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EUROSYSTEM

# Technical Paper

## Potential deleveraging in the German banking system and effects on financial stability

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## Non-technical summary

The Bundesbank and the German Financial Stability Committee (*Ausschuss für Finanzstabilität* – G-FSC) define financial stability as a state in which the financial system neither causes nor excessively amplifies a macroeconomic downturn. In the event of an unforeseen shock, such as an economic slump, the banking sector may be exposed to high losses and some banks may become distressed. There is then a risk that many banks will simultaneously shrink their balance sheets. In an extreme case, this deleveraging could lead to a situation where otherwise creditworthy enterprises and households are ultimately no longer able to obtain the loans they need. A restriction on lending of this kind would then have a procyclical effect and could exacerbate an economic slump.

The monitoring tool presented in this paper estimates ex ante the potential deleveraging in the German banking system and assesses the potential impact of a stress period on the banking system. The tool first records banks' current capital reserves, i.e. the sum of their capital buffers and excess capital. These are compared with the capital depletion resulting from first-round effects in a baseline scenario and an adverse scenario. We then estimate the extent of banks' potential deleveraging in response to the first-round effects as well as to contagion effects from the interbank market. Lastly, the stress effects result in the aggregate lending capacity of the banking system being restricted. Substitution effects are taken into account here, as some banks will step in when others lend less. Especially in an adverse scenario, the decline in lending capacity can be significant and threaten financial stability. If banks are willing to use their buffers, the constraint on lending capacity will be smaller. If they do not use their buffers, there may be additional negative effects on the real economy. For example, real GDP could fall even more sharply. From a financial stability perspective, it is therefore desirable that banks use their buffers even if this may increase their probability of default and, at least in the short term, leave them less resilient. The results of the monitoring tool can be updated on a quarterly basis and are fed into Bundesbank publications, such as the 2020 and 2021 editions of the Financial Stability Review. The tool is based primarily on supervisory reporting data.

## Nichttechnische Zusammenfassung

Unter Finanzstabilität verstehen die Bundesbank und der Ausschuss für Finanzstabilität (AFS) einen Zustand, in dem das Finanzsystem einen gesamtwirtschaftlichen Abschwung weder verursacht noch übermäßig verstärkt. Im Fall eines unvorhergesehenen Schocks, etwa einem Wirtschaftseinbruch, kann der Bankensektor hohen Verlusten ausgesetzt sein und einige Banken können in Schieflage geraten. Dann besteht die Gefahr, dass viele Banken gleichzeitig ihre Bilanzen verkürzen. Im Extremfall könnte dieses Deleveraging dazu führen, dass letztlich auch kreditwürdige Unternehmen und private Haushalte nicht mehr angemessen Kredite erhalten würden. Eine solche Einschränkung der Kreditvergabe würde dann prozyklisch wirken und könnte einen wirtschaftlichen Einbruch verstärken.

Das in diesem Papier dargestellte Monitoring-Tool schätzt ex-ante ab, wie hoch das Deleveraging-Potenzial im deutschen Bankensystem ist und bewertet die potenziellen Auswirkungen einer Stressphase auf das Bankensystem. Hierfür werden zunächst die aktuellen Kapitalreserven der Banken erfasst, das heißt die Summe ihrer Kapitalpuffer und ihres Überschusskapitals. Diesen wird der Kapitalverzehr gegenübergestellt, der sich in einem Basisszenario und einem adversen Szenario aus Erstrundeneffekten ergibt. Anschließend wird abgeschätzt, wie umfangreich das Deleveraging der Banken ist, das sich als Reaktion auf die Erstrundeneffekte sowie Ansteckungseffekte aus dem Interbankenmarkt ergibt. Zuletzt ergibt sich aus den Stresseffekten eine Einschränkung der aggregierten Kreditvergabekapazität des Bankensystems. Dabei werden Substitutionseffekte berücksichtigt: Manche Banken springen ein, wenn andere weniger Kredite vergeben. Insbesondere in einem adversen Szenario kann der Rückgang der Kreditvergabekapazität bedeutsam sein und die Finanzstabilität gefährden. Sind Banken bereit, ihre Puffer zu nutzen, fällt die Einschränkung der Kreditvergabekapazität geringer aus. Nutzen sie ihre Puffer nicht, kann es zu zusätzlichen negativen Effekten auf die Realwirtschaft kommen. So könnte etwa das reale BIP noch stärker einbrechen. Aus Sicht der Finanzstabilität ist es daher erwünscht, dass Banken ihre Puffer nutzen auch wenn sich dadurch ihre Ausfallwahrscheinlichkeit erhöhen kann und sie zumindest kurzfristig weniger widerstandsfähig wären. Die Ergebnisse des Monitoring-Tools können quartalsweise aktualisiert werden und fließen in Publikationen der Bundesbank ein, etwa die Finanzstabilitätsberichte 2020 und 2021. Es werden vornehmlich Daten aus dem aufsichtlichen Meldewesen verwendet.

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# Potential deleveraging in the German banking system and effects on financial stability*

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**Abstract**

The stability of the German banking system, in its capacity as an integral component of the country's financial system, has come under particular scrutiny, not least since the onset of the COVID-19 pandemic. Financial stability hinges on whether banks are sufficiently resilient to stress effects, which can arise if the economy suffers an unexpected downturn, for example. This might coincide with system-wide deleveraging if banks are insufficiently resilient. System-wide deleveraging, in turn, could pose a risk to financial stability and have adverse repercussions for the real economy. The monitoring tool presented in this paper can be used to determine the potential deleveraging based on a sequence of six analytical steps that take multiple first-round scenarios into account. The sequence comprises (i) the loss-absorbing capacity of banks in the current (starting) situation, (ii) the banking system's key stress channels, (iii) deleveraging as a bank response to a reduction in their loss-absorbing capacity, (iv) second-round effects in the interbank market, and (v) the resulting effects on lending capacity to non-financial corporations, allowing for substitution effects. To illustrate the role played by macroprudential buffers, the scenarios initially assume that banks use their buffers. That is to say, banks tolerate undershooting the macroprudential buffer requirements and attempt to maintain their supply of credit. As a next step, a comparison is then made with the results if banks do not use their buffers. This comparison allows us, last of all, (vi) to estimate the macroeconomic effect of buffer use on the real economy. The results produced by the monitoring tool indicate that buffer use involves a macroeconomic trade-off. Given a (slightly) higher probability of default and spells of lower resilience, banks have to restrict their lending to a lesser extent, which allows an additional downturn in real GDP to be avoided.

Keywords: Financial Crises, Banks, Government Policy and Regulation

JEL-Classification: G01, G21, G28

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## 1 Rationale behind this analysis

The Bundesbank and the German Financial Stability Committee (*Ausschuss für Finanzstabilität* – G-FSC) understand financial stability as a state in which the financial system is able to fulfil its functions at all times. The functional viability of the financial system is of vital importance for the real economy. Unforeseeable events, such as the onset of the coronavirus pandemic, can jeopardise the stability of the financial system. The financial system should neither cause nor excessively amplify a downturn in overall economic activity, which is why it needs to be sufficiently resilient – in other words, able to absorb losses and, ultimately, reduce contagion or feedback effects. An unforeseen shock exposing the banking sector to severe stress effects and causing distress at some banks increases the risk that many banks will simultaneously shrink their balance sheets (deleverage) in an effort to maintain the capital ratios required by the market or by supervisors. In a very adverse scenario, this deleveraging could lead to such high tensions in the credit market that ultimately even creditworthy enterprises and households would no longer get the credit they need. Lending constraints might then have a procyclical effect, amplifying the original shock.

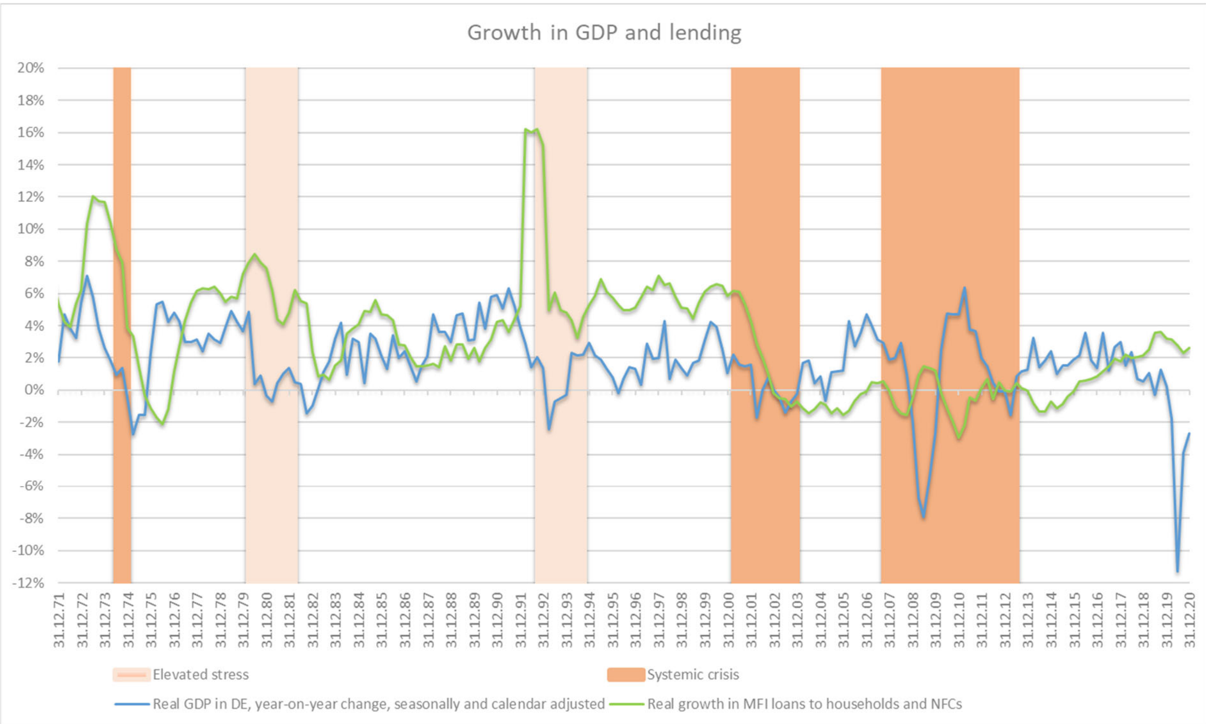
One core element of macroprudential regulation for the banking system are macroprudential capital buffers, which were introduced around the world as a lesson learned from the 2008-09 financial crisis. These buffers are designed to boost banking system resilience to cyclical and structural systemic risk[2] as a way of reducing the likelihood that the banking system will act procyclically in a stress phase and exacerbate a shock. If a bank experiencing stress sees its capital fall and total risk exposure amount (risk-weighted assets, RWAs) rise, its regulatory capital ratio – i.e. the ratio of capital to RWAs – will decline. Depending on the size of the gap between the stressed capital ratio and the regulatory minimum requirements or any other target ratio for the bank, the stress effects can cause banks to adjustments in response. Banks looking to stabilise their capital ratio would have an incentive to reduce their RWAs, since in a crisis they would be unable to accumulate fresh equity capital by retaining profits, while raising capital in the markets would be expensive. Banks would, however, be able to reduce their RWAs by deleveraging – that is, by deciding not to extend maturing loans or to stop issuing new loans, for example. A scenario where a large number of banks or a few large credit institutions, in a stress phase, intend to reduce RWAs at the same time can lead to system-wide deleveraging and thus to procyclical effects for the real economy. Unlike with the minimum requirements, banks can temporarily fall short of the requirements for the capital buffers without risking large-scale constraints on their business activities. Then, however, they would be restricted in the extent to which they can make distributions in the form of dividends and variable remuneration. From a bank's perspective, one factor in favour of buffer use is that in stress phases, for example, it will be able to quickly cater for stronger customer demand for new loans, even if its resilience declines at the same time. In other words, banks that use their

[2] An overview of the capital and other macroprudential buffers can be found at Macroprudential measures | Deutsche Bundesbank

buffers and deliberately undershoot the requirements for capital buffers can stabilise their lending in periods of stress.

