with such instruments.

129. As a response to the potential stigma associated with coupon cancellation of AT1 instruments, banks could choose or be required to suspend dividends on CET1 and maintain payment of AT1 coupons as some of the case studies presented in Section 6.3.2 suggest. The fact that AT1 coupon cancellation is of a one-off nature without the potential of a future offsetting effect via a higher coupon (as is the case for CET1) could also reinforce this effect. The European Systemic Risk Board has suggested that coordinated decisions by supervisors on dividend or coupon distribution restrictions can help mitigate market stigma when addressing sector-wide difficulties.[63] In practice, most jurisdictions did not impose sector-wide restrictions on AT1 coupons before or during the Covid-19 pandemic.

6.3.4 Permanency of AT1 capital instruments

130. The Basel III reforms require AT1 capital instruments to be perpetual, but also allow the issuer to call them after five years following the date of issuance with prior supervisory approval. In addition, many AT1 instruments include call options that can be exercised at subsequent interest reset dates (eg quarterly, semiannually or every five years) or at any time after the first call date. Therefore, in addition to the contractual provision on perpetuity, the focus of supervisory assessment has also considered the permanency of AT1 instruments.[64]

131. In practice, the majority of banks have called their AT1 capital instruments at the first possible call date. The European Banking Authority (2021) confirmed in its AT1 capital monitoring report that banks generally call AT1 instruments at the first call date, while only a few calls have not been exercised based on prudential or economic considerations.

132. These observed trends may be a consequence of the decreasing interest rate environment over the past several years; banks have incentives to call at the first call date if they are able to refinance their AT1 capital instruments at more favourable conditions. Indeed, one jurisdiction highlighted a few instances where banks did not call their AT1 capital instruments at the first exercise date because it would be uneconomical to do so in an increasing interest rate environment, as is the case currently. Decisions to not call AT1 instruments have had a limited impact on the pricing or liquidity conditions for bank capital securities, which suggests that the market has become more receptive to decisions by banks not to call AT1 instruments.

6.3.5 Interaction with the point of non-viability

133. Per the FSB's *Key attributes of effective resolution regimes for financial institutions*,[65] resolution should be initiated when a bank is no longer viable or likely to be no longer viable. Basel III defines the point of non-viability (PoNV) as the moment when an AT1 or Tier 2 instrument must either be written off or converted into common equity, at the option of the relevant authority. Since the introduction of the new resolution framework, a bank may be considered no longer viable or likely to be no longer viable by a decision of the relevant authority before the regulatory trigger of a 5.125% CET1 ratio is activated.

[63] See European Systemic Risk Board, *System-wide restraints on dividend payments, share buybacks and other pay-outs*, June 2020, p 5, www.esrb.europa.eu/pub/pdf/reports/esrb.report200608_on_System-wide_restraints_on_dividend_payments_share_buybacks_and_other_pay-outs_2~c77216425b.en.pdf.

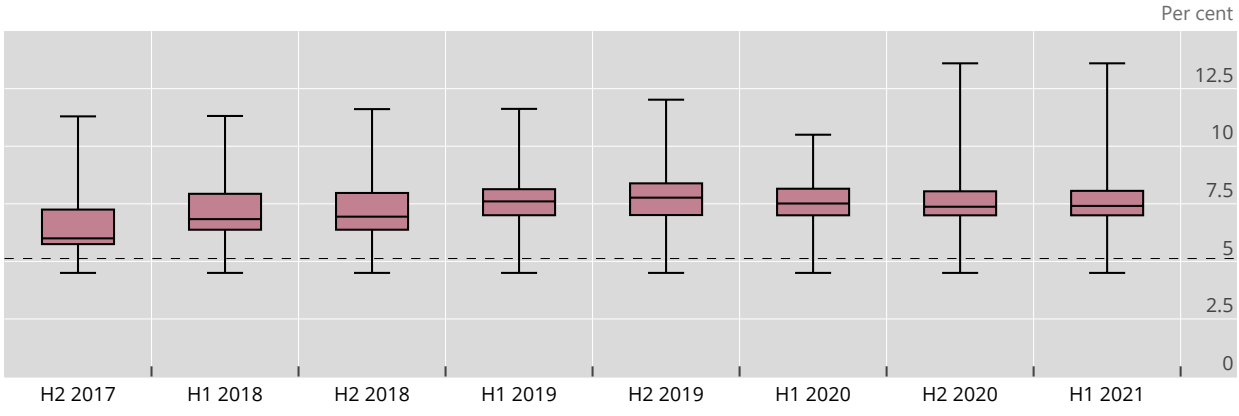
[64] While the Definition of capital (CAP) standard does not include the concept of permanency, it encompasses requirements such as the obligation for an issuing institution to set the first call date at least five years after the issuance (CAP 10.11(5)) and the competent authority's prior approval before any redemption/repayment of the instrument (CAP 10.11(6)). In addition, as stated in CAP 10.11(5)(c) of the Basel Framework, the issuing institution must either replace the called instrument or demonstrate that its capital position is well above the minimum capital requirements.

[65] See FSB (2014).

134. However, non-compliance with capital requirements is not the only condition that may render an entity FOLTF – this assessment may also be triggered by liquidity weaknesses. Situations where the PoNV is reached prior to the regulatory trigger could curb the loss-absorbing capacity of AT1 instruments on a going-concern basis.

Actual CET1 ratio requirements compared with the minimum regulatory 5.125% trigger

Graph 6



This box-and-whisker diagram shows the distribution of reported banks' CET1 requirements, including the combined buffer requirement but excluding the Pillar 2 requirement and guidance. Boxes represent the first, second and third quartiles of the population. The whiskers are set at maximum (100th percentile) and minimum (0th percentile) reported values. The horizontal line is set at 5.125% to compare these requirements with the minimal regulatory trigger. Outliers are not winsorised.

Source: Basel Committee on Banking Supervision.

135. Market practice has resulted in some AT1 capital instruments featuring a trigger that is higher than a 5.125% CET1 ratio, with a 7% CET1 ratio trigger being commonly used. Based on the Committee's data, Graph 6 illustrates the distribution of CET1 ratio requirements reported by banks, including combined buffers but excluding Pillar 2 requirements and guidance. It can be seen that banks' CET1 ratio requirements are generally higher than the minimal regulatory 5.125% trigger (horizontal line); this is also due to buffer requirements.[66]

6.4 Comparability of the leverage ratio across jurisdictions

136. When the leverage ratio was designed, the Committee considered whether accounting framework divergences could lead to differences in how the leverage ratio would be implemented across member jurisdictions, which would undermine its comparability. Furthermore, the Committee considered the treatment of central bank reserves in the leverage ratio, especially the potential effects in periods of stress. These two aspects are discussed in this subsection.

6.4.1 Treatment of different accounting frameworks

137. Amendments to the leverage ratio standard in 2014 and 2017 sought to improve comparability of the ratio across banks in different jurisdictions that may arise from differences in accounting frameworks. To that end, the final standard includes specific treatments for certain types of exposure, including securities financing transactions and derivatives, in the calculation of the leverage ratio exposure measure. Empirical analysis was undertaken to understand whether those specific treatments reduced accounting-related discrepancies in the leverage ratio (see Annex A.9). Overall, the analysis suggests that

[66] For buffer usability, also see BCBS (2022b).

the amendment of the Basel III leverage ratio standard that was finalised in 2017 is likely to have mitigated differences in banks' leverage ratios due to accounting differences between US GAAP and IFRS and, to a lesser extent, for banks that apply other national accounting standards.

6.4.2 Central bank reserves exemption

138. A further feature of the 2017 amendment of the leverage ratio standard concerned central bank reserves, which may be temporarily exempted by national authorities from the leverage ratio exposure measure in exceptional macroeconomic circumstances. This new exemption requires a commensurate increase in the minimum leverage ratio requirement to offset the impact of the exemption and requires banks to disclose the leverage ratio without the application of such exemption. Some jurisdictions implemented this exemption in 2020 to mitigate the impact of the pandemic on capital requirements. The exemptions aimed to minimise potential unintended consequences of the leverage ratio reform, such as (i) challenging the implementation of monetary policy; (ii) acting as a disincentive to access central bank liquidity facilities; (iii) limiting the supply of credit to the economy; or (iv) challenging the functioning of financial markets.

139. The central bank reserves exemption has been implemented differently across the six jurisdictions that have used it thus far.[67] For example, in some jurisdictions, banks are required to disclose the impact that exemptions have had along with the ongoing leverage ratio without exemptions. Some jurisdictions that granted temporary exemptions during the Covid-19 period did not impose a recalibration when implementing the exemption. Moreover, in some jurisdictions, government bonds were exempted to support market intermediation and/or loans guaranteed by their government to support bank lending under specific programs.

140. Although implemented in various ways during the Covid-19 period, the introduction of the jurisdiction-specific central banks reserves exemption in the leverage ratio signalled to the public that regulators are mindful of the potential impact of the leverage capital constraints on the implementation of monetary policy and on financing of the economy under stress conditions.

6.5 Conclusions

141. This section's analyses suggest that increases in CET1 capital amounts were the main driver of increases in banks' CET1 ratios, particularly for less capitalised banks. On top of these quantitative impacts, the Basel III reforms improved the loss-absorbing capacity of banks' own funds by tightening the definition of eligible capital instruments. Likewise, increased standardisation of the criteria qualifying instruments as CET1 and AT1 instruments has strengthened banks' capital base. However, robust empirical conclusions regarding the loss-absorption capacity of AT1 instruments cannot be drawn at this stage.

142. The introduction of the leverage ratio supplemented the risk-based capital ratios with a simple, transparent and non-risk-based measure that can act as a backstop to risk-based capital requirements. The 2014 and 2017 amendments of the leverage ratio standard helped to make the leverage ratio more comparable across different accounting standards and jurisdictions. However, jurisdiction-specific application of the standard's temporary exemption of central bank reserves in the leverage ratio exposure measure, as was exercised to address Covid-19-related stress in 2020, has resulted in some temporary differences in country-specific application of the standard.

[67] See Annex A.10 for details.

7. Additional analysis of liquidity reforms

143. Beyond the amendments to the capital framework, Basel III has also introduced a new regulatory regime for liquidity. This section expands the evaluation of liquidity reforms undertaken in the earlier sections on resilience (Section 4) and systemic risk (Section 5). It complements the work of the July 2021 BCBS report and the October 2022 BCBS report; the latter discussed issues of liquidity buffer usability.

144. There has been a significant improvement in banks' liquidity risk management since the GFC, with banks holding more HQLA and relying less on unstable funding sources. This section provides additional insights on how firms adjusted their liquid assets and funding streams in relation to the Basel III liquidity requirements by examining how a shortfall or surplus in banks' liquidity ratios relates to subsequent changes in their subcomponents (Section 7.1). Moreover, it explores some specific aspects of the LCR calculation which were highlighted in the Covid-19 stress, including some potentially cyclical elements (Section 7.2). Finally, it assesses the available evidence on the reforms' impacts on the intermediation of markets and regulatory optimisation by banks (Section 7.3).

7.1 Relationship between shortfall or surplus in liquidity ratios and changes in their subcomponents

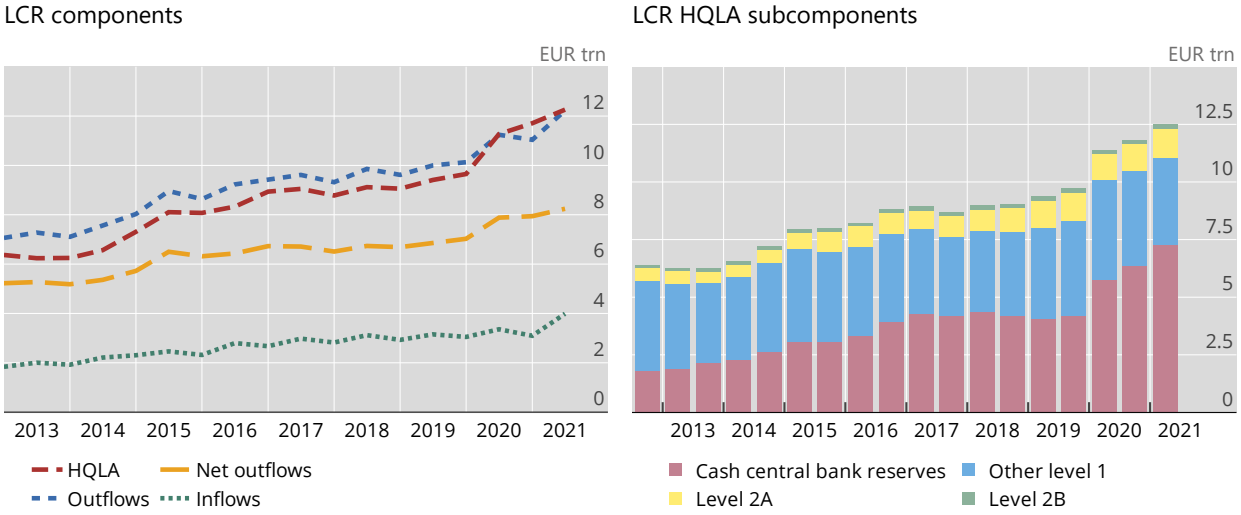
7.1.1 Descriptive analysis of liquidity ratio subcomponents

145. The increase in banks' LCRs over time was driven mostly by increases in HQLA, which were partly offset by increases in net outflows (outflows minus inflows) (see Graph 7.1, left-hand panel). The bulk of the HQLA held by banks is Level 1 HQLA, mostly composed of central bank reserves and sovereign securities, with the remainder largely composed of Level 2A HQLA (see Graph 7.1, right-hand panel). Inflows grew substantially during the period of implementation of the LCR (see Graph 7.2, left-hand panel). The underlying components of LCR outflows generally increased during the period in which the LCR was implemented, but at a slower pace than HQLA and inflows. The proportion of LCR outflows stayed relatively stable (see Graph 7.2, central panel). As LCRs increased, global LCR shortfalls (defined as the amount of additional HQLA needed by a bank to achieve an LCR of 100%) quickly diminished (see Graph 7.2, right-hand panel).[68]

[68] Note that the banks with shortfalls in H2 2020 and H1 2021 relative to the 100% LCR Basel standard are from a jurisdiction in which banks with limited international activity are not required to hold a 100% LCR. These banks are not in shortfall relative to the domestic LCR requirement to which they are subject.

Development of LCR and HQLA subcomponents

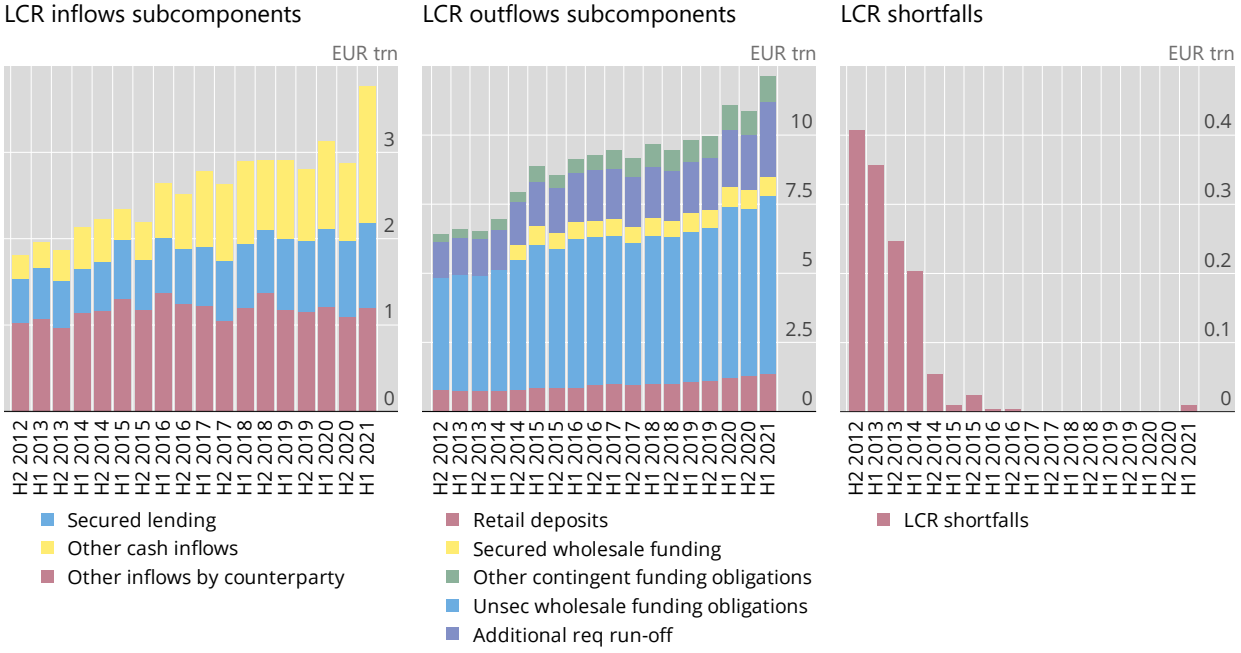
Balanced data set — Graph 7.1



Source: Basel Committee on Banking Supervision.

