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How usable are capital buffers?

An empirical analysis of the interaction between capital buffers and the leverage ratio since 2016

No 329

Contents

Abstract

This paper analyses banks' ability to use capital buffers in the euro area, taking into account overlapping capital requirements between the risk-based capital framework and the leverage ratio capital framework from 2016 to 2022. This analysis is the first to quantify buffer usability in multiple jurisdictions and across various bank types, identify key drivers of buffer usability and assess the impact of various policy measures using longer time series. The paper shows that while both risk-based and leverage frameworks play a key role in enhancing the resilience of the banking system and ensuring financial stability, their simultaneous application creates interactions that may affect the functioning of capital buffers. In this regard, we investigate to what extent banks could have drawn down regulatory capital buffers in the risk-based framework without breaching current leverage ratio requirements, which is in line with the approach to buffer usability taken in ESRB (2021b). We show that buffer usability was partially constrained in the period examined and is expected to remain so under the current regulatory framework and if risk weight densities (RWDs) remain low. This finding indicates that the leverage ratio constitutes an effective backstop to the risk-based framework, both as regards minimum requirements and capital buffers. Limited buffer usability was identified especially for global systemically important institutions (G-SIIs) that rely largely on internal modelling approaches to calculate risk-based capital requirements, leading to comparably low risk weights and making the leverage ratio relatively more binding. Adding to previous contributions, we find that banks' ability to use capital buffers fluctuated over time, generally increasing before 2019 and decreasing after the start of the coronavirus (COVID-19) pandemic, with substantial heterogeneity across countries. Furthermore, we provide new insights into the relationship between the RWD of a bank and its buffer usability and find that there is a critical RWD range between 25% and 50% for which buffer usability is limited and very sensitive to RWD changes. Additionally, we perform a counterfactual analysis that investigates how a positive neutral countercyclical capital buffer and leverage ratio buffers would have changed buffer usability over time. Finally, we assess the impact of the implementation of the new Basel capital standards (Basel III) and find that full implementation of Basel III will materially increase the usability of capital buffers for G-SIIs.

Keywords: macroprudential policy, capital buffers, buffer usability, banking regulation, leverage ratio.

JEL codes: G21, G28.

Non-technical summary

Macroprudential buffers are regulatory capital requirements that are applied on top of minimum capital requirements. Buffers are intended to be used by banks in times of stress to absorb unexpected losses, so that they are not forced to cut back their vital services to the broader economy. Furthermore, capital buffers should generally increase the resilience of the banking system and certain elements of the framework also aim at dampening the financial cycle. Thereby, capital buffers' overarching objective is to safeguard the stability of the financial system. Over the years, the regulatory framework has been adjusted to account for the lessons learned from the global financial crisis. The risk-based framework has been complemented with parallel regulatory requirements that further strengthen bank resilience and facilitate the recapitalisation of troubled banks and therefore strongly promote financial stability. While capital buffers feature prominently in the risk-based prudential framework, they are less prominent or absent in other frameworks. This creates complex interactions between the parallel requirements and may lead to circumstances in which buffers in the risk-based framework might not be fully usable in practice and thus might not be able to fully achieve their objectives.

In particular, banks are now required to simultaneously comply with (i) the risk-weighted (RW) framework, (ii) the leverage ratio (LR) framework and (iii) resolution requirements (minimum requirement for own funds and eligible liabilities, MREL). The RW framework determines the level of capital a bank must hold in relation to the risk profile of its portfolio. The LR framework requires banks to hold capital in relation to their non-risk-based exposures. The LR framework therefore enhances overall resilience and limits excessive leverage in the banking system, making it an important pillar of the overall prudential framework. Furthermore, the LR framework provides additional safeguards against model risk and measurement error by complementing the RW capital framework with a relatively simple non-risk-based measure that is binding especially when risk weights are low.[1] Meanwhile, MREL is designed to ensure that a bank has the resources required to guarantee its resolvability in case it fails.

To some extent, banks can use the same capital to comply with these parallel requirements. Therefore, for banks that are relatively more constrained by the parallel requirements, part of the capital that constitutes the risk-based macroprudential buffer may actually be needed to fulfil the LR or resolution requirements. In such cases, banks cannot fully use the capital buffers to absorb losses, as doing so would imply violating these parallel requirements. This issue is known as limited buffer usability with respect to capital overlaps. The analysis in this paper focuses on the overlaps of macroprudential capital buffers with the LR requirement, since information on the LR requirement has been available since 2016 whereas the MREL intermediate targets have only applied since 2022.

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[1]   See BCBS (2011).

Generally, it is important to note that buffer usability is a multidimensional phenomenon. Banks' use of capital buffers depends not only on their ability but also their willingness to do so. Banks may be reluctant to dip into buffers to avoid the negative consequences of restrictions on distributions or due to fears of market stigma. An analysis of banks' willingness to use capital buffers is outside the scope of this paper, as it purely focuses on banks' ability to use capital buffers without breaching overlapping capital requirements.[2]

This paper contributes to the analytical literature on buffer usability by examining for the first time how buffer usability with respect to the LR evolved and changed in the euro area from 2016 to 2022, using a multi-country and multi-year bank-level dataset. The LR has been a binding requirement since June 2021; however, it was also reported and publicly disclosed by banks beforehand, which allows for the extension of the time series backward. Furthermore, one could argue that public disclosure rules encouraged banks to comply with the LR requirement via market discipline and peer pressure even before it became formally binding. In fact, our data show that the vast majority of banks would have complied with the LR requirement in the years before it became legally binding. With this perspective, the paper analyses how buffer usability might develop in different phases of the financial cycle and also whether it differs across countries. The paper therefore broadens the analytical evidence to support ongoing discussions on buffer usability. We do not focus on MREL due to its later phase-in and resulting data limitations.

The analysis shows that buffer usability was limited in past years, especially for systemically important banks that generally have lower risk weights. The level of buffer usability increased from the end of 2016 onwards with the phasing-in of buffers, but then decreased during the coronavirus (COVID-19) pandemic. This decrease is partially due to monetary and fiscal measures, which supported financial stability in general but at the same time affected bank balance sheets, risk weight density (RWD) and regulatory requirements in a way that changed the relative bindingness of RW and LR requirements and led to reductions in the usability of buffers. This pattern differs across countries, with some having persistently high usability and others seeing varying usability over time.

Analysing the main drivers of buffer usability, this paper provides empirical evidence that RWD is the key factor determining buffer usability with respect to the LR. In this regard, it shows that there is a critical RWD range in which buffer usability is highly reactive to changes in RWD. This critical range is determined by the design and relative calibration of risk-based and leverage-based minimum requirements. The majority of euro area banks, including all global systemically important institutions, fall in this critical range, indicating that the LR functions as an effective backstop to low risk weights for these institutions.

Beyond loss absorption, buffers also provide important incentives for banks, and higher levels of buffer usability support the effective functioning of the macroprudential framework. In the absence of policy changes or substantial adjustments to banks' balance sheets and RWDs, limited buffer usability is likely to

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[2]   See on this matter, for instance, Behn et al. (2020), ECB (2022b), BCBS (2021) and BCBS (2022).

prevail in the long term as well. This highlights the need to closely monitor the impact of various policy measures and regulatory reforms, which are expected to increase buffer usability by changing the relative bindingness of the RW and LR frameworks. In this regard, the paper assesses the possible effects of positive neutral countercyclical capital buffers and LR buffers as well as the full implementation of the Basel capital standards (Basel III) on buffer usability. The paper can hence contribute to a better understanding of the impact of various measures on the usability of buffers without compromising the objectives of leverage requirements.

1   Introduction

Macroprudential policy was developed based on the lessons learned from the global financial crisis of 2007-08. One of the main lessons of the crisis was that ensuring safe and sound individual banks does not guarantee financial stability at the system level. For this reason, the individual bank-focused prudential framework of banking supervision and microprudential policy was complemented with macroprudential policy. Macroprudential authorities analyse and assess the stability of the financial system as a whole and deploy policies aimed at safeguarding financial stability at the system level.

Among these macroprudential policy tools are capital buffers, which are dedicated regulatory capital requirements banks must maintain above minimum levels. If unexpected losses materialise, banks could use these buffers to cushion them without having to breach regulatory minimum requirements. Capital buffers should also ensure that in stressed times banks do not have to deleverage and cut back lending to households and businesses in order to absorb materialising losses, by instead using buffer capital for this purpose. Besides this primary objective, buffers can also help mitigate risk-taking, disincentivise lending to overheating sectors and dampen the financial cycle. By increasing the resilience of the financial system and reducing the systemic risk it faces, capital buffers are also beneficial for the real economy.

However, capital buffers may not always work effectively in practice as they might be not completely usable for banks. Since the regulatory framework is multidimensional by design, banks have to comply not only with capital buffers that are part of the risk-based capital requirements, but also with other parallel requirements such as the leverage ratio (LR). Box 1, at the end of this introduction, presents a comprehensive overview of the risk-based and LR regulatory frameworks in the EU. Capital buffers feature prominently in the risk-based prudential framework, whereas they are less prominent or absent in other frameworks. Therefore, banks might not be able to deplete their risk-based macroprudential buffers, fully or partially, without simultaneously breaching other requirements. Breaching these other requirements is associated with more severe consequences than breaching risk-based buffer requirements, which may constrain banks' ability to use their buffers. This phenomenon occurs due to overlapping capital requirements and is referred to as "limited buffer usability" for the purpose of this paper. Limitations to buffer usability could impede the functioning of the macroprudential framework, as buffers that are not fully usable might not achieve their financial stability objectives.

Parallel requirements are not necessarily the only reason for limited buffer usability, in fact banks might also not be willing to use buffers. Limited buffer usability is a multidimensional phenomenon, and overlapping capital requirements are just one aspect of it. The coronavirus (COVID-19) experience provides indications that banks may avoid dipping into buffers and instead lend less or rebalance portfolios towards safer assets to ensure sufficient capital headroom,

because they want to avoid negative consequences associated with buffer breaches such as limitations on distributions and market stigma effects.

A dedicated analysis of buffer usability from the perspective of banks' willingness to use buffers is beyond the scope of this paper but has been the subject of other extensive studies. Contributions to this literature include Abad and Garcia Pascual (2022), BCBS (2021), BCBS (2022), Behn et al. (2020) and ECB (2022b). Banks may not be willing to use their buffers because of the negative consequences (e.g. restrictions on distributions and stigma effects) they face when breaching buffer requirements. This is especially associated with structural buffers, compared with buffers that can be released by authorities, as releasing such buffers would free up capital that can be used by banks without restrictions. Therefore, one of the policy conclusions derived by the literature dealing with banks' unwillingness to use buffers is to call for a higher share of releasable buffers. In this regard, the ECB (2022b) sets out different implementation options, such as introducing a positive neutral level of the countercyclical capital buffer (CCyB), introducing a core systemic risk buffer (SyRB) or making the capital conservation buffer (CCoB) releasable. However, from this angle the question of banks' ability to use buffers without breaching other parallel requirements is also important. First, if banks are willing to use their buffers, they also have to be able to do so and, second, releasing capital buffers will not be effective if the released buffer capital is still needed to meet a parallel requirement.

The issue of potentially limited buffer usability stemming from the presence of parallel requirements is receiving increasing international attention. The work of the ESRB (2021b), which analysed buffer usability for EU countries and established a reference approach to assess buffer usability as result of overlapping parallel requirements, brought the issue of limited buffer usability to international attention.[3] This work showed that because of existing capital overlaps with the LR framework, risk-based capital buffers are only up to 65% usable on average, and even less if resolution requirements[4] are also taken into account. Earlier studies, mainly by national central banks and supervisory authorities, analysed buffer usability in individual jurisdictions. In this regard, Swedish, Danish and Czech authorities studied the interaction between the LR minimum requirement and capital buffers, or their explicitly releasable part, the CCyB, finding evidence of limited buffer usability for banks in their countries (Finansinspektionen, 2016, Danmarks Nationalbank, 2018, and Pfeifer, 2020). Other studies like Norges Bank (2021), Danmarks Nationalbank (2020) and Cornacchia and Guerra (2022) also considered the need to meet the minimum requirement for own funds and eligible liabilities (MREL) as a potential limitation on buffer usability and consistently found MREL to be more constraining on buffer usability than the LR framework.[5] The most recent contributions come from Danmarks Nationalbank (2022), which shows that the

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[3] The approach of the ESRB (2021b) is condensed and made available as a software package called the buffer usability simulation tool (USIT), on which this paper draws extensively.

[4] See ESRB (2021b) for details.

[5] It is worth noting that Cornacchia and Guerra (2022) conducted their buffer usability analysis following an alternative, complementary approach to the reference approach of the ESRB (see Box 1 of ESRB, 2021b, for further details, which leads to higher buffer usability for Italian banks in comparison with the ESRB reference approach.

usability of the CCyB is reduced by almost half due to the need to comply with the LR framework, and from Fernández Lafuerza et al. (2022), who assess buffer usability for Spanish banks during the COVID-19 pandemic. Finally, the limitations on buffer usability were also acknowledged by BCBS (2022). Assessing buffer usability for a global bank dataset following the approach of the ESRB (2021b), it found that buffer usability is constrained in all BCBS jurisdictions, where, on average, around 73% of buffers would be usable without breaching the LR. However, this aggregate number hides strong geographical heterogeneity across countries. In these studies, the low level of risk weights was considered as one of the primary reasons for limited buffer usability.

While these studies have shown certain limitations on buffer usability, ongoing policy discussions suggest the need for additional analytical work. For example, in the context of the recent review of the European macroprudential framework, the European Central Bank (ECB) advised the European Commission to further monitor and assess whether impediments to buffer usability remain significant before considering if a fundamental framework revision is required.[6] Therefore, it seems that existing studies provide a good starting point in flagging the issue of buffer usability, but more work is needed to fully understand the phenomenon and better inform future policy discussions. In particular, one could argue that studies have so far used data from one specific observation in time and therefore do not reveal whether limited buffer usability is a snapshot issue due to specific circumstances at a given point in time or whether it is a more permanent issue that exists by design.[7] Furthermore, multi-country analysis remains scarce, with the exception of ESRB (2021b) and BIS (2022). The observed heterogeneity in the usability of buffers (e.g. geographical or by bank type) has generally not yet been analysed in sufficient detail. Relating observed heterogeneity to underlying structural factors such as differences in banking system or macroprudential policy stance would help inform the discussion on the expected materiality of the concerns and policies to address them.

The goal of this paper is to substantiate, strengthen and expand the analytical literature on buffer usability by shedding more light on the above-mentioned gaps and enrich the policy discussion with new insights. To the best of our knowledge, this analysis is the first multi-country time series analysis of buffer usability from a capital overlap perspective, conducted on the so far richest euro area cross-sectional micro-level bank dataset, observing 1,725 individual institutions over 25 quarters and resulting in more than 40,000 datapoints. Drawing on this large dataset allows us to explore for the first time how buffer usability has evolved over time. This not only enables us to assess to what extent limited buffer usability was an issue in the past, but also allows us to look forward based on historical experience and understand whether it is likely to remain a permanent issue. Furthermore, given the period under investigation, we can analyse how buffer usability behaved in pre-crisis times, when macroprudential capital buffers were generally being phased in,

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6   See the ESRB response, EBA response and ECB response to the call for advice of the European Commission and the targeted consultation on the macroprudential review.

7   However, the ESRB (2021b) conducts scenario analyses on how banks adjust to upcoming final requirements and finds that limited buffer usability will persist, as it is a result of the current regulatory setup.

and how the dynamics changed due to the circumstances of the COVID-19 pandemic. Also, by exploiting the bank-level and geographical heterogeneity of our rich dataset, this paper puts a stronger focus on investigating how observed low risk weight densities (RWDs) for larger banks, in combination with the calibration of minimum requirements, are a key determinant of limited buffer usability, compared with previous contributions on this topic. Finally, we analyse how different measures, such as positive neutral CCyBs and LR buffers, as well as the full implementation of the Basel capital standards (Basel III), could have changed buffer usability over time by means of counterfactual simulations.