There is a risk in stress phases that the banking system will amplify negative developments. The database produced by Lo Duca et al. (2017) can be used to identify periods for Germany over the past 50 years that were characterised by elevated stress or a systemic crisis.[3] The path of GDP growth and of growth in lending by German banks to non-financial corporations and households follows a discernible pattern: shortly before or at the onset of a stress or crisis period, first GDP growth falls, then credit growth. After that, GDP typically declines more strongly or (if it had already recovered beforehand) slumps again (see Figure 1).[4]

<u>Figure 1: Lending by German banks in earlier crisis periods</u>




The monitoring tool presented in this paper was developed to estimate the potential deleveraging in the German banking system and its effects on financial stability. The monitoring results can be updated on a quarterly basis, and new developments can be taken into account. The insights have a bearing on financial stability oversight, benefit macroprudential policymaking, and feed into Bundesbank publications such as the Financial Stability Review.[5] The potential deleveraging is estimated based on a sequence of six analytical

[3] Systemic crises in the German financial system were identified in the following periods: Q2 1974-Q4 1974, Q1 2001-Q4 2003, Q3 2007-Q2 2013. The German financial sector was exposed to elevated stress in the following periods: Q1 1980-Q1 1982 and Q3 1992-Q3 1994. At least one of the following conditions needs to be satisfied for a period to be identified as a financial crisis: (I) the financial system is either the root cause of the shock or amplifies a shock and thus worsens real economic performance considerably, (II) the financial system was in crisis, i.e. market infrastructures were not functioning and/or large/significant institutions were considerably distressed or insolvent, and (III) institutional measures were taken to restore the stability of the financial/banking system (e.g. IMF assistance, exceptional liquidity measures by the central bank or government assistance measures). Other types of stress phase are said to exist when they do not satisfy the aforementioned conditions but were nonetheless referred to as a stress phase by national supervisors and identified as a crisis/stress phase in financial stress indicators or other studies.

[4] Notifications to the monthly balance sheet statistics (BISTA) reveal this cyclical pattern in particular in the supply of short-term loans. But the growth rates of medium-term loans often declined as well in earlier stress and crisis periods. Growth in long-term lending, on the other hand, stayed relatively steady, apart from during the systemic crisis in the early 2000s.

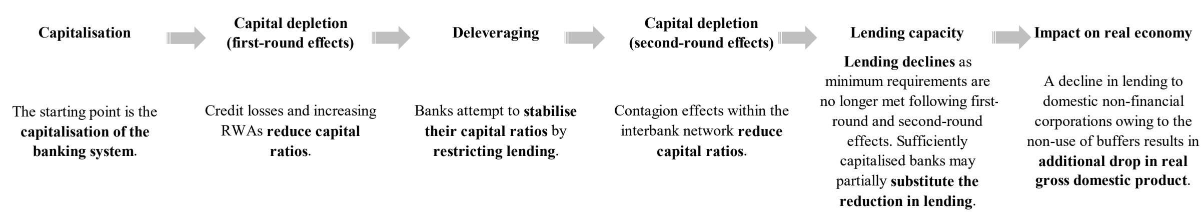
[5] Analytical results based on the monitoring tool can be found, for example, in Deutsche Bundesbank (2020, 2021).

steps, with multiple first-round stress scenarios being considered. Section 2 of this paper provides a detailed account of how the individual analytical steps are designed and presents the overarching thread running through the sequence of steps making up the monitoring tool. In Section 3, there is a description of the underlying stress scenarios for the first-round effects and the key takeaways from the monitoring tool. Section 4 offers a conclusion on the assessment of the potential deleveraging for the German banking system and its effects on financial stability.

## 2 Analytical steps

The sequence of the monitoring tool's analytical steps is shown in Figure 2. Banks' capitalisation in the form of usable reserves of common equity tier 1 (CET1) capital is determined in step 1. "Usable" means that banks can use this portion of their equity to absorb losses and maintain lending on a going concern basis. In step 2, CET1 reserves are compared to capital depletion from first-round effects in stress scenarios of varying intensity. The first-round effects cover the relevant stress channels for the German banking system. In response to the first-round effects, banks attempt, in step 3, to stabilise their capital ratio at an assumed target capital ratio, provided that their capital ratio fell below this target following the first round. Banks achieve this by reducing exposures, and deleveraging occurs. Subsequently, in step 4, contagion effects caused by banks' interconnectedness are taken into consideration. As claims that banks have on each other default and risk-weighted assets rise, further capital depletion occurs as a result of second-round effects. It is assumed that the effects in steps 2 to 5 will materialise within two years.[6] In step 5, the impact of the depletion of CET1 reserves on the banking system's lending capacity is estimated. If, following the second-round effects, banks fail to meet their regulatory minimum requirements and have CET1 reserves of less than zero, they will issue no more new loans to non-financial corporations. Account is also taken of the fact that banks that have sufficient CET1 reserves after first-round and second-round effects will, in part, substitute this reduction in lending. To illustrate the role played by macroprudential buffers, the scenarios initially assume that banks use their buffers. A comparison is then made with the results if banks do not use their buffers. In the last step, step 6, real economic effects in the form of an additional decline in real gross domestic product (GDP) are estimated. These effects are calculated from the amount by which lending capacity to domestic non-financial corporations declines because the buffers are not used.

Figure 2: Sequence of analytical steps




[6] The idea behind this is that the stress scenarios in the individual modules have a forecast horizon of roughly one year, and banks that are deleveraging allow their loans to expire or curtail new lending during the following year.

In Sections 2.1 to 2.6, the methodology and the underlying calculations used in the steps are described. The description refers in each case to a formula box at the end of each section. There is also an explanation of how the results for each step help answer the overarching questions that the monitoring tool is designed to resolve, i.e., in terms of the depletion of CET1 reserves and the effect on lending capacity. At times, reference is made to analyses and methods that have already been published, say in a Bundesbank discussion paper or technical paper. In those cases, the publication in question is cited without expounding the methodology in detail again.

## 2.1 Capitalisation at starting point

As a rule, banks can use their CET1 reserves to absorb losses and stabilise lending on a going concern basis. This relates to the surplus capital that they hold on a voluntary basis above the capital requirements and the combined buffer requirements (CBRs), which must always be met using CET1. However, many banks do not have access to lower-quality capital components such as, for instance, additional tier 1 (AT1) capital[7] to absorb losses until they become insolvent (gone concern). These capital components are therefore not usable on a going concern basis. It is consequently usually possible to counter the procyclicality of lending in stress situations only if CET1 reserves in the banking system are used.

The starting point in step t=1 of the sequence of the monitoring tool are therefore banks' CET1 reserves [1.1.a]. These are determined based on the data from the Common Reporting Framework (COREP). The CET1 reserves are calculated as the difference between a bank's CET1 ratio [1.1.b] and the bank-specific CET1 minimum requirements in the starting situation [1.1.c]. The CET1 reserves consequently contain the combined buffer requirements and the surplus capital that banks hold voluntarily above the combined buffer requirements and bank-specific minimum requirements. The combined buffer requirements can be calculated from the sum of the capital conservation buffer (CCoB), which is 2.5% for all banks, the buffer for global/other systemically important institutions (G-SII/O-SII buffer) and the institution-specific ratio of the countercyclical capital buffer (CCyB).[8] The bank-specific minimum requirements as a percentage of RWAs are calculated from four components [1.1.c]: all banks must hold 4.5% of their RWAs in CET1 capital as a minimum requirement. In addition, the bank-specific minimum requirements for CET1 under Pillar 2 (P2R) must be met, as a failure to meet these requirements can also involve supervisory sanctions.[9] Finally, capital requirements to be fulfilled in AT1/T2[10] must also be taken into consideration, as they can have an impact on the CET1 to be held by banks: Banks have an AT1/T2 gap if they have insufficient AT1 or T2 capital to meet their AT1/T2 minimum requirements. In this case, they must close the gap using CET1 capital.

[7] The threshold specified in the CRR as of which AT1 instruments are converted into capital is 5.5% of RWAs. For most banks, however, the CET1 minimum requirements which, if breached, result in supervisory consequences are higher than that.

[8] German banks are not currently subject to the systemic risk buffer or to a CCoB that is raised via Article 458 of the CRR.

[9] The P2R reform of March 2020 is taken into consideration, in other words, banks under the supervision of the Single Supervisory Mechanism (SSM) must likewise now only meet their P2R with at least 56.25% CET1, rather than 100% previously. Banks that are not under the supervision of the SSM only had to meet their P2R with at least 56.25% CET1 even beforehand. A further 18.75% of the P2R has to be met at least with AT1, and the remaining 25% of P2R must be met with at least T2.

[10] T2 refers to supplementary or tier 2 capital.

The risk-weighted minimum AT1 requirement in the starting situation t=1 is the sum of 1.5% of the RWAs that all banks have to meet equally and the bank-specific P2R requirement for AT1 [1.1.c.i]. From mid-2021, every bank must also maintain, alongside the minimum requirements as a percentage of RWAs, a minimum requirement of 3% of the leverage ratio exposure measure (LREM) in the form of T1. The capital held to meet the risk-weighted minimum requirement for CET1 and AT1 can be counted towards this requirement. If the nominal T1 requirement in € that results from the leverage ratio (LR) exceeds the amount of the nominal minimum requirement of CET1 in €, the difference between the two terms represents the AT1 minimum requirement resulting from the leverage ratio. If, meanwhile, the AT1 ratio as a percentage of a bank's RWAs is insufficient to meet the respective AT1 minimum requirement, the bank must use CET1 to make up the difference. The AT1 gap per bank is then calculated from the maximum shortfall in the risk-weighted and the non-risk-weighted view. If, by contrast, a bank has sufficient AT1, its AT1 gap is zero. The T2 gap in the starting situation t=1 is derived, as described in [1.1.c.ii], from the difference between the T2 minimum requirements and the sum of T2 as a percentage of RWAs and the surplus AT1 as a percentage of RWAs that the bank voluntarily holds above its risk-weighted AT1 minimum requirement [1.1.c.iii]. As there is no non-risk-weighted minimum requirement for T2, the T2 minimum requirement only calls for banks to hold 2% of RWAs, which all banks must meet, and the bank-specific P2R requirement for T2.

Formula box:[11] step 1

[1.1.a]

$$CET1_{t=1}^{Reserves} = CET1_{t=1}^{Ratio} - CET1_{t=1}^{Min}$$

[1.1.b]

$$CET1_{t=1}^{Ratio} = \frac{CET1_{t=1}}{RWAs_{t=1}}$$

[1.1.c]

$$CET1_{t=1}^{Min} = 4.5\% + P2R^{in\ CET1} + AT1_{t=1}^{Gap} + T2_{t=1}^{Gap}$$

[1.1.c.i]

$$AT1_{t=1}^{Gap} = max \begin{cases} (1.5\% + P2R^{in\ AT1}) - \frac{AT1_{t=1}}{RWAs_{t=1}} \\ (\frac{3\% * LREM_{t=1}}{RWAs_{t=1}} - 4.5\% - P2R^{in\ CET1}) - \frac{AT1_{t=1}}{RWAs_{t=1}} \\ 0 \end{cases}$$

[1.1.c.ii]

$$T2_{t=1}^{Gap} = max \begin{cases} (2\% + P2R^{in\ T2}) - (\frac{T2_{t=1}}{RWAs_{t=1}} + \frac{AT1_{t=1}^{Surplus}}{RWAs_{t=1}}) \\ 0 \end{cases}$$

[1.1.c.iii]

$$AT1_{t=1}^{Surplus} = max \begin{cases} \frac{AT1_{t=1}}{RWAs_{t=1}} - (1.5\% + P2R^{in\ AT1}) \\ 0 \end{cases}$$

| | |
|---|---|
| $t$ | Index for the step within the monitoring tool sequence |

[11] For ease of readability, the bank-specific index is not listed in formula boxes 1-5.

## 2.2 Capital depletion through first round

In step 2, the CET1 reserves are compared to the capital depletion that results from the first-round effects in the stress scenarios. The first-round effects are based on a number of modules and cover the relevant stress channels within the receivables portfolios $i$ for German banks.[12] The scenarios differ in terms of the severity of their stress assumptions. The CET1 reserve as a percentage of RWAs declines in the first round if the CET1 ratio drops or the minimum capital requirement in CET1 as a percentage of RWAs rises. The CET1 ratio, in turn, drops if RWAs rise (denominator effect) or capital declines (numerator effect). The CET1 minimum requirement changes because the losses and the rise in RWAs have an impact on the AT1/T2 gap.