Development of LCR outflow, inflow subcomponents and shortfalls

Balanced data set — Graph 7.2



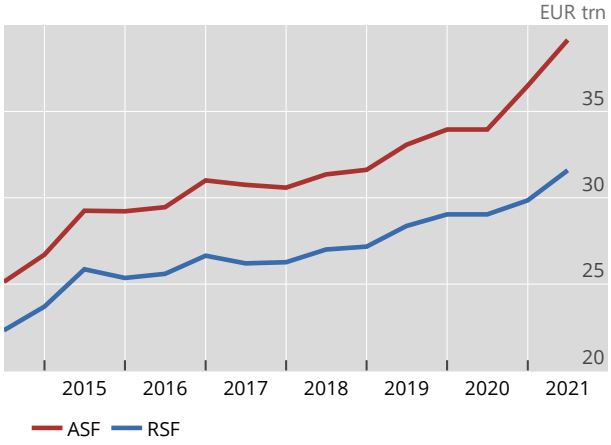
Source: Basel Committee on Banking Supervision.

146. The increase in banks' NSFRs was mainly due to increases in ASF, which were partly offset by increases in RSF (see Graph 8.1, left-hand panel). ASF from retail customers and small businesses (ie deposits) constitutes the biggest subcomponent of ASF (see Graph 8.1, right-hand panel). RSF increases have mostly been concentrated in lending, particularly lending with a maturity above one year. The aggregate amounts of most other RSF categories have stayed relatively stable (see Graph 8.2, left-hand panel). As NSFRs improved, global NSFR shortfalls (defined as the amount of additional ASF needed by a bank to achieve an NSFR of 100%) diminished (see Graph 8.2, right-hand panel).

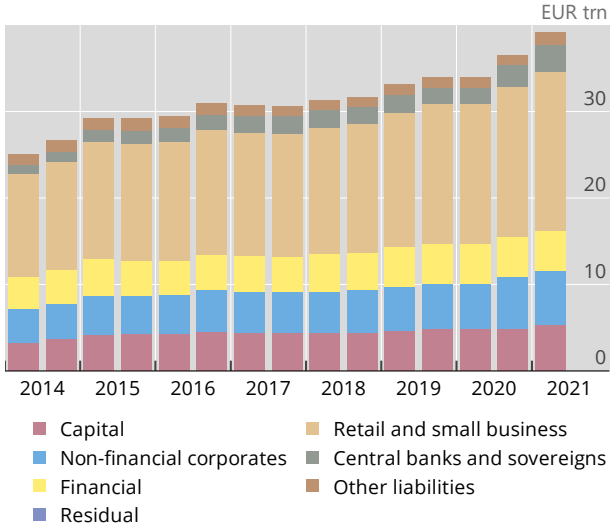
Development of NSFR and ASF subcomponents

Balanced data set — Graph 8.1

NSFR components



NSFR ASF subcomponents

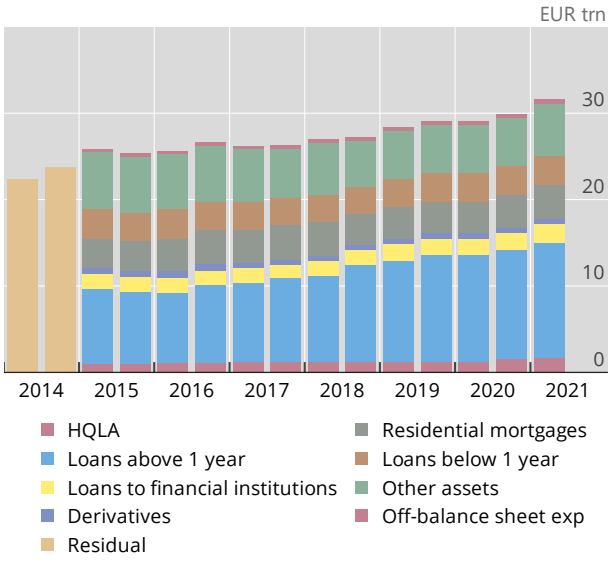


Source: Basel Committee on Banking Supervision.

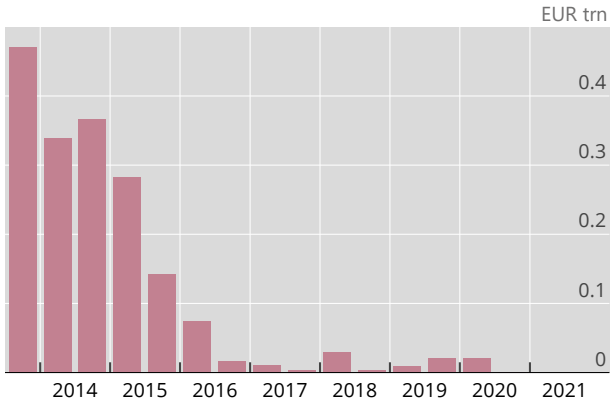
Development of RSF subcomponents and NSFR shortfalls

Balanced data set — Graph 8.2

NSFR RSF subcomponents



NSFR shortfalls



Source: Basel Committee on Banking Supervision.

7.1.2 Regression analysis

147. To empirically estimate the relationship of shortfalls in banks' liquidity ratios to changes in the subcomponents of these ratios, several least squares regressions were performed. The baseline model reads:

$$\left(\frac{y}{TA}\right)_{i,t} \cdot 100 - \left(\frac{y}{TA}\right)_{i,t-1} \cdot 100 = \alpha + \beta \cdot max\{100 - R_{i,t-1}, 0\} + \gamma \cdot max\{R_{i,t-1} - 100, 0\} + FE_{i,t} + \varepsilon_{i,t},$$

where $\left(\frac{y}{TA}\right)_{i,t}$ refers to the LCR or NSFR subcomponent y as a proportion of total assets TA for bank i in reporting period t, $max\{100 - R_{i,t-1}, 0\}$ is the shortfall (in terms of percentage points) to a fully loaded LCR or NSFR of 100% of bank i in the previous reporting period $t-1$, $max\{R_{i,t-1} - 100,0\}$ is the surplus above a fully loaded LCR or NSFR of 100%, $FE_{i,t}$ refers to different fixed effects and $\varepsilon_{i,t}$ is the error term.[69] The use of jurisdiction-time fixed effects controls for systemic differences between jurisdictions in specific time periods, such as monetary policy measures. In addition, bank fixed effects capture time-independent differences across banks.

148. For the LCR regressions, the time period assessed is between H1 2013 and H1 2021 and the sample includes 235 banks from 27 different countries.[70] This analysis includes data through the Covid-19 period, as data availability allows for an extension of the time period covered in the LCR regressions. Analysis considering data only until 2019 shows similar results. Nearly half of the banks in the sample are in Group 1 and about 100 of the banks in this sample experienced an LCR shortfall in at least one period in the sample.[71]

Regression results for the effect of the LCR on changes in its subcomponents Table 7

	$\Delta\left(\frac{HQLA}{TA}\right)_{i,t}$	$\Delta\left(\frac{Cash\ \&\ reserves}{TA}\right)_{i,t}$	$\Delta\left(\frac{Other\ level\ 1}{TA}\right)_{i,t}$	$\Delta\left(\frac{Net\ outflows}{TA}\right)_{i,t}$
	(1)	(2)	(3)	(4)
Shortfall to 100% LCR	0.0382***	0.0124*	0.0161**	–0.0299***
	(0.0106)	(0.00658)	(0.00816)	(0.00825)
Surplus above 100% LCR	–0.0130***	–0.00514***	–0.00693***	0.0165***
	(0.00252)	(0.00169)	(0.00195)	(0.00170)
R^2	0.404	0.399	0.323	0.363
Observations	2,553	2,567	2,547	2,516

Standard errors are in parentheses and clustered at the bank level. The dependent variables and the control variables are winsorised at the 1st and 99th levels. LCR is capped at 300%. The symbols *, ** and *** denote significance at the 10%, 5% and 1% level respectively. Jurisdiction-time fixed effects and bank fixed effects are included in all regressions.

Source: Basel Committee on Banking Supervision.

149. The regression results presented in Table 7 show a positive relation between the size of the LCR shortfall and the size of the subsequent increase in HQLA. The results show that banks with larger LCR shortfalls in the previous period generally increased their HQLA more than did banks with a smaller shortfall or no shortfall. There is an inverse relationship for net outflows; banks with larger LCR shortfalls increased their net outflows less than did banks with a smaller shortfall or no shortfall. A 1-percentage-point increase in the LCR shortfall is associated with approximately four basis points more growth in the HQLA-to-total assets ratio and approximately three basis points less growth in the net outflows-to-total

69 Alternative specifications including a number of control variables (including banks' CET1 ratios, leverage ratios, return on assets, and the natural logarithm of total assets) were also considered for robustness and produced similar results. The specifications with no control variables are presented here because they include a larger sample.

70 Note that the phase-in of the LCR was gradual (ie the requirement was generally gradually increased rather than set immediately to 100%), took multiple years, and did not proceed at the same pace across different jurisdictions. The Basel LCR standard only expected the LCR to be fully phased in by January 2019. Still, banks subject to the standard knew that the requirement would eventually converge to an LCR of 100%. Therefore, the shortfall has been consistently calculated relative to an LCR of 100% rather than to the not-fully phased-in interim requirements to which banks were subject in different jurisdictions.

71 Table A11.1 in Annex A.11 sets out descriptive statistics of variables used in the analysis.

assets ratio in the subsequent semester.[72] This suggests that the LCR requirement played a role in driving the changes subsequently observed in HQLA and net outflows, even after accounting for general market trends.

150. Among HQLA categories, growth in "other Level 1 HQLA", which comprises mainly sovereign securities, showed the strongest association with previous LCR shortfalls. Other subcomponents of HQLA and net outflows either do not have a statistically significant relationship with LCR shortfall, or their relation is only weakly statistically significant.

151. The increase in HQLA was partly driven by increases in holdings of sovereign securities which are not subject to haircuts. This trend was also seen in banks that reduced their RWA density by increasing their sovereign exposures (Section 6.1.1).

152. For NSFR regressions, the time periods assessed are H1 2013–H2 2019 for ASF and RSF, H1 2014–H2 2019 for the subcomponents of ASF, and H2 2015–H2 2019 for the subcomponents of RSF.[73]

Regression results for the effect of the NSFR on changes in its subcomponents Table 8

	$\Delta\left(\frac{ASF}{TA}\right)_{i,t}$	$\Delta\left(\frac{Financial\ ASF}{TA}\right)_{i,t}$	$\Delta\left(\frac{RSF}{TA}\right)_{i,t}$
	(1)	(2)	(3)
Shortfall to	0.144***	0.0928***	–0.116***
100% NSFR	(0.0329)	(0.0280)	(0.0421)
Surplus above	–0.0597***	–0.0121*	0.147***
100% NSFR	(0.0122)	(0.00697)	(0.0167)
R^2	0.571	0.257	0.334
Observations	2,451	2,078	2,463

Standard errors are in parentheses and clustered at the bank level. The dependent variables and the control variables are winsorised at the 1st and 99th levels. NSFR is capped at 300%. The symbols *, ** and *** denote significance at the 10%, 5% and 1% level. Jurisdiction-time fixed effects and bank fixed effects are included in all regressions.

Source: Basel Committee on Banking Supervision.

153. As shown in Table 8, the results show that banks with larger NSFR shortfalls in the previous period generally increased their ASF more than did banks with a smaller shortfall or no shortfall. Similarly, these banks increased their RSF less than did banks with a smaller shortfall or no shortfall. A 1-percentage-point increase in the NSFR shortfall is associated with approximately 14 basis points more growth in the ASF-to-total asset ratio and approximately 12 basis points less growth in the RSF-to-total asset ratio in the subsequent semester. This suggests that the NSFR requirement played a role in driving the changes subsequently observed in ASF and RSF, even after accounting for other financial market trends.

154. Among ASF categories, growth in ASF from financial firms displayed the strongest association with previous NSFR shortfalls. The relation between growth in the other subcomponents of ASF and RSF and the NSFR is generally not statistically significant or weakly statistically significant.[74]

[72] Note that despite the negative effect of an LCR shortfall on the growth of the net outflows-to-total assets ratio, the net outflows-to-total assets ratio still generally grew for banks with an LCR shortfall once the fixed effects in the model are taken into account.

[73] Table A11.2 in Annex A.11 sets out descriptive statistics of the variables used for the NSFR regressions. The sample period used for the NSFR regressions runs through H2 2019. This sample period is shorter than the sample period used for the LCR regressions because NSFR data was not collected by the Committee for H1 2020 due to the Covid-19 pandemic.

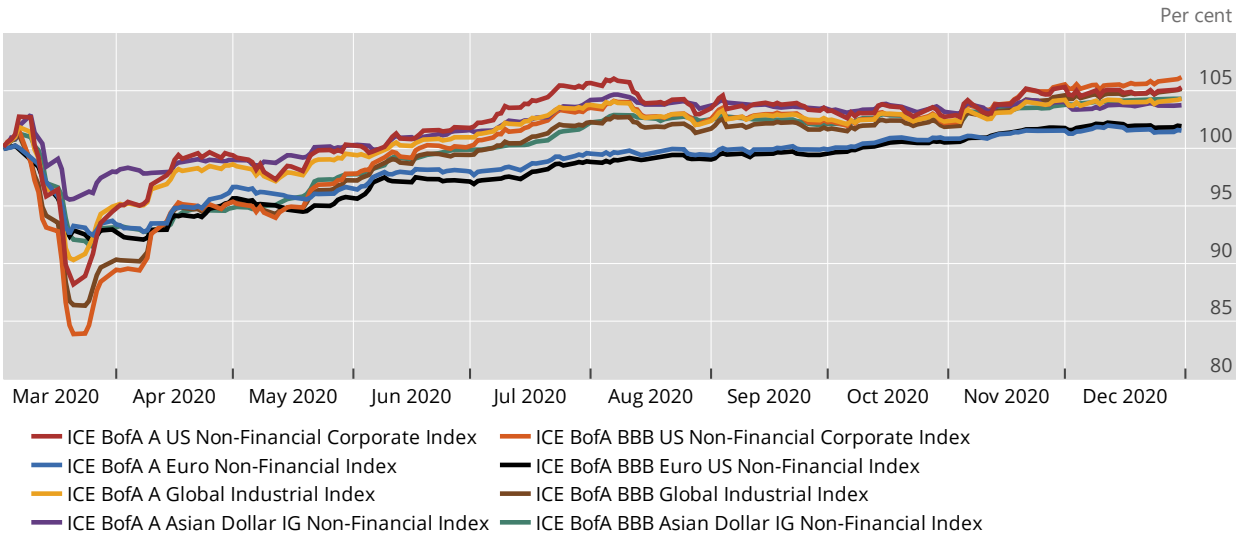
[74] The one exception is growth in RSF from derivatives, which is positively associated with NSFR shortfall.

7.2 HQLA and outflows during stress

155. During the Covid-19 stress, Level 1 assets including sovereign debt securities exhibited price volatility at the onset of the pandemic, followed by a recovery. This short-term drop in prices was associated with the "dash for cash" episode, when there was an elevated demand for cash and a precipitous rise in sovereign bond yields.[75]

156. Similarly, at the onset of the pandemic, proxy indices for Level 2A assets experienced temporary price declines of magnitudes that could have resulted in some individual Level 2A assets exceeding the maximum 10% price decline threshold set in the LCR standard. At the same time, proxy indices for Level 2B assets saw price declines that were large and sustained enough to potentially make individual Level 2B assets ineligible as HQLA by virtue of exceeding the Level 2B price decline thresholds, which are set at 20% for fixed income bonds and 40% for common equity shares (see Graphs 9.1 and 9.2).[76] For banks with significant exposure to Level 2B assets at the time, these types of price fluctuation could have resulted in increased volatility and downside pressure on their liquidity ratios. HQLA-eligible assets receive a preferable treatment in the NSFR, so price declines are also relevant for that standard. However, this issue is currently of limited materiality since Level 2B assets constitute, on average, only about 2% of total HQLA and 1% of RSF. For individual banks, these proportions are higher, and that could be a source of volatility in liquidity ratios for these banks.[77]

Performance of total return index proxies for Level 2B HQLA — Graph 9.1



Source: Reuters.