Box 1
An overview of the EU prudential framework for banks

The aim of this box is to give a brief overview[8] of the European prudential framework, which requires banks to fulfil different parallel capital requirements. Among these, we will focus our attention on risk-based requirements and leverage-based requirements. These requirements must be met with regulatory capital, which differentiates between Tier 1 capital and Tier 2 capital. The former is a higher-quality capital that absorbs losses mostly on a "going concern" basis (i.e. before a bank fails) and is the sum of Common Equity Tier 1 (CET1) and Additional Tier 1 (AT1) capital, while the latter is a lower-quality capital that absorbs losses on a "gone concern" basis (i.e. when the bank has failed). CET1 capital is the first to absorb losses and is mainly composed of common shares and retained earnings, while AT1 capital is composed of other instruments that can still absorb losses but are not qualified as CET1, such as contingent convertible bonds. Tier 2 capital is mainly composed of subordinated debt.

Risk-based capital framework

The risk-based capital framework requires banks to hold regulatory capital according to the risk profile of their assets. The basis for calculating risk-based requirements is therefore the total risk-weighted assets, also called the total risk exposure amount (TREA), where riskier exposures contribute more strongly to capital requirements. The framework is composed of a minimum requirement, a buffer requirement and Pillar 2 guidance.

- **Minimum requirement:** This is composed of a Pillar 1 (P1) requirement equal for all banks and a bank-specific Pillar 2 requirement (P2R). P1 imposes a minimum CET1 capital requirement of 4.5% of the TREA, a Tier 1 capital requirement of 6% of the TREA and a total capital requirement of 8% of the TREA. Above P1, supervisors may impose a P2R to reflect microprudential risks of the particular bank not reflected in P1, which can be partially fulfilled with both Tier 1 and Tier 2 capital, provided that at least 75% of the capital is Tier 1 and 75% of the Tier 1 capital is CET1. Minimum capital requirements must be met at all times. Breaching any of them can result in severe consequences for banks, culminating in the withdrawal of their banking licence.

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[8]   A comprehensive description of the framework can be found for example in ESRB (2021b).

- **Buffer requirement:** This must be met with CET1 capital and is composed of the capital conservation buffer (CCoB), capital buffers for global and other systemically important institutions (G-SIIs and O-SIIs), the systemic risk buffer (SyRB) and the countercyclical capital buffer (CCyB). Each of these buffers is set separately with a different purpose but with the same macroprudential nature.[9] All the buffers together constitute the combined buffer requirement (CBR), which stacks above the risk-based minimum requirement. The consequences of breaching the CBR are milder than the minimum requirement. Indeed, in times of stress, banks should be able to dip into the buffers with the consequences of restrictions on distribution (dividends, share buy-backs, coupon payments on AT1 instruments and bonuses) and provided they submit a capital conservation plan including a timeframe for the increase of own funds with the objective of meeting fully the CBR.

- **Pillar 2 guidance (P2G):** This is an institution-specific requirement set by supervisors stacking above the CBR. In contrast to the minimum requirement and CBR, a breach of P2G does not involve any automatic regulatory consequences, with the exception of having to provide arguments for not meeting P2G to supervisors and having to submit a revised capital plan for the eventual restoration of compliance.[10]

Leverage-based capital framework

The leverage framework is designed as a requirement based on the size of balance-sheet and off-balance-sheet items, without factoring in the riskiness of exposures. It is intended to restrict the build-up of leverage in the banking system and to complement the risk-weighted requirements as a simple backstop measure against model risk and measurement error.[11] The basis for calculating requirements is the total leverage ratio exposure measure (LREM).[12] Similar to the risk-weighted framework, it is composed of a minimum requirement, a capital buffer for G-SIIs and potentially P2G.

- **Minimum requirement:** This is composed of a P1 requirement and a P2R.[13] Both need to be met with Tier 1 capital. The P1 requirement is set equal for all banks at 3% of the LREM, while the P2R is bank-specific and may be set by supervisors. As in the risk-based framework, the P2R stacks above the P1 requirement. If leverage-based minimum requirements are breached, consequences similar to those for breaching risk-based requirements are applied. In the EU, the leverage ratio became a binding minimum requirement in June 2021.

- **Buffer requirement:** As of 2023, G-SIIs need to meet a Tier 1 capital buffer requirement equal to the LREM, multiplied by 50%[14] of the applicable risk-based G-SII buffer rate. This buffer requirement stacks above the leverage ratio minimum requirement. In case of LR buffer breaches, similar consequences are applied to those for the CBR.

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[9]   More information on the CBR can be found on the ESRB official website.

[10]   Despite this non-bindingness, banks tend to comply with P2G. In addition, repeated non-compliance with P2G may result in P2R increases.

[11]   See BCBS (2011).

[12]   LREM is a measure to capture the risk of excessive leverage in banks comprising both on-balance-sheet and off-balance-sheet exposures.

[13]   For details, see the ECB Banking Supervision website.

[14]   This number is commonly referred as the "conversion factor".

- **Pillar 2 guidance (P2G-LR):** This is an institution-specific, legally non-binding requirement set by supervisors and based on a bank's stress test result. It stacks above the leverage ratio buffer requirement. As of 2022, no P2G-LR requirements had been implemented.

The leverage ratio was calibrated as a backstop to risk-based prudential requirements, meaning that only a limited number of globally active banks are expected to find the leverage requirements more restrictive than risk-based requirements. However, due to the low risk weights of large banks in Europe, the leverage ratio framework is particularly constraining for European banks.[15] Even though overall risk-based requirements are still higher for most European banks than overall leverage requirements, the data show that the leverage ratio functions as a backstop not only to the risk-based minimum requirement but in many cases also as a de facto backstop to the buffer requirement (implying limited buffer usability).

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[15] For example, De Haan and Kakes (2020) find that peak losses accumulated during the period 2007-16 would exceed the 8% minimum risk-based requirement for 20% of banks, whereas they would exceed the 3% leverage requirement for 25% of banks. This shows that the loss absorbency of both minimum requirements is rather comparable.

2 The concept of buffer usability and its main determinants

The analysis conducted in this paper strictly follows the conceptual and empirical approach to buffer usability laid out in ESRB (2021b). We therefore analyse whether banks can deplete (use) their macroprudential capital buffers that stack on top of risk-weighted (RW) minimum requirement without simultaneously breaching the parallel applicable leverage ratio (LR) minimum requirement.[16] Unlike the ESRB (2021b), we do not consider potential additional restrictions on buffer usability due to the MREL framework, because for the observed period MREL requirements were not applicable and data were not available.[17]

Since banks' capital instruments that are used to meet buffers in the RW framework can simultaneously also be used to meet the minimum requirement in the LR framework, there is a certain overlap between the two frameworks that may reduce the usability of buffers. If a bank meets the LR minimum requirement with capital that is also used to meet the combined buffer requirement (CBR), this part of CBR is not usable. Furthermore, given that the regulation requires banks to meet the CBR with the highest capital quality, i.e. with Common Equity Tier 1 (CET1) capital, one must focus specifically on CET1 capital to determine buffer usability. More precisely, the usability of capital buffers is reduced if the CET1 amount used to comply with the LR minimum requirement is in nominal terms larger than the CET1 amount used to comply with the RW minimum requirement.

Chart 1 illustrates the limited usability of buffers presented by the LR for a stylised bank. The vertical axis depicts the CET1 amount used to comply with the LR and RW frameworks. We assume low average risk weights for this bank, which implies that the LR minimum requirement is relatively more binding than the RW minimum requirement. This is shown in the chart by the CET1 part of the LR minimum requirement (MR-LR) exceeding the CET1 RW minimum requirement (MR-RW) on top of which the CBR is stacked. The part of the MR-LR that creates the effective overlap with the CBR is illustrated by the blue shaded area in the CBR. This part of the CBR may not fulfil its buffer role, as the bank is not able to deplete this part of the CBR without breaching the LR minimum requirement. Only the non-shaded part of the CBR is freely usable, as it exceeds in nominal terms the CET1 LR minimum requirement, i.e. there are no LR overlaps restricting the usability of this part. Ultimately, buffer usability for this bank is below 50%, meaning that a larger part of the CBR cannot be used without breaching the LR minimum requirement. This illustrates that buffer usability depends on actual bank-specific capital requirements, banks' risk profile and the corresponding risk weights (which in this case are

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[16] This concept is not related to banks' actual willingness to use buffers. In fact, the ability to use buffers without breaching minimum requirements is a precondition for banks' willingness to use buffers.

[17] It should be acknowledged, however, that the ESRB ATF report, using a range of assumptions, found MREL to be the most constraining issue for CBR usability. Therefore, the analysis in this paper could– under similar assumptions – be extended to account for buffer usability dynamics with respect to MREL.

assumed to be low). Therefore, the conceptual example cannot be generalised, and buffer usability analysis must be bank-specific.

Chart 1

Example of limited buffer usability for a bank with low risk weights due to capital overlaps with the leverage ratio
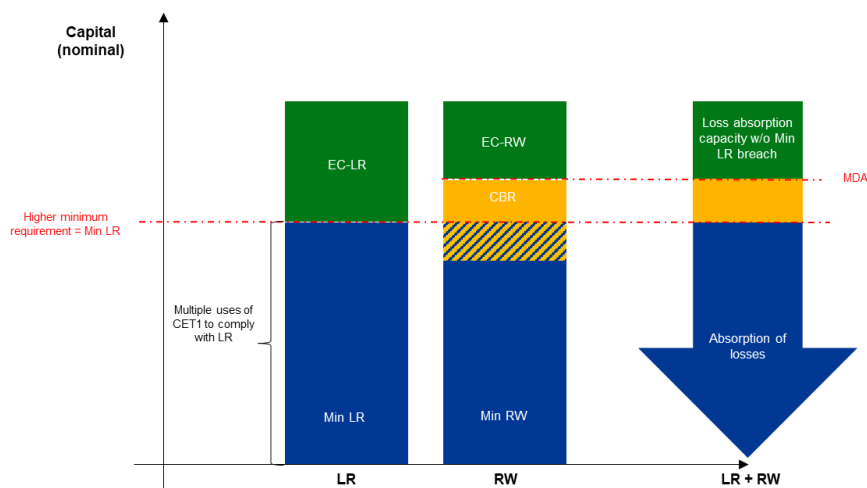
Source: ESRB (2021b), amended by the ECB.
Notes: This chart presents a stylized example bank. All components are expressed in CET1 terms. EC-LR = excess capital (LR capital stack), MR-LR = minimum requirement, EC-RW = excess capital (risk-weighted capital stack), CBR = combined buffer requirement, MR-RW = risk-weighted minimum requirement (risk-weighted capital stack), MDA = maximum distributable amount threshold. The figure assumes that the MR-LR is the highest minimum requirement. The bank in the example is not subject to a G-SII leverage buffer. The blue on yellow shaded area in the RW stack indicates the non-usable part of the CBR.

The calculation of buffer usability is complicated by the fact that the LR and RW capital frameworks require different capital qualities. To calculate buffer usability analytically, one first has to calculate the CET1 amount used to comply with the LR and RW frameworks respectively and then evaluate the overlap between the CET1 amount used in the LR framework and the CET1 amount used in the RW framework.

In the stylised example above, any factor that decreases the amount of CET1 capital needed in the RW framework compared with the LR framework decreases buffer usability, and vice versa. These CET1 amounts are directly determined by the respective RW/LR nominal capital requirements, which further depend on the respective regulatory Pillar 1, Pillar 2 and CBR rates and on the respective underlying basis, which is the total risk exposure amount (TREA) for the RW framework and the leverage ratio exposure measure (LREM) for the LR framework. For example, a lower risk-based minimum requirement (all else being equal) means that less CET1 capital is needed in the RW framework, increasing capital overlap and reducing CBR usability. If, however, CBR rates are increased (i.e. the amount of required buffer capital above the CET1 minimum leverage requirement is higher), capital overlap will decrease and CBR usability will increase. Aside from regulatory requirements, the relative bindingness of the LR and RW capital frameworks is also determined by the risk profile of the bank, which can be described analytically by the risk weight density (RWD = TREA/LREM). The higher the RWD, the more constraining the RW framework is.

The composition of regulatory capital that banks use to comply with different requirements has a multifaceted impact on buffer usability. First, the treatment of Additional Tier 1 (AT1) capital is different in the RW and LR frameworks. The RW framework restricts the amount of AT1 capital that can be used to meet the minimum requirement (i.e. AT1 capital is capped at 25% of Tier 1 capital; Box 1), while no such restrictions exist in the LR framework. Therefore, banks may have "surplus" AT1 capital – in excess of what is used to meet Tier 1 requirements in the RW framework – which would be available to meet LR requirements. Any such surplus AT1 capital would therefore reduce the CET1 amount that is needed to comply with LR requirements and hence decrease the overlap and increase buffer usability. Second, as regards Tier 2 capital, it should be pointed out that this can only be used to meet the minimum requirement in the RW framework (subject to some restrictions; Box 1) and not that in the LR framework. Therefore, any eligible T2 capital used to meet RW minimum capital requirements would "free up" CET1 capital, as the latter would no longer be needed to comply with the RW minimum requirement. Lower CET1 capital locked in the RW minimum would reduce the CET1 element of the RW capital stack and would thus increase the overlap with the LR minimum requirement. This would reduce buffer usability (Chart 1), albeit increasing surplus CET1 capital above regulatory requirements. Third, if a bank increases AT1 capital when this instrument simultaneously meets RW and LR requirements, or if it increases Tier 2 capital beyond what is eligible in the RW framework (i.e. 25% of total capital), this has zero impact on buffer usability. Finally, increasing surplus CET1 capital does not affect overlap and hence has no effects on buffer usability, as surplus CET1 capital would only increase the voluntary CET1 buffers on top of the LR and RW capital stack (green boxes in Chart 1). The full analytical approach to calculate buffer usability and a more detailed discussion of the underlying determinants can be found in Annex 1.

From a broader financial stability perspective, however, higher reliance on AT1 and Tier 2 capital may not be beneficial. First, replacing higher-quality capital with lower-quality capital reduces going concern loss-absorbing capacity. The loss absorbency of CET1 capital is superior to AT1 and Tier 2 capital, so incentivising a higher share of the latter capital types may not improve financial stability. Second, banks' willingness to use buffers is a further dimension of the overall phenomenon of constrained buffer usability. While a detailed analysis of banks' willingness to use capital buffers is beyond the scope of this paper, it must be acknowledged that higher AT1 capital might in fact have a negative impact on buffer usability from this perspective. Notably, banks with more AT1 capital may have stronger incentives not to dip into buffers in order to avoid the cancellation of AT1 coupon payments.[18]

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[18]   To increase the usability of buffers that are not releasable, the ECB for instance supports strengthening the features of AT1 instruments to reduce the stigma effects associated with banks cancelling AT1 coupon payments when they fall beneath the level of their combined buffer requirements (see ECB, 2022b).

3 An empirical analysis of buffer usability over time

This section presents the main empirical results of this paper. We show how buffer usability evolved in the observed period from 2016 to the third quarter of 2022 and also look at the heterogeneity of buffer usability across bank types and countries. Furthermore, we analyse the main drivers of the observed dynamics, such as capital composition and RWD.