As a rule, modules with first-round effects can be flexibly integrated into the monitoring tool. This allows an analysis of individual, isolated effects as well as holistic scenarios as long as two conditions are met. First, there must be an effect on capital or on RWAs, for instance as a result of rising risk weights. Second, it must be possible to clearly map the effects to the different COREP exposure classes. The remainder of this paper will focus on the most important channels for the German banking system in order to analyse the effects of the COVID-19 pandemic. The first-round effects are differentiated into modules on capital depletion resulting from losses and increases in RWAs and capital increase modules. Subsequently, their impact on CET1 reserves is described. The following modules on first-round effects are taken into consideration:

- Use of irrevocable credit commitments (drawdown of credit lines) by enterprises;
- losses from exposures to enterprises ("corporates");
- losses from exposures in real estate-secured retail business;
- losses from market risk;
- increase in risk weights for default risk in the exposure class "corporates";
- increase in risk weights for default risk in the exposure class "non-real estate-secured retail business";
- increase in risk weights for default risk in the exposure class "real estate-secured retail business";
- foreseeable capital issuance.

<u>*Capital depletion modules*</u>

Because enterprises **make use of credit commitments**, banks' exposures increase in the first round. The additional exposures to enterprises in exposure class $i_1$ are subject to default risk. It leads to capital depletion both immediately and in subsequent modules. One way for enterprises to receive loans even in periods of stress is to make use of irrevocable credit commitments (alternatively referred to as drawdown of credit lines), which are reported at the bank-corporate sector level in the German central credit register. Enterprises have already negotiated these credit commitments before the crisis and can draw on them at any time as

[12] Less relevant stress channels such as the impact of the increase in RWAs for market risk or the increase in RWAs for clearing member banks on contributions to the CCPs' default fund and on the net trading position versus CCPs are disregarded in this paper.

needed. The level of $\alpha^j$, i.e. the proportion of credit lines which enterprises in sector j draw down, depends on two factors. The more the enterprises in a sector are affected by the crisis, as measured by sales development per sector compared with other sectors, and the lower their cash reserves in proportion to fixed costs, the higher $\alpha^j$ will be.[13] If credit lines are drawn down, the bank's exposures increase. These exposures are subject to credit risk of the "corporates" exposure class [2.1.a]. Since the credit lines are already counted as an exposure amount in line with their conversion factor $CF^{EAD\ in\ i_1}$ even before being drawn down, only the remaining part is additionally counted as an unsecured exposure subject to credit risk (exposure at default, or EAD). The conversion factor is dependent on the residual maturity $r$ of the committed, irrevocable credit line and on whether it is being applied to a CRSA or IRB exposure [2.1.a.i]. The increase in exposures to enterprises in t=2 then derives from the part of the exposure amount not yet counted, which results from the drawdown of the credit line.[14] Drawn-down credit lines lead to direct capital depletion, because RWAs have to be formed for the part of the exposure amount not previously counted. Hence, RWAs increase even if the risk weight underlying the credit commitment remains constant.

There is capital depletion in the first round per bank, as **losses from exposures to enterprises** (exposure class $i_1$) occur. The rationale behind these stress effects and their modelling follows Memmel and Roling (2021). To embed the results in the monitoring tool, these are assigned to the "corporates" exposure class $i_1$ (COREP). The increase in credit losses in $i_1$ per bank then comprises the loss rates (lr) per sector and the bank-specific exposures to these sectors in t=2 – that is, including the drawn-down credit lines [2.1.b].[15] Account is also taken of government-guaranteed promotional loans that were granted, such as by the KfW Group. These formed part of the government support measures taken in response to the COVID-19 pandemic. Since the government is liable for up to 100% of these promotional loans, the government-guaranteed amount per bank is deducted from their stock of outstanding corporate loans to the respective sector. The increase in loss rates is based on how severely the sector was affected by the crisis:[16] the sectors are divided into "strongly affected" and "less strongly affected" on the basis of data on current sales developments among German enterprises [2.1.b.i]. If sales development is at or above the median of all sectors for which sales development figures are known, the sector is assessed as "less strongly affected". If sales growth is below the median, the sector is considered "strongly affected". If no sales development figures are known for a given sector, the binary variable $Affected^j$ is applied on the basis of other information or expertise.

There is capital depletion in the first round owing to **losses from exposures in real estate-secured retail business** (exposure class $i_3$)**.** The rationale behind these stress effects and their modelling follows Barasinska et al. (2019). To embed the results in the monitoring tool,

[13] Jimenez, Lopez and Saurina (2009) show that credit commitments are used more by enterprises that end up not being able to repay the resultant claims.

[14] Credit commitments that are not used remain, as before, in t=2 in total exposures to enterprises proportionally in line with their conversion factor.

[15] In contrast to $Exposures_{t=2}^{in\ i_1}$ determined in [2.1.a], the sector-specific exposures $Exposures_{t=2}^{in\ i_1\ vs.j}$ of a bank in $i_1$ also contain the secured part of the exposure amount.

[16] An example of the precise design of the assumptions is given in Section 3.

these are assigned to the exposure class “real estate-secured retail business” in $i_3$ (COREP). Credit losses for residential real estate loans are derived from the empirical relationship between the probability of default (PD) and loss given default (LGD) as well as the level of a bank’s exposures in $i_3$ [2.1.c]. The stress parameters PD and LGD depend on the projected development of residential real estate prices and the unemployment rate (UR) [2.1.c.i]. In addition, it is assumed for the purposes of the monitoring tool that the underlying scenarios materialise within a period of up to two years. This is consistent with the other modules in steps 2 to 5.

There is capital depletion in the first round owing to **losses from market risk**. The rationale behind the losses caused by declines in market prices and their modelling follows Falter et al. (2021). Based on a market risk scenario comprising adverse developments in interest rates, spreads and equity prices, the losses are the sum of losses in the trading book and in the banking book [2.1.d]. Losses in the trading book are approximated using the historical distribution of trading loss ratios. Losses in the banking book are computed on the basis of granular data on the securities portfolios in banks’ banking books for which the risk parameters lead to revaluation [2.1.d.i].[17] For losses in the trading book, the entire trading book is taken into account, i.e. including the extent to which banks hold derivatives positions. For losses in the banking book, however, derivatives are not considered, which means these tend to be estimated conservatively.

There is capital depletion in the first round because the **risk weights for default risk in the exposure class “corporates” $i_1$ increase**. A bank’s average risk weight for exposures to enterprises after first-round effects is computed as follows: both IRB and CRSA exposures are multiplied by the risk weights and totalled. They are then expressed as a ratio of their unweighted amount [2.1.e].[18] The stock of exposures to enterprises in t=2 takes into account the drawdown of credit lines, which are allocated pro rata to IRB and CSRA exposures on a bank-specific basis. The rationale behind the increase in risk weights for IRB corporate exposures and the modelling follows Memmel and Roling (2021). To embed the results in the monitoring tool, the effects are assigned to the “IRB corporate exposures” exposure class (COREP).[19] In the stress test, a PD is calculated which derives from a function of the historical distribution of loss rates for the different sectors j. The PD is translated into an increase in risk weights using regulatory requirements [2.1.e.i]; the average LGDs lie between 30% and 40% depending on the sector.[20] For the average risk weights for CRSA corporate exposures, it is assumed that these are a function of the historical distribution of bank-specific average risk weights in the CRSA [2.1.e.ii].

There is capital depletion in the first round because the **risk weights for default risk in non-real estate-secured retail business (exposure class $i_2$) increase.** A bank’s average risk

[17] Banks hold equity capital (e.g. shares) and debt capital (e.g. bonds) as well as fund units in their banking book.

[18] The terms $Exposures_{t=2}^{in\ i_1(IRBA)}$ and $Exposures_{t=2}^{in\ i_1(CRSA)}$ only contain the EAD, i.e. the part of overall exposures to enterprises that is exposed to credit risk. There is thus no need to adjust for the government-guaranteed portion of the promotional loan.

[19] Exposures to large corporates in the financial sector (e.g. insurers) and unsupervised financial corporations, which are also included in the corporates exposure class (COREP), account for only a small proportion of less than 5%. The average risk weight for these exposures, at around 45%, is also similar in size to the average risk weight for the entire IRB corporates exposure class.

[20] Based on data from the German central credit register.

weight for exposures in non-real estate-secured retail business after first-round effects is computed as follows: both IRB and CRSA exposures are multiplied by the risk weights and totalled. They are then expressed as a ratio of their unweighted amount [2.1.f]. For the average risk weights for exposures in both CRSA and IRB non-real estate-secured retail business, it is assumed that these take on a certain value from the historical distribution of bank-specific average risk weights [2.1.f.i and 2.1.f.ii]. Since there is no increase in exposures in this exposure class, the stock of exposures in t=2, to which the risk weights after the first round refer, is the same size as in the starting situation t=1.

There is capital depletion in the first round because the **risk weights for default risk in real estate-secured retail business (exposure class $i_3$) increase.** A bank's average risk weight for exposures in real estate-secured retail business after first-round effects is computed as follows: both IRB and CRSA exposures are multiplied by the risk weights and totalled. They are then expressed as a ratio of their unweighted amount [2.1.g]. The stressed risk weights depend on the PD and LGD in the case of IRB exposures [2.1.g.i], and depend on the loan-to-value (LTV) ratio in the case of CRSA exposures [2.1.g.ii]. The rationale behind the increase in risk weights and the modelling is described in module box A (appendix). Since there is no increase in exposures in this exposure class, the stock of exposures in t=2, to which the risk weights after the first round refer, is the same size as at the starting point t=1.

*Capital increase modules*

There is a capital increase when **capital issuance** is **foreseeable** for a bank. Capital issuance that has been announced or already conducted and not yet recognised in regulatory capital is considered here. If the issuance is foreseeable at starting point t=1, the capital will be credited to the bank for t=2. The underlying assumption is that announced capital issuance will be fully subscribed. Where CET1 is being issued, this directly results in an increase in CET1 reserves [2.2.b.i]. Where AT1 or T2 capital is being issued, this may result in a smaller AT1/T2 gap in t=2 and can consequently likewise increase CET1 reserves [2.2.c.i and 2.2.c.ii]. The monitoring tool does not currently take into account other capital increases, e.g. from the retention of profit for the financial year. This is in line with a conservative approach when recognising profits for the financial year.