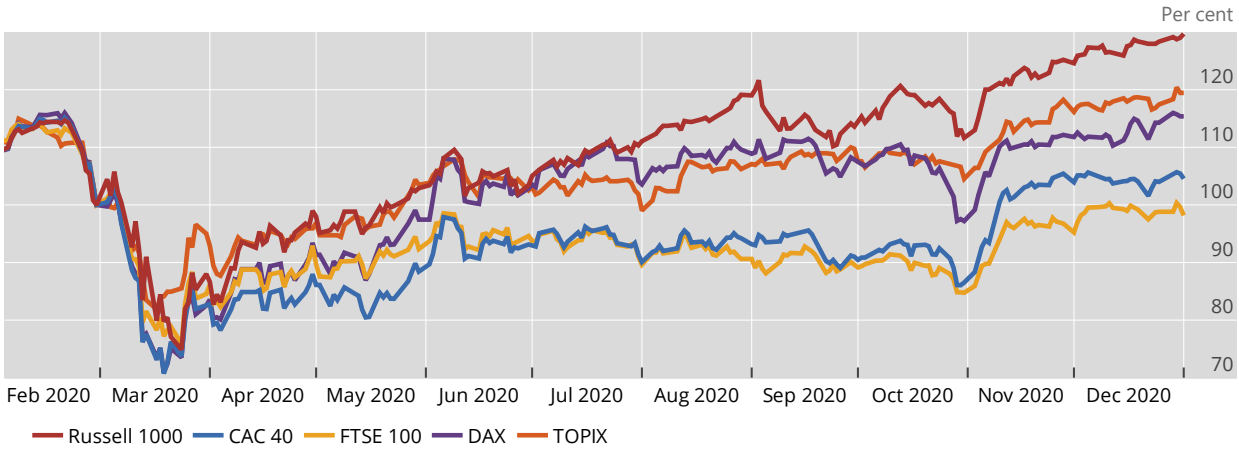
[75] Section 2.3 of FSB's *Holistic review of the March market turmoil* provides further details on that episode.; see www.fsb.org/2020/11/holistic-review-of-the-march-market-turmoil/.

[76] Price movements of indices are used as proxies for the HQLA eligibility requirements that apply at the individual asset level, hence these findings should be treated as suggestive rather than conclusive.

[77] At the 95th percentile, Level 2B assets make up around 8.4% of HQLA and 3.4% of RSF. See Annex A.12 for more details on the materiality of Level 2B assets.

Performance of equity index proxies for Level 2B HQLA

Graph 9.2



Source: Reuters.

157. The Historical Look-Back Approach (HLBA) is the method used in the LCR framework to measure potential liquidity needs related to market valuation changes on derivative or other transactions.[78] The July 2021 BCBS report provided a preliminary finding that during the pandemic the HLBA calculation behaved cyclically for some banks. A more detailed analysis further supports this finding in Annex A.13. At the fifth percentile of most affected banks, the increase in HLBA pushed down the LCR by 8.6 percentage points (2 percentage points at the 25th percentile) from December 2019 to June 2020. These effects were concentrated in the Americas and Europe.[79] Changes in the LCR of this size are material because in order to keep LCRs well above 100%, banks have been found to take or consider taking defensive actions as LCR levels fall towards this threshold (see October 2022 BCBS report). There appears to be only a weak relationship between the level of HLBA-based outflows included in the LCR denominator and the size of a bank's derivatives portfolios[80] (see Annex A.14 for more details). This is consistent with the jump in HLBA-based outflows observed in H1 2020 being due to the sharp moves in market prices and with the HLBA measure having limited sensitivity to changes in risk. Indeed, some jurisdictions have adopted alternative approaches to measure this risk in the LCR that avoid the cyclical effect of the HLBA measure.[81]

78 Specifically, the HLBA is calculated as the largest absolute net 30-day collateral flow realised during the preceding 24 months irrespective of the size of the derivative portfolio having changed since the HLBA peaking point. Due to the requirement's two-year historical observation period, the HLBA measure of risk increases during and for 24 months after periods of extreme market volatility.

79 The LCR reduction was 8.2 pp (4.8 pp) and 17.3 pp (1.9 pp) for the Americas and Europe respectively, with the Rest of the World having smaller effects with an LCR reduction of 3.5 pp (0.4 pp).

80 As examined through cross-sectional and within-bank correlations. Size is considered using both notional amount and fair value of derivatives.

81 Brazil adopts a different methodology, assuming an outflow of 30% of the required margin posted, which is more correlated to the actual volume of derivatives held by a bank; see BCBS, *Regulatory Consistency Assessment Programme (RCAP) – Assessment of Basel III LCR regulations – Brazil*, October 2017. Should a bank, for example, plan to sell its derivatives portfolio as part of its recovery planning, a risk-sensitive treatment for variation margins would allow it to immediately reap the net outflow benefit from that sale. In addition, as noted in paragraph 166 of the July 2021 BCBS report, Mexico temporarily adjusted its LCR standard during the Covid-19 stress period to allow banks to exclude market movements observed in March 2020 from the calculation of the HLBA-based outflow.

158. The July 2021 BCBS report specifically flagged derivative initial margin outflows to central counterparties (CCPs) as a significant drain and debt buybacks as an outflow that may have been inadequately captured in the LCR during the Covid-19 stress period.[82]

159. Data from some jurisdictions indicate that each of these sources of liquidity demand accounted for a few LCR percentage points across banks during the Covid-19 "dash for cash" stress episode (see Annex A.15). This is material in the context of banks trying to maintain LCRs well above 100% during periods of market stress as noted in the October 2022 BCBS report. Moreover, the aggregate numbers (which are by nature biased towards the largest and most diversified banks) will tend to underestimate the effect on certain internationally active banks with specialised business models (eg those that have greater house exposure to CCPs or more material reliance on wholesale funding sources).[83]

160. Finally, drawdown rates for credit facilities also determine outflows. As described in the July 2021 BCBS report, banks experienced large draws on loan facilities in the early days of the pandemic. The LCR requires banks to hold liquidity against the risk of drawdowns. The requirement varies according to the type of counterparty. Data for a number of jurisdictions indicate that drawdowns were mostly within the range provided for in the LCR, at least at aggregate levels. Drawdowns appear to have been above the amount provided for in the LCR in a few jurisdictions for non-financial corporates (LCR outflow rate of 10%). See Table 9 and Annex A.16 for details.[84]

Average indicative presumed drawdown ratios: end-February to end-March 2020

Table 9

Customer Sectors	Drawdown Assumption	Jurisdictions (anonymised)							
		1	2	3	4	5	6	7	8
Non-financial	–10%	–11.3%	–12.6%	–4.6%	–4.7%	–4.6%	–4.1%	–4.6%	–16.7%
Financial	–40%	3.2%	–0.6%	–21.3%	1.9%	–6.7%	N.A.	–7.2%	–8.9%
Retail	–5%	1.0%	–0.6%	–1.0%	2.6%	19.7%	–2.1%	12.6%	–7.6%

∗ Drawdown is expressed as negative numbers.

Source: Jurisdictional data.

7.3 Market intermediation and regulatory arbitrage and optimisation

7.3.1 Liquidity standards and market intermediation

161. Banks play a crucial role in securities markets, making markets and providing liquidity to those who wish to buy, borrow, finance or sell securities. This can result in liquidity and funding risk, and since the liquidity reforms require banks to limit or mitigate such risks, they can alter banks' incentives regarding market intermediation activity – this is consistent with banks becoming more resilient. A relevant question for evaluation is whether the standards may have affected market intermediation beyond this. The July

[82] The LCR scenario envisages the potential need for banks to buy back debt early (LCR 20.2). However, the LCR does not specifically require banks to hold liquidity against commercial paper (CP) or certificates of deposit (CDs) with a residual maturity greater than 30 days, but rather leaves it to national discretion (LCR 40.73).

[83] For example, for large UK subsidiaries of international banks in aggregate, CCP initial margin had a negative impact of more than 10pp on the LCR.

[84] The data are the monthly changes in the overall balance of undrawn credit facilities. The eight jurisdictions comprise three from Europe, two from Asia and three from the Americas. The data include 15 G-SIBs and 30 D-SIBs. Such changes only approximate the LCR drawdown, as they do not necessarily factor in newly arranged and/or matured facilities. Other factors could influence the numbers; for example, rollover of credit facilities might have been hampered by operational constraints at the beginning of the pandemic and corrective actions may have been undertaken after the decrease observed in March 2020.

2021 BCBS report examined the question of market liquidity in March 2020 and noted that while liquidity deteriorated, including in markets traditionally seen as deep and liquid, extensive policy actions by jurisdictions helped stabilise key markets.[85]

162. The LCR was designed to be broadly neutral towards intermediation in securities markets provided banks are not engaging in significant maturity and liquidity transformation. In certain cases, transactions of a kind which would usually have a neutral impact on a bank's LCR could have a negative impact, for example, where banks are constrained by the LCR's inflow cap.[86] Banks are rarely constrained by the inflow cap, at least at the consolidated group level, though the incidence may be higher at lower levels within groups (eg for entities which are more focused on market-making and dealer activities).[87] Banks with repo matched books are also relatively more likely to be constrained by the inflow cap.[88]

163. There is some limited empirical evidence on the effect of the LCR on market intermediation. Gerba and Katsoulis (2021) find that during stress periods, banks that are jointly constrained or close to being jointly constrained by the leverage ratio and the LCR reduce their government bond repo borrowing and lending activity to a greater extent than do banks that are constrained by a single ratio. The authors link the results to structural effects of regulatory ratios on banks' trading decisions in terms of prices and volumes, as well as their reluctance to breach regulatory thresholds. They also find evidence that for the period 2016–20, during which banks were increasing their LCRs, banks reduced longer-term reverse repo lending against lower-quality collateral. This is in line with the intended goal of the LCR to strengthen banks' liquidity positions. Macchiavelli and Pettit (2021) show that the introduction of the LCR in the United States was associated with banks providing fewer collateral upgrades. The study does not consider stressed periods and notes that some of their findings can be attributed to de-risking immediately after the GFC. Moreover, to the extent that the LCR does impose costs, some of these costs may be socially efficient.[89]

164. Because the NSFR has been implemented relatively recently, this evaluation has not to date identified evidence of its impact on market intermediation. However, some jurisdictions have made amendments to their local implementation of the NSFR to mitigate any potential effects on banks' incentives to undertake transactions involving market intermediation. In particular, jurisdictions have reduced the RSF factor applicable to securities financing transactions backed by Level 1 collateral as well as outright holdings of such collateral.

7.3.2 Regulatory arbitrage and optimisation

165. This subsection explores whether banks have optimised their activities in ways that make the LCR framework less effective. One potential concern is window dressing. Banks may attempt to improve their LCRs around dates for which they publicly disclose the LCR, particularly in jurisdictions where they

[85] This has been explored by the FSB in *Lessons learnt from the Covid-19 pandemic from a financial stability perspective: interim report*, July 2021; and *Enhancing the resilience of non-bank financial intermediation: progress report*, November 2021.

[86] The LCR inflow cap prevents banks from relying solely on anticipated inflows to meet their outflows in a stress. Inflows (in the LCR denominator) are capped at 75% of a bank's outflows. This generally ensures that even a bank whose assets and liabilities are contractually matched during the 30-day window holds a quantity of HQLA. It imposes an LCR cost on matched transactions using non-Level 1 collateral, which could, at the margin, disincentivise banks from intermediating in markets via repo matched books, including during a stress. The LCR's caps on the composition of a bank's HQLA (40% of total HQLA for Level 2 assets and 15% of total HQLA for Level 2B assets) could potentially amplify any effect on banks that are subject to the inflow cap.

[87] The inflow cap may also not be binding because the outflow requirements are calibrated more stringently than the inflow requirements.

[88] Banks with such books generate large and matched LCR inflows and outflows, including for transactions of less than 30 days backed by non-Level 1 collateral.

[89] The findings by Macchiavelli and Pettit (2021) indicate for example that the LCR regulations to an extent embed in regulation the de-risking actions that firms took after the financial crisis and before the LCR was introduced.

voluntarily disclose LCRs as of particular dates, rather than as an average over a period of time. Data collected by the Committee have not shown systematic evidence of such "window-dressing" behaviour.[90]

166. Another potential concern is that banks change the contractual form of transactions in ways that reduce the LCR requirements without a commensurate reduction in their liquidity risk. One example is a shift in the way that banks structure financing and lending transactions with wholesale counterparties, such as hedge funds, by using derivatives. Derivative products appear to have become more important to banks' role as financial market intermediaries and facilitators of leveraged trading strategies (ie prime brokerage).[91] Industry commentary has recognised that the LCR provides incentives for this structure.[92] However, quantitative analysis of the impact of these structures on the LCR is not available.

167. The incentive provided by the LCR to cluster maturities just outside of the LCR's 30-day maturity window also presents a potential concern. Information from various sources suggests that such transactions are not a significant concern in practice at present, but this evidence is not comprehensive. Information collected by the Committee from some supervisory authorities in 2019 indicated that there was evidence of a modest but noticeable pattern of deterioration in liquidity positions just beyond the 30-day point, with variation between banks. In the case of Sweden, Hansson and Lindqvist (2022) show that the cumulative cash flow of Swedish banks peaked at day 30 and decreased towards maturity of six months.[93] EBA (2021) makes use of similar data at the EU level to analyse how banks had optimised their liquidity positions by estimating a five-week LCR proxy and comparing this proxy with the regulatory 30-day LCR.[94] This analysis finds that the five-week LCR proxy mildly deteriorated compared with the regulatory 30-day LCR, implying that there may be some worsening in liquidity risk that warrants attention just over day 30 along the maturity horizon. Correspondingly, in its 2019 liquidity stress test, the ECB-SSM found some cases of liquidity profiles deteriorating just beyond 30 days.[95] In the case of UK banks, the net liquidity position of major banks in the United Kingdom – calculated by applying a stress scenario based on LCR assumptions – also shows that there is a deterioration just beyond day 30, with the net liquidity position decreasing by 8% from day 30 to day 35. That said, the magnitude of this decrease is small, as the observed decrease is equivalent to less than 3% of their HQLA.

7.4 Conclusions

168. The analyses suggest that Basel III's LCR and NSFR requirements are associated with changes that banks have made to the liquidity risk exposures measured in those ratios' components. Banks with greater LCR shortfalls have experienced greater increases in HQLA and lesser increases in net outflows. Similarly, banks with greater NSFR shortfalls have experienced greater increases in ASF and lesser increases in RSF. Among HQLA and ASF categories, non-reserve Level 1 HQLA and ASF from financial firms increased the most in reaction to LCR and NSFR shortfalls, respectively. All of this suggests that the introduction of

[90] See Annex A.17 for this analysis.

[91] For example, the notional amounts outstanding for equity swap derivatives (the most relevant contractual structure here) at the six largest US banks increased by 550% between 2009 and 2018.

[92] For example, see K Devasabai, "Primes push synthetics as Basel III bites", *Risk.net*, 2 April 2013, www.risk.net/asset-management/hedge-funds/2257348/primes-push-synthetics-basel-iii-bites.

[93] See Hansson and Lindqvist (2022), www.riksbank.se/en-gb/press-and-published/publications/economic-commentaries/could-the-banks-cope-with-large-deposit-outflows-assessment-according-to-a-new-liquidity-metric/introduction/.

[94] See EBA (2021), www.eba.europa.eu/sites/default/documents/files/document_library/Publications/Reports/2021/963932/Second%20EBA%20report%20on%20monitoring%20of%20LCR%20implementation%20in%20the%20EU.pdf.

[95] See European Central Bank Single Supervisory System (ECB-SSM), *Sensitivity analysis of liquidity risk – Stress test 2019 – Final results*, October 2019, slide 24.

liquidity ratios was followed by a significant improvement in banks' liquidity, especially in the case of banks with an initial shortfall.

169. Some specific aspects of the LCR calculation were highlighted in the Covid-19 stress. One was the potential for certain features of the LCR to exacerbate the downward (cyclical) pressure in a stress, in the context of banks trying to maintain their LCRs well above 100%. More broadly, there is little evidence of any inappropriate calibration of the LCR's core outflow assumptions.

170. This analysis found no clear evidence that regulatory optimisation actions pursued by banks should call into question the overall effectiveness of Basel III's liquidity reforms. Relating to market intermediation, there is some limited and non-conclusive evidence of adverse effects. This should be considered in the context of banks' reluctance to allow liquidity ratios to fall below normal levels.