3.1 Empirical approach and data

For the analysis carried out in this paper, we use the buffer usability simulation tool (USIT) developed by the Analytical Task Force (ATF) of the European Systemic Risk Board (ESRB) for overlapping capital requirements. USIT is a software package based on the statistical software R that allows researchers to calculate the usability of capital buffers using bank-level data. To calculate CBR usability with respect to the LR, USIT uses the methodology of ESRB (2021b), as described in the previous section and in more detail in Annex 1.[19]

Supervisory bank-level data for a large sample of euro area banks over six years is used for this analysis. The data are obtained through supervisory common reporting obligations (COREP) and cover the capital composition of banks as well as the respective regulatory capital requirements under the RW and LR capital frameworks. Our dataset spans from the third quarter of 2016 to the third quarter of 2022. To ensure that any observed time dynamics do not result from changes in the sample composition, we use a balanced sample of 1,725 banks, containing global systemically important institutions (G-SIIs), other systemically important institutions (O-SIIs) and other smaller banks, located in 19 euro area countries.[20] The aggregate assets of the sample accounted for 75% of banks' total euro area assets in the fourth quarter of 2021.[21]

Our analysis describes buffer usability according to evolving regulatory circumstances at any given time in our sample. We use all requirements and capital data as reported by banks, thereby reflecting the rules applicable at each reporting date. Hence, any changes to buffer usability implied by changes to the regulatory framework are implicitly reflected in the results.[22] Following this approach, we observe actual in-time usability dynamics, but it becomes slightly more challenging to disentangle the underlying drivers of the observed effects, as they can

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[19] USIT is currently being maintained by the ECB and is available for members of the ESRB.

[20] BE, CY, DE, EE, IE, GR, ES, FR, IT, LT, LU, LV, MT, NL, AT, PT, SI , SK and FI.

[21] Based on the ECB Statistical Data Warehouse MFI euro area aggregate balance sheet statistics for the fourth quarter of 2021.

[22] Such changes include the LREM definition LR becoming a Pillar 1 requirement as of June 2021 as well as the temporary exemption of central banks' reserves from the LREM.

originate from changes in RWDs but also changes implied by regulatory circumstances (phasing-in of buffers, changes in the definition of the LREM, etc.).[23]

For analytical purposes, we treat the LR as a binding minimum even before it became applicable in June 2021. Banks were required to report and publicly disclose their LR requirements from as early as 2016. This assumption enables the time series analysis to be extended back to 2016, which allows us to obtain a more complete picture of the interactions between capital buffers, RWDs and the LR. Furthermore, banks may have also started to frontload the capital requirement under the applicable LR requirement in the period under observation, as we observe from our data that the vast majority of banks would also have complied with LR capital requirements before the LR became binding in 2021.

## 3.2   Development of buffer usability over time

Buffer usability has evolved considerably over time. This is observable from panel b) of Chart 2, which shows the evolution of average CBR usability.[24] Initially, CBR usability decreased from around 53% in the third quarter of 2016 to its lowest value of 49% in the second quarter of 2017. The trend then reversed, and buffer usability started to steadily increase. This trend was temporarily disrupted in mid-2018 and early 2019, but generally buffer usability continuously increased until the end of 2019, when it reached its highest observed value of 72%. Coinciding with the outbreak of the COVID-19 pandemic in Europe, buffer usability fell sharply to 56.8% in the second quarter of 2020, only to rise again to 70% by the end of the year. After this rebound, buffer usability again declined sharply and afterwards fluctuated at around 60%, eventually ending up at around 50% towards the end of the sample. These results allow us to draw three important conclusions.

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[23]   This could be achieved, for instance, by means of counterfactual scenarios that assess what buffer usability would have been if current rules were applied to evolving balance sheets.

[24]   Average CBR usability as a percentage is calculated as the weighted mean of CBR usability across all banks at a given point in time, where we use banks' CBRs as weights.

Chart 2

Time dynamics of buffer usability in the euro area over time
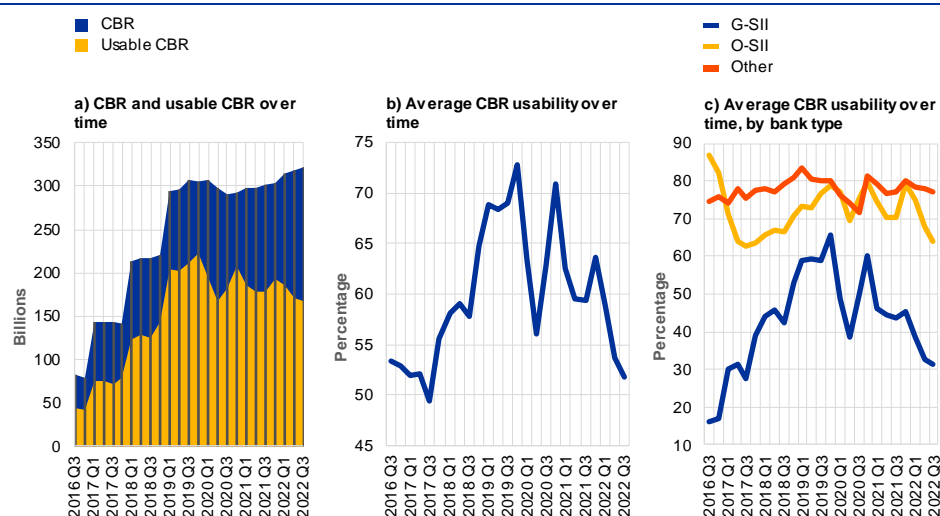
Sources: Supervisory data and USIT.
Notes: CBR (blue bars) and usable CBR (yellow bars) in panel a) are displayed in nominal terms (billions). Average CBR usability
panel b) and panel c) is calculated in as the weighted mean of individual banks' buffer usability with respect to the LR, where the size
of the CBR is taken as weights.

First, as identified by previous studies, constraints on the usability of capital buffers due to overlaps with the LR are persistent. Buffer usability was constrained throughout the observed period and appeared to worsen during crisis times, which was likely a side effect of the different public support measures taken (as explained further in Section 3.5). On average across all years, only 61.1% of the CBR was fully usable. Even in the periods with high usability (i.e. at the end 2019, just before the pandemic), around a third of buffers still remained unusable. This insight is further supported by panel a) of Chart 2, which shows that throughout the observed period the total nominal CBR (blue bars) was only usable to a limited extent (yellow bars).

Second, buffer usability is strongly driven by RWD, with limitations being particularly pronounced for G-SIIs and much less prominent for O-SIIs and other banks.[25] Panel c) of Chart 2 shows that G-SIIs exhibit consistently lower average usability compared with O-SIIs and other banks. Averaged over the observed period, CBR usability for G-SIIs was around 46%, while for O-SIIs and other banks it was considerable higher at around 75%. The findings confirm that limited buffer usability tends to be more emphasised for G-SIIs, as also found by the ESRB ATF report (ESRB, 2021b). One important reason for this is that larger and more complex banks – and especially G-SIIs – tend to rely more strongly on modelling approaches to calculate their capital requirements, whereas smaller and

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[25] In the EU, G-SIIs are also O-SIIs. However, to uniquely allocate banks in this analysis, O-SIIs are defined as O-SIIs other than G-SIIs. For each quarter, we classified banks as "O-SIIs" if they report only O-SII buffers, as "G-SIIs" if they report G-SII and O-SII buffers, and as "Other" in all other cases.

less complex banks mainly rely on standardised approaches.[26] Modelling approaches tend to produce lower risk weights than standardised approaches. Therefore, the average RWD for G-SIIs is lower (32%) than for O-SIIs (39%) and other banks (48%), implying that – ceteris paribus – G-SIIs tend to be more constrained by the LR, followed by O-SIIs and other banks (see also ESRB, 2021b) and thus have lower CBR usability. However, other aspects such as differences in banks' portfolios and business models may also play a role.

Third, buffer usability is particularly volatile for G-SIIs. While the trajectories of buffer usability share some common traits across bank groups, buffer usability is more volatile for G-SIIs compared with O-SIIs and other banks. For the latter, buffer usability was relatively stable in the period observed, with the exception of a temporary reduction at the onset of the COVID-19 period. Interestingly, while buffer usability generally decreased for G-SIIs during the pandemic, such a pattern was not observed for O-SIIs and other banks. For O-SIIs, the COVID-19 period seemed to slow the pre-pandemic increase in buffer usability (after an initial drop) and also induced slight volatility.

Overall, our findings indicate that the pattern in aggregate usability is strongly driven by the pattern observed for G-SIIs, given their large market share in the euro area banking sector. Since G-SIIs generally have lower average risk weights, the LR functions in many cases as an effective backstop for these institutions. These findings also suggest that authorities should monitor RWD when assessing buffer usability in the context of the functioning and effectiveness of the capital buffer framework.

3.3 Underlying factors of buffer usability – empirical correlation analysis

Before discussing what is behind the observed time dynamics of buffer usability, we assess which of the determining factors of buffer usability appear to be the most influential empirically. As noted in Section 2, RWD, regulatory requirements and capital composition are the key drivers of buffer usability (see also ESRB, 2021b). However, a general empirical indication of which of these factors is most important would help better understand the observed time dynamics in buffer usability.

A simple panel regression approach is conducted to identify the key driving forces of buffer usability. To do so, we calculate how a standard deviation in the changes of RWD, AT1 capital and Tier 2 capital is associated with changes in buffer usability. This is achieved by running a simple set of panel regressions using the

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[26]   The largest part of the TREA comes from the exposure to credit risk. Since Basel II, banks are allowed to determine their asset risk weights for credit risk using two approaches. First, there is the internal ratings-based (IRB) approach, which allows banks to use internal models that rely on historical data to estimate the probability of default (and possibly also loss-given-default) for a given exposure, which feeds into a formula to derive the final risk weight. Second, there is the standardised approach (SA), which directly attributes specific risk weights set out in the regulation for a given asset class, sometimes based on external credit ratings.

complete balanced sample, where we regress the first differences in buffer usability against the first differences in RWD, AT1 capital and Tier 2 capital. It should be noted that this analysis is not conducted to explain the time dynamics in buffer usability observed in Section 3.2, but to establish a general empirical indication on the relevance of the respective determinants of buffer usability. The regression table of this analysis is presented in Annex 2.

It should be noted that this approach has limitations, as the relationship between RWD, capital composition and buffer usability is not linear. Given that the used regression models impose a linear structure on otherwise very complex, non-linear relationships (see Annex 1), we are not able to accurately model the underlying dynamics. Therefore, we interpret the regression coefficients purely as an indication of conditional correlations and refrain from making causal statements in this exercise.[27] Nevertheless, the exercise allows us to compare how changes in the different variables, ceteris paribus, for the average bank are more or less strongly correlated with changes in buffer usability, providing an indication of the relative relevance of the underlying factors.

The results indicate that RWD is the most impactful driver of changes in buffer usability, followed by Tier 2 capital and AT1 capital. On average, a standard deviation in the changes of RWD, AT1 capital and Tier 2 capital was associated with changes of 2.41 percentage points, 0.09 percentage points and -0.78 percentage points in buffer usability respectively.[28] This is in line with expectations and Section 2. RWD chiefly determines the relative bindingness of the LR versus the RW capital framework, which translates into the overlap between the LR minimum requirement and the CBR. Whereas the presence of Tier 2 capital reduces risk-based CET1 minimum requirements and thus buffer usability, AT1 capital increases buffer usability only in a specific situation where it reduces CET1 minimum leverage requirements, but not risk-based CET1. Therefore, it is not surprising that changes in Tier 2 capital are more strongly correlated with changes in buffer usability than AT1 capital.

3.4 A closer look at the role of risk weight density in determining buffer usability

As RWD is the key factor in determining the overlap between LR and RW capital requirements, we will analyse its relationship with buffer usability more carefully. Initial insights can be obtained from Chart 3, which shows a scatter plot of CBR usability on the vertical axis against RWD on the horizontal axis, where each dot represents one bank in one period. Clearly, there is a very strong positive

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[27] Furthermore, given the mentioned limitations of the model, we cannot exclude the fact that the obtained coefficients and the resulting correlations are to some extent biased.

[28] It should be noted that the effects of changes in RWD and the capital composition on buffer usability may in fact also be time-dependent. An analysis of the potential state dependency in this respect is outside the scope of this paper.

relationship between RWD and buffer usability, which again confirms that RWD is a strong determinant of the capital overlap between the RW and LR frameworks.

The relationship between RWD and buffer usability reveals that buffer usability is especially sensitive to changes in RWD for a specific RWD range. A closer look at the graphs reveals that for banks which operate below a certain RWD level, buffer usability is almost always 0, meaning that buffers are completely restricted by the LR minimum requirement. Conversely, for banks above a certain RWD, buffers are fully usable. From looking at the graph, these RWD levels appear to be between 25% and 50% respectively (marked by the red lines in Chart 3). In this range, buffer usability appears to be highly sensitive to changes in RWD for most banks. On average, an increase in RWD of 1 percentage point increases buffer usability by around 4 percentage points.[29] Given the sensitivity of buffer usability in this particular RWD range, we will call this range the "critical RWD range"[30] in the remainder of this paper.[31]

Chart 3

RWD as a crucial determinant of CBR usability
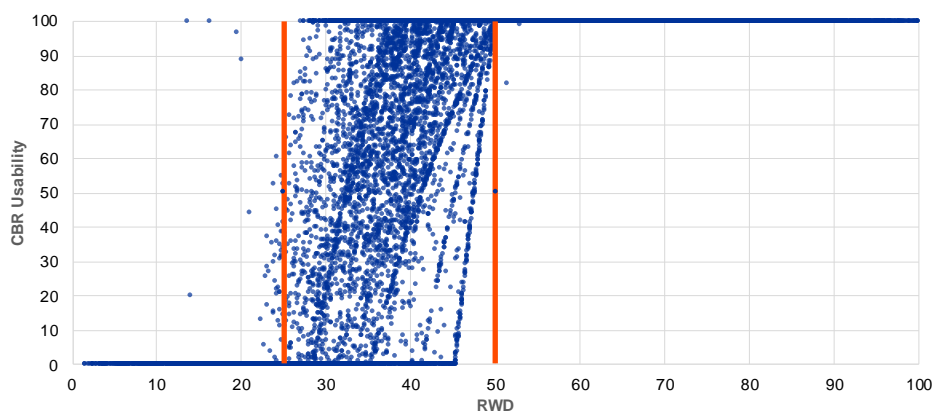
Sources: Supervisory data and USIT.
Notes: Each dot in this chart represents one bank at a given time observation. The figure shows all banks over all periods of the balanced sample, therefore multiple dots correspond to the same bank.

The actual critical RWD range is bank-specific and can be more precisely determined algebraically. To understand what determines the critical RWD range in more detail, we algebraically search for the minimum RWD that ensures that minimum risk-based requirements are equal to the minimum leverage requirement, thereby leading to a zero overlap and full buffer usability. Given that it is ultimately the CET1 amount used to comply with the different requirements that matters for buffer usability, one also has to account for available AT1 and Tier 2 capital (see

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[29] The slope coefficient of a regression line fitting the observations that lie in this range would be 4.32.

[30] The applied term "critical" is purely technical and does not imply any value judgement.

[31] The "critical RWD range" should not be confused with a related concept defined by the ESRB (2015) in its handbook on operationalising macroprudential policy in the banking sector (Annex 1 of critical average risk weight, CARW) and later also used by Pfeifer et al. (2016) and Pfeifer (2020), which refers to the point at which both frameworks (LR and RW, including buffers) are equally constraining for a given bank, implying zero buffer usability for banks without any leverage buffer.

also Section 2), which complicates the analysis and the resulting critical RWD formula (for a detailed derivation, we refer to Annex 3).[32]

$$RWD_C = \frac{\max\left(0, LR_{\%LREM} + P2RL_{\%LREM} - AT1_{\%TREA} \cdot RWD_C\right)}{\max\left(0, P1_{\%TREA} + P2R_{\%TREA} - \min\left(AT1_{\%TREA}, \; 3.5 + \frac{7}{16}P2R_{\%TREA} - \min\left(T2_{\%TREA}, \; 2 + \frac{1}{4}P2R_{\%TREA}\right)\right)\right) - \min\left(T2_{\%TREA}, \; 2 + \frac{1}{4}P2R_{\%TREA}\right)} \tag{1}$$

A numerical evaluation exercise of the critical RWD formula reveals that it will lie between 27% and 44% for most banks, with an upper bound of 50%. A first look at the critical RWD formula shows that the range is determined by Pillar 1 and Pillar 2 regulatory requirements (P1 and P2R) under the RW and LR frameworks as well as AT1 and Tier 2 capital composition. We evaluate this critical RWD formula with different combinations of P2R, AT1 capital and Tier 2 capital, while assuming the P2R for leverage to be zero ($P2RL_\% = 0$ as the case for all banks in our sample). The results reveal the following key points. First, the critical RWD has an upper bound of 50%. This is the case when the risk-based P2R is zero (a hypothetical case)[33] and banks have ample Tier 2 capital. The upper bound of 50% means that banks with an RWD above 50% will never have limited buffer usability.[34] Second, the critical RWD has a theoretical lower bound of 0%. This is the case when banks have sufficient AT1 capital such that no CET1 capital is needed to comply with the LR requirements.[35] The theoretical lower bound of zero implies that for banks with this specific capital composition, buffers will be fully usable, irrespective of their RWD, as in such cases the LR can never create any overlap in CET1 terms, even if this is not realistic in practice. For the most common combinations according to our dataset of P2Rs of 1% to 3% and AT1 and Tier 2 capital ranging from 0% to 3% of the TREA, the critical RWD will lie between 27% and 44%. This is consistent with what we see in Chart 3.[36]

Buffer usability can be expected to be volatile for banks operating in the critical RWD range of 25% to 50%. Any changes to the risk profile of such banks will induce changes to the RWD that are likely to translate into strong fluctuations in buffer usability. Conversely, for banks outside the critical range, buffer usability can be expected to be stable, either at 0% or 100%.