*CET1 reserves after first round*

The overall result of the individual capital depletion and capital increase modules is a change in the CET1 ratio and CET1 minimum requirements of banks. This in turn affects the CET1 reserves [2.2.a]. The bank-specific CET1 ratio is initially determined in t=2 [2.2.b]. A bank's CET1 in the numerator of this ratio derives from CET1 in the starting situation t=1, plus potential capital increases for CET1 and minus losses from exposure classes $i_1$ and $i_3$ as well as losses from market risk [2.2.b.i] resulting from first-round effects. To determine the overall effect on RWAs in t=2 [2.2.b.ii], the balance sheet effect of losses must first be considered. On the assets side, the stock of unsecured exposures per exposure class is reduced, as credit defaults occur. RWAs in t=2 can then be calculated by multiplying the stressed risk weights of the three exposure classes by the respective stock of unsecured exposures minus losses, where the stock of exposures in t=2 matches that of the starting point with the exception of $i_1$ (due to credit lines being drawn). Finally, the sum of RWAs in the three exposure classes is added up with the starting situation RWAs deriving from other risks.[21]

The second component to determining CET1 reserves after the first round is the bank-specific CET1 minimum requirements [2.2.c]. As at the starting point in t=1, these are derived from 4.5% of RWAs plus the bank-specific minimum requirements for CET1 from the P2R as well as the AT1 and T2 gap. While the 4.5% and the requirements from the P2R as a ratio of RWAs are constant, the AT1/T2 gaps as a ratio of RWAs after first-round effects can take on a different value in t=2. As described in [2.2.c.i] and [2.2.c.ii], the stock of AT1 or T2 plus excess AT1, which the bank voluntarily holds over and above its AT1 minimum requirement, in relation to RWAs in t=2 is deducted from both the risk-weighted requirements $(1.5\% + P2R^{in\ AT1})$ and $\left(2\% + P2R^{in\ T2}\right)$ and the non-risk-weighted AT1 requirement $(\frac{3\% * LREM_{t=2}}{RWAs_{t=2}} - 4.5\% - P2R^{in\ CET1})$. If the sum of first-round effects results in an increase (decrease) in RWAs and if in addition no issuance of AT1 or T2 is foreseeable, the ratio of AT1/T2 and excess AT1[22] to RWAs falls (rises) and the AT1/T2 gap widens (narrows) ceteris paribus in t=2. The non-risk-weighted AT1 requirement can also change in t=2 owing to its dependence on the quotient of the LREM and RWAs, producing new values for both the numerator and denominator. As depicted in [2.2.c.iii], the LREM in t=2 is derived from the LREM at the starting point t=1 plus the portion of the corporate exposure amount not yet counted arising from the drawdown of irrevocable credit commitments taking into account the conversion factors,[23] minus the losses incurred in the first round.[24] If the ratio of the LREM to RWAs in t=2 as against the starting point in t=1 has fallen (risen), the unweighted AT1 requirements decrease (increase) and, ceteris paribus, the AT1 gap narrows (widens). If on account of first-round effects there is a comparatively strong increase in RWAs and a concurrent less strong increase or decrease in the LREM, this can even lead to a lower unweighted AT1 requirement and higher weighted AT1 requirement for a bank after the first round in t=2.

Formula box: step 2

[2.1.a]

$$Exposures_{t=2}^{in\ i_1} = Exposures_{t=1}^{in\ i_1} + \sum_j (\alpha^j * (1 - CF^{EAD\ in\ i_1}) * Irrevocable\ credit\ commitment^j)$$

[2.1.a.i]

$$CF^{EAD\ in\ i_1} = \begin{cases} 0.2, & in\ CRSA\ with\ r \leq 1\ year \\ 0.5, & in\ CRSA\ with\ r > 1\ year \\ 0.75, & in\ IRBA \end{cases}$$

[2.1.b]

$$Losses^{\ in\ i_1} = \sum_1^j lr^{Affected^j=1} * \left(Exposures_{t=2}^{in\ i_1\ to\ j} - Promotional\ loans^{to\ j\ gov.guaranteed}\right) + \sum_1^j lr^{Affected^j=0} * \left(Exposures_{t=2}^{in\ i_1\ to\ j} - Promotional\ loans^{to\ j\ gov.guaranteed}\right)$$

[2.1.b.i]

---

[21] For example, these can be RWAs for market risk or operational risk.

[22] Calculated as described in [1.1.c.iii] but with input parameters from t=2.

[23] Since it makes no difference for the LREM whether it is an IRB or CRSA exposure, the conversion factor depends solely on the residual maturity of the committed, irrevocable credit line. If this is one year at the most, the conversion factor is 20%; otherwise, it is 50%.

[24] The portion of a defaulted exposure that is not written off, which can arise from the realisation of loan collateral, remains on the bank's balance sheet and is counted toward the LREM in full.

$$Affected^j = \begin{cases} 1, if\ \Delta sales^j < median(\Delta sales^j) \\ 0, if\ \Delta sales^j \geq median(\Delta sales^j) \end{cases}$$

[2.1.c]

$$Losses^{in\ i_3} = f(PD^{i_3}; LGD^{i_3}; Exposures^{in\ i_3})$$

[2.1.c.i]

$$PD^{i_3} = f(UR; residential\ RE\ prices)$$
$$LGD^{i_3} = f(residential\ RE\ prices)$$

[2.1.d]

$$Losses^{market\ risk} = Losses^{banking\ book} - Min\left(\frac{Trading\ result}{Trading\ book}\right)^{historical} * Trading\ book$$

[2.1.d.i]

$$Losses^{banking\ book} = f(interest\ rates, spreads, equity\ prices, banking\ book)$$

[2.1.e]

$$RW^{in\ i_1} = \frac{\left(RW^{\ in\ i_1(IRBA)} * Exposures_{t=2}^{in\ i_1(IRBA)} + RW^{\ in\ i_1(CRSA)} * Exposures_{t=2}^{in\ i_1(CRSA)}\right)}{Exposures_{t=2}^{in\ i_1(IRBA)} + Exposures_{t=2}^{in\ i_1(CRSA)}}$$

[2.1.e.i]

$$RW^{\ in\ i_1(IRBA)} = f\left(PD^{i_1(IRBA)}\right) = \sum_{1}^{j} f(\ lr^j\ )^{historical}$$

[2.1.e.ii]

$$RW^{\ in\ i_1(CRSA)} = f\left(RW^{\ in\ i_1(CRSA)}\right)^{historical}$$

[2.1.f]

$$RW^{in\ i_2} = \frac{\left(RW^{\ in\ i_2(IRBA)} * Exposures_{t=2}^{in\ i_2(IRBA)} + RW^{\ in\ i_2(CRSA)} * Exposures_{t=2}^{in\ i_2(CRSA)}\right)}{Exposures_{t=2}^{in\ i_2(IRBA)} + Exposures_{t=2}^{in\ i_2(CRSA)}}$$

[2.1.f.i]

$$RW^{\ in\ i_2(IRBA)} = f\left(RW^{\ in\ i_1(IRBA)}\right)^{historical}$$

[2.1.f.ii]

$$RW^{\ in\ i_2(CRSA)} = f\left(RW^{\ in\ i_1(CRSA)}\right)^{historical}$$

[2.1.g]

$$RW^{in\ i_3} = \frac{\left(RW^{\ in\ i_3(IRBA)} * Exposures_{t=2}^{in\ i_3(IRBA)} + RW^{\ in\ i_3(CRSA)} * Exposures_{t=2}^{in\ i_3(CRSA)}\right)}{Exposures_{t=2}^{in\ i_3(IRBA)} + Exposures_{t=2}^{in\ i_3(CRSA)}}$$

[2.1.g.i]

$$RW^{in\ i_3\ (IRBA)} = f\ (PD^{i_3}; LGD^{i_3})$$

[2.1.g.ii]

$$RW^{in\ i_3\ (CRSA)} = f\ (LTV^{i_3})$$

[2.2.a]

$$CET1_{t=2}^{reserves} = CET1_{t=2}^{ratio} - CET1_{t=2}^{minimum\ requirements}$$

[2.2.b]

$$CET1_{t=2}^{ratio} = \frac{CET1_{t=2}}{RWAs_{t=2}}$$

[2.2.b.i]

$$CET1_{t=2} = CET1_{t=1} + CET1^{increase} - Losses_{t=2}^{in\ i_1} - Losses_{t=2}^{in\ i_3} - Losses_{t=2}^{market\ risk}$$

[2.2.b.ii]

$$RWAs_{t=2} = RWAs_{t=1}^{other\ risks} + \sum_{i_1}^{i_3}(RW_{t=2}^{in\ i} * (Exposures_{t=2}^{in\ i} - Losses_{t=2}^{in\ i}))$$

[2.2.c]

$$CET1_{t=2}^{minimum\ requirements} = 4.5\% + P2R^{in\ CET1} + AT1_{t=2}^{gap} + T2_{t=2}^{gap}$$

[2.2.c.i]

$$AT1_{t=2}^{gap} = max \begin{cases} (1.5\% + P2R^{in\ AT1}) - \frac{(AT1_{t=1} + AT1^{increase})}{RWAs_{t=2}} \\ (\frac{3\% * LREM_{t=2}}{RWAs_{t=2}} - 4.5\% - P2R^{in\ CET1}) - \frac{(AT1_{t=1} + AT1^{increase})}{RWAs_{t=2}} \\ 0 \end{cases}$$

[2.2.c.ii]

[2.2.c.iii]

$$T2_{t=2}^{gap} = max \begin{cases} (2\% + P2R^{in\,T2}) - (\frac{(T2_{t=1} + T2^{increase})}{RWAs_{t=2}} + \frac{AT1_{t=2}^{excess}}{RWAs_{t=2}}) \\ 0 \end{cases}$$

$$LREM_{t=2} = \left( LREM_{t=1} + \alpha^{j} * (1 - CF^{LREM}) * Irrevocable\ credit\ commitments^{j} - \sum_{i_1}^{i_3} Losses_{t=2}^{in\ i} - Losses_{t=2}^{market\ risk} \right)$$

| | |
|---|---|
| $i_1$ | Exposure class: corporates |
| $i_2$ | Exposure class: non-real estate-secured retail business |
| $i_3$ | Exposure class: real estate-secured retail business |
| $t$ | Index to step within the monitoring tool sequence |

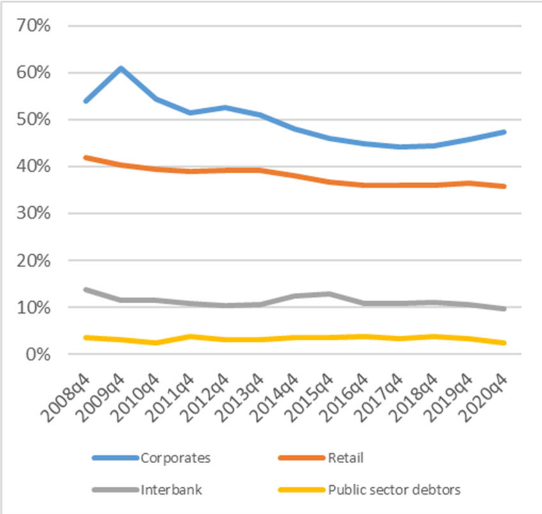
## 2.3 Deleveraging

Step 3 of the monitoring tool estimates **deleveraging in the German banking system**. This deleveraging occurs because banks fall short of their bank-specific target capital ratios following first-round effects.[25] Deleveraging means that banks shrink their balance sheets. The ways in which banks may do this are outlined, for example, in European Central Bank (2012). In the monitoring tool, banks shrink their balance sheets by allowing loans with a residual maturity of less than one year to expire and not relending this loan volume. This requires loans that are not renewed automatically and are not pledged. Banks can also sell marketable assets (Level 2 assets) as long as they maintain a target ratio for the liquidity coverage ratio (LCR). The data for calculating the results in this step come from the Common Reporting Framework (COREP). The intention behind shrinking a balance sheet is to stabilise the bank-specific capital ratio in case it falls below the previously defined target following first-round stress. Taking on new equity capital, which could likewise stabilise the capital ratio, would be difficult for banks in times of stress owing to higher risk premia. It is therefore assumed that no further equity capital will be taken up save for the foreseeable capital issuances considered in step 1. In line with steps 2, 4 and 5 of the monitoring tool, it is assumed that the results of this step will be seen within a time frame of up to two years.

For deleveraging, the monitoring tool assumes that banks follow a specific order when reducing their exposures if their equity ratio falls below the target ratio owing to losses and rising RWAs. First, banks reduce their stock of loans to enterprises (including commercial real estate loans), they then sell free Level 2 assets, and finally they cut back on retail business. This assumption ensures that banks prioritise reducing their RWAs when under stress. By first reducing exposures with relatively high risk weights and short maturities, banks are able to restore their target capital ratios. At the same time, by scaling down RWAs in the corporate and retail exposure classes and marketable assets, they can partially withdraw from business areas where the risks are growing the most depending on the assumed stress scenarios. Other exposure classes and Level 1 assets[26] are not drawn on for deleveraging as only a comparatively small amount of RWAs can be reduced in this case owing to their lower RWA densities (Figure 3).

[25] The fact that banks decide on bank-specific target capital ratios can be found extensively throughout the literature (Berger et al., 2008; De Jonghe and Öztekin, 2015; De-Ramon, Francis and Harris, 2016; Jokipii and Milne, 2011).
[26] Compared to the assumed risk weight of 10% for Level 2 assets, Level 1 assets have lower risk weights, if any risk weight at all.

Figure 3: RWA densities of the largest exposure classes aggregated across all German banks




Note: The RWA density is calculated as the ratio of risk-weighted assets (RWAs) to their respective gross exposures, weighted by their share in the CRSA and IRBA portfolios. In addition, it is taken into account that, in the IRBA, regulatory provisioning adjustments are made to the capital that must be held.