171. All in all, these analyses suggest that the introduction of LCR and NSFR requirements as part of the Basel III framework has led to a significant improvement in banks' resilience to liquidity shocks.

8. Potential side effects of Basel III on bank lending, cost of capital and business models

172. The previous sections of this report assessed the intended effects of the Basel lll reforms of increasing resilience and reducing systemic risk (Section 4 and Section 5). The report also looked in detail at the effects of capital reforms (Section 6) and newly introduced liquidity regulation (Section 7). This section considers potential other effects for banks' customers and clients. These effects could result from banks changing their behaviour in response to new regulatory restrictions. In this section, we assess a range of potential effects of the Basel III reforms, including their impact on lending (Section 8.1.3), on cost of capital (Section 8.1.4) and on business models (Section 8.2).

8.1 Effects on bank lending and cost of capital

173. Banks can meet higher regulatory capital requirements by increasing regulatory capital (the numerator of the ratios) as well as by reducing RWA and leverage exposures (the denominator of the ratios). Section 6 illustrates that banks with lower CET1 ratios typically increased their capital. However, banks that are unable or unwilling to raise sufficient new capital to meet requirements may reduce RWA and exposures by cutting back on lending.

174. Similarly, Basel III's introduction of the LCR and the NSFR required banks to increase their liquidity. Section 7 shows how banks increased their HQLA and stable funding as a result of the Basel III reforms. However, holding additional HQLA is in potential conflict with holding other assets to maintain lending to the real economy. Likewise, the financing of long-term loans impacts the NSFR.

175. To assess the effects of the Basel III reforms, this section investigates whether the announcement of the Basel III standards was followed by reductions in bank lending. In theory, this effect is likely to be stronger for banks with lower capital and liquidity ratios at the time of the jurisdictional announcement date relative to banks with higher capital and liquidity ratios. Therefore, the section also examines whether Basel III has hampered bank lending for banks that had to increase their regulatory ratios significantly during the transition phase of the reforms.

176. Cost of (equity) capital and/or other funding costs are an important factor that banks consider when deciding whether to increase capital, HQLA and stable financing or reduce exposures (eg lending) to manage their capital ratios. An incomplete Modigliani-Miller effect (see eg Aboura and Lépinette (2015), Cline (2015)) suggests that the weighted average cost of capital may rise during the transition to a new regulatory regime. In addition, if no management actions on capital ratios are taken, an increase in

regulatory requirements due to the introduction of a new requirement can reduce a bank's distance from its regulatory default threshold, which may imply an increase in the cost of capital. However, available evidence suggests that complying with stricter regulation may, beyond the short-run increase, reduce average funding costs over the medium term (Belkhir et al (2021), Gambacorta and Shin (2018), Toader (2015)). Therefore, this study also tests whether banks with lower capital and liquidity ratios experienced changes in (equity) capital or debt financing costs during the transition phase for Basel III.

8.1.1 Methodology

177. The methodology underlying this analysis mirrors the methodology used in Section 4, which is described in Section 3.2. The analysis seeks to identify how bank lending, cost of capital and cost of debt changed after the jurisdictional announcement date of the Basel III reforms. For this, panel data are used to exploit time and cross-sectional variation. The main regression equation set out in Section 3.2 is adjusted slightly to reflect banks' anticipated behavioural changes prior to the jurisdictional announcement date. Coefficients are estimated for the effects over a five-year period before and after this date ($-5 \leq \tau \leq 5$) because the effects of the reforms on lending or on cost of capital and debt may manifest before the official jurisdictional announcement date. Thus, the model reads:

$$y_{i,t} = \alpha_i + \theta_t + \gamma \cdot Macro_{c,t-1} + \sum_{\tau} \beta_\tau \cdot D_\tau \cdot Impact_i + \varepsilon_{i,t},$$

where i denotes the individual bank, c the country, and t the time period. $y_{i,t}$ is the dependent variable of interest – for loans, the natural logarithm of the sum of all loans granted by bank i is used; for cost of capital and debt, cost in percentage points is used. D_τ are dummy variables that are equal to one in the relevant time period τ. $Impact_i$ is a variable that indicates the extent to which a bank is affected by the respective Basel III reform at the jurisdictional announcement date. Time-specific event-window coefficients β_τ are estimated, $Macro_{c,t-1}$ are lagged country-specific control variables (Hodrick-Prescott filtered GDP growth, the volatility index VIX or V2X and the policy interest rate), and α_i and θ_t are bank- and time-specific fixed effects. The error term $\varepsilon_{i,t}$ is clustered at the bank level.

178. This methodology controls for various demand factors that may affect lending volumes and, therefore, aims to identify the effect of the Basel III reforms on bank lending supply. Nevertheless, it is possible that the methodology does not fully control for the specific demand conditions that banks face, which would reduce the accuracy of the estimates.

8.1.2 Data

179. Semiannual data described in Section 3.1 are used for the analyses in this section, covering the period 2011–19.[96]

180. Each observation date in the baseline specification uses the natural logarithm of a measure of lending that contains loans to non-financial corporates, SMEs and retail clients, ie each bank's total lending to the real economy. Specifically, this lending measure represents total on- and off-balance sheet exposures to these borrowers as measured by the leverage ratio exposure measure values, but does not include derivatives. In robustness checks, an analysis examines the impact of the reforms on lending to non-financial corporations, SMEs and retail clients separately.

181. Banks' cost of capital information is not available in the Committee's data set. For listed banks, semiannual estimates for the cost of equity and the cost of debt were derived from Bloomberg, which draws on the capital asset pricing model (CAPM).

182. Lagged GDP growth (after Hodrick-Prescott filtering) and the policy interest rate are included in the regressions as control variables for loan demand and supply at the jurisdiction level. Furthermore, a

[96] Newer data are excluded because they are heavily influenced by the Covid-19 crisis.

volatility index is used to capture general uncertainty and fluctuations on financial markets. Time-specific fixed effects θ_t and bank-specific fixed effects α_i help to control for general time-specific trends and bank-specific levels of lending and capital costs.

183. Descriptive statistics for all variables are set out in Annex A.2.

8.1.3 Effects on lending

184. For the regression results on the effects of the Basel III reforms on bank lending, Table 10 reports whether bank lending differs depending on the $D_\tau Impact_i$ measure after the jurisdictional announcement date of the Basel III reforms.

185. The mostly insignificant coefficients suggest that, in general, loan growth by banks with weaker regulatory ratios does not differ from that for other banks. The weakly significant, positive coefficients after the introduction of the leverage ratio point to higher credit growth for these banks. However, a 10-percentage-points lower LCR at the event date is associated with 0.2-percentage-point lower lending one year later and 0.4-percentage-point lower lending two years later.

Regression results for total lending as dependent variable, by years since jurisdictional announcement date

Table 10

Dependent variable	Total lending			
	(1)	(2)	(3)	(4)
Reform considered	CET1 ratio	Leverage ratio	LCR	NSFR
One year after	0.0028	0.0047*	–0.0002*	0.0004
(τ = 1)	(0.0022)	(0.0026)	(0.0001)	(0.0004)
Two years after	–0.0031	0.0125	–0.0004*	0.0011
(τ = 2)	(0.0039)	(0.0079)	(0.0002)	(0.0008)
Three years after	–0.0034	0.0218*	–0.0006	0.0021
(τ = 3)	(0.0058)	(0.0130)	(0.0004)	(0.0016)
Four years after	0.0001	0.0434	–0.0008	0.0052
(τ = 4)	(0.0097)	(0.0282)	(0.0006)	(0.0045)
Five years after	0.0028	0.0574	–0.0004	0.0121*
(τ = 5)	(0.0136)	(0.0393)	(0.0006)	(0.0072)
Coefficients for $\tau < 0$	Yes	Yes	Yes	Yes
R^2 (within)	0.0880	0.0983	0.0804	0.1490
Observations	2,535	2,579	2,484	2,551
Number of banks	196	199	193	191

The table shows the regression coefficients for CET1 ratio, leverage ratio, LCR and NSFR when total lending is considered as dependent variable in columns (1)–(4). The data set used is taken from the Basel Committee on Banking Supervision and described in more detail in Section 3.1; the methodology is presented in Section 3.2. $Impact_i$ is measured by the individual regulatory ratio at the jurisdictional announcement date. Controls are the lagged GDP growth, lagged market-implied volatility (VIX/V2X) and the lagged policy rate. Fixed effects are included at the bank and time level. Robust standard errors, clustered at the bank level, are reported in parentheses. The symbols *, ** and *** denote significance at the 10%, 5% and 1% level.

Source: Basel Committee on Banking Supervision.

186. Thus, the regression results above do not imply that banks with initially low regulatory ratios reduced their lending after the Basel III reforms. Furthermore, as Graph A18 in Annex A.18 shows, bank lending grew in aggregate after the Basel III reforms both for banks above the initial median of a given

regulatory ratio and banks below the initial median of that regulatory ratio, for each of the four regulatory ratios under analysis.[97]

187. For an additional analysis, the event date was changed to the global announcement date using first the available observations in the data (ie H1 2011 for capital reforms and H2 2012 for the liquidity reforms; regression results are available in Table A19.1 of Annex A.19. The coefficients show that banks more affected by the CET1 ratio or the leverage ratio have significantly lower lending growth in the following years, consistent with findings by Gropp et al (2019) that study the relationship between increased requirements and reductions in credit supply. The additional analysis also weakly confirms this finding for both liquidity ratios. These results suggest that banks may have reacted to the reforms closer to their global announcement date, potentially because of the increased market discipline after the GFC, and that banks may have at least partially adjusted to the reform by the time of their jurisdictional announcement dates. Accordingly, coefficients shown in Table 11 may underestimate the overall effect of the reforms.

188. Further robustness checks are reported in Annex A.19 and show that banks with low initial CET1 ratios increased their overall lending less than other banks. These checks consider all four reforms entering the regression jointly and they confirm the potentially negative relation of the CET1 or leverage ratio and loan growth (Table A19.2). A more granular analysis of the main components of bank lending to the real economy – specifically lending to retail borrowers, SMEs and non-financial corporates – was also conducted. These tests do not reveal significant differences across sectors (see Tables A19.3–A19.5 of Annex A.19). Generally, the results of these more granular regressions have limited statistical significance. Using country-time fixed effects instead of macroeconomic control variables also does not change the main results.

189. An important countervailing theme is that the higher capital ratios arising from the reforms may support lending in a subsequent downturn. This question is assessed in the July 2021 BCBS report using methodologies that are similar to those used in this report. That report found that banks with higher CET1 ratios, both in absolute terms and measured as distance to buffer requirements, grew their lending more during the Covid-19 pandemic.[98] The academic literature (eg Jiménez et al (2017)) also documents that higher capital supports lending during downturns. These findings indicate that, while the implementation of higher capital requirements may hamper loan growth, as documented in this report, one can also see a beneficial effect of the higher capital ratios on lending in a subsequent downturn.

190. The regression results in this section concern the effect of the Basel III reforms on volumes of bank lending to the economy. To fully understand the effect of the Basel III reforms on bank lending, ideally one should also analyse other contract terms, such as the lending rate or the collateral. However, this could not be done for this report given the lack of sufficiently detailed data on these contract terms. Also, the data available focus only on bank lending to non-financial corporates, SMEs and retail clients, which does not allow for an assessment of the impact of the Basel III reforms on total lending (including interbank and non-bank lending) in the various jurisdictions affected by the Basel III reforms.

8.1.4 Effects on cost of equity and cost of debt

191. The following regressions assess the impact of the Basel III reforms on cost of equity and cost of debt. Table 11 reports regression results, where both cost of equity and cost of debt are scaled to annual percentage points. Note that market data are available only for a subsample of listed banks and, therefore,

[97] Graph A18 in Annex A.18 also shows that the pre-reform trends for the banks above and below the initial median of each regulatory ratio are similar, which suggests that the effect is not merely the continuation of pre-existing differences between lower and higher capital banks and is more likely attributed to the Basel III reform.

[98] This finding is statistically significant in some, but not all, of the specifications used in the July 2021 BCBS report.

only approximately 60 large banks can be included in these analyses (as opposed to almost 200 banks in the regressions analysing the effects on lending).

Regression results for cost of (equity/debt) capital as dependent variable, by years since jurisdictional announcement date

Table 11

Dependent variable	Cost of equity				Cost of debt			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Reform considered	CET1 ratio	Leverage ratio	LCR	NSFR	CET1 ratio	Leverage ratio	LCR	NSFR
One year after	–0.0133	–0.0572	–0.0018	0.0031	–0.0252***	0.0142	0.0004	–0.0014
(τ = 1)	(0.0263)	(0.0451)	(0.0021)	(0.0031)	(0.0090)	(0.0114)	(0.0004)	(0.0009)
Two years after	–0.0785	–0.0298	–0.0056	0.0003	–0.0462**	0.0137	0.0009	–0.0016
(τ = 2)	(0.0584)	(0.0780)	(0.0042)	(0.0070)	(0.0176)	(0.0193)	(0.0009)	(0.0018)
Three years after	–0.1104	–0.2190**	–0.0050	–0.0023	–0.0578**	0.0102	–0.0003	–0.0021
(τ = 3)	(0.0878)	(0.1090)	(0.0054)	(0.0104)	(0.0244)	(0.0294)	(0.0013)	(0.0027)
Four years after	–0.0674	–0.2500*	–0.0112	0.0031	–0.0543*	–0.0116	–0.0028	–0.0016
(τ = 4)	(0.1006)	(0.1387)	(0.0067)	(0.0144)	(0.0276)	(0.0368)	(0.0018)	(0.0041)
Five years after	–0.0144	–0.3518**	–0.0201**	0.0026	–0.0393	–0.0704	–0.0065**	0.0045
(τ = 5)	(0.1189)	(0.1652)	(0.0078)	(0.0207)	(0.0295)	(0.0463)	(0.0026)	(0.0055)
Coeff. for τ < 0	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R^2 (within)	0.3331	0.3469	0.3446	0.3412	0.4715	0.4354	0.5320	0.4468
Observations	1,229	1,157	1,184	1,211	1,229	1,157	1,184	1,211
Number of banks	69	65	66	68	69	65	66	68

The table shows the regression coefficients for CET1 ratio, leverage ratio, LCR and NSFR when cost of equity is considered as dependent variable in columns (1)–(4), while columns (5)–(8) display the coefficients for cost of debt as a dependent variable. The data set used is taken from the Basel Committee on Banking Supervision and described in more detail in Section 3.1; the methodology is presented in Section 3.2. $Impact_i$ is measured by the individual regulatory ratio at the jurisdictional announcement date. Controls are the lagged GDP growth, lagged implied volatility (VIX/V2X) and the lagged policy rate. Fixed effects are included at the bank and time level. Robust standard errors, clustered at the bank level, are reported in parentheses. The symbols *, ** and *** denote significance at the 10%, 5% and 1% level.

Source: Basel Committee on Banking Supervision.

192. The regression results suggest that banks more affected by the leverage ratio and LCR reforms (measured by those with a weaker leverage and/or LCR ratio) saw a greater decrease in their cost of equity after the reforms relative to other banks. Meanwhile, the regressions suggest that banks most affected by either the risk-based capital reform or the LCR reform saw, to a lesser extent, a greater decrease in their cost of debt after the reforms relative to other banks. Ceteris paribus, more equity and less debt funding makes both sources of funding less risky and therefore less costly.

193. An additional analysis of the weighted average cost of capital (WACC) finds that, after the proposal of the reforms, WACC is lower for banks with a low initial CET1 ratio or low initial LCR relative to other banks (see Table A19.6 of Annex A.19). These results are supportive of Basel III reforms reducing the relative risk of banks that entered the reforms with weaker regulatory requirements, and consequently improving their relative cost of funding.