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[32]   The denominator of the formula is complicated by the fact that AT1 and Tier 2 capital can fill only a limited part of the P1 and P2R, and any extra AT1 and Tier 2 capital on top of this would no longer reduce the risk-based CET1 minimum requirement. If we assume banks have no "extra" AT1 and Tier 2 capital, the equation can be simplified to

$$RWD_C = \frac{P1LR_{\%LREM} + P2LR_{\%LREM}}{P1RW_{\%TREA} + P2R_{\%TREA} - T2_{\%TREA}}$$

which shows that AT1 capital affects critical RWD only if banks have some extra AT1 and Tier 2 capital.

[33]   The lowest P2R for banks under the ECB's direct supervision in 2020-23 was 0.75%.

[34]   This statement holds if banks have no P2R for leverage. In Chart 3, there are four observations where a bank has limited buffer usability despite having an RWD above 50%. This is caused by the exemption of central bank exposures and the simultaneous upward recalibration of P1 for leverage, which for this bank led to an increase in nominal leverage requirements and therefore had a similar effect to a positive P2R for leverage.

[35]   In this context, it should be kept in mind that the immediate loss-absorbing capacity of CET1 capital is superior compared with AT1 capital, as also discussed in Section 2.

[36]   Annex 3 provides the derivation and detailed overview of the results obtained from the numerical evaluation exercise of the critical RWD formula (8), which are the basis for the conclusions drawn below.

G-SIIs and O-SIIs in particular tend to operate within this critical RWD range.
Panel a) of Chart 4 illustrates the RWD distribution for G-SIIs, O-SIIs and other
banks. The red horizontal lines again mark the critical RWD range. Especially G-SIIs
operate in the critical RWD range, with almost all G-SII data points being located
within the red lines. On average, O-SIIs also exhibit higher RWDs and higher
dispersion, with more than 50% of O-SII observations[37] being located within the
critical range. The reason for this is that these banks tend to rely on the IRB
approach to calculate risk weights and hence end up with comparably lower risk
weights and lower RWDs. By contrast, the majority of other banks are found to
operate with RWD levels above the critical range of 50%, therefore making them less
prone to changes in buffer usability (as shown in Section 2).

Chart 4

Distribution of banks' RWD
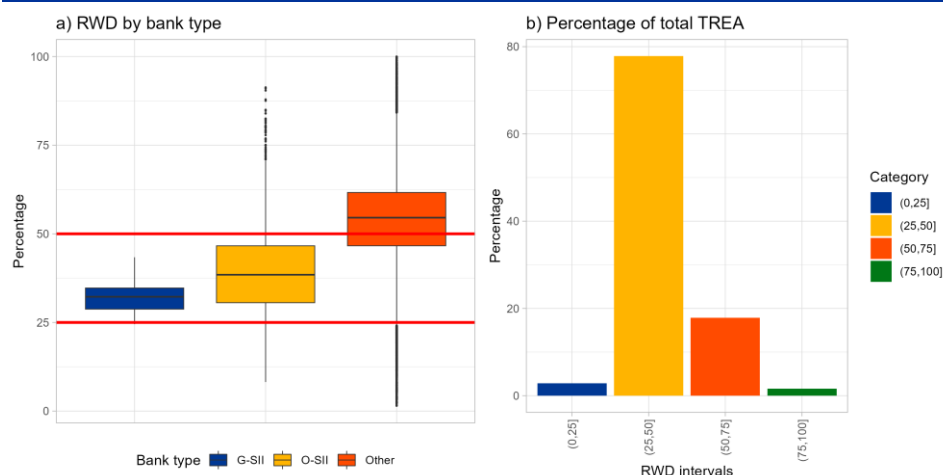
Sources: Supervisory data and USIT.
Notes: The figure shows all banks over all periods of the balanced sample, therefore more observations correspond to the same bank.
The red horizontal lines mark the critical RWD range. The boxplots show the interquartile range by means of horizontal lines (boxes)
(25th to 75th percentile), as well as the first and fourth quartile by means of vertical lines and outlier observations (dots).

**Banks that operate in the critical RWD range, which is subject to limited and
volatile buffer usability, represent almost 80% of the banking system's TREA
in the euro area.**[38] This can be seen from panel b) in Chart 4 and comes as an
implication from the previous observation that the majority of large institutions (G-
SIIs and O-SIIs)[39] are found to operate within the critical RWD range. From a
banking system perspective, the vast majority of exposures are therefore held by
banks that might already have somewhat limited and RWD-sensitive buffer usability.
G-SIIs are subject to the greatest volatility in buffer usability compared with other
types of banks, which is likely to persist in the future.

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[37]   The boxplots are based on pooled data across all observations, highlighting that the majority of banks
operated within the critical RWD range throughout the observed period.

[38]   The general critical range of 25-50% is considered here. It should be noted that the critical RWD range
can also be considered bank-specific, as discussed below.

[39]   On average, G-SIIs and O-SIIs together accounted for around 75% of the euro area banking system's
total assets.

3.5 What drove the observed dynamics in buffer usability?

The development of buffer usability can be categorised into three phases: (i) initial decrease, (ii) steady increase until the outbreak of the pandemic, and (iii) crisis and post-crisis volatility. To describe what drives the observed time dynamics of buffer usability, we plot the time series of average buffer usability (Chart 5, bottom right) alongside the time series of the key determinants. The three above-mentioned phases are marked by vertical dotted lines.

Chart 5

Evolution of buffer usability and underlying key determinants
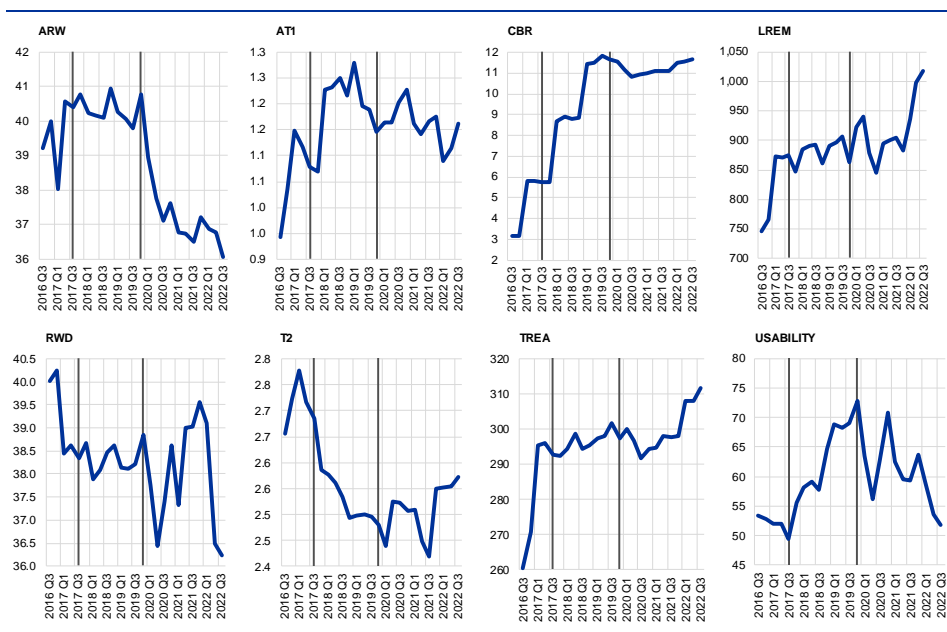
Sources: Supervisory data and USIT.
Notes: ARW = approximation of an average risk weight, calculated as TREA/total assets, expressed in percentage of TREA. Whereas RWD is calculated as TREA/LREM. AT1 and Tier 2 capital are expressed as a percentage of the TREA. CBR, LREM and TREA are expressed in billions. USABILITY stands for average buffer usability and is expressed in percentages.

In the initial phase from the third quarter of 2016 to the second quarter of 2017, buffer usability decreased from 52% to 46%, mainly driven by a sharp decline in RWD and an increase in Tier 2 capital. Both of these developments work to decrease buffer usability and seem to outweigh the simultaneously noticeable increase in AT1 capital ratio and the first observed phasing-in of buffers (i.e. the first stage of increases in the CBR), both of which would have a positive effect on buffer usability. This also confirms that changes in Tier 2 capital ratio are more strongly associated with changes in buffer usability as compared with changes in AT1 capital ratio, as was found in the empirical correlation analysis. The decrease in RWD was caused by the leverage exposure measure increasing more strongly than risk-weighted assets, implying that banks expanded their balance sheets and focused mostly on lower risk-weighted assets.

Increasing buffer usability in the second phase appears to be mainly driven by the phasing-in of buffer requirements, which increased the CBR and is especially relevant for G-SIIs and O-SIIs. In the second phase from early 2017 until the end of 2019, during which buffer usability increased steadily, all relevant

determinants from a capital composition perspective contributed towards more usable capital buffers. The AT1 ratio continued to increase further (but the development starts to reverse early 2019), T2 ratio starts to decrease steadily and the phasing in of buffers continues gradually. This increase in the CBR is mainly a result of the phase in of CCoB and OSII buffers, but also due to the build-up of CCyB in some jurisdictions. At the same time, RWD remained relatively stable between 38% and 39%, with some minor fluctuations.[40] This gradual increase in buffer usability occurred for G-SIIs and O-SIIs, while for other banks buffer usability was rather stable (see Section 3.2). The results show that the phasing-in of buffers closed the gap in buffer usability between O-SIIs and other banks to some extent until the pandemic, while buffer usability remained comparably lower for G-SIIs.

At the onset of the COVID-19 pandemic in Europe in early 2020, buffer usability entered a volatile state. This period started with a sharp decline in buffer usability, which is worth analysing in more detail. First, we can observe that the building-up of buffers stopped, and some buffers were also released or reduced (namely the CCyB, but also O-SII buffers and the SyRB in some countries) in response to the COVID-19 crisis. As a result of the lower CBR, the usability of remaining buffers naturally decreased. Second, Tier 2 capital ratio increased again, which outweighed the simultaneous increase in AT1 capital ratio, ultimately also contributing to the significant drop in buffer usability. Third and most importantly, RWD experienced a very significant drop from the onset of the pandemic. This decline in RWD was caused by a sharp increase in the LREM, coupled with a decrease in the TREA, which came as a reaction of the banking system inter alia to monetary and fiscal support measures implemented during the pandemic period.

The monetary policy stimulus undertaken in response to the market turmoil caused by COVID19 significantly increased banks' leverage. The spread of the pandemic, lockdowns and economic uncertainties put financial markets under severe pressure.[41] Asset prices rapidly decreased, economic uncertainty increased, and investors tried to rebalance their portfolios towards more liquidity in the search for safety. In order to stabilise markets and also to support the economy more generally, the ECB initiated a dedicated asset purchase programme, the pandemic emergency purchase programme (PEPP) (Lane, 2020). The PEPP was initiated in the first quarter of 2020, which led to a sharp increase in the Eurosystem's[42] balance sheet (Chart 6, panel b). Generally, such asset purchase operations inject liquidity in the form of central bank reserves in the banking system. As central bank reserves enter the LREM (in this period),[43] the strong increase in the LREM at the beginning of the

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[40] A closer look at the TREA and LREM reveals that both increased over time at relatively the same pace, so RWDs remained rather stable. The LREM appears to be subject to relatively stronger volatility and therefore affected more strongly the fluctuation in RWDs in this phase.

[41] For example, the ECB's Composite Indicator of Systemic Stress, an aggregate measure for systemic stress which is scaled between 0% (no stress) and 100%, increased sharply from 4% to around 33% from the end of 2019 to early 2020. Such radical increases have before only been measured during the global financial crisis.

[42] The ECB and Eurosystem central banks.

[43] This was the case at the beginning of the PEPP, but Eurosystem central bank reserves were allowed to be deducted from the LREM from September 2020 until March 2022. See also SSM Press Release The removal of the exemption in early 2022 is also reflected by an increase in the LREM and hence RWD towards the end of our sample period, which is accompanied by an observed decrease in average buffer usability.

pandemic from the fourth quarter of 2019 to the first quarter of 2020 can be attributed to exceptional monetary policy stimulus.

Chart 6

Time series of government debt securities held by EU credit institutions; total Eurosystem balance sheet; seasonal pattern in LREM
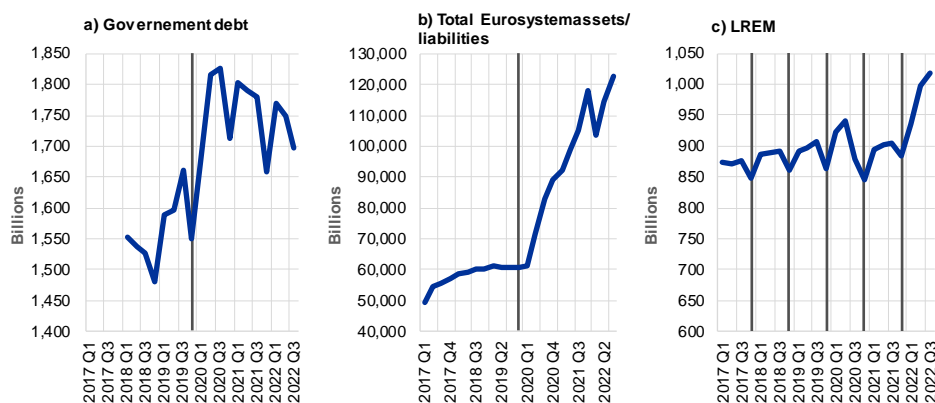
Sources: Government debt holding data from supervisory data FINREP, Eurosystem balance sheet from the ECB's Statistical Data Warehouse and LREM from supervisory data COREP.
Notes: Gov. debt holdings are quarterly, while Eurosystem balance sheet data are monthly. The vertical line in panel b) represents the fourth quarter of 2019. As data on government exposures were not available to all banks in our sample, this graph is based on a subsample, which still accounts for 88% of total assets of the balanced sample used for the main analysis and is only available after the first quarter of 2018. The LREM is aggregated by means of a weighted average and presented in billions; the vertical lines in panel c) indicate fourth-quarter periods.