The results of a regression analysis as shown in equation [3.0] also indicate that banks reduce the share of their corporate exposures in particular when their equity ratios come under pressure. The analysis considers the change in the share of the exposures in z-3, i.e. the quarter before the surplus capital comes under pressure, against z, corresponding to two quarters after the surplus capital came under pressure.[27] This specification is justified by the fact that banks cannot react immediately to a decline in the surplus capital by shrinking their balance sheets from one quarter to the next; instead, this process may span multiple quarters. The model takes account of this fact by considering the change over three quarters. The autocorrelation of error terms that result owing to the construction of the dependent variable is taken into account using Newey-West standard errors. Banks' profitability, refinancing behaviour and risk propensity are included in the regression as control variables as these factors could influence a potential deleveraging scenario.[28] The model's estimation shows that, for the corporate exposure class alone, the ratio to total exposures declines across all definitions of capital pressure (based on CET1, T1 and TC (total capital)), although the results are only statistically significant at a level of 1% for T1 and TC.[29] According to these results, banks in the sample reduce the ratio of their corporate exposures to total exposures on

[27] It should be borne in mind that, in this specification, the surplus capital may decline due to falling capital ratios caused by losses and a rise in RWAs but also because of rising capital requirements.

[28] The averages for each bank across the entire observation period are used for these variables.

[29] As the capital class CET1 has only formally existed since 2014, for this classification there are only a small number of observations for which the surplus capital comes under pressure. This could be one reason that explains the lack of significance. The results remain robust for the other two capital classes if the criterion for the binary variable capital pressure $_{z-2}$ is specified for the bank's surplus capital in z-2 amounting to a maximum of one or three percentage points.

average by 0.66 (T1) or 0.50 (TC) percentage point in one quarter. This effect is also economically significant as it is certainly not unusual for banks' capital to come under pressure over multiple quarters in the event of a systemic crisis and this could result in larger cumulative effects.

[3.0]

$$\Delta \text{Exposures}_{b,z,i} = \boldsymbol{\alpha} + \boldsymbol{\beta}(\text{Capital pressure}_{b,z-2}) + \boldsymbol{\delta}(X_b) + \boldsymbol{\varepsilon}_{b,z}$$

| | |
|---|---|
| $\Delta \text{Exposures}_{z,i}$ | Change in the share of exposures in exposure class i to total exposures for the period between z-3 and z for bank b. Four exposure classes are considered with i={corporates, retail, interbank, public sector debtors}. |
| Capital $\text{pressure}_{z-2}$ | Binary variable that assumes the value 1 if the bank's surplus capital (defined as the difference between the capital ratio and all regulatory capital requirements including the combined buffer requirements; for CET1, T1 and TC) in z-2 does not exceed 2 percentage points and the surplus capital is lower than 50% of the average surplus capital of the bank across the total observation period. |
| $X_b$ | Vector of bank-specific control variables: RoA; loan-to-deposits ratio; a binary variable that assumes the value 1 for the banks with average RWA densities in the upper 10th percentile over the observation period. |

To calculate the balance sheet reduction, the bank-specific deleveraging potential in terms of RWAs is derived first. To this end, the following exposure volume in t=2 is calculated in the corporates ($i_1$), non-real estate-secured ($i_2$) and real estate-secured ($i_3$) retail business exposure classes: loans that are not renewed automatically, that are not pledged and that have a residual maturity $m$ of less than one year. This exposure volume is multiplied by the risk weights after the first round [3.1.a]. The losses from the first round are applied pro rata to the stocks of loans with short residual maturities. There is no information on the maturities of exposures arising from the drawdown of irrevocable lending commitments by enterprises in t=2. Furthermore, the lending commitments tend not to be used at the start but only up to two years into the observation horizon. They are therefore assigned to the loans that have a residual maturity of more than one year. The potential deleveraging in RWA terms through free (unused), liquid Level 2 assets[30] assigned to the exposure class $i_4$ is also added. This is calculated by multiplying the stock of free, liquid Level 2 assets by a risk weight of 10% [3.1.a.i].[31] The stock of free, liquid level 2 assets is calculated as set out in [3.1.a.ii]: the losses from the first round in t=2 that affect these assets are deducted from excess, i.e. voluntary, liquid Level 2 assets ("surplus"). The liquid Level 2 assets are valued at market value ($MW$). Valuation at market value is calculated by using the case-specific add-ons to the value of the assets described in [3.1.a.iii] and pursuant to Article 9 of the Delegated Regulation,[32] which provides for the inclusion of haircuts ($V9$).[33] This in turn is based on the minimum arising from

[30] Level 2 assets include securities claims such as shares or bonds.
[31] The risk weights for Level 2 assets are assumed to be 10% even in a stress scenario (Basel Committee on Banking Supervision, 2013).
[32] See Commission Delegated Regulation (EU) 2021/424 amending the Capital Requirements Regulation (CRR).
[33] For LCR purposes, highly liquid assets are split into Level 1 assets and less liquid Level 2 assets. The latter can only make up a maximum of 40% of the stock of highly liquid assets. In turn, Level 2 assets are divided into Level 2A assets and Level 2B assets which, according to certain eligibility criteria, may be counted towards liquid assets at the discretion of national supervisory authorities. The assets are then given different haircuts to take account of their degree of liquidity in stress situations. Level 2A assets are subject to a haircut of 15%, while the haircuts for Level 2B assets may vary depending on the type of security (Basel Committee on Banking Supervision, 2013).

the total stock of liquid Level 2 assets and excess liquid assets, taking account of haircuts in each case, as described in [3.1.a.iv]. The excess liquid assets after the inclusion of haircuts is calculated according to [3.1.a.v] from the total amount of excess liquid assets[34] and from the liquid assets held voluntarily above the target LCR of 110% [3.1.a.vi]. Consistent with the capital requirements, it is assumed that banks will also strive for a target LCR that is slightly above the regulatory minimum of 100%.

After this, the target value for deleveraging on the part of banks that fall short of their target capital ratios after the first round is calculated. As the Capital Requirements Regulation (CRR) – with the introduction of the leverage ratio – provides for a second, parallel capital requirement to T1 to be fulfilled from mid-2021 in addition to the risk-weighted requirements for CET1, two target values are calculated for capital ratios [3.1.b]. The target value as a percentage of RWAs is determined by the target ratio for CET1, which is calculated using the risk-weighted requirement. If the CET1 ratio falls below the target ratio for CET1 after the first round, the target value in RWA terms can be calculated as the difference between the stock of RWAs in t=2 and the stock of RWAs allowed by the intended target capital ratio with a set CET1 from t=2. The result equals the RWAs that a bank has to deleverage in order to achieve the intended target capital ratio. If the CET1 ratio lies above the target ratio after the first round, the target value for deleveraging is zero. At the same time, the target value for the exposure amount, which is counted in full towards the leverage ratio (LREM), is calculated in an identical manner using the target ratio for T1 derived from the leverage ratio.

The monitoring tool is designed to now make a distinction between two worlds for each underlying first-round scenario [3.1.b.i] Each of these worlds represent corner solutions for banks' target ratios for CET1:

- **World with use of buffers:** Banks attempt to stabilise their capital ratios just above the risk-weighted minimum requirements. Banks therefore use their capital buffers as envisaged by macroprudential regulation. The risk-weighted target capital ratio is 1 percentage point[35] above the bank-specific minimum CET1 requirements after the first round.
- **World without use of buffers:** Banks do not use their buffers and aim for a target capital ratio equal to the risk-weighted minimum requirements plus the combined buffer requirements (CBR). This means that banks attempt to avoid falling short of their buffer requirements.

In both worlds, an unweighted target T1 ratio is assumed alongside the risk-weighted target CET1 capital ratio. The target ratio for unweighted capital requirements assumes the same value of 3.3% in both worlds. If the unweighted capital requirement exceeds the weighted one, the bank-specific target capital ratio increases and a bank would need to further reduce loan volume in order to reach it. In the following steps of the monitoring tool, the results for the two

[34] In terms of the total liquidity buffer, this amount makes up only a very small part of excess liquid assets.
[35] This assumption for the target capital ratio is justified by the fact that banks aim to stay above the minimum requirements. This would entail stricter supervisory measures up to and including the withdrawal of the bank's banking licence.

worlds (with and without buffers) can be compared. This yields information on the costs and benefits of using macroprudential capital buffers.

Lastly, actual deleveraging taking into account the target values from the risk-weighted CET1 requirement and the unweighted T1 requirement is determined. Deleveraging to both $CET1^{Target\ ratio}$ and $T1^{Target\ ratio}$ produce a congruent target value for RWAs and exposure volume, with the RWAs corresponding to the product of exposure volume and risk weight in t=2. Maximum actual deleveraging in terms of RWAs and exposure volume is then determined according to which requirement results in higher nominal requirements [3.1.c]. In the event that a bank undershoots its risk-weighted CET1 target ratio, this bank then reduces its RWA potential, taking into account the above defined order, until the appropriate target value for deleveraging is reached [3.1.c.i]. $h$ denotes the marginal individual exposure that needs to be deleveraged in order to reach the target value. Should the target value exceed the grand total of deleveraging potential, the bank reduces its total deleveraging potential. This would then be insufficient to restore the target capital ratio. Congruently, deleveraging in RWA terms is converted using the inverse of the risk weights in t=2 into deleveraging in exposure volume terms. Using the same method, deleveraging is determined for the event that a bank undershoots its T1 target ratio from the unweighted capital requirement [3.1.c.ii]. Bearing in mind the defined order, exposures with a residual maturity of less than one year are reduced, and Level 2 assets are offloaded until marginal individual exposure $h$ and thus the target value for the unweighted exposure volume is reached. Multiplication by the risk weights per exposure class after the first round in t=2 yields the deleveraging in RWA terms in the event of a bank undershooting the T1 target ratio.

<u>*CET1 reserves after deleveraging*</u>

Based on the values determined in this manner, the CET1 reserves after deleveraging can then be derived from the difference between the CET1 ratio and the CET1 minimum requirements in t=3 [3.2.a]. The CET1 ratio in t=3 [3.2.b] increases if, compared with t=2, the denominator decreases by the amount $RWAs_{t=3}^{Deleveraging}$ [3.2.b.i]. Deleveraging also affects the CET1 minimum requirements. Again, the 4.5% and the requirements from the P2R as a ratio of RWAs are constant, while the AT1/T2 gaps as a ratio of RWAs after deleveraging can take on a different value in t=3 [3.2.c]. In the case of lower RWAs, the quotient of AT1 or T2 and AT1 surplus[36] to RWAs increases, whereby, ceteris paribus, the AT1 and T2 gaps after deleveraging shrink in t=3 [3.2.c.i. and 3.2.c.ii]. In addition, deleveraging affects the unweighted AT1 requirement as, in the same way as the RWAs, the LREM also decreases by the amount of the reduced exposures [3.2.c.iii]. If the ratio of LREM to RWAs in t=3 compared with the situation after the first round in t=2 has risen (fallen), the unweighted AT1 requirements increase (decrease) and the AT1 gap widens (narrows), ceteris paribus.

<u>Formula box: step 3</u>

[3.1.a]

$$RWAs^{Deleveraging\ potential} = \sum_{i_1}^{i_4} RWAs^{Deleveraging\ potential} = \sum_{i_1}^{i_3}(RW^{in\ i} * \sum_{i_1}^{i_3} Exposures_{t=2}^{i\ where\ m\leq 1\ year}) + RWAs^{Deleveraging\ potential\ in\ i_4}$$

[36] Calculated as described in 1.1.c.iii but with input parameters from t=3.