8.2 Effects on business models

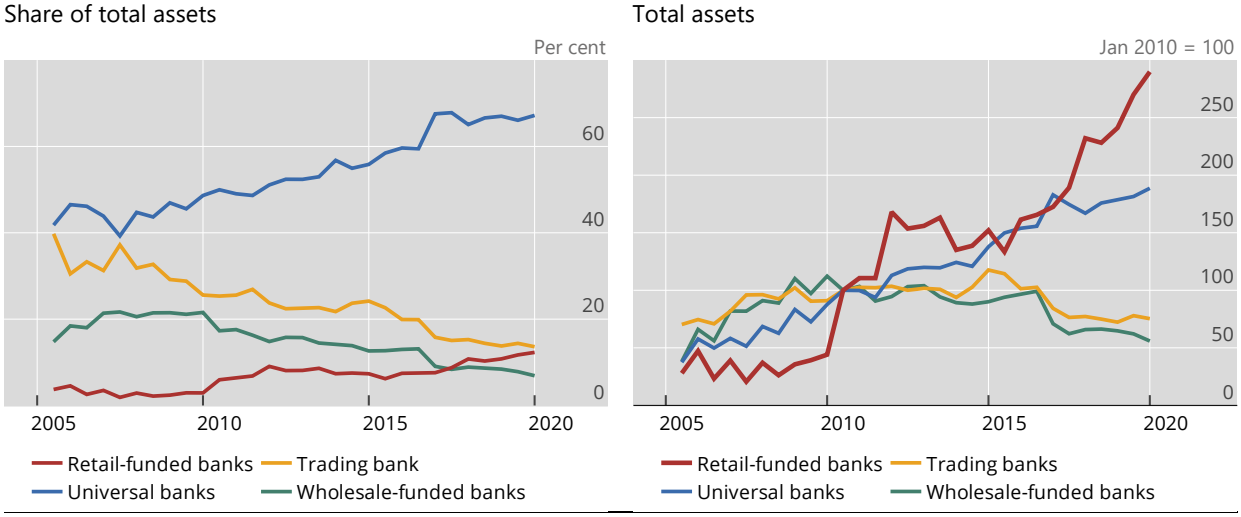
194. Beyond changes to their lending and cost of capital, banks may react differently to Basel III. Banks differ substantially in both the investments and loans that they make as well as their sources of funding.

Such differences in banks' balance sheets are often related to their "business model".[99] While, in general, identical requirements are applied across banks of different business models, one might expect requirements that are related to balance sheets to have a different impact across banks with different business models. For example, leverage ratio requirements may bind more tightly on banks that have a lower RWA density (eg wholesale banks), while reforms to the risk-based requirements for market risk would have greater impact on banks specialised in trading activities.

195. This subsection explores how business models have evolved in the last 15 years, and whether banks with different business models were differentially affected by Basel III reforms. To this end, this study uses the definition of business models developed by Roengpitya et al (2017), which relies on a statistical methodology (based on a clustering algorithm) using balance sheet ratios. The empirical approach allocates banks into four business model clusters: "retail-funded" banks (R), "wholesale-funded" banks (W), "trading" banks (T), and "universal" banks (U) (see Annex A.20).

196. Graph 10 reports the market share of each business model over time (left-hand panel) and the indexed total assets of each business model category (right-hand panel). The graphs indicate a general shift in banking assets towards retail-funded and universal banks, as well as a concurrent shift away from wholesale-funded and trading bank business models. The right-hand panel of Graph 10 indicates that this is largely driven by growth in the total assets of retail-funded and universal banks starting in 2005, and intensifying after the GFC. The total assets of wholesale-funded and trading banks grew somewhat before the GFC, were flat over much of the reform period, and have declined somewhat since 2016. Graph A20.2 in Annex A.20.2 provides some additional detail, showing a concurrent shift toward deposit funding and away from wholesale funding across most bank business models; the share of assets invested in loans or the trading book changed little for any business model category.

Market share and total assets of bank business models (2005–19) Graph 10



The graph shows the evolution of the market share of retail-funded banks (red line), trading banks (yellow line), universal banks (blue line) and wholesale-funded banks (green line) over time. The left-hand panel shows the evolution of the market share in relation to total assets in the banking sector, while the right-hand panel exhibits total assets for each business model, normalised with respect to the 2010 level of total assets for each business model. The graph displays the market share for a balanced data set of banks.

Source: Basel Committee on Banking Supervision.

197. While the shift towards universal and retail-funded banks is noticeable, this analysis cannot clearly attribute the cause to the Basel III reforms, in particular as the shift began prior to the GFC. Further, the

[99] Amel and Rhoades (1988) define the business model from the balance sheet structure, while Stiroh and Rumble (2006) broaden the definition to the revenue mix.

results depend on the choice of business model definition and are sensitive to a few transitions of large banks to different business models.

8.3 Conclusions

198. The analyses provide only weak evidence that adjustment to the Basel III reforms contributed to a reduction in lending at some banks. However, this report does not draw conclusions regarding the extent to which this side effect of the Basel III reforms is offset by the intended positive effects of the reforms on banks' resilience. These analyses do not indicate that the reforms have reduced the aggregate supply of credit to the economy, as the overall level of bank lending expanded in most jurisdictions during the implementation of the reforms.[100]

199. The analyses do not indicate a significant negative side effect in the form of a higher cost of capital. Rather, they indicate that banks experienced a cost of capital decrease following introduction of the Basel III reforms. In addition, banks' cost of capital decreased when the reforms were announced, with an even stronger effect for banks with lower initial ratios. This may suggest that markets recognised improvements in banks' resilience resulting from Basel III by lowering the cost of accessing capital markets. Furthermore, while there has been a significant shift in bank business models since 2005, it is difficult to connect this directly with the Basel III reforms.

9. Interactions within and among Basel III and resolution reforms

200. Basel III introduced a range of new requirements beyond Basel II's focus on risk-based capital requirements. While the previous sections of this report analysed each regulatory ratio separately, this section considers the consequences of their coexistence. This section begins by providing background and setting out the approach (Section 9.1). In addition to the side effects discussed in Section 8, this section presents qualitative insights (Section 9.2) as well as a quantitative analysis (Section 9.3) on the potential side effects resulting from the interactions between various reforms as well as the impact of such interactions on market-based measures of resilience. In a further step, potential interactions between Basel III standards and the resolution framework are discussed (Section 9.4).

9.1 Motivation and approach

201. Before the GFC, the global prudential standards for banks focused on one single metric – the risk-based capital requirement. The GFC highlighted that banks were subject to different types of risks which were not adequately captured under a prudential framework with this single metric. As a response, the Basel III framework consists of multiple regulatory requirements, including the capital and liquidity reforms as well as the resolution regimes established by the FSB.

202. With such a multi-dimensional framework, it becomes important to understand and assess how the different requirements interact and whether these interactions create any unintended consequences. To that end, this report uses several approaches to search for qualitative and quantitative evidence on the extent to which different parts of the regulatory framework reinforce each other or partially overlap. These approaches include a literature review, conceptual framework analysis, empirical (correlation and regression) analysis and case studies.

[100] This is also the conclusion of the assessment of the impact of Basel III using macroeconomic models (see de Bandt et al (2022)).

203. The multi-dimensional nature of the post-GFC regulatory framework can be rationalised by the Tinbergen Rule, which implies that each policy target requires a separate policy instrument. Although the overall objective of the framework is to enhance bank resilience, each of the regulatory metrics within the Basel III framework aims to deal with a specific risk that banking institutions face. For example, the Committee adopted two minimum liquidity standards – the LCR and NSFR – to address excessive liquidity risks arising in the short term and funding risks in the long term, respectively. The leverage ratio was introduced to curb the build-up of excessive on- and off-balance sheet leverage in the banking system.

204. At the same time, some overlap between requirements can be expected. As risks faced by banks generally tend to be positively correlated, when one requirement is used to reduce a particular risk, it may have the effect of also reducing other risks targeted by other requirements. However, requirements may differ in their efficiency in reducing different types of risk. Thus, their combination may be more efficient in enhancing resilience and reducing risks. Conversely, multiple overlapping requirements may result in regulatory inefficiency and associated macroeconomic costs. If using multiple regulations does not amplify such costs, a multi-dimensional set of requirements can be beneficial since it allows the regulator to achieve the desired level of resilience with lower costs to the real economy.

9.2 Interactions within the Basel III framework: qualitative insights

205. This section reviews the academic literature on interactions both between capital (risk-based requirements and the leverage ratio requirement) and liquidity (LCR and NSFR) frameworks and within the capital framework, followed by a qualitative analysis on interactions within the liquidity framework.

9.2.1 Insights from academic literature

206. Academic literature on the interaction between capital and liquidity requirements is still limited but suggests that there exist some channels through which the two requirements could act as substitutes in reducing solvency and liquidity risks and the probability of a crisis. However, such substitutability is partial given differences in the two requirements' efficiency in dealing with different sources of financial instability.[101]

207. The literature contains mixed insights on the impact of the interaction of capital and liquidity requirements on lending. Some papers (De Nicolo et al (2014), Behn et al (2019) and Covas and Driscoll (2014)) find that adding liquidity requirements in addition to capital requirements leads to a greater reduction in lending to non-financial sectors. On the other hand, Kim and Sohn (2017) find that, for large US commercial banks, the effect of an increase in capital ratio on credit growth becomes positive when banks retain sufficient liquid assets (in particular during the GFC).

208. The literature on interactions between the risk-based capital ratio and the leverage ratio suggests the two ratios are complements in enhancing banks' resilience as they bind banks differently in different times, cover different types of risk and provide complementary benefits in case of bank distress. See Annex A.21 for a detailed review of the relevant papers and their findings.

[101] For instance, rising capital requirements could be used to reduce banks' liquidity risks as their liabilities would be replaced with equity. However, eliminating excessive liquidity risk by asking banks to borrow less could be less efficient than liquidity requirements which could tackle excessive liquidity risks more directly; increasing capital requirements would also create costs through lower credit provision. In that case, combining capital and liquidity requirements could achieve the same reduction in solvency and liquidity risks at a lower cost to the economy.

9.2.2 Qualitative analysis on interactions within the liquidity framework

209. Two qualitative studies are presented here to assess how the LCR and NSFR interact and whether they support each other as intended by the Basel III framework.[102] The first analysis performs a balance sheet decomposition and reconciliation among requirements to assess overlaps and differences between the LCR and NSFR treatment of banks' balance sheets. The second analysis evaluates, based on Cecchetti and Kashyap (2018), the interaction between the LCR and NSFR based on a reference variable (ie total liabilities or short-term runnable liabilities).

210. To assess the overlaps and differences of the requirements through reconciliation of the LCR and NSFR, a bank's balance sheet is decomposed to analyse how each of its components is treated by the LCR and the NSFR. In applying the LCR and NSFR factors to the components of a bank's balance sheet[103] (see Annex A.22 for details), at least three meaningful comparisons can be made:

- First, when looking at the entirety of balance sheet and off-balance sheet (OBS) operations, a large proportion of such operations is considered by the NSFR and not by the LCR. This is not surprising as the LCR operates in a 30-day window whereas the NSFR takes into consideration both short- and long-term windows. As a consequence, the NSFR captures risks and developments that are not captured by the LCR.
- Second, the LCR, with its focus on a 30-day window, considers contingent risks from OBS operations which are not considered by the NSFR. Thus, the LCR serves to ensure banks have enough liquidity to face a 30-day stress scenario, which cannot be ensured by the NSFR alone.
- Third, when looking at the treatment of those elements that are considered by both requirements, the situation is heterogeneous, with the LCR being stricter for some of them and the NSFR for others, and with important variations across business models.

211. A simplified balance sheet model allows us to express both the LCR and the NSFR requirements as inequalities with the same sign with respect to the same reference variable (Cecchetti and Kashyap (2018)). Empirical analyses of the aforementioned model show that the two requirements are complementary and bind different types of bank in different ways for a sample of banks in the euro zone (Behn et al (2019)) and for the Mexican banking system (Bank of Mexico (2021)). Related models were used which adjust some of the over-simplifications in Cecchetti and Kashyap (2018) to better show the interactions of different variables in the requirements. These models were then calibrated using the Committee's data. The analysis finds that, in most cases, the binding requirement changes over time for the same bank, providing additional evidence of a non-redundant relationship (see Annex A.23 for details).

9.3 Interactions within the Basel III framework: quantitative analysis

212. This section first examines the co-movement of regulatory ratios in banks. This analysis could give an indication as to whether regulatory ratios have tended to exhibit high correlation (which could possibly indicate some overlap) or to move in opposite directions (which in turn could suggest the potential for conflicting effects). Then, several regressions are conducted to examine the impact of

[102] The Basel III framework states that "[the LCR and NSFR] standards are designed to achieve two separate but complementary objectives. The first is to promote the short-term resilience of a bank's liquidity risk profile […]. The second objective is to reduce funding risk over a longer time horizon…". See *Basel III: the Net Stable Funding Ratio*, October 2014, www.bis.org/bcbs/publ/d295.pdf.

[103] Based on the balance sheet decomposition and after reconciling both requirements and inverting the LCR weighting factors (1 – LCR weight), one can compare the weighting factors (inflow rates, outflow rates, haircuts, ASF and RSF) between the two requirements and assess their similarities and differences. The balance sheet decomposition was conducted with data from the Basel Committee's semiannual quantitative impact studies (QIS) using a balanced data set of 34 banks from 12 jurisdictions which reported information on each of the biannual periods (Q2 and Q4) from Q2 2016 to Q2 2021 (11 periods in total).

interactions on banks' resilience and lending. Summary statistics of banks' regulatory ratios can be found in Annex A.2 (Table A2.2).

9.3.1 Correlation analysis

213. Table 12 shows the within-bank correlation during 2012–21, averaged over time, among the main regulatory ratios. The correlation across pairs of most regulatory ratios is positive, which may suggest a lack of potentially conflicting relations. While there is a negative correlation between the LCR and the risk-based capital ratios, this does not necessarily suggest a conflicting effect given the extremely weak and sometimes insignificant correlation coefficients. The correlations between the two liquidity ratios as well as between leverage and the risk-based capital ratios are relatively low or moderate, which suggests that changes in one ratio do not cause a proportionate movement in the other ratio. The correlations are very similar if the pandemic period is excluded. This supports the earlier discussion that both sets of ratios (LCR versus NSFR, risk-based capital versus leverage) bind banks differently and address different types of risk. As expected, banks' CET1, Tier 1 and total capital ratios are highly correlated since they have a common denominator and overlapping numerators.

Within-bank correlation across regulatory ratios — Table 12

	CET1 ratio	Tier 1 ratio	Total capital ratio	Leverage ratio	LCR	NSFR
CET1 ratio	1.0000					
Tier 1 ratio	0.9755*** (0.0000)	1.000				
Total capital ratio	0.9170*** (0.0000)	0.9464*** (0.0000)	1.000			
Leverage ratio	0.4704*** (0.0000)	0.4734*** (0.0000)	0.3568*** (0.0000)	1.000		
LCR	–0.0590*** (0.0021)	–0.0497*** (0.0097)	–0.0206 (0.2841)	0.0193 (0.3150)	1.000	
NSFR	0.2051*** (0.0000)	0.2121*** (0.0000)	0.1707*** (0.0000)	0.2584*** (0.0000)	0.0890*** (0.0000)	1.000

Note: *** denotes coefficients significantly different from zero at the 1% confidence level; p-values are in parentheses.

Source: Basel Committee on Banking Supervision.

214. The analysis next focuses specifically on the correlation of the LCR and NSFR. First, the cross-sectional correlation is computed at each half-year during the period 2012–21 (instead of averaging over time as in Table 12. The result shows substantial fluctuations through time (from 30% to 80%) in the balanced data set. While meaningful correlation is observed in some years, it is far from perfect, which suggests that substantial differences exist between the LCR and NSFR standards (see Annex A.24 for more details).

215. Second, the intertemporal relationship between the LCR and the NSFR is analysed with a view to estimating whether current values of the LCR can be explained by lagged values of the NSFR, or vice versa. After controlling for firm fixed effects, only lagged values of the same requirement provide significant explanatory power for its current value, without an equivalent relation being demonstrated due to lagged values of the other requirement. A description of the model and results are presented in Annex A.25.

9.3.2 Regression analysis

216. This section summarises an empirical analysis of the impact of interactions between pairs of different regulatory ratios on banks' resilience and lending. We use definitions of complementarity and substitutability consistent with those used in game theory and consumer theory: we treat two requirements as complements (substitutes) if the total increase in the prudential benefit (eg improvement

in banks' resilience) generated by those requirements is bigger (smaller) than the sum of the increases induced by each individual requirement. The study first looks at whether regulatory ratios act as substitutes or complements in improving banks' resilience using market-based measures (eg CDS spread) before turning to an assessment of whether their interactions dampen or amplify effects on lending.