Fiscal support measures also contributed to the observed dynamics by reducing the average risk weights. In addition to the monetary stimulus, governments across Europe intervened strongly in order to help the economy tackle the COVID-19 shock by means of various fiscal support measures. These included public loan guarantees and moratoria, tax reliefs and deferrals as well as various forms of grants and transfers, mainly targeting corporates and households directly.[44] Such fiscal support measures can create a downward push on the TREA through two main mechanisms: portfolio rebalancing and public guarantees affecting risk weights. First, in order to finance these fiscal support programmes, sovereigns needed to issue public debt on a large scale. Banks played a major role in buying these issued government bonds, which is reflected in a significant increase in sovereign exposures on European banks' balance sheets compared with the pre-pandemic period. This can be seen in panel a) of Chart 6, which shows the stock of debt issued by European sovereigns and held by banks in our sample. Given that the accounting treatment of sovereign exposures with respect to the calculation of capital requirements assigns these assets very low or even zero risk weights, the average risk weights decreased. Second, many of the fiscal support measures came in the form of public loan guarantees. In principle, for any bank loan subject to such a programme, the risk of the debtor's default (credit risk) is transferred from the bank to the sovereign backing the respective guaranteed programme. This risk mitigation is recognised by deducting a part of the guaranteed exposure when calculating the risk exposure amount, which lowers the TREA. Furthermore, the risk weight of publicly guaranteed loans can to some extent be substituted by the risk weight of the

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44 For more details, see Budnik et al. (2021) and ESRB (2021a).

sovereign guarantor, which leads to very low or zero risk weights for these exposures. In both cases, the risk exposure amount of the guaranteed loans is reduced, implying a reduction in the TREA. In fact, most of the public loan guarantee programmes in the euro area were initiated in the first quarter of 2020,[45] which coincides with the observable decline in the TREA in Chart 5. In summary, the combination of monetary policy stimulus, which significantly increased banks' LREM, and fiscal support measures, which pushed down the TREA, appeared to contribute to the sharp decrease in buffer usability at the beginning of the COVID-19 pandemic.

"Window dressing" behaviour may also help explain the observed changes in buffer usability. After this initial "crisis" drop in buffer usability, the trend is reversed, and buffer usability rebounds for a short period, only to fall sharply again in the next quarter. The rebound occurs in the fourth quarter of 2020 and is clearly driven by a significant decline in the LREM, while the TREA continues to further decrease. A more detailed look at the time series in the LREM reveals a seasonal pattern of decreasing LREM values at year-end quarters, which could indicate that this rebound in the fourth quarter of 2020 is just one instance of a regularly occurring decrease in the LREM at year end quarters, only more pronounced (Chart 6). This seasonal phenomenon may be attributable to "window dressing", where banks systematically and temporarily scale down parts of their business operations at period-end dates in order to engineer more favourable reporting metrics, which can ultimately be beneficial in terms of regulatory capital requirements (see Allen and Saunders, 1992, Behn et al., 2018 and Bassi et al., 2023). The LREM may be more prone to window dressing than the TREA, because liquid securities holding and short-term interbank and wholesale exposures command relatively low risk weights.[46] This window dressing effect could explain the repeated increases in buffer usability at year-ends and their subsequent reductions immediately afterwards.[47]

Throughout the crisis, buffer usability remained volatile and tended to decline as the LREM further increased and average risk weights decreased, but the temporary exemption of central bank reserves from the LREM had a positive impact on buffer usability. Buffer usability remained relatively volatile and at lower levels than before the pandemic. During this phase, the AT1 capital ratio generally decreasing, weighing negatively on the development of buffer usability. The CBR was relatively stable, but the Tier 2 capital ratio started to become somewhat volatile. The main underlying reason for this development was again fluctuating RWD values. These appear to have been driven both by LREM volatility and slowly increasing TREA values. The LREM increases again in the first quarter of 2021, as the window dressing effect that pushed it down in the fourth quarter of 2020 disappears and buffer usability decreases again. One would expect the LREM to end up at a higher level, given that the PEPP continued to steadily increase excess liquidity in the banking system (Chart 6). However, in the first quarter of 2021 another support measure was introduced, which allowed banks to exempt euro central bank reserves

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[45] For more information, see Falagiarda et al. (2020).

[46] Banks can engineer a temporarily lower LREM by means of targeted repo operations, for instance.

[47] To support this analysis, we ran an adapted version of the regression set-up presented in Section 3.3 that accounts for fourth-quarter periods by means of dummy variables and that weights the observation by the TREA amount. The sign of these dummy variables is estimated to be positive and significant, supporting the window dressing hypothesis. Details are available from the authors upon request.

from the LREM in order to facilitate monetary policy transmission. These exemptions not only facilitated monetary transmission, but also increased the usability of capital buffers during the pandemic to some extent.[48] From the fourth quarter of 2020, the TREA steadily increases, but since the average risk weight does not notably increase, this appears to be mainly driven by growing banks' balance sheets. Underlying factors for this development should be inter alia the drawing of credit lines by non-financial corporations (NFCs). These credit lines were activated by NFCs due to increased liquidity needs as a result of the pandemic turmoil, which mechanically affects banks' balance sheets.[49] Ultimately, at the end of our sample in the third quarter of 2022, buffer usability was at lower levels than before the pandemic and slightly above the levels at the beginning of 2016.

3.6 Exploring heterogeneity in euro area countries

This section further investigates the time dynamics of buffer usability at country level. Since macroprudential policy in the EU is primarily conducted at national level,[50] it is important to also investigate how usable capital buffers were over time at country level. The ESRB (2021b) has shown that there is heterogeneity in the level of buffer usability across different regions. This section will look into this further by also analysing whether the development of buffer usability is different across countries. Heterogeneity might be expected due to differences in the respective banking systems, such as the share of significant institutions, differences in bank portfolios and past crisis experience entering risk weight calculations.

There is heterogeneity in the overall level and time paths of buffer usability across euro area countries. This becomes immediately visible from Chart 7, which plots the time series of average buffer usability for different countries in our sample.[51] First, we have countries where buffer usability started at a low level and increased over time. These are BE, DE, FR, LU and NL. The second group of countries, namely GR, LV, AT, SI and FI, comprises those where buffer usability remained high and relatively stable over time. Finally, there are countries where buffer usability was high but decreased over time, namely EE, IE, ES,[52] IT and MT.

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[48] Without the exemption measure applied, buffer usability would have fallen to around 50% and remained at this level until the end of the observed period. On average, buffer usability would have been around 5 to 7 percentage points lower depending on the respective period.

[49] Drawing a credit line transfers off-balance-sheet exposures directly to the balance sheet of a bank, increasing its TREA. The activation of credit lines started at the beginning of the pandemic but only appears to have increased the aggregated TREA once the impact of portfolio rebalancing towards government debt and reduced risk exposures as a consequence of government guarantees faded out. More information can also be found here (ECB Financial Stability Review May 2020).

[50] Macroprudential policy is a shared competence between national authorities and the ECB in the banking union. The SSM Regulation provides the ECB with powers to apply higher buffer requirements and more stringent measures, subject to close coordination with national authorities.

[51] We only show this time series plot for countries where we have a certain number of banks in our dataset.

[52] Our results for ES banks are broadly in line with Fernández Lafuerza et al. (2022), who find high levels of buffer usability for Spanish banks in early 2019 that then decrease at the onset of the pandemic.

Chart 7

Time series of average buffer usability for euro area countries
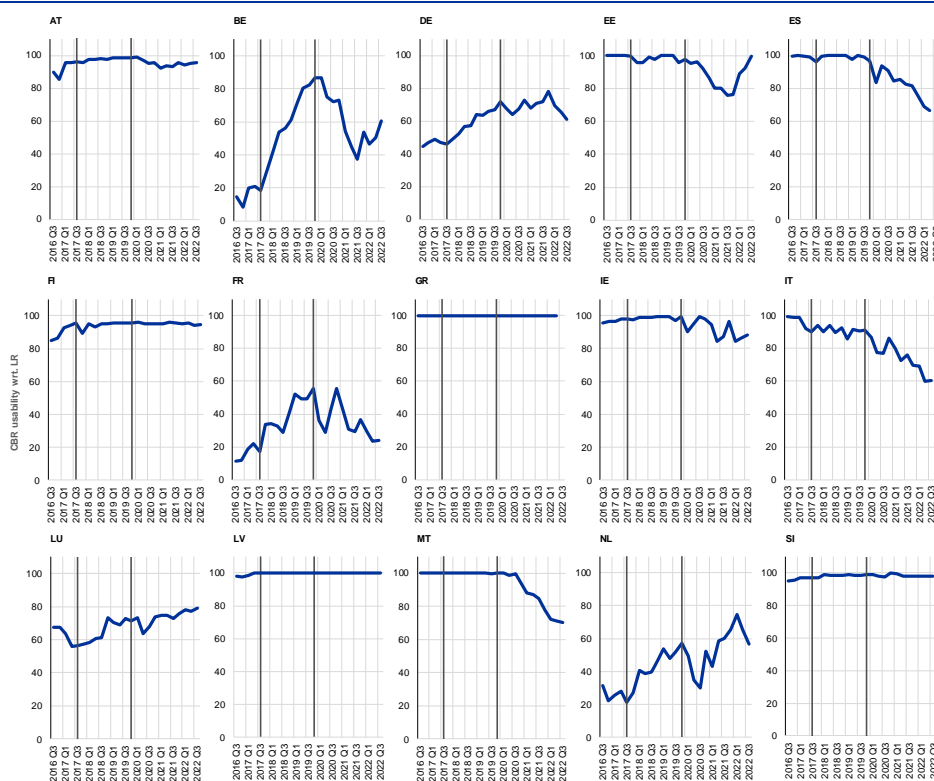
The first group of countries with low but increasing buffer usability comprises western European countries, often G-SII host jurisdictions. A relatively steady upward trend in buffer usability is especially visible for DE, while the remaining countries experience some fluctuation but all eventually end up at higher values of buffer usability in 2022 than in 2016. The lowest levels of buffer usability for this group are found in FR and NL. With the exception of BE and LU, these countries all host EU G-SIIs, which as we have seen tend to display the lowest values of buffer usability compared with other types of banks. Compared with all euro area countries, this group consistently faces the lowest values of buffer usability over the whole observed period.

The RWDs of banks in this group tend to lie within the critical range of 25-50%, and while buffer usability generally increased, COVID-19 stopped a further increase in buffer usability for some of them. Being in the critical RWD range, buffer usability in these countries is very sensitive to changes in RWD. Their RWDs tended to increase over the observed timeframe, improving buffer usability over time. Increasing RWD trends are especially pronounced for DE and NL. For DE, the increase in RWD seems to be driven by an overall decrease in the LREM. For NL, the LREM significantly decreased and the TREA increased, especially towards the end of the observed period. Furthermore, the beginning of the COVID-19 crisis halted the increase in buffer usability for BE, NL and FR. In fact, usability

subsequently started to fall relatively strongly for BE and NL and became volatile with a decreasing trend for FR. For BE and FR, usability eventually ended at lower levels compared with pre-pandemic times, albeit higher than in 2016. In DE, NL and LU, COVID-19 led to a temporary decrease in buffer usability but did not break the overall increasing trend.[53]

Within this group, the decline in usability due to COVID-19 was especially pronounced for BE, FR and NL, which are, with the exception of BE, G-SII home jurisdictions. Given that these countries were less affected by the global financial crisis and the euro area sovereign debt crisis, the risk weights estimated by internal models are comparably lower than for G-SIIs operating in countries that where significantly affected by these crisis periods (IT and ES).[54] Therefore, banks in these countries had the lowest risk weights in the sample (36.6% on average) and were in the critical RWD range, which made their buffer usability sensitive to changes in RWD. In these countries, capital composition also played a favourable role in the development of buffer usability, with Tier 2 capital tending to decrease and no clear pattern emerging in the development of AT1 capital.

The second group of countries had high and relatively stable buffer usability, thanks to their banks having RWDs typically above the critical range. For AT and SI, we see that average buffer usability was above 90% with some slight fluctuations. For the remaining countries, we even see steady levels at or close to 100% buffer usability over the entire period under investigation. This pattern stems from the fact that the vast majority of banks have average RWD values that lie above the critical range. Therefore, for these countries the RW framework is generally more binding than the LR framework, and hence limited buffer usability due to the LR is less of an issue. One reason for this is that the average risk weights attached to the portfolios of these banks are comparably high. First, these countries do not host any G-SIIs and their banks are rather small and less complex, which implies that they rely relatively less on IRB approaches to calculate risk weights, resulting in overall higher risk weights around and above 60%. In addition, the banking sectors of GR, LV and SI were heavily hit by previous crises, which increased the risk weights of those banks using IRB models.[55]

Since RWD values are decreasing in all of these countries, their buffer usability could become more limited if the trend continues. The RWD trend in this group is generally downward, especially since the beginning of the COVID-19 period. In the latter case, this can be attributed to the effects of public support measures. Decreasing RWD values are especially prominent in GR, where RWD decreased from over 70% in 2018 to 55% in early 2022, but also in FI and LV. For AT and SI, this trend eventually reversed, and RWD increased in 2022. Furthermore, AT experienced fluctuating RWD values slightly below 50%. RWD would therefore be in the critical range, but the favourable development in capital composition seems

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[53] Data on the respective determinants of buffer usability at the country level used for the descriptive analysis in this chapter are available from the authors upon request.

[54] Based on a limited sample for which data on internal PDs was available, we observed that the average PD in BE, FR and NL was less than half of the average PD in ES and IT.

[55] Furthermore, for those banks relying on the IRB approach, PDs are on average higher compared with PDs found in the third group, demonstrating lower buffer usability.

to have been able to keep buffer usability at a high level. The decreasing trend in RWD for these countries can be attributed to greater increases in the LREM compared with the TREA, especially for AT, FI, GR and LV. Furthermore, GR and LV simultaneously experienced decreasing TREA values. If the downward RWD trend continues, most of the countries mentioned will enter the critical range relatively soon. Should this occur, they may end up in the third group with high but decreasing buffer usability, unless the implementation of new regulatory measures (such as the risk weight floors introduced by Basel III) and changes in capital composition offset the effect of decreasing RWD.

Finally, the third group of countries exhibited initially high buffer usability, which then started to decrease. At the beginning of our sample in 2016, these countries exhibited similarly high levels of buffer usability to those seen for the second group. However, at a certain point in time, each of them faced a gradual decline in buffer usability. For IT, this decline started around 2016 and 2017, whereas for the remaining countries, it began with the outbreak of the pandemic. For EE the decreasing trend was eventually reversed towards the end of the sample, which is due to the introduction of a CCyB of 1% in 2022.

Each of the countries' average RWD lies at the upper end of the critical RWD range, and these RWDs are decreasing. At the beginning of our sample in 2016, these countries exhibited an average RWD of 47-48%, which then steadily decreases. Their average risk weights are lower than for the second group of countries, but still higher than for the first group. As some of them are G-SII home jurisdictions (IT and ES), we would expect lower risk weights compared with the second group of countries that are not G-SII homes. But given IT and ES were stronger effected by the global financial crisis and the euro area sovereign crisis, their IRB risk weights are considerably higher than for G-SII countries in the first group (DE, NL and FR). As the RWDs of this group moved downwards into the critical RWD range, their buffer usability started to decrease.

The drop in RWDs after the COVID-19 outbreak can be explained by monetary policy accommodation and public support measures, which are also reflected in gradually decreasing probability of default (PD) values in the case of IRB banks in this group. Overall, the drop in RWDs can be explained by increasing LREM values, with the strongest increases again occurring at the onset of the pandemic as a result of the monetary policy stimulus, the roll-out of fiscal support packages and decreasing average risk weight values (see also Section 3.5). The latter may be explained by the fact that IRB PD estimations are affected by various public support measures given to corporates (such as guarantees and moratoria) and that PDs tend to decrease as historical crisis observations in the internal IRB calculations start to be too far in the past to weigh on their internal risk weight estimates any longer. This may be especially relevant for ES and IT but also for IE, where PDs are also comparably high.

In summary, buffer usability increased in G-SII home countries that were less affected by previous crises, remained relatively stable for smaller countries with no G-SIIs and tended to decrease in countries more significantly affected by previous crises where large and complex banks are present. The reason for

this is that large and complex banks, and in particular G-SIIs, tend to use the IRB approach to calculate risk weights, resulting in lower risk weights on average, which are also affected by past crisis experience. For countries affected by past crises, risk weights tend to decrease over time, which indicates that their buffer usability levels are expected to fall when crisis observations become more distant. The COVID-19 shock generally weighs negatively on buffer usability, but the outcome is less severe for countries with high and stable buffer usability.