[3.1.a.i]

$$RWAs^{Deleveraging\ potential\ in\ i_4} = LL2As^{free} * RW^{in\ i_4}$$

[3.1.a.ii]

$$LL2As^{free} = LL2As^{Surplus\ MV} - Losses^{Market\ risks\ in\ L2A}$$

[3.1.a.iii]

$$LL2As^{Surplus\ MV} = \begin{cases} \frac{LL2As^{Surplus\ V9}}{0.50}, & if\ LL2As^{Surplus\ V9} \leq LL2BAs^{V9}\ and\ LL2As^{Surplus\ V9} \leq Equities^{V9} + Bonds^{V9} \\ \frac{LL2As^{Surplus\ V9}}{0.75}, & if\ LL2As^{Surplus\ V9} \leq LL2BAs^{V9}\ and\ LL2As^{Surplus\ V9} > Equities^{V9} + Bonds^{V9} \\ \frac{LL2As^{Surplus\ V9}}{0.85}, & if\ LL2As^{Surplus\ V9} > LL2BAs^{V9}\ and\ LL2As^{Surplus\ V9} \leq LL2AAs^{V9} \\ \frac{LL2AAs^{Surplus\ V9}}{0.85}, & if\ LL2As^{Surplus\ V9} > LL2BAs^{V9}\ and\ LL2As^{Surplus\ V9} > LL2AAs^{V9} \end{cases}$$ [37]

[3.1.a.iv]

$$LL2As^{Surplus\ V9} = min \begin{cases} LAs^{Surplus\ V9} \\ LL2As^{V9} \end{cases}$$

[3.1.a.v]

$$LAs^{Surplus\ V9} = LAs^{Surplus} + LAAs^{Surplus}$$

[3.1.a.vi]

$$LAs^{Surplus} = max \begin{cases} \frac{LCR - 110\%}{100\%} * Net\ outflow \\ 0 \end{cases}$$

[3.1.b]

$$RWAs^{Target\ deleveraging} = max \begin{cases} RWAs_{t=2} - \frac{CET1_{t=2}}{CET1^{Target\ ratio}} \\ 0 \end{cases}$$

$$\wedge$$

$$Exposures^{Target\ deleveraging} = max \begin{cases} LREM_{t=2} - \frac{T1_{t=2}}{T1^{Target\ ratio}} \\ 0 \end{cases}$$ [38]

[3.1.b.i]

$$CET1^{Target\ ratio} = \begin{cases} CET1^{Min}_{t=2} + 1\%, & with\ buffer\ use \\ CET1^{Min}_{t=2} + CET1^{Buffer}, & without\ buffer\ use \end{cases}$$

$$\wedge$$

$$T1^{Target\ ratio} = 3.3\%$$

[3.1.c]

$$RWAs^{Deleveraging} = max\left(\sum_{i_1}^{i_4} RWAs^{Deleveraging\ to\ CET1^{Target\ ratio}}; \sum_{i_1}^{i_4} RWAs^{Deleveraging\ to\ T1^{Target\ ratio}}\right)$$

$$\wedge$$

$$Exposures^{Deleveraging} = max\left(\sum_{i_1}^{i_4} Exposures^{Deleveraging\ to\ CET1^{Target\ ratio}}; \sum_{i_1}^{i_4} Exposures^{Deleveraging\ to\ T1^{Target\ ratio}}\right)$$

[3.1.c.i]

$$\sum_{i_1}^{i_4} RWAs^{Deleveraging\ to\ CET1^{Target\ ratio}} = \begin{cases} \sum_{i_1}^{i_4}\sum_{1}^{h} RWAs^{Deleveraging\ potential\ in\ i}, & if\ RWAs^{Deleveraging\ potential} \geq RWAs^{Target\ deleveraging} \\ \sum_{i_1}^{i_4} RWAs^{Deleveraging\ potential\ in\ i}, & if\ RWAs^{Deleveraging\ potential} < RWAs^{Target\ deleveraging} \end{cases}$$

$$\wedge$$

$$\sum_{i_1}^{i_4} Exposures^{Deleveraging\ to\ CET1^{Target\ ratio}} = \sum_{i_1}^{i_4} \frac{RWAs^{Deleveraging\ to\ CET1^{Target\ ratio}}}{RW^{in\ i}}$$

[3.1.c.ii]

$$\sum_{i_1}^{i_4} Exposures^{Deleveraging\ to\ T1^{Target\ ratio}} = \begin{cases} \sum_{i_1}^{i_4}\sum_{1}^{h} Exposures^{in\ i\ where\ m\leq 1\ year}, & if\ Exposures^{in\ i\ where\ m\leq 1\ year} \geq Exposures^{Target\ deleveraging} \\ \sum_{i_1}^{i_4} Exposures^{in\ i\ where\ m\leq 1\ year}, & if\ Exposures^{in\ i\ where\ m\leq 1\ year} < Exposures^{Target\ deleveraging} \end{cases}$$

$$\wedge$$

[37] A haircut of 75% is a conservative approximation, as in this case – depending on the bank – Level 2B assets could be liquidated with varying haircuts applied.

[38] The target ratios (i.e. $CET1^{Target\ ratio}$ and $T1^{Target\ ratio}$) are given as quotients.

$$\sum_{i_1}^{i_4} RWAs^{Deleveraging\ to\ T1^{Target\ ratio}} = \sum_{i_1}^{i_4}(Exposures^{Deleveraging\ to\ T1^{Target\ ratio}} * RW^{in\ i})$$

[3.2.a]

$$CET1_{t=3}^{Reserves} = CET1_{t=3}^{Ratio} - CET1_{t=3}^{Min}$$

[3.2.b]

$$CET1_{t=3}^{Ratio} = \frac{CET1_{t=2}}{RWAs_{t=3}}$$

[3.2.b.i]

$$RWAs_{t=3} = RWAs_{t=2} - RWAs^{Deleveraging}$$

[3.2.c]

$$CET1_{t=3}^{Min} = 4.5\% + P2R^{in\ CET1} + AT1_{t=3}^{Gap} + T2_{t=3}^{Gap}$$

[3.2.c.i]

$$AT1_{t=3}^{Gap} = max\begin{cases} (1.5\% + P2R^{in\ AT1}) - \frac{(AT1_{t=1} + AT1^{Gain})}{RWAs_{t=3}} \\ (\frac{3\% * LREM_{t=3}}{RWAs_{t=3}} - 4{,}5\% - P2R^{in\ CET1}) - \frac{(AT1_{t=1} + AT1^{Gain})}{RWAs_{t=3}} \\ 0 \end{cases}$$

[3.2.c.ii]

$$T2_{t=3}^{Gap} = max\begin{cases} (2\% + P2R^{in\ T2}) - (\frac{(T2_{t=1} + T2^{Gain})}{RWAs_{t=3}} + \frac{AT1_{t=3}^{Surplus}}{RWAs_{t=3}}) \\ 0 \end{cases}$$

[3.2.c.iii]

$$LREM_{t=3} = LREM_{t=2} - Exposures^{Deleveraging}$$

| | |
|---|---|
| $m$ | Residual maturity of exposure |
| $i_4$ | Exposure class in which Level 2 assets are contained. |
| $LAs, LL2As, LL2AAs\ and\ LL2BAs$ | Liquid assets total and according to level 2, 2A and 2B |
| $t$ | Index to step within the monitoring tool sequence |

## 2.4 Capital depletion through second-round effects

In step 4 of the monitoring tool, the depletion of capital reserves through second-round effects in the interbank market (exposure class $i_5$) is determined by means of an algorithm.[39] Before the algorithm starts, the matrix of bilateral interbank claims and liabilities is modified. It is assumed that, when reducing their balance sheets, borrowing banks D deleverage their short-term interbank liabilities (with maturities of up to one year) in line with their respective share in short-term total liabilities (excluding central bank refinancing). This reduction is reflected in the fact that the liabilities of borrowing banks D to their respective lending banks C decrease. The deleveraging of interbank liabilities of borrowing banks D is thus split pro rata between their lending banks C. The bilateral claims are based on reports to the German central credit register. They also contain information on the LGD. Information on the regulatory capital ratios and the leverage ratio is taken from the Common Reporting Framework (COREP).

In the first iteration step (k=1) of the algorithm, the values for the regulatory capital and for the RWAs from t=3 are used. The regulatory capital ratios for CET1 capital, tier 1 capital and total capital (TC) and the leverage ratio for borrowing banks D are updated ([4.1.a] and [4.1.b]). Should the capital ratios in t=3 no longer meet the regulatory minimum requirements of Pillar 1 and Pillar 2, the borrowing banks are considered failed, i.e. they are assigned a probability

[39] The algorithm is based on an expansion of the banking system loss model. The fundamentals of the model can be found in Fink et al. (2016). The expansions concern the functional relationship between the tier 1 capital ratio and probability of default of a bank and the criterion for a bank default that now takes into account all regulatory minimum requirements.

of default (PD) of 100%.[40] Should the borrowing bank meet the regulatory minimum requirements, the PD is updated by means of statistical methods [4.1.c].

The functional relationship between the CET1 capital ratio ($CapRat_{Cap=1}$) and the PD of the affected bank are determined using a cumulative loss function that is estimated from historical data. The loss distribution follows a logarithmic function and indicates the cumulative probability of the bank for a certain loss amount.[41] Specifying a predefined default point (in this case: $CapRat_{Cap=1}$ less the bank-specific Pillar 2 requirement (P2R)), the PD can be determined as a function of the CET1 ratio [4.1.c.i].

From the second iteration step (k=2), the impact of the PD increase of borrowing banks on the PD of lending banks is calculated. The calculation is performed in two sub-steps. In the first sub-step, an increase in the PD of the borrowing bank raises the expected credit loss (EL) of the lending bank. The EL is deducted from the regulatory capital and reduces the balance sheet value ([4.1.d] and [4.1.e]). In addition, the lending bank's RWAs are recalculated. When performing the calculation, a distinction is made between the internal ratings-based approach (IRBA) and the credit risk standardised approach (CRSA), depending on which approach the affected bank has selected for valuing the exposure [4.1.f]. The RWAs in exposure class $\boldsymbol{i_5}$ increase accordingly [4.1.g]. The updated EL and RWA values then lead to a depletion of capital reserves and thus to a decrease in the regulatory capital ratios and the leverage ratio of the lending banks ([4.1.h] and [4.1.j]).

In the second sub-step, the decrease in the regulatory capital ratios leads to an increase in the PD of the lending bank. Should the updated capital ratios and the leverage ratio no longer meet the regulatory minimum requirements of Pillar 1 and Pillar 2, the algorithm considers the lending bank failed and assigns it a PD of 100%. Should the lending bank meet the regulatory minimum requirements, the PD is updated by means of statistical methods [4.1.k], in the same way as in the calculations in [4.1.c]. As, in most cases, lending banks have credit liabilities to other banks at the same time, the shock spreads further in the interbank market. The iteration step is repeated until the PD only increases by a minimal amount that is smaller than the limit ε [4.1.k.i]. Once the algorithm has ended, the capital depletion of all banks after second-round effects is calculated. This takes the form of losses and an increase in RWAs in exposure class $\boldsymbol{i_5}$ ([4.1.l] and [4.1.m]).

<u>*CET1 reserves after second-round effects*</u>

After determining the capital depletion in the second round, the CET1 reserves for the fourth step of the monitoring tool in t=4 can be calculated [4.2.a]. As in the preceding steps, this is taken from the difference between the CET1 ratio [4.2.b] and CET1 minimum requirements [4.2.c]. The CET1 stock in the numerator of the CET1 ratio derives from CET1 in t=3 less the losses from exposure class $\boldsymbol{i_5}$[4.2.b.i]**.** The RWAs in t=3 and the increase in RWAs due to

[40] The selected default criterion is based on the regulatory principle of "failing or likely to fail" (FOLTF). The supervisory classification FOLTF is assigned if there is no prospect of an institution meeting the minimum requirements again within the next 12 months. Because, in the model, the potential deleveraging of the affected banks is exhausted before the second round and prospective capital increases are already recognised, we assume that the failure to meet the minimum requirements is permanent.

[41] The approach is based on the fundamental idea of modelling probabilities of default from the equal expected impact (EEI) approach, which is used to calibrate O-SII buffers. See also Board of Governors of the Federal Reserve System (2015).

second-round effects in $\boldsymbol{i_5}$ [4.2.b.ii] add up to the RWAs in t=4, which are in the denominator of the CET1 ratio. Following the same procedure as described after taking account of the first-round effects in t=2, the losses and the increase in RWAs also again yield effects on the AT1/T2 gaps, as shown in [4.2.c.i] and [4.2.c.ii]. Subsequently, banks' CET1 minimum requirements change in t=4 [4.2.c]. For the LREM in t=4, losses are again deducted from the LREM from the previous step t=3 [4.2.c.iii].