217. To capture the effects of regulatory ratio interactions, a simple panel data model is estimated following Kim and Sohn (2017). It departs from the baseline specification outlined in Section 3 as it focuses on the levels of banks' regulatory ratios rather than shortfalls, and uses data for the whole period 2011–19 irrespective of regulatory requirements' implementation dates. This approach allows us to build on the methodology in existing academic literature and assess the impact of various combinations of banks' regulatory ratios on their resilience and lending over time. The approach does not focus on how constraining different ratios are when requirements have been implemented. Another reason for using a simple panel regression model is that requirements were implemented at different points in time, limiting the ability to estimate interactions between them. Following Kim and Sohn (2017), dependent variables on a year-on-year growth basis are also estimated.[104] The model reads as follows:

$$\Delta Y_{i,c,t/t-2} = \alpha + \beta_1 \cdot RegRatio1_{i,t-2} + \beta_2 \cdot RegRatio2_{i,t-2} + \beta_3 \cdot (RegRatio1_{i,t-2} * RegRatio2_{i,t-2}) + \theta X_{c,t} + \delta_i + \theta_t + \varepsilon_{i,c,t},$$

where *i* denotes the individual bank, *c* the country, and *t* the time period. The dependent variable $\Delta Y_{i,c,t/t-2}$ is the year-on-year growth of either the bank's resilience measure or the bank's lending growth. Two main independent variables – $RegRatio1$ and $RegRatio2$ – are continuous variables that represent the bank's regulatory ratios. They are lagged by one year to avoid endogeneity issues. $X_{c,t}$ is a vector of macroeconomic or financial variables such as a country's GDP growth or the value of the VIX/V2X indexes, indicators of international investors' risk aversion. Time and bank fixed effects (θ_t and δ_i, respectively) are also included to control for other unobserved factors that could affect resilience and lending. Bank control variables are not included as this excessively restricts the number of observations.

218. The main coefficient of interest is β_3 – the coefficient of the interaction term. Its sign can help to shed light on the interaction between regulatory ratios as it captures how the relationship between a bank's resilience or lending growth and a given regulatory ratio (eg risk-based capital) depends on the other ratio (eg leverage ratio).

219. In particular, β_3 can be interpreted here as an indicator of the marginal effect of increasing one regulatory ratio when the other ratio also increases. In the analysis on banks' resilience, a negative β_3 would indicate that a reduction in a bank's risk (captured through CDS spread) when a regulatory ratio increases is greater if the other ratio increases as well, suggesting the two are complements in enhancing that bank's resilience. A positive coefficient in this case would meanwhile suggest that the additional benefit of increasing one ratio decreases when the other ratio also increases. This could be interpreted to mean that those two requirements are substitutes in increasing bank resilience, according to the specific definition above, ie there is a decreasing marginal effect on resilience from their joint use relative to the sum of the effects on resilience induced by each individual reform. See Annex A.26 for further details on interpretation of the regression coefficients, including β_3.

220. Table 13 presents the results of the interactions between the CET1 ratio, the leverage ratio, the LCR and the NSFR in pairwise fashion on year-on-year growth in the five-year senior CDS spreads. The analysis finds that most interaction terms are relatively small in magnitude and statistically insignificant, which could be the result of different regulatory requirements affecting banks' stability independently.

221. Only the interaction between the LCR and the NSFR (column (6)) shows jointly significant results on the coefficients of both the interaction term and the individual ratios. The negative signs on individual

[104] See Annex A.26 for technical details on empirical design issues.

ratios show that, as expected, increasing banks' liquidity ratios is associated with decreases in CDS spreads. A positive sign of the interaction coefficient implies that the total effect of these two ratios on the decrease in CDS spreads is less than the sum of individual impacts, which in turn suggests that the LCR and NSFR could be seen as partial substitutes in impacting banks' resilience as measured by CDS spreads. Consistent with the findings in the qualitative analysis that the LCR and NSFR have complementary objectives and address different time horizons, the results of the regression are interpreted as indicating that both ratios contribute to markets' perception of banks' resilience but the marginal effect of one ratio on banks' resilience (as measured through CDS spread) decreases when taking into account the effect of the other ratio.

Regression results on the impact of interactions on CDS spreads' yoy growth rate — Table 13

Variables	(1)	(2)	(3)	(4)	(5)	(6)
CET1*Leverage	–0.364					
	(0.526)					
CET1*LCR		0.0154				
		(0.0149)				
CET1*NSFR			0.00193			
			(0.0298)			
Leverage*LCR				0.130**		
				(0.0526)		
Leverage*NSFR					0.176**	
					(0.0830)	
LCR*NSFR						0.00557**
						(0.00256)
CET1 ratio	2.054	–1.688	0.331			
	(2.441)	(2.071)	(3.574)			
Leverage ratio	5.728			–22.27*	–25.84*	
	(6.405)			(12.50)	(14.86)	
LCR		–0.141		0.00739		–0.520**
		(0.205)		(0.148)		(0.251)
NSFR			–0.125		–2.293	–0.866***
			(0.383)		(1.622)	(0.319)
GDP Growth	–366.7**	434.1	436.2	–3,325*	–4,503**	407.6
	(168.4)	(344.6)	(379.9)	(1,889)	(2,206)	(362.8)
VIX	23.67*	3.894	1.773	–63.44*	–109.9**	7.939
	(12.01)	(11.64)	(10.22)	(37.25)	(43.75)	(12.33)
Constant	43.48	–21.91	–31.56	114.5*	410.6*	44.56
	(28.83)	(29.50)	(44.29)	(67.43)	(220.5)	(33.72)
R^2	0.732	0.708	0.683	0.663	0.656	0.702
Observations	622	475	493	140	135	489
Number of banks	45	43	43	35	34	43
Bank Fixed Effects	YES	YES	YES	YES	YES	YES
Time Fixed Effects	YES	YES	YES	YES	YES	YES

Robust standard errors in parentheses. *** indicates p<0.01; ** indicates p<0.05; * indicates p<0.1.

Source: Basel Committee on Banking Supervision.

222. The interaction term between leverage and liquidity (LCR and NSFR) ratios is also statistically significant in columns (4) and (5). This suggests that increases in banks' leverage ratios result in faster decreases in their CDS spreads, but this effect would be weaker for banks with increasing LCRs or NSFR.

This effect is again consistent with the two requirements being partial substitutes in increasing banks' resilience.

223. It needs to be noted, however, that as the model estimates dependent variables using the year-on-year growth rates, it does not necessarily assess the specific impact of the Basel III reforms, but rather focuses on the interaction between pairs of regulatory ratios without providing causal evidence on the link between regulatory ratios and their interactions on the one hand and banks' resilience or lending on the other.

224. Annex A.26 also reports the regression analysis on the impact of interaction on the year-on-year lending growth. Only the interaction between the CET1 ratio and the leverage ratio shows to be weakly significant. The individual coefficients are positive, indicating that banks with higher CET1 ratios or leverage ratios exhibit a positive effect on lending growth. This finding is in line with the results shown in Section 8.1. However, the negative interaction coefficient indicates a dampening impact on lending growth. This means that banks with higher CET1 ratios or leverage ratios may increase their lending, but there is a negative marginal effect on a bank's lending when taking into account both ratios compared with the sum of the positive effects of higher CET1 and leverage ratios on lending. However, as indicated, these results are not significant enough to provide evidence of any material impact on lending stemming from the interaction of Basel III capital and/or liquidity standards.

225. Robustness checks included the search for the existence of non-linear effects on the regression results by adding quadratic terms of the interaction to the equations. The results confirmed the findings regarding the interaction between the LCR and the NSFR. Different measures of resilience other than the change in CDS spreads (cost of equity, cost of debt, expected default frequency, PD, Marginal Expected Shortfall, Systemic risk measure) were also estimated. However, the results were not robust from one measure to the other.

9.4 Interactions between the Basel III and resolution framework

226. This section aims to assess how the interaction of the Basel III framework and the resolution reforms is related to banks' resilience and lending. The Basel III framework aims to increase banks' resilience and the resolution framework seeks to reduce systemic disruption and taxpayers' losses associated with the resolution of a financial institution. The frameworks could interact through their impact on several sources of financial stability such as banks' capital structure, market discipline and cost of crises. At the same time, one of the main tools of the resolution framework, the TLAC requirements, imposes additional constraints on banks' balance sheets by adding another type of loss-absorbing requirement. Therefore, the introduction of these additional requirements can be expected to interact with Basel III regulatory ratios. Hence, there is a need to take this interaction into account to understand how banks manage their balance sheets and to assess the compounded effects on banks' resilience measures and loan supply.

227. The nature of the interaction between both sets of reforms is explored using a review of existing literature, findings from the BCBS member survey, and two case studies of actual bank resolution events. Some descriptive statistics and correlation analysis using Basel III capital and liquidity ratios, as well as TLAC ratios and TLAC headroom for G-SIBs, are also considered. Insights from those various analyses indicate that Basel III and TLAC enhance banks' capital structure, support market discipline and help to reduce the cost of a crisis.

228. TLAC requirements enhance banks' resilience and reduce the costs associated with a potential bank resolution by requiring additional amounts of eligible liabilities and equity capital. As per the BCBS member survey, jurisdictions estimate that the introduction of TLAC requirements substantially increased the amount of total capital requirements as TLAC instruments include non-regulatory capital instruments that come on top of Basel III minimum regulatory capital requirements. However, some analyses suggest

that overlaps across the two frameworks may negatively affect the functioning of the capital buffer component of the Basel Framework or lead to undue complexity due to difficulties in understanding banks' reactions to shocks affecting any element of either framework (as discussed in Section 10.4).[105]

229. Resolution reforms could play a complementary role to Basel III in addressing the TBTF issue since they aim at improving the resolvability of financial institutions, which could enhance market discipline and help lessen the TBTF problem. The FSB report on the evaluation of the TBTF reforms for systemically important banks (SIBs) found that these reforms have made banks more resilient and resolvable, producing net benefits to society. The FSB report found that market discipline appears to have improved, particularly given that the sensitivity of SIBs' CDS prices to their risk has increased since the GFC.[106] Some studies (eg Gimber and Rajan (2019)) analyse the impact of resolution reforms on market discipline by examining changes in banks' funding costs. Berndt et al (2022) find significant reductions in market-implied probabilities of government bailouts for G-SIBs with US headquarters after the GFC, along with higher wholesale debt financing costs for these banks after controlling for insolvency risk.

230. Both Basel III and the resolution frameworks could also help reduce the cost of a crisis. Using data for banks' balance sheets in 17 countries, Jordà et al. (2021) find that economies with better capitalised banking systems recover faster from financial crises as credit begins to flow back more readily, which could help mitigate associated social and economic costs. Brooke et al (2015) also find that countries which had more rapid and effective crisis resolution policies had similar initial annual crisis costs but then recovered more quickly. Reponses to the BCBS member survey suggest that the LCR and NSFR are likely to have positive effects on liquidity available in resolution unless liquidity buffers are already substantially eroded once an institution is declared failing or likely to fail. Some respondents to the BCBS member survey suggested that one of the main benefits of the LCR is to provide additional time to authorities to react in a stress event, which would help organise an orderly resolution of banks and reduce the costs of banks' failure.

231. The analysis also includes case studies for two banks from the US and Europe (see Annex A.27). The analysis for the US bank which failed during the GFC shows that Basel III requirements could have prompted the bank to address problems earlier, which would have likely reduced the probability that it would face problems in a crisis. The resolution tools available to the authorities made it possible to reduce the cost of the bank's failure. On the other hand, the analysis of the European bank resolution (which happened after the Basel III reforms) shows that the main channel of interaction between the Basel III and resolution frameworks resulted from the benefits the LCR provided in terms of additional time for the regulators and supervisors to resolve the bank, eg to find a buyer.

232. Finally, simple descriptive statistics for G-SIBs show that the overall amount of their loss-absorbing instruments (including TLAC eligible instruments) is more than double the CET1 capital level, which indicates an increased resilience as a result of the Basel III capital ratio and TLAC requirements. Using within-bank correlation analysis, the TLAC headroom is found to be positively correlated with Basel III capital and liquidity ratios. The correlation between the TLAC headroom and the leverage ratio is the only highly significant one. However, the level of correlation is moderate (around 34%), which does not provide sufficient ground to conclude that the two ratios exhibit strong co-movement or could be potentially redundant. See Annex A.28 for more details on the descriptive statistics and correlation analysis, as well as findings from a supplementary regression analysis.

[105] See ESRB (2021).

[106] See Financial Stability Board, *Evaluation of the effects of too-big-to-fail reforms*, 1 April 2021, www.fsb.org/wp-content/uploads/P010421-1.pdf.

9.5 Conclusions

233. The various pieces of qualitative and quantitative analysis suggest that the Basel III reforms support each other in enhancing banks' resilience. Based on a literature review and correlation analyses, the risk-based capital and leverage ratio requirements appear to support each other in enhancing banks' resilience given that they bind banks differently over economic cycles, cover different types of risk and provide complementary benefits in the event of bank distress. Regarding liquidity, the analysis of the interaction between the LCR and NSFR indicates that they cover different types of risk in banks' balance sheets and that banks' LCRs and NFSRs are not highly correlated. Consistent with these findings, evidence from regression analyses suggests that both liquidity ratios enhance banks' resilience. However, when both ratios increase, their positive impact on bank resilience (as measured by changes in CDS spreads) could be weaker than their respective impacts on a standalone basis.

234. While the literature contains mixed insights regarding the impact of the interaction of capital and liquidity requirements on lending, this report's empirical analyses did not find substantial evidence of an impact on lending stemming from the interaction among the Basel III requirements.

235. Both the Basel III and the resolution frameworks have increased banks' resilience and they interact to potentially reduce the cost of bank crises. This report's assessment of qualitative information and case studies suggest a positive interaction between the Basel III and the resolution frameworks to reinforce the resilience of the financial system by reducing the cost of crises.

10. Complexity in the Basel III regulatory framework

236. The previous sections of this report conclude that Basel lll has enhanced the resilience of banks and the global banking system and reduced systemic risk (see Section 4 and Section 5). Due to the multitude of new requirements introduced to address a larger number of banking risks, Basel lll has become a sophisticated multi-dimensional framework. As Section 9 shows, there are interactions between the regulatory requirements which in turn increase the complexity of the framework. This section of the report provides an exploratory and descriptive analysis of the degree of regulatory complexity within the Basel Framework. As there is no counterfactual, the discussion that follows does not seek to answer the question of whether the same degree of enhancement in resilience and reduction in systemic risk could be achieved by a less complex framework.

237. This section begins with a discussion of trade-offs associated with greater complexity and a presentation of the methodological approach used (Section 10.1). An analytical framework considering three different aspects of regulatory complexity is then applied to the Basel standard texts to compare the complexity of Basel III relative to Basel II (Section 10.2) as well as to analyse the parts of Basel III that are most complex (Section 10.3). This is followed by a discussion of regulatory complexity resulting from the parallel regulatory minimum requirements and different forms of capital (Section 10.4). Finally, overall conclusions are set out (Section 10.5).

10.1 Motivation and methodological approach

238. Complexity has various dimensions and implications. For the purpose of the following analyses, regulatory complexity is viewed as a characteristic of the regulatory framework that impacts the ability of its stakeholders – for example, regulators, supervisors and banks – to understand, transpose, supervise, monitor, calculate and comply with the regulatory requirements and assess their implications and economic effects.

239. Simplicity is a desirable feature in regulation, but there are clear trade-offs that may need to be made in the process of setting standards (BCBS (2013)). Regulatory standards balance various ideal attributes, such as being risk-sensitive, simple, comparable and comprehensive, while at the same time limiting opportunities for regulatory arbitrage and providing cost-efficient solutions. Moreover, regulation should be sufficiently flexible and adaptable to be appropriate for different types of bank, in different countries and in different macroeconomic environments. Balancing these trade-offs can influence the complexity of a regulatory standard.

240. There are several reasons for the complexity of the Basel III framework. Internationally active banks are typically complex organisations. They often (i) consist of various bank and non-bank affiliates (organisational complexity); (ii) provide a range of different services to a variety of customers (business complexity); and (iii) are active in many countries (geographical complexity). Moreover, banks are exposed to many different types of risk, captured through the use of models, which are simplifications of the real world. Furthermore, global standards such as the Basel Framework must accommodate different types of bank across many jurisdictions and accommodate the different accounting standards used by those banks.[107] Since Basel II was published in 2004, the membership of the Committee has expanded from 13 to 28 member jurisdictions, increasing the need to include optionality in the framework in order for banks or jurisdictions to choose between different models and approaches for a given metric. Moreover, since the GFC, the Committee has intentionally revised the framework to address more types of risk, increasing both the comprehensiveness and complexity of the framework. In addition, the Committee's efforts to develop standards that are risk-sensitive have resulted in additional complexity of both the standardised and internally modelled approaches included in the framework.