4 Extensions

In this section, we analyse certain aspects relevant for policymakers. First, leveraging on the functionalities of USIT, we perform counterfactual analysis to assess the impact of different hypothetical policy measures on the evolution of buffer usability. Second, we provide an estimate of how the implementation of Basel III reforms could affect buffer usability.

4.1 Exploring counterfactual outcomes

Building on the work of the ESRB (2021b), we analyse the effect of selected measures on buffer usability. The ESRB (2021b) discussed and analysed different options that would increase CBR usability. Our analysis extends this work by assessing, in a descriptive manner, how some of these options would have changed the observed trajectory of buffer usability by means of counterfactual analysis. We will focus on the options of increasing the size of the CBR (implemented here by means of a hypothetical positive neutral CCyB rate) and introducing buffers in the LR framework, as these options were discussed in the context of the recent macroprudential review.[56] The results of these counterfactual analyses are presented in Chart 8 below. In addition, we also analyse the impact of the implementation of the Basel III capital framework on buffer usability.

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[56] Generally, options that could increase buffer usability need to either increase the nominal size of the CBR or change the overlap between the RW framework and parallel requirements. Therefore, some options that are being discussed to support buffer usability from the willingness to use perspective, such as making the CCoB releasable, would not increase buffer usability due to overlapping requirements, as this would not imply any changes to the relative bindingness of the frameworks. Therefore, this option is not relevant for this setting and is not analysed in this paper. It is also useful to note that removing the possibility of double-counting of capital across frameworks is less interesting for a counterfactual analysis, as such a measure would restore buffer usability to 100% in all periods by design.

Chart 8

Development of buffer usability under different counterfactual scenarios
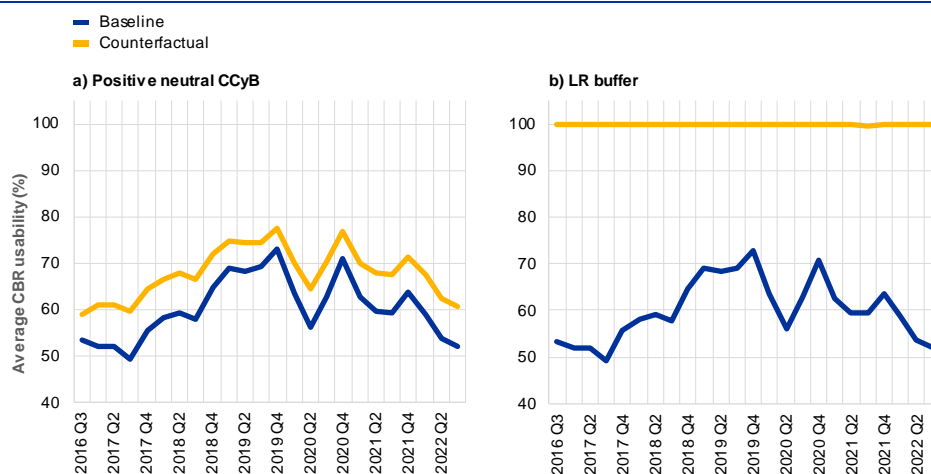
- ■— Baseline
- ■— Counterfactual

a) Positive neutral CCyB

b) LR buffer

Sources: Supervisory data and USIT.
Notes: Baselines represent the actual usability as presented in the previous section, which is identical in both panels. CBR usability is calculated as the weighted mean of individual banks' buffer usability with respect to the LR, where the size of the CBR is taken as weights. The blue lines show the baseline outcomes, and the yellow lines show buffer usability under different counterfactual scenarios. In the counterfactual scenario of panel b), usability is defined as any usable buffer capital (CBR or LRB) as a percentage of the CBR (see also Box 2 below).

A positive neutral CCyB would have increased buffer usability throughout the observed period. In this counterfactual analysis we assume that all banks in our sample would hold a minimum CCyB level of at least 1% throughout the observed period, corresponding to the concept of a positive neutral[57] CCyB. This measure would increase macroprudential space in the sense of increasing the amount of releasable capital buffers, thus enhancing macroprudential authorities' ability to address large and disruptive systemic shocks that may go beyond the unwinding of domestic imbalances and that may hit (large parts of) the banking union simultaneously.[58] Having more CCyB capital means a larger CBR,[59] which increases its usability (see also Section 1). Therefore, it is not surprising that buffer usability would be higher with a positive neutral CCyB in place compared with the baseline outcome. However, the overall time pattern in buffer usability remains broadly unchanged. On average over all years, the increase in buffer usability due to a 1% positive neutral CCyB would be around 7.5 percentage points.

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[57] With the exception of SK, all euro area countries in our sample had a CCyB not higher than 1% in place throughout the observed period. For simplicity, the 1% CCyB is assumed to apply to all exposures (not only to domestic or euro area exposures) and remain in place also during the pandemic times, although it would have likely been released at that time.

[58] See the ECB response to the European Commissions' call for advice on the review of the EU macroprudential framework, part 2.1.

[59] It should be noted that from a capital overlap perspective on buffer usability, any increase in the CBR will increase CBR usability. Therefore, an equally large increase in the CCoB, for example, would lead to similar outcomes. The focus on a positive neutral CCyB is chosen here as several euro area and non-euro area jurisdictions (CZ, CY, EE, IE, LT, NL, SE) maintain positive CCyB rates of 0.5-2% even when cyclical systemic risk is not clearly elevated. Furthermore, the positive neutral CCyB was one option considered in recent policy discussions to support buffer usability from the perspective of banks not being willing to use buffers, as having more releasable capital buffers would strengthen buffer usability from that angle. The advantages of such a policy were recognized by the BCBS communication from October 2022, and it was also suggested by the ECB as one of the potential options to increase the share of releasable buffers, thereby enhancing the countercyclical properties of the macroprudential framework (see ECB, 2022a, and ECB, 2022b).

Mirroring the entire CBR in the LR framework would have the potential to substantially improve buffer usability. The reason for limited buffer usability is that the entire set of buffers is included only in the risk-based framework. If the same buffers were mirrored in the leverage framework and put also on top of the LR minimum requirement, these potential impediments would disappear. Such an addition would, however, lead to increased capital requirements for banks constrained by the LR. See also Box 2 for a discussion on how the willingness of banks to dip into buffers affects the desirability of mirroring only certain kinds of buffers in the leverage framework.

For example, using a 50% conversion factor to mirror the entire CBR in the leverage framework would achieve full buffer usability. In Chart 8, panel b), we show the increase in buffer usability if the entire CBR had been mirrored into the leverage framework in the same way as the G-SII LR buffer, i.e. with a conversion factor of 50%, since 2016. The results show that such a leverage ratio buffer (LRB) would completely resolve buffer usability constraints implied by the LR minimum requirement.[60] A conversion factor of 50% results in a sizeable LRB in nominal terms and would in many instances be larger than the CBR under the RW framework. Therefore, such increases in buffer usability would be achieved by increases in overall capital requirements and would also redefine the LR from a backstop (binding only for a limited number of banks) to becoming the primary constraint for a larger number of banks.[61]

The effect of an LRB on buffer usability depends on the relationship between the applied conversion rate to the average RWD and the size of the CBR. The size of the LRB is mechanically determined by the chosen conversion rate as well as by the size of the CBR. Furthermore, from a conceptual point of view, the impact of an LRB on buffer usability depends on whether the LR framework, including buffers, will be more constraining than the RW framework. This relationship is primarily determined by the RWD. Taking these aspects together, there is a certain conversion rate for a given RWD and CBR for which the LRB will be higher than the CBR and increase buffer usability.[62] If the conversion rate is above the average RWD, the LRB will be more likely to increase buffer usability but also raise capital requirements. Chart 9 below differentiates the LRB impact for the different conversion rates shown in each panel. The average RWD across our sample lies at 38%. With a conversion rate of 30%, buffer usability would increase to 96%, and with

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[60] When solely considering the overlap between the LR and RW frameworks, it seems natural that adding a sizeable buffer on top of the LR capital stack can increase buffer usability considerably. The ESRB (2021b) also performed an analysis of the buffer effects of an LRB, but also taking into account capital overlaps with MREL requirements. In this case, while still strongly improving the total usability of buffers (for the ESRB sample on average from 29% to 77% on average for the ESRB sample), buffer usability is not fully restored, as parallel constraints from the MREL framework still affect buffer usability.

[61] The increase in capital requirements under this scenario depends on the given year and can go up to 1.1% of TREA.

[62] More precisely, for buffer usability effects the CET1 amount under the LR and RW frameworks is important. Therefore, the critical RWD range as depicted before is the relevant quantity to consider. An analytical solution for the minimum conversion rate at which a bank would benefit in terms of buffer usability if a LRB is introduced is possible, but is again complicated by the fact that one needs to account for AT1 and Tier 2 capital to end up at the CET1 amounts under the LR and RW frameworks.

a 40% conversion rate buffer usability would be almost 100%.[63] Furthermore, it is worth noting that the LRB will reduce volatility in buffer usability at lower conversion rates. This shows that significant benefits to buffer usability would accrue even at conversion factors lower than 50%, which would in turn limit the capital impact.

Chart 9
Development of buffer usability if LRBs are introduced for different conversion rates
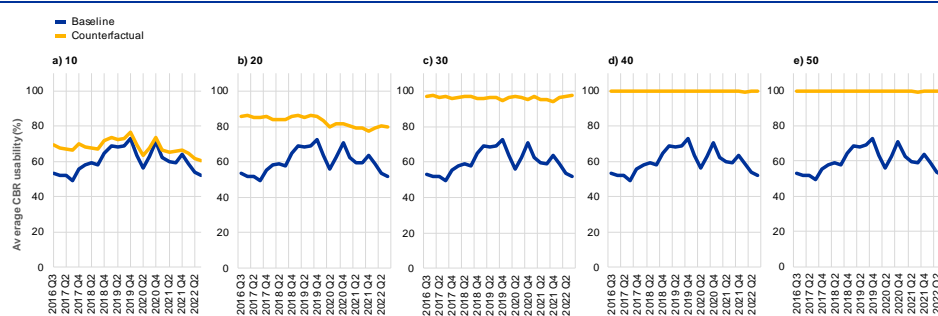
Sources: Supervisory data and USIT.
Notes: Baselines represent the actual usability as presented in the previous section, which is identical in all panels. CBR usability is calculated as the weighted mean of individual banks' buffer usability with respect to the LR, where the size of the CBR is taken as weights. The blue lines show the baseline outcomes, and the yellow lines show the total usability of buffers if the CBR is mirrored in the LR framework at different conversion rates specified in each panel.

For a thorough policy discussion of options to increase buffer usability we refer to the ECB's reply to the macroprudential review. The analysis of options to increase buffer usability in this paper remains of a descriptive nature, with the main goal to contribute to and substantiate the quantitative analysis of the ESRB (2021b). It therefore refrains from providing an in-depth policy discussion or voicing preferences. Such a discussion, also comprehensively taking into account the perspective of limited buffer usability due to banks' unwillingness to use buffers, including an analytical cost-benefit analysis, can be found in the ECB's or the ESRB's reply to the EU Commission's call for advice on the EU's comprehensive macroprudential review (see ECB, 2022a, ECB, 2022b, and ESRB 2022).

Box 2
Mechanics of leverage ratio buffers affecting buffer usability and effective releasability

This box explains how the introduction of leverage ratio buffers (LRBs) might affect buffer usability and the effective releasability of risk-based buffers, depending on whether banks are willing to dip into their buffers.

Scenario 1: Banks are willing to use buffers

Any unconstrained Common Equity Tier 1 (CET1) part of LRBs that exceeds the risk-weighted (RW) combined buffer requirement (CBR) can compensate for limited CBR usability resulting from the overlap with leverage ratio (LR) minimum requirement (represented by the blue on yellow shaded part in the RW stack) and increase total usable buffer capital. This concept was defined in the report of the Analytical Task Force (ATF) of the European Systemic Risk Board (ESRB) as the "total

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[63] The weighted average buffer usability across years for each conversion rate is: 68% with a conversion rate (CR) of 10, 82.50% with a CR of 20, 96.29% with a CR of 30, 99.91 with a CR of 40 and 99.99% with a CR of 50.

usability of buffers". Under the assumption that banks are willing to use buffers, the total usability of buffers can only be greater than the CBR usability or equal to it (in the cases where the LRB either is fully constrained by other parallel frameworks or the LRB does not exceed the CBR).

This approach is further illustrated in panel a) of Chart A below by means of a hypothetical bank. For this bank, the LRB would exceed the RW CBR and is fully usable. The LRB that exceeds the CBR is, such as in this case, represents additional usable buffer capital. It is therefore added to the usable CBR, resulting in an improvement in the total usability of buffers, which is highlighted by the yellow on green shaded area in the RW stack of panel a).

While the concept of the total usability of buffers corresponds to the capital amount freely available to absorb losses, it may differ in terms of applicable capital conservation measures.[64] For instance, it may be that a bank needs to fully deplete its LRB in order to make use of capital buffers, while only part of the CBR has been used simultaneously. In this case, all capital conservation measures would be triggered from an LRB perspective.

**Scenario 2: Banks are not willing to use buffers**

Under this assumption, the usability of releasable RW buffers might be reduced to the extent that structural (i.e. non-releasable) LRBs overlap with the RW CBR, depending on the nature of buffers mirrored in the LR. This mechanism is illustrated in more detail in panel b) of Chart A. For this hypothetical bank, the LR minimum requirement would already "block" part of the RW CBR and hence reduce its usability (blue on yellow shaded area in the CBR). If now a structural buffer were mirrored in the LR framework, and under the premise that banks are not willing to use buffers, any structural LR buffer would work as a de facto LR minimum requirement from the bank's point of view. This would ultimately intensify the overlap between the LR framework and the RW CBR (red shaded area in the CBR) and would further reduce the usability of releasable buffers in the CBR. However, if the part of the LRB that mirrors the releasable part of the CBR is releasable itself, LRBs would not constrain releasability but rather increase the releasable buffer space.