*Effect on lending capacity after second round*

After taking account of all bank-specific relevant effects from steps t=2 to t=4, the CET1 reserves are finally assessed at the bank level. If the CET1 ratio is below the CET1 minimum requirements after taking into account the second-round effects, the CET1 reserves assume a negative value in t=4. It is assumed that the banks are unable to raise further new capital in the stress phase beyond the foreseeable capital issuance included in t=2. If a bank now undershoots the CET1 minimum requirements, there are supervisory consequences that can range from a restriction on certain business activities to withdrawal of its banking licence. The monitoring tool therefore assumes that banks with a negative CET1 reserve in t=4 entirely suspend new lending and do not renew maturing loans [4.3] The additional decrease in a bank's lending capacity per exposure class $\boldsymbol{i}$ results from the difference between the stock of exposures in t=2 with a residual maturity of a maximum of one year and exposures that, due to deleveraging, might already have been reduced in t=3.

Formula box: step 4

$\boldsymbol{k = 1\ describes\ situation\ after\ deleveraging\ in\ t = 3}$

[4.1.a]

$$\mathrm{Cap}Rat_{Cap,D,1} = \frac{Cap_{t=3}}{RWAs_{t=3}}\ where\ Cap := \{CET1_{t=3}; T1_{t=3}; TC_{t=3}\}$$

[4.1.b]

$$Lev_{D,1} = \frac{T1_{t=3}}{LREM_{t=3}}$$

[4.1.c]

$$PD_{D,1} = \begin{cases} 1, & \mathrm{Cap}Rat_{Cap,D,1} < CapRat^{Min}_{Cap,D} \vee Lev_{D,1} < LR^{Min} \\ min\{1, \pi(\mathrm{Cap}Rat_{Cap=1,D,1})\}, & \mathrm{Cap}Rat_{Cap,D,1} > CapRat^{Min}_{Cap,D} \wedge Lev_{D,1} > LR^{Min} \end{cases}$$

[4.1.c.i]

$$\pi(\mathrm{CapRat}_{Cap=1,D,k}) := e^{\frac{\mathrm{CapRat}_{Cap=1,D,k} - P2R_D + \alpha}{\beta}}$$

$\boldsymbol{Iteration\ from\ k = 2}$

[4.1.d]

$$LREM_{C,k} = LREM_{C,k-1} - \sum_{D} Exposure^{i_5}_{C,D_{C,D}} \cdot LGD_{C,D} \cdot (PD_{D,k-1} - PD_{D,k-2})$$

[4.1.e]

$$Cap_{Cap,C,k} = Cap_{Cap,C,k-1} - \sum_{D} Exposure_{C,D}^{i_5} \cdot LGD_{C,D} \cdot \left(PD_{D,k-1} - PD_{D,k-2}\right)$$

[4.1.f]

$$\Delta RW_{C,k}^{i_5} = \begin{cases} \max\left(0, RW^{(IRBA)}\left(PD_{D,k-1}, LGD_{C,D}, M_{C,D}\right) - RW^{(IRBA)}\left(PD_{D,k-2}, LGD_{C,D}, M_{C,D}\right)\right) \\ \max\left(0, RW^{(CRSA)}\left(Rat\left(PD_{D,k-1}\right), M_{C,D}\right) - RW^{(CRSA)}\left(Rat\left(PD_{D,k-2}\right), M_{C,D}\right)\right) \end{cases}$$

[4.1.g]

$$RWAs_{C,k}^{i_5} = RWAs_{C,k-1}^{i_5} + \sum_{C} \Delta RW_{C,k}^{i_5} \cdot Exposure_{C,D}^{i_5}{}_{C,D}$$

[4.1.h]

$$CapRat_{Cap,C,k} = \frac{Cap_{Cap,C,k}}{RWAs_{C,k}}$$

[4.1.j]

$$Lev_{C,k} = \frac{T1_{C,k}}{LREM_{C,k}}$$

[4.1.k]

$$PD_{C,k} = \begin{cases} 1, & \text{Cap}Rat_{Cap,C,k} < CapRat_{Cap,C}^{Min} \vee Lev_{C,k} < LR^{Min} \\ min\{1, \pi\left(\text{Cap}Rat_{Cap=1,C,k}\right)\}, & \text{Cap}Rat_{Cap,C,k} > CapRat_{Cap,C}^{Min} \wedge Lev_{C,k} > LR^{Min} \end{cases}$$

$\boldsymbol{Iteration\ to\ k = K\ where\ K \coloneqq index\ of\ the\ last\ iteration}$

[4.1.k.i]

$$k = \begin{cases} k+1, & PD_{C,k} - PD_{C,k-1} > \varepsilon \\ K, & PD_{C,k} - PD_{C,k-1} \leq \varepsilon \end{cases}$$

[4.1.l]

$$Losses^{i_5} = Cap_{Cap=1,C,1} - Cap_{Cap=1,C,K}$$

[4.1.m]

$$\Delta RWAs^{i_5} = RWAs_{C,k=K} - RWAs_{C,k=1}$$

[4.2.a]

$$CET1_{t=4}^{Reserves} = CET1_{t=4}^{Ratio} - CET1_{t=4}^{Min}$$

[4.2.b]

$$CET1_{t=4}^{Ratio} = \frac{CET1_{t=4}}{RWAs_{t=4}}$$

[4.2.b.i]

$$CET1_{t=4} = CET1_{t=3} - Losses^{i_5}$$

[4.2.b.ii]

$$RWAs_{t=4} = RWAs_{t=3} + \Delta RWAs_{t=4}^{i_5}$$

[4.2.c]

$$CET1_{t=4}^{Min} = 4.5\% + P2R^{in\,CET1} + AT1_{t=4}^{Gap} + T2_{t=4}^{Gap}$$

[4.2.c.i]

$$AT1_{t=4}^{Gap} = max \begin{cases} (1.5\% + P2R^{in\,AT1}) - \dfrac{(AT1_{t=1} + AT1^{Gain})}{RWAs_{t=4}} \\ \left(\dfrac{3\% * LREM_{t=4}}{RWAs_{t=4}} - 4.5\% - P2R^{in\,CET1}\right) - \dfrac{(AT1_{t=1} + AT1^{Gain})}{RWAs_{t=4}} \\ 0 \end{cases}$$

[4.2.c.ii]

$$T2_{t=4}^{Gap} = max \begin{cases} (2\% + P2R^{in\,T2}) - \left(\dfrac{(T2_{t=1} + T2^{Gain})}{RWAs_{t=4}} + \dfrac{AT1_{t=4}^{Surplus}}{RWAs_{t=4}}\right) \\ 0 \end{cases}$$

[4.2.c.iii]

$$LREM_{t=4} = LREM_{t=3} - Losses^{i_5}$$

[4.3]

| $Exposures^{Stop\ new\ lending\ in\ i} = \begin{cases} Exposures_{t=2}^{i\ where\ m\leq 1\ year} - Exposures^{Deleveraging\ in\ i}, & CET1_{t=4}^{Reserves} < 0 \\ 0, & CET1_{t=4}^{Reserves} \geq 0 \end{cases}$ | |
|---|---|
| $k$ | Iteration step of the algorithm |
| $i_5$ | Exposure class interbanks |
| $\mathrm{Cap}Rat_{\kappa,D,k}$ | Regulatory capital ratio; $Cap := \{1,2,3\}\ where\ 1 \triangleq CET1, 2 \triangleq Tier1, 3 \triangleq TC$ for borrowing bank D in iteration step k |
| $Lev_{D,k}$ | Regulatory leverage ratio for borrowing bank D in iteration step k |
| $CapRat_{\kappa,D}^{Min}$ | Regulatory minimum requirements for Pillar 1 (4.5% CET1, 6% T1 and 8% TC) and Pillar 2 (P2R) |
| $LR^{Min}$ | Regulatory minimum requirement for leverage ratio (3%) |
| $PD_{D,k}$ | Probability of default for borrowing bank D in iteration step k |
| $LREM_{C,k}$ | Leverage ratio exposure of lending bank C in iteration step k |
| $Exposure_{C,D}^{i_5}$ | Exposure of borrowing bank C to borrowing bank D in exposure class $i_5$ taking account of the modified credit matrix due to deleveraging. |
| $LGD_{C,D}$ | Loss given default of C's exposure to D in exposure class $i_5$ |
| $Cap_{Cap,C,k}$ | Regulatory capital ratio with $Cap := \{1,2,3\}\ where\ 1 \triangleq CET1, 2 \triangleq Tier1, 3 \triangleq TC$ for lending bank C in iteration step k |
| $RW$ | Risk weight according to IRBA or CRSA |
| $Rat$ | Function that translates an exposure's PD in the CRSA into an implicit rating. A risk weight is then assigned to this rating in compliance with Basel requirements. |
| α,β | Model parameters for loss distribution |
| $\varepsilon$ | Limit where $\varepsilon > 0$ |
| $t$ | Index to step within the monitoring tool sequence |

## 2.5 Effect on lending capacity

In step 5 of the monitoring tool, the effects of both depletion of CET1 reserves and deleveraging on aggregate lending capacity in the German banking system are estimated, taking into account potential substitution effects. There is a decline in lending capacity due to deleveraging in t=3 and a suspension of new lending in t=4. Substitution effects arise from the fact that banks that still have CET1 reserves after the second round at t=4 can use these reserves for lending and thus are able to (partially) substitute the reduction in lending. The estimation in step 5 focuses on exposure class $\boldsymbol{i_1}$: corporate exposures are relevant for real economic effects and, in addition, are the only exposure class for which substitution effects on the basis of granular data can be estimated.

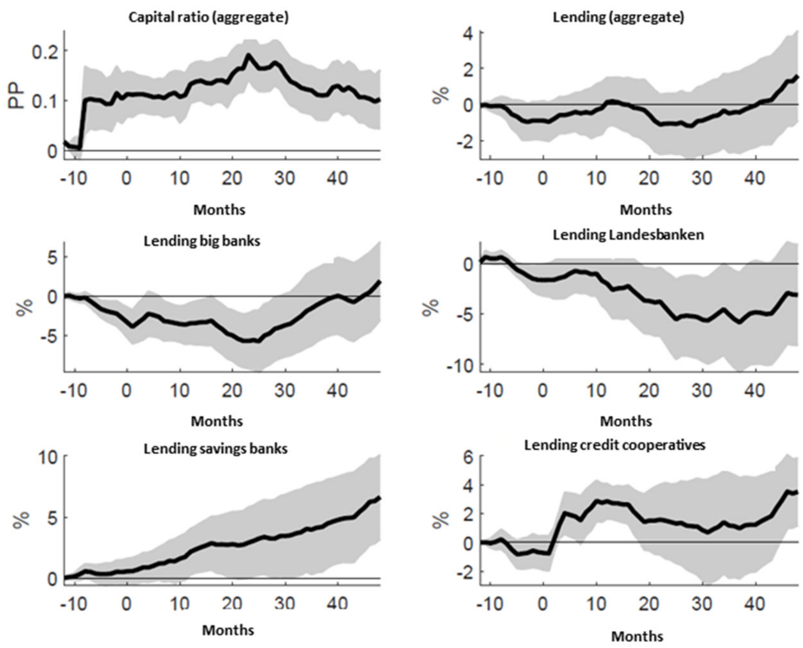
Substitution effects in connection with lending in the German banking system have already been observed in the past. An analysis using a time series model for the period from 1960 to 2007 reveals the following:[42] savings banks and credit cooperatives expanded their lending as a result of higher regulatory capital requirements, while big banks and Landesbanken reduced their lending (Figure 4).[43] In aggregate terms, there was thus no significant drop in lending by

[42] This analysis of the German banking system is analogue to Eickmeier, Kolb and Prieto (2018) for the United States

[43] These historical instances of tightening capital ratios were always permanent and carried out for static (non-cyclical) reasons, as shown by the narrative approach of the analysis.

German banks. This shows that parts of the banking system were willing to use their free lending capacity to increase their market shares. The increased lending by this part of the banking system meant that the decline in lending in other parts of the banking system was able to be substituted.