241. There are several drawbacks to a complex regulatory framework.[108] Complex rules could pose capital planning challenges, and could lead to spurious risk assessments and a misallocation of capital. Complex regulations could also undermine supervisors' ability to effectively assess both the capital adequacy of banks and banks' capital management processes, making consistent and comparable implementation of standards more difficult to achieve. They could also encourage firms to pursue more favourable interpretations of the regulations. All of these factors may undermine market discipline by making it more difficult for stakeholders to understand and compare banks' risk profiles. In addition, regulatory complexity may hinder the ability of supervisors to anticipate potential sources of procyclicality.[109] Reduced transparency can also harm interbank markets and banks' access to liquidity. In addition, complex regulations may provide incentives for banks to develop products primarily devoted to circumventing regulations. As a consequence, the effectiveness of regulatory capital requirements may diminish and banks may increase in complexity (Gerding (2016)). Furthermore, complex rules applied to simple banking activities may limit competition, giving advantages to larger and more complex banks, potentially providing incentives for banks to become even more complex and aggravating the TBTF problem.[110]

242. Regulatory complexity cannot easily be measured empirically and may differ in subjective perceptions. Colliard and Georg (2022) provide one useful conceptual framework for analysing regulatory complexity, differentiating between three dimensions of regulatory complexity.

- "Problem complexity" describes a regulation as complex if it applies multiple rules to the regulated entities and foresees a large number of regulatory actions or interventions. Examples of problem complexity include the degree of optionality permitted in the framework, the multiple

[107] As an example, Admati and Hellwig (2013) show that under US GAAP standards, JP Morgan Chase Bank could claim that its equity value was about 8% of assets, but under IFRS standards this fraction would shrink to a mere 4.5%.

[108] See Haldane (2012), Gai et al (2019) and Woods (2022).

[109] Both BCBS (2021) and BCBS (2022b) examine various sources of procyclicality of the regulatory framework.

[110] This may, to a certain extent, be mitigated by appropriate use of proportionality in the application of the framework.

tiers of capital recognised by the framework, and the risk that the models used (by both banks and regulators) do not fully capture all existing and future risks.

- "Psychological complexity", or what we term "linguistic complexity", characterises a regulation as complex if it is difficult for a reader to comprehend.[111] Different aspects of linguistic complexity include overall readability, the precision of the text and references within and/or across different paragraphs.
- "Computational complexity" characterises a regulation as complex if its implementation is time-consuming and computationally costly. Examples include conditional requirements within standards (ie if one requirement is dependent on another requirement, concept or calculation) or standards that use complex mathematical formulae and multiple input variables (see BCBS (2013)).

243. To facilitate the measurement of complexity of the Basel Framework,[112] this report uses (i) responses to the BCBS member survey (described in Section 3); (ii) linguistic analysis methods (as outlined in Amadxarif et al (2019) and used by Brookes et al (2022)); and (iii) analysis of the number of calculation steps and input variables within the Basel III standards.[113] Each approach has drawbacks and limitations, but together they can convey a message about the complexity of the regulatory framework. While the subsections that follow document an increase in regulatory complexity with the introduction of Basel III, it should be noted that this increase in regulatory complexity does not necessarily result in banks becoming more complex in response. On the contrary, several studies have found that banks have either reduced their complexity or stayed equally complex since the GFC.[114]

10.2 Regulatory complexity of Basel III vs Basel II

244. To compare the development of regulatory complexity over time, this subsection evaluates and compares the complexity of the Basel III and Basel II frameworks in the three dimensions set out above (Sections 10.2.1 to 10.2.3). Of note, analysis of the potential complexity of jurisdictional implementation of the Basel Frameworks' standards is outside of the scope of this report. In addition, this section elaborates on the costs incurred in complying with the regulatory framework (Section 10.2.4).

10.2.1 Problem complexity

245. In terms of "problem complexity", Basel III is more complex than Basel II by design. While Basel II focused on a single minimum risk-based capital requirement, Basel III contains several parallel requirements (ie risk-based and leverage ratio capital requirements, in addition to LCR and NSFR liquidity requirements and large exposures limits). Optionality to choose between different models or approaches is an additional driver of problem complexity in Basel III. In the BCBS member survey, a majority of respondents (69%) indicated that optionality had driven regulatory complexity. The respondents

[111] See also BCBS (2013), which applies a similar definition. It is worth noting that supervisors and banks typically have ongoing discussions to ensure rules are understood and followed. While such dialogue may reduce the linguistic complexity for banks, it would not necessarily do so for other stakeholders.

[112] For the complexity analysis in this report, we have assessed the version of the consolidated Basel framework that is applicable as of 1 January 2023.

[113] See Annex A.29 for a description of the methodological approaches used in these analyses.

[114] For US bank holding companies, Correa and Goldberg (2022) document an increase in the number of bank and non-bank affiliates (organisational complexity) prior to the GFC and a decrease afterwards, while the range of different services to a variety of customers provided (business complexity) and number of activities in many countries (geographical complexity) lack clear trends both before and after the GFC. Buch and Goldberg (2022) document similar trends using a data set with international banks.

highlighted that this (i) reduced comparability across banks domestically and internationally; (ii) increased the potential for misinterpretation by banks; (iii) made it more challenging for regulators to supervise effectively; and (iv) increased the need for banks to invest in skilled staff and infrastructure in order to manage multiple regulatory approaches. On the other hand, respondents also acknowledged that such optionality has delivered benefits, including being able to tailor regulation to fit jurisdictions' specific needs and the characteristics of different types of exposure, highlighting the trade-off between regulatory complexity and flexibility.

10.2.2 Linguistic complexity

246. To assess how easily a reader can comprehend the standard texts of the Basel II and Basel III frameworks, the analysis uses the Flesch-Kincaid grade level readability score, which indicates the number of years of schooling a reader would need to understand the text (Kincaid et al (1975)). The scores indicate that comprehension of both frameworks necessitates at least a university degree level of education. The score for Basel II is 15.7 and for Basel III is 18.8, with the latter suggesting the need for a postgraduate degree level of education.[115] To put these findings into perspective, other global standards such as the CPSS/IOSCO's *Principles for financial market infrastructures (PFMI)* and the FSB's *Key attributes of effective resolution regimes for financial institutions* have comparable or even higher scores of 18.0 and 23.1, respectively.[116] To provide another point of reference, a calculation of scores for 10 articles in the *Financial Times* found that, on average, they have a lower readability score (ie more readable) than both Basel Framework texts, implying that they featured less linguistic complexity.[117]

247. Other metrics also suggest that Basel III is more linguistically complex than Basel II. The Basel lll standard texts are more than twice as long as the Basel ll standard texts. Even though longer texts are not necessarily more complex, they contain more content to be processed by the reader. Moreover, Basel III has twice as many cross-references than Basel II, implying that the understanding of a given standard in Basel III may be more dependent on the understanding of other standards within the framework than was the case in Basel II. Thus, the Basel III text likely requires more time and effort to understand than does the Basel ll framework.

10.2.3 Computational complexity

248. The extent to which the implementation of a regulation is time-consuming and computationally costly can be assessed by counting the number of computational steps included in the Basel II and Basel III texts. A standard that contains many calculation steps is considered to be more complex, as it likely will require more data collection, specific data structures and more sophisticated technical systems in order to efficiently conduct the required computations.

249. Due to the differences in the frameworks' design, it is not straightforward to compare the number of calculation steps in Basel II with those in Basel III. While in general Basel II contains more principles on how to calculate different measures, Basel III contains more explicit formulas. This is partly due to Basel III being more prescriptive and including more examples of how measures are to be calculated. These additional explicit formulas can make the framework more complex, but also may assist in clarifying the requirement.

250. This analysis can be elaborated by looking in more detail at the standardised approaches for credit risk and market risk, focusing on the number of inputs needed to calculate the capital

[115] An overview of the results of the linguistic complexity analysis is presented in Table A30.1 in Annex A.30.

[116] The PFMI refers to CPSS and IOSCO (2012) and *Key attributes of effective resolution regimes for financial institutions* refers to FSB (2014). The Flesch-Kincaid scores for these standards have been calculated as part of the analysis in this report.

[117] We looked at 10 articles published in the *Financial Times* at around 1 May 2022, and their readability scores ranged from 9.9 to 18.2, with an average of 14.2.

requirements.[118] For credit risk, the analysis indicates that the framework did not change materially from Basel II to Basel III, as the concepts and major exposure classes are consistent across both frameworks.[119] For market risk, the results imply that Basel III requires approximately twice as many input parameters as the standardised approach in Basel II. The main source for this difference could be due to Basel III's fundamental revision of the standardised approach to calculate capital requirements for market risk exposures based on risk sensitivities rather than exposure components.

10.2.4 Compliance costs

251. In the BCBS member survey, respondents indicated that the Basel III reforms have resulted in increased regulatory compliance costs for both banks and supervisors. Some 85% of respondents indicated that the implementation and supervision of Basel III has resulted in an increase in their own resources (eg staff, information technology systems) since 2011. Moreover, 81% of respondents estimated that the resources that banks within their jurisdiction devote to complying with the Basel Framework had increased since 2011. However, such costs are likely to decline over time as banks get used to the new requirements, as new technologies develop to facilitate assessment and measurement of complex problems and as banks receive clarity on interpretative issues from the Committee through Frequently Asked Questions or from their supervisors through supervisory dialogue.

10.3 Complexity of individual Basel III standards

252. While the above analysis focused on whether the Basel III framework is more complex than Basel II, the following analysis considers the complexity of the individual standards included in the Basel III framework. The focus here is on assessment of "linguistic" and "computational complexity"; the notion of "problem complexity" is more relevant when comparing the entire frameworks of Basel III versus Basel II.

253. Table 14 summarises statistics regarding the relative complexity of the different standards in Basel III. Column (1) lists the different standards in Basel III. Columns (2) through (4) show the share of BCBS member survey respondents who indicated the respective Basel III standard as one of the three most complex elements in three different dimensions: (i) complexity of transposing a standard into domestic rules (column (2)); (ii) complexity of supervising a standard (column (3)); and (iii) complexity for banks, as perceived from supervisors' point of view, in implementing the standard (column (4)). Columns (5) and (6) show aspects of computational complexity: (i) the number of calculation steps that the different standards require (column (5)) and (ii) the number of data cells in the Basel III monitoring workbook that are used to collect inputs associated with that standard (column (6)). Column (7) shows the number of words per standard. Finally, Column (8) shows the Flesch-Kincaid readability scores of the different standards.[120]

[118] The focus of the analysis is on these two standards as most capital requirements for banks derive from credit and market risk. Further, the analysis focuses on standardised approaches as they are more comparable and more explicitly defined than internal models.

[119] Of note, the analysis did not consider the inclusion of a more granular risk weight table to be an increase in the number of input parameters as the risk weight itself is given in the standard text. Consequently, more granular risk weight tables in the Basel III credit risk standard relative to Basel II do not in themselves affect this analysis of the number of input parameters.

[120] Other results on linguistic complexity are discussed in Brookes et al (2022).

Relative complexity of Basel III standards — Table 14

Basel III standard	BCBS member survey results			Computational complexity		Linguistic complexity	
	Transposition	Supervision	For banks	Formulas	QIS	Number of words	Readability
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Market risk (MAR[a])	21%	20%	21%	very high	3 159	48,895	17.7
Credit risk (CRE[a])	13%	9%	17%	very high	4 000	88,639	18.8
Counterparty credit risk (CRE[a])	10%	19%	18%	high	374	24,679	17.7
CVA risk (MAR[a])	7%	3%	9%	medium	27	8,890	18.5
Supervisory Review Process (SRP)	-	-	-	medium	-	48,611	18.2
Definition of capital (CAP)	9%	3%	6%	medium	120	11,928	19.2
NSFR (NSF)	5%	3%	5%	low	- [b]	5,899	25.2
Risk-Based Capital Requirements (RBC)	-	-	-	low	-	9,081	17.4
Liquidity Coverage Ratio (LCR)	10%	10%	7%	low	398[b]	24,656	19.8
Leverage Ratio (LEV)	0%	0%	1%	very low	66	7,653	22.5
Operational risk (OPE)	2%	6%	0%	very low	184	3,768	20.3
Large exposures (LEX)	6%	16%	10%	very low	-	5,934	19.9
Margin Requirements (MGN)	-	-	-	very low	-	7,047	19.1
Scope and Definitions (SCO)	-	-	-	very low	-	6,372	18.2
Core Principles for Effective Banking Supervision (BCP)	-	-	-	none	-	28,655	19.8
Disclosure Requirements (DIS)	-	-	-	none	-	7,613	20.4

Note: [a] In this analysis we divide the standard CRE into credit risk and counterparty credit risk. Similarly, the standard MAR is divided into market risk and CVA risk. [b] The data for NSFR are encapsulated in the template for LCR data and so are not reported separately. Most complex standard is indicated by red and least complex by green. Empty cells reflect that certain standards were not provided as an answer option to choose in the BCBS member survey or no data are collected for them in the Basel III monitoring template. Percentages in columns (2) to (4) are calculated by first giving each response for the most complex standard a score of 3, the second most complex a score of 2 and the third most complex a score of 1, and then adding the score for each standard and dividing it by the weighted sum of all scores to get weighted percentages. The values do not add up to 100% by column due to the option to provide answers beyond the Basel standards, which were given as answer alternatives.

Source: Basel Committee on Banking Supervision.

254. Columns (2) to (4) show that respondents to the BCBS member survey consider market risk to be the most complex standard, followed by counterparty credit risk, credit risk, the large exposures framework and the LCR. The market risk and credit risk standards include the most calculation steps (column (5)), the most data elements collected via the Basel III monitoring exercise (column (6)), and the highest number of words (column (7)). However, the market risk and credit risk standards are among the most readable Basel III standards according to the Flesch-Kincaid readability score (column (8)). These results indicate that most of the complexity metrics assessed are highly correlated. However, the readability metric is not as correlated with the other metrics assessed. For example, the NSFR and the leverage ratio, which require the highest level of education to understand (ie have the highest readability score), score low on other measures of complexity.[121]

[121] The Flesch-Kincaid readability scores should not be interpreted in isolation since they are imprecise in the presence of tables and formulas in the text such as in the Basel framework. As a result, standards with more formulas and tables containing simple text could receive a low (more readable) score even if they are challenging to understand. In addition, some tables may be rather easy to understand for most readers but could generate high scores (less readable) depending on the way they are structured. For further details please see Annex 29.1.

10.4 Parallel minimum requirements and regulatory complexity

255. The various capital and loss-absorbing instruments in the Basel capital and FSB resolution frameworks were designed to contribute to banks' resilience. However, the relationships between capital instruments and between capital and resolution frameworks can potentially also be a source of regulatory complexity. While a thorough analysis of these issues is outside the scope of this report, it is worth noting that an empirical analysis of European banks (ESRB (2021)) illustrates the potential overlap of risk-based capital, leverage ratio, and EU resolution requirements and the complexity that parallel requirements may present to capital planning.[122]

256. For some banks, these parallel requirements may also limit the availability of buffers that banks need to maintain.[123] The interaction between the ratios will vary depending on whether the change is mainly driven by changes in the numerator or in the denominator. In most cases, risk weights, total exposures and capital may all change simultaneously, which can have non-trivial implications for banks' capital management incentives.

257. All loss-absorbing instruments increase banks' resilience. However, these instruments take different forms, and a differentiation of going- and gone-concern instruments is motivated by different purposes. Capital instruments needed to secure the continuation of a bank on a going-concern basis require different properties than loss-absorbing capital instruments aimed at securing deposits and facilitating resolvability on a gone-concern basis. The variety of instruments that can absorb losses and the interaction of parallel requirements may potentially add a degree of complexity to the framework and complicate banks' funding structures. Supervisors' and external stakeholders' assessment of banks' financial resilience can thus become more complex. At the same time, a differentiation of capital instruments can be cost-efficient for banks.

10.5 Conclusions

258. By construction and intent, Basel III addresses a larger number of risks than did Basel II. In order to more comprehensively address risks, Basel III is a more sophisticated and arguably more complex regulatory framework. However, the framework's increase in complexity has not necessarily led banks to become more complex in response. On the contrary, other studies have found that banks have either reduced their complexity or stayed equally complex since the GFC.

259. Although this study shows that the Basel lll framework is likely to be more complex than was Basel II, the increase in complexity should be viewed in the light of the positive effect of Basel III's contributions to banks' resilience as demonstrated throughout this report. Basel III's relative complexity is due to its comprehensiveness and multi-dimensional nature, which result in more interactions among its component standards and make the framework more time-consuming for banks to understand and comply with. The analysis also shows that the market risk and credit risk standards – which address two core business risks of banks – involve the most computational complexity among the individual standards of the Basel III framework.

[122] See BCBS (2022b) for details.

[123] The July 2021 BCBS report also discussed limits to buffer usability, including the potential overlaps between these three capital requirements.