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[64] Banks that dip into their buffers are subject to automatic restrictions on distribution that gradually become more severe as banks dip deeper in their buffer range (see Box 1). The buffer range is divided into four buckets. In the upper buckets the restrictions on distributions are partial, while in the lowest bucket banks are not allowed to pay dividends, coupons on AT1 instruments or bonuses at all. Banks may simultaneously breach both risk-based and LR buffers, but their position within the parallel buffer ranges may be different. Therefore, they may be subject to different levels of restrictions on distribution in the RW and LR frameworks.
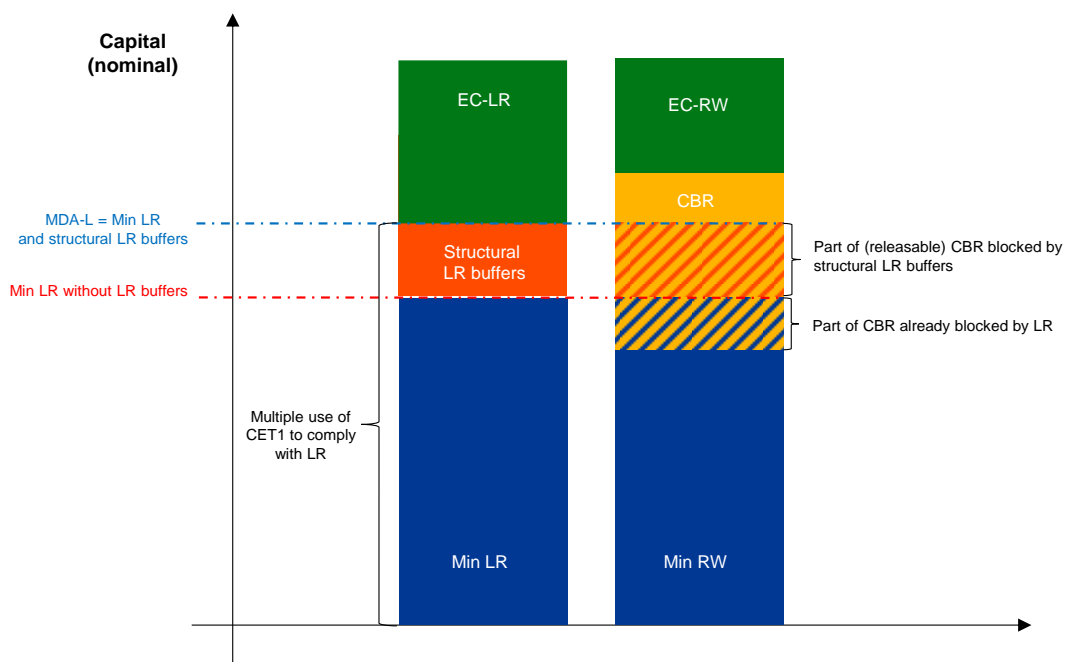
Chart A
Illustration of buffer usability effects due to the leverage ratio buffer

a) Scenario 1
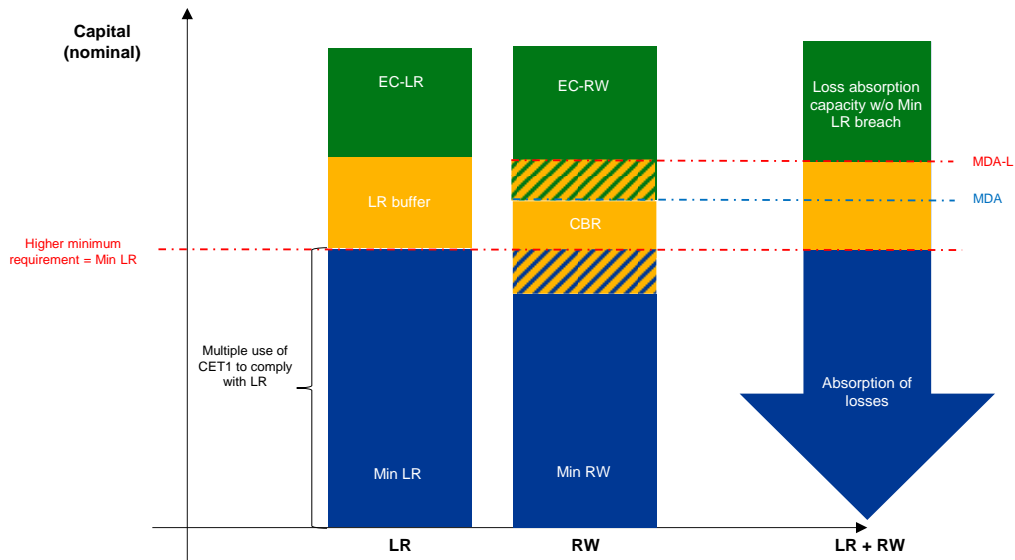
b) Scenario 2

Sources: Panel a): ESRB ATF; panel b): ECB and USIT handbook.
Notes: This chart presents a stylized example bank. The relative sizes of the elements are for illustrative purposes and do not relate to any particular set-up in the EU banking sector. For simplicity, the figures only take into account the RW and LR capital frameworks while abstracting from the minimum requirement for own funds and eligible liabilities and total liabilities and own fund requirements. EC stands for excess capital above the RW and LR requirements respectively (EC-LR and EC-RW).

An important corollary of this exposition is that if banks are unwilling to dip into buffers but only use released buffers, adding only structural buffers to the LR framework could in fact reduce the effective releasability of risk-based buffers. Banks may in practice not be willing to use buffers because they want to avoid market stigma effects or automatic restrictions on distribution that are associated with breaching the maximum distribute amount (MDA).[65] In this situation, adding only non-releasable LRBs may harm the effective releasability of risk-based buffers, because a release of elements of the CBR (in particular, of the countercyclical buffer) may not translate into free capital if structural LRBs remain in place and overlap. For example, mirroring only other systematically important institution (O-SII) buffers in addition to global systemically important institution (G-SII) buffers in the leverage framework would actually worsen the releasability of risk-based buffers if banks were unwilling to dip into them. For this reason, the ECB has advised against mirroring only O-SII leverage buffers (see ECB, 2022b).

4.2 Impact of Basel III reforms on buffer usability

Measures that increase banks' risk weights, such as the output floor or other proposals of Basel III, will also increase buffer usability. Increased risk weights automatically translate into a higher TREA, which makes the risk-based capital framework more binding relative to the LR and hence directly increases buffer usability. A faithful implementation of Basel III reforms, besides strengthening bank resilience and promoting financial stability, can therefore also improve buffer usability. The biggest benefits for buffer usability would be expected for banks having very low risk weights due to the application of internal models, because the output floor[66] may lead to a substantial increase in the TREA of such banks.

A faithful implementation of Basel III may substantially improve buffer usability, especially for G-SIIs. The European Banking Authority's (EBA's) Basel monitoring report estimates that a full implementation of Basel III will lead to an increase in capital requirements of 15%, mainly driven by increases in risk-based requirements due to the output floor, which will make the LR on average less binding (see EBA, 2022, for further details). Based on this, we can expect that Basel III will lead to an increase in buffer usability, in particular for G-SIIs. Indeed, using data from the 2021 Basel monitoring quantitative impact study (QIS),[67] we can provide an

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[65] Breaches of the CBR and leverage buffers are both subject to MDA restrictions, so there is no reason why banks' willingness to dip into the CBR should differ from their willingness to dip into the LRB. Banks' unwillingness to dip into buffers would imply that policymakers can incentivise banks to maintain the provision of their critical services in crises only by releasing some of the buffer requirements. For further details, see ECB (2022b).

[66] The Basel III output floor ensures that the TREA of a bank will never be lower than 72.5% of TREA if the bank used only non-modelling approaches to calculate capital requirements. Given the fact that capital requirements for credit risks are the largest, the output floor will lead to an increased TREA for banks relying particularly heavily on the IRB approach for credit risk. Details can be found in the 2021 EBA Basel III monitoring exercise (EBA, 2022).

[67] These data comprise bank-level information required to estimate the impact of the different Basel III proposals on the TREA and capital requirements and are hence required to assess the impact of Basel III on buffer usability. Given that the sample for which the required data are available is considerably smaller, and also represents only one point in time, compared with the data used in the rest of this paper, the results of the QIS exercise may not be compared with the previous analysis and should solely be seen as an indication of the potential of Basel III to increase buffer usability.

estimate of the impact of the full implementation of Basel III reforms on buffer usability for 50 SSM banks, which is presented in Chart 10.[68] The results suggest that Basel III would increase average buffer usability to around 89% for this specific sample.[69] The impact is particularly notable for G-SIIs relative to O-SIIs. For this specific sample, average buffer usability for G-SIIs would increase from 46.9% to 90.3% and for O-SIIs from 73.8 to 92.9%, almost closing the usability gap between the two groups of banks currently observed. However, it should be noted that only a full and faithful implementation would yield such significant increases in buffer usability.[70]

Chart 10
Change in buffer usability due to Basel III
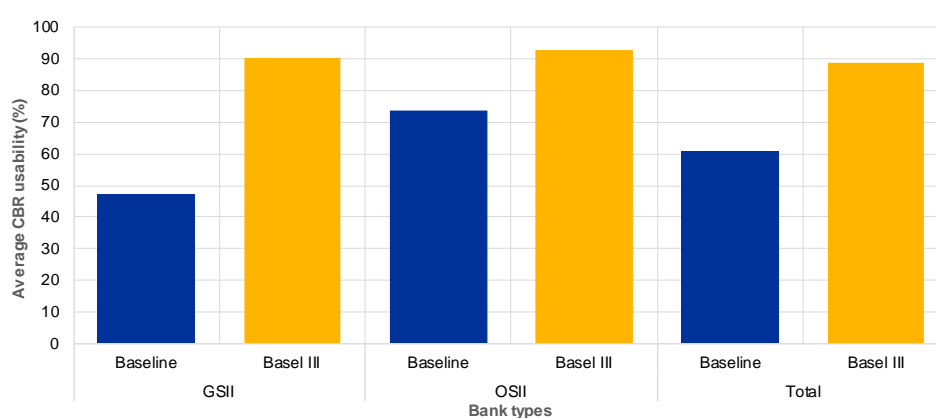
Sources: QIS data and USIT.
Notes: The analysis is based on a subsample (N=50) of banks, for which sufficient data from the 2021 QIS exercise are available. Baselines represent the actual usability before the application of Basel III reforms. Basel III shows CBR usability after the full implementation of the Basel III package. CBR usability is calculated as the weighted mean of individual banks' buffer usability with respect to the LR, where the size of the CBR is taken as weights. Total presents the results aggregated for all banks in the subsample.

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[68] An assessment of the impact of the Basel III output floor on buffer usability has also been conducted by the ESRB (2021b). The ESRB reported much smaller benefits for buffer usability, because it considered also MREL and the output floor was less effective in removing usability impediments stemming from the leverage-based MREL.

[69] The banks included in the QIS dataset are mostly G-SIIs and O-SIIs, therefore often rely heavily on internal models. If smaller and less complex banks were also included in the QIS analysis, the impact of Basel III may be smaller, given that those institutions use standardised approaches more extensively and thus are not affected by the output floor.

[70] See also Enria, A., de Guindos, L. and Campa, J.M. (2022), "Strong rules, strong banks: let's stick to our commitments", *ECB Blog*, 4 November.

5 Conclusion

This paper provides an empirical assessment of the usability of capital buffers with respect to parallel LR requirements from 2016 to the third quarter of 2022. Leveraging on the buffer usability simulation tool (USIT) developed for the purposes of the ESRB (2021b) and using a large bank-level supervisory dataset of euro area banks, this paper is the first empirical study of capital buffer usability from a capital overlap perspective over a longer time span. This allows for an analysis of changes to buffer usability in different economic phases, exploring heterogeneity across banks and countries and taking a closer look at the underlying structural drivers of buffer usability.

Buffers were found to be not fully usable throughout the observed period, especially for G-SIIs given the interaction between risk-based requirements and the LR. On average across all years, only 61.1% of the CBR was usable. Average buffer usability was especially limited for G-SIIs (46%) compared with other types of banks (around 75%). The main reason is on average low RWDs for G-SIIs, which rely more heavily on internal models. These tend to produce lower risk-based capital requirements, making the non-risk-weighted LR framework relatively more binding for these banks.

Buffer usability gradually increased until the COVID-19 crisis, when it started to become volatile and ended at lower levels than before the pandemic. After an initial drop at the end of 2016, buffer usability steadily increased, mainly due to the phasing-in of buffers – including the CCoB, G/O-SII buffers, the SyRB and the CCyB. This trend stopped with the outbreak of the COVID-19 pandemic. At that time, buffer usability significantly decreased for two reasons: first because of a combination of banks' expanding balance sheets after expansionary monetary policies (in particular, the ECB's PEPP) and second because of decreasing risk-weighted assets, mainly driven by government loan guarantees under fiscal support measures. The combination of increasing non-risk-based requirements and decreasing risk-based requirements made the LR framework relatively more constraining, which resulted in lower levels of buffer usability. Afterwards, buffer usability was volatile but generally on a rather decreasing trend.

Buffer usability is primarily determined by a bank's RWD, and there is a critical range of 25% to 50% where buffer usability tends to be limited and prone to volatility. RWD, defined as a ratio of TREA and LREM, predominantly affects the relative bindingness of the LR and RW frameworks and strongly determines the overlap between the LR, the CBR and buffer usability. Our analysis shows that there is a critical RWD range of 25% to 50% in which buffer usability tends to be limited and very responsive to any changes in RWD, while buffer usability is generally 0% (no buffers usable) for densities below 25% and 100% (all buffers usable) for densities above 50%. To a lesser degree, buffer usability is affected by the capital composition. Many banks, and especially G-SIIs, operate within the critical range, which makes them prone to limited buffer usability.

Buffer usability and its evolution over time are heterogeneous across euro area countries. In countries with smaller and less complex banks, buffer usability was relatively high and stable due to high average risk weights. However, RWDs for these countries are generally decreasing, which could lead to more limited buffer usability in the future should this trend continue. Similarly, G-SII home countries that were more severely affected by the global financial crisis and the Eurozone sovereign debt crisis started with higher risk weights and thus higher levels of buffer usability in 2016. As their risk weights also tended to decrease over time, they entered the critical range and their buffer usability decreased. For many countries, the largest decrease in buffer usability coincides with the outbreak of the pandemic. Conversely, buffer usability increased for countries where it was especially low in 2016. These countries are often G-SII home jurisdictions that were less affected by previous crises and hence have very low risk weights produced by internal models. The phasing-in of buffers was especially important for improving buffer usability in these countries.

Additional analysis was conducted to assess the effect of various measures, such as a positive neutral CCyB rate, LRBs and the implementation of the Basel III reform, by means of counterfactuals. Our analysis showed that a positive neutral CCyB, advocated as one of the options to increase the amount of releasable buffers to support banks in weathering systemic shocks, would increase the CBR and hence support buffer usability in all periods. Regarding LRBs, their effectiveness in supporting buffer usability strongly depends on the considered conversion rate between risk-based and non-risk-based buffers. Specifically, mirroring the CBR also at lower conversion rate than 50% (which is currently used for the conversion of G-SII buffers) would substantially enhance buffer usability, at the cost of increasing overall capital requirements. However, if only structural buffers were mirrored, this could constrain the effective releasability of RW buffers if banks are not willing to dip into structural buffers. Furthermore, a full implementation of Basel III reforms, especially the output floor, is expected to increase the RWD of some banks that are particularly constrained by the LR. This would materially improve buffer usability, especially for G-SIIs.

Further research could focus on the implications of MREL for buffer usability and on the functioning of the macroprudential framework. The final phasing-in of MREL by 2024 implies that this element of the capital framework will also become binding and interact with risk-based capital buffers. The ESRB (2021b) has already indicated that buffer usability could be constrained by MREL as well. This shows that the phasing-in of MREL and its impact on buffer usability warrant further monitoring going forward. Furthermore, the literature is so far missing analytical methods to assess the resulting consequences of the observed limitations on buffer usability for the practical functioning of the macroprudential framework, that go beyond conceptual considerations. In this regard, further research is needed to assess how limited buffer usability might influence the loss-absorbing capacity of the buffer framework.

Annexes

Annex 1   Details on the analytical approach to calculate buffer usability and its main determinants

The following paragraphs present the exact approach and formulas to calculate buffer usability. [71] Buffer usability is a function of the CBR and the capital overlap between the RW and LR frameworks:

$$CBR\ Usability\ in\ \% \ = \ Usable\ CBR\ /\ CBR\ *\ 100$$

$$Usable\ CBR \ = \ max(0, (CBR - CBR\ Overlap))$$

$$CBR\ Overlap \ = \ max(CET1\ LR\ minimum\ requirements \\ - CET1\ RW\ minimum\ requirements, 0)$$

which requires the calculation of CET1 LR and CET1 RW minimum requirements. This quantity determines how much CET1 capital needs to be used in the respective minimum requirement after all lower-ranking components of capital are used. For the LR framework, the CET1 requirements are calculated by deducting available AT1 capital from nominal Tier 1 LR requirements:

$$CET1\ LR\ minimum\ requirements \ = \ max(0, ((P1LR\ +\ P2LR) * LREM\ – AT1))$$

And for the RW framework, for which the regulation foresees three minimum requirements – one expressed in terms of CET1 capital, one in Tier 1 capital and another in total capital, these are obtained by summing up P1 and P2 minimum CET1 requirements as well as any parts of Tier 1 and total capital RW requirements that are not fulfilled by Tier 1 or Tier 2 capital respectively (so-called AT1 gap and Tier 2 gap).

$$CET1\ RW\ minimum\ requirements \\ = (P1RW_{CET1} + P2RW_{CET1}) * TREA\ +\ AT1\ gap\ RW\ +\ T2\ gap\ RW)$$

The AT1 gap is calculated as:

$$AT1\ gap\ RW \ = \ max\{0, AT1\ gap\ RW\_tmp\ \}$$

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[71]   In addition to the provided formulas, the following statements apply:
     AT1 = T1 – CET1;
     P1R-LR = 3% * LREM; (Art. 92 1(d) CRR)
     P1RW_CET1 = 4.5%, (Art. 92 1(a) CRR)
     P1RW_T1 = 6%; (Art. 92 1(b) CRR)
     P1RW_TC = 8%; (Art. 92 1(c) CRR)
     P2RW_CET1 = 0.75 * P2-RW-T1
     P2RW_T1 = 0.75 * P2-RW-TC
     P1LR = 3%; (Art. 92 1(d) CRR)

$AT1\ gap\ RW\_tmp$
$$= [(P1RW\_T1 - P1RW\_CET1) + (P2RW\_T1 - P2RW\_CET1)]$$
$$* TREA - AT1$$

$AT1\ gap\ RW\_tmp$ is an intermediate result stated explicitly in order to simplify the equations. Further, the T2 gap is obtained analogously, but any negative AT1 gap (i.e. more available AT1 capital than required to comply with all AT1 RW requirements) is subtracted from the Tier 2 gap, as these AT1 instruments are also free to comply with the additional total capital requirements:

$$T2\ gap\ RW = max\{0, [(P1RW\_TC - P1RW\_T1) + (P2RW\_TC - P2RW\_T1)]$$
$$* TREA - T2 + min(0, AT1\ gap\ RW\_tmp)\}$$

This completes the step of calculations necessary to obtain buffer usability. The calculations are implemented in USIT. See ESRB (2021b) for details. From these formulas, one can analytically explore how different factors influence buffer usability in different ways.