References

Aboura, S and E Lépinette (2015): "Do banks satisfy the Modigliani-Miller theorem?", *Economics Bulletin*, vol 35, no 2, pp 924–35.

Acharya V, R Engle and M Richardson (2012): "Capital shortfall: a new approach to ranking and regulating systemic risks", *American Economic Review*, vol 102, no 3, pp 59–64.

Acharya V, L Pedersen, T Philippon and M Richardson (2017): "Measuring systemic risk", *The Review of Financial Studies*, vol 30, no 1, pp 2–47.

Acosta-Smith, J, M Grill and J Lang (2018): "The leverage ratio, risk-taking and bank stability", *Bank of England Staff Working Papers*, no 766.

Acosta-Smith, J, G Arnould, K Milonas and Q-A Vo (2019): "Capital and liquidity interaction in banking", *Bank of England Staff Working Papers*, no 840.

Admati, A and M Hellwig (2013): *The bankers' new clothes: what's wrong with banking and what to do about it*, Princeton University Press.

Adrian, T and N Boyarchenko (2018): "Liquidity policies and systemic risk", *Journal of Financial Intermediation*, vol 35, part B, pp 45–60.

Adrian, T and M Brunnermeier (2016): "CoVaR", *American Economic Review*, vol 106, no 7, pp 1705–41.

Adrian, T, M Fleming, O Shachar and E Vogt (2017): "Market liquidity after the financial crisis", *Annual Review of Financial Economics*, vol 9, pp 43–83.

Aldasoro, I, D Delli Gatti and E Faia (2017): "Bank networks: contagion, systemic risk and prudential policy", *Journal of Economic Behavior and Organization*, vol 142, pp 164–88.

Allahrakha, M, J Cetina and B Munyan (2018): "Do higher capital standards always reduce bank risk? The impact of the Basel leverage ratio on the US triparty repo market", *Journal of Financial Intermediation*, vol 34, pp 3–16.

Allen, F, G Covi, X Gu, O Kowalewski and M Montagna (2020): "The interbank market puzzle", *European Central Bank Working Papers*, no 2374.

Altunbas, Y, S Manganelli and D Marques-Ibanez (2011): "Bank risk during the financial crisis: do business models matter?", *European Central Bank Working Papers*, no 1394.

Amadxarif, Z, J Brookes, N Garbarino, R Patel and E Walczak (2019): "The language of rules: textual complexity in banking reforms", *Bank of England Staff Working Papers*, no 834.

Amel, D and S Rhoades (1988): "Strategic groups in banking", *The Review of Economics and Statistics*, vol 70, no 4, pp 685–89.

Anbil, S and Z Senyuz (2018): "The regulatory and monetary policy nexus in the repo market", *FEDS Paper* 2018–027, Board of Governors of the Federal Reserve System, https://doi.org/10.17016/FEDS.2018.027.

Ayadi, R, W De Groen, I Sassi, W Mathlouthi, H Rey, and O Aubry (2016): "Banking business models monitor 2015 Europe", https://papers.ssrn.com/abstract=2784334

Bai, J, A Krishnamurthy and C−H Weymuller (2018): "Measuring Liquidity Mismatch in the Banking Sector", *Journal of Finance*, vol 73, no1, pp 51–93.

Baldo, L, A Bucalossi and A Scalia (2018): "Leverage ratio and central bank operations in the euro area", *Economic Notes: Review of Banking, Finance and Monetary Economics*, vol 47, no 1, pp 21–68.

Banerjee, R and H Mio (2018): "The impact of liquidity regulation on banks", *Journal of Financial Intermediation*, vol 35, part B, pp 30–44.

Bank of Mexico (2021): "Interaction between the Liquidity Coverage Ratio (LCR) and the Net Stable Funding Ratio (NSFR)", *Financial Stability Report*, December, Box 4, pp 64–7.

Basel Committee on Banking Supervision (BCBS) (2006): *Basel II: International convergence of capital measurement and capital standards: a revised framework - comprehensive version*, June, www.bis.org/publ/bcbs128.pdf.

——— (2009): *Strengthening the resilience of the banking sector*, December, www.bis.org/publ/bcbs164.pdf.

——— (2010a): *An assessment of the long-term economic impact of stronger capital and liquidity requirements*, August, www.bis.org/publ/bcbs173.pdf.

——— (2010b): *Basel III: A global regulatory framework for more resilient banks and banking systems*, December, www.bis.org/publ/bcbs189.pdf.

——— (2013): *The regulatory framework: balancing risk sensitivity, simplicity and comparability*, July.

——— (2016): "Literature review on integration of regulatory capital and liquidity instruments", *Working Papers*, no 30, March.

——— (2021): *Early lessons from the Covid-19 pandemic on the Basel reforms*, July, www.bis.org/bcbs/publ/d521.pdf.

——— (2022a): *Basel III monitoring report*, February, www.bis.org/bcbs/publ/d531.pdf.

——— (2022b): *Buffer usability and cyclicality in the Basel Framework*, October, www.bis.org/bcbs/publ/d542.pdf.

Behn, M, R Corrias and M Rola-Janicka (2019): "On the interaction between different bank liquidity requirements", *Macroprudential Bulletin,* European Central Bank.

Behn, M, C Daminato and C Salleo (2019): "A dynamic model of bank behaviour under multiple regulatory constraints", *European Central Bank Working Papers*, no 2233.

Belkhir, M, S Naceur, R Chami and A Samet (2021): "Bank capital and the cost of equity", *Journal of Financial Stability*, vol 53, no C.

Benoit, S, J-E Colliard, C Hurlin and C Pérignon (2017): "Where the risks lie: a survey on systemic risk", *Review of Finance*, vol 21, no 1, pp 109–52.

Berger, A and C Bouwman (2009): "Bank liquidity creation", *The Review of Financial Studies*, vol 22, no 9, pp 3779–3837.

Berndt, A, D Duffie and Y Zhu (2022): "The decline of too big to fail", https://ssrn.com/abstract=3497897 or http://dx.doi.org/10.2139/ssrn.3497897.

Boissay, F and F Collard (2016): "Macroeconomics of bank capital and liquidity regulations", *BIS Working Papers*, no 596.

Bonner, C and S Eijffinger (2016): "The impact of liquidity regulation on bank intermediation", *Review of Finance*, European Finance Association, vol 20, no 5, pp 1945–79.

Brei, M, and L Gambacorta (2014): "The leverage ratio over the cycle", *BIS Working Papers*, no 471.

Brodeur, A, N Cook and A Heyes (2020): "Methods matter: p-hacking and publication bias in causal analysis in economics", *American Economic Review*, vol 110, no 11, pp 3634–60.

Brooke, M, O Bush, R Edwards, J Ellis, B Francis, R Harimohan, K Neiss and C Siegert (2015): "Measuring the macroeconomic costs and benefits of higher UK bank capital requirements", *Bank of England Financial Stability Papers*, no 35.

Brookes, J, M Everitt and Q-A Vo (2022): "The Basel regulatory framework: evolution of its textual complexity", *Bank of England Underground paper*, https://bankunderground.co.uk/2022/08/24/the-basel-regulatory-framework-evolution-of-its-textual-complexity/.

Busch P, G Cappelletti, V Marincas, B Meller and N Wildmann, (2021): "How useful is market information for the identification of G-SIBs?", *European Central Bank Occasional Papers*, no 260.

Buch, C and L Goldberg (2022): "Complexity and riskiness of banking organizations: evidence from the International Banking Research Network", *Journal of Banking & Finance*, vol 134, January.

Carletti, E, I Goldstein and A Leonello (2020): "The interdependence of bank capital and liquidity", mimeo.

Caruana, J (2010): "Systemic risk: how to deal with it?" Bank for International Settlements, www.bis.org/publ/othp08.htm.

Cecchetti, S and A Kashyap (2018): "Chapter 12: What binds? Interactions between bank capital and liquidity regulations", in P Hartmann, H Huang and D Schoenmaker (eds), *The changing fortunes of central banking*, pp 192–202.

Cline, W (2015): "Testing the Modigliani-Miller theorem of capital structure irrelevance for banks", *Peterson Institute for International Economics Working Papers*, no 15-8.

Cohen, B and M Scatigna (2016): "Banks and capital requirements: channels of adjustment", *Journal of Banking & Finance*, vol 69, no S1, pp S56–69.

Colliard, J-E and C-P Georg (2022): "Measuring regulatory complexity", *CEPR Discussion Papers,* no DP14377, January, https://ssrn.com/abstract=3535463.

Committee on Payment and Settlement Systems (CPSS) and International Organization of Securities Commissions (IOSCO) (2012): *Principles for financial market infrastructures (PFMI)*, April.

Committee on the Global Financial System (2017): *Repo market functioning*, *CGFS Papers*, no 59.

Correa, R and L Goldberg (2022): "Bank complexity, governance, and risk", *Journal of Banking & Finance*, vol 134, 106013, January.

Covas, F and J Driscoll (2014): "Bank liquidity and capital regulation in general equilibrium", *FEDS Paper,* Board of Governors of the Federal Reserve System.

De Bandt, O, B Durdu, H Ichiue, Y Mimir, J Mohimont, K Nikolov, S Roehrs, J-H Sahuc, V Scalone and M Straughan (2022): "Assessing the impact of Basel III: evidence from structural macroeconomic models", Banque de France, *Working Paper,* no 864.

De Bandt, O and P Hartmann (2000): "Systemic risk: A survey", *European Central Bank Working Paper*, no 35, November.

De Mendonça, H and R da Silva (2018): "Effect of banking and macroeconomic variables on systemic risk: an application of ΔCOVAR for an emerging economy", *The North American Journal of Economics and Finance*, vol 43, pp 141–57.

De Nicolò, G, A Gamba and M Lucchetta (2014): "Microprudential regulation in a dynamic model of banking", *The Review of Financial Studies*, vol 27, no 7, pp 2097–138.

DeYoung, R, I Distinguin and A Tarazi (2018): "The joint regulation of bank liquidity and bank capital", *Journal of Financial Intermediation*, vol 34, pp 32–46.

Deutsche Bundesbank, "Longer-term changes in the unsecured interbank money market", *Monthly Report*, September.

Eisenbach, T, T Keister, J McAndrews and T Yorulmazer (2014): "Stability of funding models: an analytical framework", *FRBNY Economic Policy Review*, February, pp 29–47.

European Banking Authority (EBA) (2021): *Monitoring of Liquidity Coverage Ratio implementation in the EU – second report*, March.

European Systemic Risk Board (ESRB) (2021): *Report of the Analytical Task Force on the overlap between capital buffers and minimum requirements*, December.

Fender, I and U Lewrick (2015): "Calibrating the leverage ratio", *BIS Quarterly Review*, December, pp 43–58, https://ssrn.com/abstract=2700244.

Financial Stability Board (FSB) (2014): *Key attributes of effective resolution regimes for financial institutions*, 15 October.

Gai, P, M Kemp, A Sánchez Serrano and I Schnabel (2019): "Regulatory complexity and the quest for robust regulation", European Systemic Risk Board, *Reports of the Advisory Scientific Committee*, no 8, June.

Gambacorta, L and H S Shin (2018): "Why bank capital matters for monetary policy", *Journal of Financial Intermediation*, no 35, part B, pp 17–29.

Gehrig, T and M Iannino (2021): "Did the Basel Process of capital regulation enhance the resiliency of European banks?", *Journal of Financial Stability*, vol 55.

Gerba, E and P Katsoulis (2021): "The repo market under Basel III", *Bank of England Staff Working Papers,* no 954.

Gerding, E (2016): "The dialectics of bank capital: regulation and regulatory capital arbitrage", *Washburn Law Journal*, vol 55, pp 357–84.

Gimber, A and A Rajan (2019): "Bank funding costs and capital structure", *Bank of England Staff Working Papers*, no 805.

Goel, T, U Lewrick and A Mathur (2019): "Playing it safe: global systemically important banks after the crisis", *BIS Quarterly Review*, September, pp 35–47.

Gomez, F and Q-A Vo (2020): "Liquidity management, fire sale and liquidity crises in banking: the role of leverage", *Bank of England Staff Working Papers*, no 894, 27 November.

Grill, M, J Jakovicka, C Lambert, P Nicoloso, L Steininger and M Wedow (2017): "Recent developments in euro area repo markets, regulatory reforms and their impact on repo market functioning", *Financial Stability Review*, vol 2.

Gropp, R, T Mosk, S Ongena and C Wix (2019): "Banks Response to Higher Capital Requirements: Evidence from a Quasi-Natural Experiment", *The Review of Financial Studies*, vol 32, no 1, pp 266-299.

Haldane, A (2012): "The dog and the frisbee", August, www.bis.org/review/r120905a.pdf.

Hansson, I and T Lindqvist (2022): "Could the banks cope with large deposit outflows? Assessment according to a new liquidity metric", *Riksbank's Economic Commentaries*, No 7, May.

Ikeda, D (2018): "Bank runs, prudential tools and social welfare in a global game general equilibrium model", *Bank of England Staff Working Papers*, no 732.

Jimenez, G, S Ongena, J-L Peydró and J Saurina (2017): "Macroprudential Policy, Countercyclical Bank Capital Buffers, and Credit Supply: Evidence from the Spanish Dynamic Provisioning Experiments", *Journal of Political Economy*, vol 125, no 6, pp 2126-2177.

Jordà, Ò, B Richter, M Schularick and A Taylor (2021): "Bank capital redux: solvency, liquidity, and crisis", *The Review of Economic Studies,* vol 88, no 1, pp 260–86.

Kara, G and S Ozsoy (2020): "Bank regulation under fire sale externalities", *The Review of Financial Studies*, vol 33, no 6, June, pp 2554–84.

Kiema, I and E Jokivuolle (2014): "Does a leverage ratio requirement increase bank stability?", *European Central Bank Working Papers*, no 1676, May.

Kim, D and W Sohn (2017): "The effect of bank capital on lending: Does liquidity matter?", *Journal of Banking & Finance*, vol 77, pp 95–107.

Kim, K, A Martin and E Nosal (2020): "Can the US interbank market be revived?", *Journal of Money, Credit and Banking*, vol 52, no 7, pp 1645–89.

Kincaid, J, R Fishburne, R Rogers and B Chissom (1975): *Derivation of new readability formulas (Automated Readability Index, Fog Count and Flesch Reading Ease Formula) for Navy enlisted personnel*, Chief of Naval Technical Training, Naval Air Station Memphis.

Koenig, P (2015): "Liquidity requirements: a double-edged sword", *International Journal of Central Banking*, vol 11, pp 129–67.

Kotidis, A and N van Horen (2018): "Repo market functioning: the role of capital regulation", *Bank of England Staff Working Papers*, no 746.

Laeven L, L Ratnovski and H Tong (2016): "Bank size, capital, and systemic risk: some international evidence", *Journal of Banking & Finance*, vol 69, no S1, pp S25–34.

Macchiavelli, M, L Pettit (2021): "Liquidity regulation and financial intermediaries", *Journal of Financial and Quantitative Analysis*, vol 56, no 6, pp 2237–2271.

Macroeconomic Assessment Group (2010): "Assessing the macroeconomic impact of the transition to stronger capital and liquidity requirements", December, www.bis.org/publ/othp12.pdf.

Mergaerts, F and R Vander Vennet (2016): "Business models and bank performance: A long-term perspective", *Journal of Financial Stability*, vol 22, pp 57–75.

Roengpitya, R, N Tarashev, K Tsatsaronis and A Villegas (2017): "Bank business models: popularity and performance", *BIS Working Papers*, no 682, December.

Roncoroni, A, S Battiston, M D'Errico, G Hałaj and C Kok (2021): "Interconnected banks and systemically important exposures", *Journal of Economic Dynamics and Control*, vol 133, no C.

Single Resolution Board (2017): "Decision of the Single Resolution Board in its executive session", 7 June.

Stiroh, K and A Rumble (2006): "The dark side of diversification: the case of US financial holding companies", *Journal of Banking & Finance*, vol 30, no 8, pp 2131–2161.

Toader, O (2015): "Estimating the impact of higher capital requirements on the cost of equity: an empirical study of European banks", *International Economics and Economic Policy*, vol 12, no 3, pp 411–36.

Vives, X (2014): "Strategic complementarity, fragility, and regulations", *The Review of Financial Studies*, vol 27, pp 3547–92.

Vo, Q-A (2021): "Interactions of capital and liquidity requirements: a review of the literature", *Bank of England Staff Working Papers*, no 916.

Woods, S (2022): "Bufferati", speech at City Week 2022, Bank of England, 26 April.

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