A higher amount of buffers mechanically increases CBR usability. More buffer capital (all else being equal) directly increases the amount of buffer capital that is above the blocked part of the CBR, which would imply a higher share of usable buffers. The next key quantity to consider is the CBR overlap, which is solely determined by the CET1 amount used to comply with the LR and RW frameworks respectively, as shown by the third equation: the part of minimum CET1 LR requirements that exceeds minimum CET1 RW requirements limits buffer usability.

The CET1 amount used to comply with LR and RW requirements is at first directly determined by the regulatory Tier 1 and total capital requirements. Any increase in the nominal LR minimum requirement, either as a result of increases in the regulatory rates ($P1LR, P2LR$) or an increase in the scope of bank operations (i.e. increase in $LREM$), would increase the minimum LR requirement and increase the overlap between the LR and RW frameworks, hence reducing buffer usability. By contrast, any increases in the RW minimum requirement, due to increased requirements ($P1RW, P2RW$) or increased risk weights (i.e. increases in $TREA$), lifts the CBR relative to the LR framework upwards, thereby reducing the overlap and increasing buffer usability. Ultimately, for a given bank, the size of the overlap between the LR and the CBR will depend on the relative bindingness of the LR and RW capital frameworks. If a bank is constrained by the RW capital stack, while the LR framework is comparably less constraining, the overlap will be relatively small – and vice versa if a bank is highly leveraged. This relative bindingness of the risk-based and leverage requirements is primarily determined by the risk profile of the bank, which can be described analytically by its RWD (RWD = TREA/LREM). The higher the RWD, the more constraining the RW framework is.

The composition of regulatory capital banks use to comply with the total risk-weighted capital requirement (TRWCR) has a multifaceted impact on buffer

usability. From the LR framework perspective, more AT1 capital[72] means less of the LR requirement has to be met with CET1 capital, which reduces the CET1 overlap with the CBR. For the RW framework, more AT1 capital would decrease buffer usability, because if banks are using more AT1 capital to comply with the TRWCR, this reduces the CET1 amount locked in the RW capital stack, hence increasing the CET1 overlap with the LR. The overall overlap effect of AT1 capital depends on how much CET1 capital the bank uses to comply with the Tier 1 requirement (above the minimum of 4.5%) in the RW framework. If, on top of the minimum RW CET1 requirement, a bank fulfils its Tier 1 requirement solely with AT1 capital, more AT1 capital will decrease the extent to which LR requirements are met with CET1 capital. If, on top of the minimum CET1 requirement, a bank uses CET1 capital to comply with the Tier 1 requirement, more AT1 capital will not change the overlap (and hence have no effect on buffer usability) up to the extent that it substitutes for CET1 capital used for the Tier 1 requirement. Any surplus AT1 capital, in excess of what is used to meet the Tier 1 requirement, would reduce the overlap (due to the decreasing LR CET1 component) and hence increase buffer usability. What regard to Tier 2 capital, since this is not eligible in the LR framework, more Tier 2 capital used to meet the TRWCR (up to a limit of 2% of the TREA) will always lead to less CET1 capital being needed to comply with the TRWCR, hence reducing the CET1 capital locked in the RW framework, increasing the overlap and reducing buffer usability. As extensively discussed in Section 2, all the mechanisms described above are purely conceptual and illustrative as they focus on buffer usability from a capital overlap perspective and do not take into account the broader financial stability perspective (see Section 2 for more details).

Furthermore, it should be noted that increasing surplus CET1 capital does not affect the overlap and hence has no effects on buffer usability, as surplus CET1 capital does not affect LR/RW capital overlap. The concept of buffer usability assumes that banks have sufficient CET1 capital to meet their minimum requirements and buffers so that the latter can be used to absorb losses or support lending. However, surplus CET1 capital would increase the voluntary CET1 buffers on top of the LR and RW capital stack (the green boxes in Chart 1) and would thereby have a positive impact on bank resilience and the usability of excess capital.

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[72] In line with the conceptual approach in this paper, we focus on the role of AT1 capital in buffer usability solely from the overlap perspective. From the perspective of banks' willingness to use capital buffers, more AT1 capital might in fact negatively affect buffer usability, as banks with more AT1 capital may have stronger incentives not to dip into buffers in order to avoid the cancellation of AT1 coupon payments.

Annex 2   Results of the regression used for correlation analysis

To derive coefficients for the assessment of the empirical correlation of the driving factors of buffer usability, two panel regressions were carried out, the results of which are presented in Table 1 below. The first column shows the regression with year fixed effects, and the second one without fixed effects. The standard deviations used for the calculation of comparable conditional correlations are 0.1, 0.28 and 3.51 for AT1 capital, Tier 2 capital and RWD respectively.

Table 1

Panel regression results

	Dependent variable:	
	CBR usability wrt. LR	
	(1)	(2)
diff RWD	0.813***	0.688***
	(0.014)	(0.012)
diff AT1	1.036***	0.892***
	(0.417)	(0.419)
diff T2	-2.521***	-2.776***
	(0.158)	(0.150)
Constant	0.585	-0.039
	(0.653)	(0.043)
Year FE	Yes	No
Observations	36,374	36,374
R2	0.103	0.092
Adjusted R2	0.103	0.092
Residual std. error	8.023 (df = 36,347)	8.069 (df = 36,370)
F statistic	161.006*** (df = 26; 36,347)	1,233.674*** (df = 3; 36,370)
Note:	*p<0.1; **p<0.05; ***p<0.01	

Sources: Supervisory data and USIT.
Note: Diff indicates first differences.

Annex 3 Derivation and evaluation of the critical risk weight density formula

In order to derive the final critical RWD formula that was then used for the numerical evaluation exercise, we start by equating CET1 LR requirements with minimum CET1 risk-based requirements:

$$LR_{min} - AT1_{eligibleLR} = RB_{min} - AT1_{eligibleRB} - T2_{eligibleRB}$$

where $AT1_{eligibleLR}$ is the nominal amount of AT1 capital available and eligible for the LR minimum requirement, $T2_{eligibleRB}$ is the Tier 2 capital available and eligible for the risk-based minimum requirement and $AT1_{eligibleRB}$ is the AT1 capital available and eligible for the risk-based minimum requirement. Importantly, at this stage, we do not specify how AT1 and Tier 2 capital may used in the LR and RW frameworks, hence it should be kept in mind that $AT1_{eligibleRB}$ may differ from $AT1_{eligibleLR}$.

Next, we represent all nominal amounts in relative terms. More precisely, LR requirements are written as a percentage of the LREM, and all remaining quantities are written as a percentage of the TREA:

$$LR_{min,\%LREM} \cdot LREM - AT1_{eligibleLR,\%TREA} \cdot TREA$$
$$= RB_{min,\%TREA} \cdot TREA - AT1_{eligibleRB,\%TREA} \cdot TREA - T2_{eligibleRB,\%TREA}$$
$$\cdot TREA$$

Dividing both sides by LREM[73] and recalling that $RWD = \frac{TREA}{LREM}$:

$$LR_{min,\%LREM} - AT1_{eligibleLR,\%TREA} \cdot \frac{TREA}{LREM}$$
$$= \frac{TREA}{LREM} \cdot \left(RB_{min,\%TREA} - AT1_{eligibleRB,\%TREA} - T2_{eligibleRB,\%TREA}\right)$$

we get RWD_C, which equalises both sides as

$$LR_{min,\%LREM} - AT1_{eligibleLR,\%TREA} \cdot RWD_C$$
$$= RWD_C \cdot \left(RB_{min,\%TREA} - AT1_{eligibleRB,\%TREA} - T2_{eligibleRB,\%TREA}\right)$$

After rearranging, we get:

$$RWD_C = \frac{LR_{min,\%LREM} - AT1_{eligibleLR,\%TREA} \cdot RWD_C}{RB_{min,\%TREA} - AT1_{eligibleRB,\%TREA} - T2_{eligibleRB,\%TREA}}$$

Furthermore, we will expand the respective minimum requirements into their Pillar 1 and Pillar 2 components, i.e. substituting $LR_{min,\%LREM} = P1LR_{\%LREM} + P2LR_{\%LREM}$ and $RB_{min,\%TREA} = P1RB_{min,\%TREA} + P2RB_{\%TREA}$:

$$RWD_C = \frac{P1LR_{\%LREM} + P2LR_{\%LREM} - AT1_{eligibleLR,\%TREA} \cdot RWD_C}{P1RB_{min,\%TREA} + P2RB_{\%TREA} - AT1_{eligibleRB,\%TREA} - T2_{eligibleRB,\%TREA}}$$

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[73] Dividing by the TREA at this stage would be impractical as one would encounter problems in expressing neatly the condition on $AT1_{eligibleRB,\%TREA}$ that AT1 capital qualifies for the LR only until 3% of the LREM (plus the potential P2R rate for leverage) is reached.

So far, we have not worked with explicit eligible AT1 and Tier 2 capital under the respective frameworks, which we have to change at this stage. Starting with the LR framework, $AT1_{eligibleLR,\%TREA} \cdot RWD_C$ should not exceed the LR minimum requirement, i.e. AT1 capital in excess of the LR minimum requirement does not count in the minimum leverage framework. This implies for the formula that the numerator cannot be negative, ensured by adding a *max()* operator:

$$RWD_C = \frac{max(0, P1LR_{\%LREM} + P2LR_{\%LREM} - AT1_{\%TREA} \cdot RWD_C)}{P1RB_{min,\%TREA} + P2RB_{\%TREA} - AT1_{eligibleRB,\%TREA} - T2_{eligibleRB,\%TREA}}$$

Continuing with the RW framework, only Tier 2 capital up to 2% of the TREA and ¼ of the P2R can be used to comply with the minimum in the risk-based framework, expanding $T2_{eligibleRB,\%TREA}$ and producing a *min()* operator in the denominator:

$$RWD_C$$
$$= \frac{max(0, P1LR_{\%LREM} + P2LR_{\%LREM} - AT1_{\%TREA} \cdot RWD_C)}{P1RB_{min,\%TREA} + P2RB_{\%TREA} - AT1_{eligibleRB,\%TREA} - min\left(T2_{\%TREA}, \; 2 + \frac{1}{4}P2RB_{\%TREA}\right)}$$

Furthermore, only AT1 capital up to 3.5% of the TREA and 7/16 of the P2R, net of any eligible Tier 2 capital, counts in the risk-based framework, further complicating the formula by expanding $AT1_{eligibleRB,\%TREA}$ to:

$$RWD_C$$
$$= \frac{max(0, P1LR_{\%LREM} + P2LR_{\%LREM} - AT1_{\%TREA} \cdot RWD_C)}{P1RB_{min,\%TREA} + P2RB_{\%TREA} - min\left(AT1_{\%TREA}, \; 3.5 + \frac{7}{16}P2RB_{\%TREA} - min\left(T2_{\%TREA}, \; 2 + \frac{1}{4}P2RB_{\%TREA}\right)\right) - min\left(T2_{\%TREA}, \; 2 + \frac{1}{4}P2RB_{\%TREA}\right)}$$

As a final step, we note that the denominator cannot be negative, i.e. eligible AT1 and Tier 2 capital cannot jointly exceed the risk-based minimum requirements:

$$RWD_C$$
$$= \frac{max(0, P1LR_{\%LREM} + P2LR_{\%LREM} - AT1_{\%TREA} \cdot RWD_C)}{max\left(0, \; P1RB_{min,\%TREA} + P2RB_{\%TREA} - min\left(AT1_{\%TREA}, \; 3.5 + \frac{7}{16}P2RB_{\%TREA} - min\left(T2_{\%TREA}, \; 2 + \frac{1}{4}P2RB_{\%TREA}\right)\right) - min\left(T2_{\%TREA}, \; 2 + \frac{1}{4}P2RB_{\%TREA}\right)\right)}$$

This concludes the derivation of the expanded RWD formula, taking into account P1 and P2 minimum requirements as well as AT1 and Tier 2 capital.

In order to draw conclusions regarding the critical RWD, this formula is then evaluated numerically by means of applying different combinations of $P2RB_{\%TREA}$, $AT1_{\%TREA}$ and $T2_{\%TREA}$ at the regulatory implied Pillar 1 values to it. The results are shown in Table 2 below.

Table 2

Critical RWD (in decimals) for various combinations of P2R, AT1 capital and Tier 2 capital as a percentage of the TREA

		Tier 2			
	AT1	**0**	**1**	**2**	**3**
P2R = 0%	**0**	0.38	0.43	0.5	0.5
	1	0.38	0.43	0.5	0.5
	2	0.38	0.43	0.46	0.46
	3	0.38	0.4	0.4	0.4
		Tier 2			
	AT1	**0**	**1**	**2**	**3**
P2R = 1%	**0**	0.33	0.38	0.43	0.44
	1	0.33	0.38	0.43	0.44
	2	0.33	0.38	0.42	0.42
	3	0.33	0.37	0.37	0.37
		Tier 2			
	AT1	**0**	**1**	**2**	**3**
P2R = 2%	**0**	0.3	0.33	0.38	0.4
	1	0.3	0.33	0.38	0.4
	2	0.3	0.33	0.38	0.39
	3	0.3	0.33	0.35	0.35
		Tier 2			
	AT1	**0**	**1**	**2**	**3**
P2R = 3%	**0**	0.27	0.3	0.33	0.36
	1	0.27	0.3	0.33	0.36
	2	0.27	0.3	0.33	0.36
	3	0.27	0.3	0.33	0.33

Note: Calculated iteratively by numerically evaluating the critical RWD formula.

List of abbreviations

AT1	Additional Tier 1
BCBS	Basel Committee on Banking Supervision
BIS	Bank for International Settlements
CBR	combined buffer requirements
CCoB	capital conservation buffer
CCyB	countercyclical capital buffer
CET1	Common Equity Tier 1
COREP	common reporting
EC	excess capital
ESRB	European Systemic Risk Board
FINREP	financial reporting
G-SII	global systemically important institution
IRB	internal ratings-based
LR	leverage ratio
LRB	leverage ratio buffer
LREM	leverage ratio exposure measure
MREL	minimum requirement for own funds and eligible liabilities
NFC	non-financial corporation
O-SII	other systemically important institution
P1	Pillar 1
P2G	Pillar 2 guidance
P2R	Pillar 2 requirement
PD	probability of default
PEPP	pandemic emergency purchase programme
RW	risk-weighted
RWD	risk weight density
SyRB	systemic risk buffer
TREA	total risk exposure amount
USIT	(buffer) usability simulation tool

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