Figure 4: Development of lending by various banking groups in response to an increase in capital requirements




Note: Point estimators and 68% confidence bands of the responses of various variables to a tightening of regulatory capital ratios. The estimation assumes that banks are able to respond to the changes as of 12 months before the higher regulatory capital ratios enter into force.

The estimation of substitution effects by banks with free lending capacity is based primarily on the positive aspects of relationship lending (Beck et al., 2018). This refers to a close relationship between the lender and the borrower in which the lender has access to specific borrower-related information and can adjust its credit conditions accordingly. The outcome of the study was that relationship lending can serve to mitigate restrictive effects on lending during economic downturns. At the same time, the authors show that easing credit conditions during economic downturns as a result of relationship lending was not associated with evergreening – i.e. situations in which economically weak enterprises are constantly supplied with credit. Instead, loans were increasingly granted to economically strong enterprises that also saw positive development in the subsequent upturns. These results thus confirm that banks – provided they have access to sufficient specific information regarding their borrowers – are in a position to differentiate between economically strong and economically weak enterprises even during economic downturns and thus continue to supply the strong enterprises with credit.

In order to estimate the effects in step 5, we first identify banks that have undercapacity with regard to their lending to non-financial corporations, either because they fall short of their target capital ratio in t=3 or their CET1 minimum requirements in t=4. The extent to which a bank's lending capacity is restricted is calculated on the basis of the exposures in $\boldsymbol{i_1}$, which are not granted again due to deleveraging in t=3 or suspension of new lending in t=4 [5.1.a]. If a bank still has CET1 reserves after the second round, its undercapacity is zero. Banks that still have CET1 reserves after the second round are then allocated an overcapacity with regard to their lending to non-financial corporations. A bank's overcapacity is represented by the smaller of the two values of overcapacity, which are based on its risk-weighted CET1 requirements (in RWAs) on the one hand and non-risk-weighted T1 requirements (in the LREM) on the other [5.1.b]. The overcapacities in RWAs and the LREM are represented by the ratio between the remaining capital after the second round and the capital requirements relevant to lending ([5.1.b.i] and [5.1.b.ii]). RWA or LREM capacities that have already been used for exposures held in t=4 are deducted from this. The overcapacities in RWAs must additionally be multiplied by the inverse of the average risk weight in $\boldsymbol{i_1}$ from step t=2, so that the result represents the overcapacity with regard to lending to non-financial corporations. If a bank has no CET1 reserves after the second round, its overcapacity is zero.

In order to estimate the substitution potential in the German banking system, an algorithm is now compiled that evaluates granular loan data from the German central credit register. The German central credit register contains information on credit relationships between German banks and non-financial corporations around the world. This information is covered by matrix $\mathcal{M}^{i_1}$, which contains all outstanding exposures between lenders C and borrowers D in exposure class $i_1$ First, as shown in [5.2.a], the algorithm identifies credit relationships that are reduced due to the lender's undercapacity and for which $Match^{Delever\ CD}$ can take a value greater than zero. The variable $Match^{Delever\ CD}$ contains the outstanding exposure amount of bank C vis-à-vis borrower D that is reduced due to the bank's undercapacity. According to condition $\mathbb{A}$, only exposures with residual maturities of less than one year are eligible for this deleveraging. However, as the German central credit register does not contain any information on the residual maturities of the loans, the algorithm assumes, in simplified terms, that the credit relationships with the lowest outstanding exposure amounts also have the shortest residual maturities.[44] Then, in accordance with the condition shown in simplified form in $\mathbb{B}$, the algorithm adds together each bank's outstanding exposure amounts vis-à-vis borrowing enterprises over multiple iteration steps, starting with the lowest value not yet taken into consideration, for every bank that exhibits undercapacity. Once this total value exceeds the total undercapacity for the first time, the algorithm is stopped for that bank. As the algorithm always takes account of exposure amounts in full, it overcompensates marginally to the amount of $\mu$ in most cases, and the value in $Undercapacity^{in\ i_1}$ is exceeded, as described in [5.2.a] and [5.2.a.i]. However, as this overcompensation widens banks' gaps to their target capital ratios, this would be acceptable to banks that need to reduce their loans. This first step of the algorithm outputs the credit requests $Match^{Delever\ CD}$, which contains the outstanding exposure amount of the credit relationship affected by deleveraging and suspension of new lending.

[44] In return, credit relationships with comparatively high outstanding exposure amounts are deleveraged with subordinate priority, if at all. In future, data from AnaCredit, which also contain information on the residual maturities of granular credit relationships between banks and enterprises, may also be used to estimate potential substitution.

Next, the algorithm checks the extent to which banks that have free lending capacity – after accounting for all stress effects – can compensate for open credit requests from borrowers affected by undercapacities among their lenders. This takes account of findings regarding the positive effects of relationship lending. First, in accordance with condition $\mathbb{C}$, the algorithm excludes from credit substitution all borrowing enterprises that were categorised as belonging to a "strongly affected" sector in step 2 of the monitoring tool and for which $Affected^j = 0$ does not apply. This assumption reflects the fact that banks, within the context of relationship lending, prefer loans to enterprises for which they expect good economic development after the crisis. At the same time, this can ensure that banks take a risk-averse approach to substitution during stress phases, for which there is empirical evidence. The algorithm then carries out another set of iterations and attempts to allocate the credit requests of the borrowing enterprise to another bank and create a $Match^{Substitution\ CD}$. In each of these iterations, as described in condition $\mathbb{D}$, the algorithm first searches for additional credit relationships between a borrowing enterprise and banks that already existed in the starting situation at t=1. In addition, as shown in simplified form in condition $\mathbb{E}$, these banks must also exhibit positive overcapacity even after account is taken of substitution effects that have already been matched in previous iterations of the algorithm.

In order to bring together deleveraging and substitution at credit relationship-level in a single iteration and generate a $Match^{Substitution\ CD}$, assumptions for the algorithm are made regarding the behaviour of the borrowing enterprises affected by deleveraging. Taking consideration of the conditions described in [5.2.b], the outstanding exposure amounts identified are sorted by amount. Under the assumption that borrowing enterprises affected by deleveraging want to minimise their additional search and transaction costs, they always strive to place their entire exposure volume affected by deleveraging with a single lender that offers them the best credit conditions. As described above, credit conditions may be more favourable depending on how much specific borrower-related information is available to the lender. Given that a bank is more familiar with a borrower the higher their currently outstanding exposure amount, the algorithm assumes that borrowers prefer the lender for which the highest outstanding exposure amount is identified.

In the algorithm, a bank creates a $Match^{Substitution\ CD}$ with regard to the credit requests from borrowers affected by deleveraging, provided that the sum of all of the requests submitted to the bank do not exceed its overcapacities [5.2.b]. This is in the bank's interests because, in a highly competitive market,[45] it has an incentive during a period of stress to use its existing overcapacities and conduct profitable transactions with familiar borrowers. The assumptions behind this function of the algorithm reflect the findings of Kysucky and Norden (2015), who show in their study that the benefits of relationship lending in the form of larger exposure amounts or better credit conditions are particularly evident if there is a high degree of competition between banks. In the event that the sum of the credit requests submitted to a bank exceeds its overcapacities, however, banks will fulfil the largest remaining credit requests up until the point that the next credit request would completely exhaust their remaining

[45] The German banking system is characterised by a relatively high degree of competition.

overcapacities. The implicit assumption behind this function of the algorithm is that banks in stress phases prefer to grant comparatively higher exposure volumes when substituting loans. In addition, these calculations assume that banks have sufficient refinancing liquidity or can quickly obtain liquidity via monetary policy facilities in order to generate the loan amounts needed for substitution.

If, in the first iteration step of the algorithm, open credit requests are left unfulfilled due to insufficient overcapacities, the affected borrowing enterprises withdraw their credit requests in full. In the second iteration of the algorithm, they instead attempt to place their entire credit request with the lender for which the second highest outstanding exposure amount was identified and to create a $Match^{Substitution\ CD}$ in that way. The substitution is allocated in an identical manner as in the first iteration, but it must be taken into account that the overcapacities of this lender may have already been utilised in part during the first iteration. Ultimately, each borrowing enterprise carries its credit request forward into new iterations of the algorithm until the request is fulfilled with $Match^{Substitution\ CD}$ or until all lenders have rejected the request due to insufficient overcapacities. Lastly, for every bank that has to reduce its loans due to undercapacities, the sum of all credit requests for which another bank has created a $Match^{Substitution\ CD}$ are calculated in matrix $\mathcal{M}^{i_1}$ [5.2.c]. The value calculated in this way represents the substitution potential of a bank with undercapacity.

To clarify the algorithm, its method of functioning is explained using an example in which there are three borrowing enterprises and three banks.

$$\mathcal{M}^{i_1} = \begin{pmatrix} 0 & | & D_1 & D_2 & D_3 \\ - & - & - & - & - \\ C_1 & | & Match^{Delever\ C_1D_1} & Match^{Delever\ C_1D_2} & Match^{Delever\ C_1D_3} \\ C_2 & | & & Match^{Substitution\ C_2D_2} & \\ C_3 & | & & & Match^{Substitution\ C_3D_3} \end{pmatrix}$$

Bank $C_1$ must, due to undercapacity, allow its loans to $D_1$, $D_2$ and $D_3$ to expire following the end of their residual maturities. Then, all three borrowing enterprises start searching for banks that could take on the open credit requests in the amount of the currently outstanding exposure amounts. As $D_1$ only has a credit relationship with $C_1$ in the starting situation, a $Match^{Substitution\ CD}$ cannot be created. Next, $D_2$and $D_3$ both have the highest outstanding exposure amounts vis-à-vis $C_2$ and therefore turn to the same bank with their credit requests. However, as the credit request of $D_3$ exceeds the overcapacities of $C_2$, only the credit request of $D_2$ is fulfilled, resulting in $Match^{Substitution\ C_2D_2}$. In the next iteration of the algorithm, $D_3$ instead turns to bank $C_3$, with which it had the second highest outstanding exposure amount in the starting situation. The overcapacities of $C_3$ exceed the volume of the credit request from $D_3$, resulting in $Match^{Substitution\ C_3D_3}$.

Based on the distributional metrics for credit substitution and an evaluation of the non-substituted credit requests, the estimated substitution potential can also be analysed and the findings better categorised. If both the number of banks for which at least one $Match^{Substitution\ CD}$ is created as well as the normalised Herfindahl index of substitution potential are determined, it is possible to answer the question of whether substitution is concentrated among just a few institutions or whether many banks contribute to substitution in equal measure.[46] Furthermore, if the remaining lending capacities are determined after taking account of substitution effects, it is possible to obtain information on whether substitution significantly eroded the resilience of the banking system. The described credit substitution algorithm is an approximation of the substitution potential available in the short term, as it is based on existing credit relationships. In light of the elevated degree of competition in the banking system, it must be assumed that loans from banks with which no credit relationships currently exist will also be substituted over the medium term.

*Effect on lending capacity after consideration of substitution effects*

If the aggregate of the difference of undercapacity and $Substitution^{\,in\,i_1}$ is then calculated across all banks C in the sample, it is possible to determine the delta of lending capacity in $\boldsymbol{i_1}$ for the German banking system [5.3].

Formula box: step 5

[5.1.a]

$$Undercapacity^{in\,i_1} = Exposures^{Deleveraging\,in\,i_1} + Exposures^{Stop\,new\,lending\,in\,i_1}$$

[5.1.b]

$$Overcapacity^{in\,i_1} = min\begin{cases} Overcapacity^{in\,i_1(RWAs)} \\ Overcapacity^{in\,i_1(LREM)} \end{cases}$$

[5.1.b.i]

$$Overcapacity^{in\,i_1(RWAs)} = max\begin{cases} \left(\dfrac{CET1_{t=4} + AT1_{t=1} + +AT1^{Gain} + T2_{t=1} + T2^{Gain}}{8\% + P2R_t + \left(CET1^{Target\,ratio} - CET1^{Min}_{t=4}\right)} - RWAs_{t=4}\right) * \dfrac{1}{RW^{in\,i_1}_{t=2}}, & CET1^{Reserves}_{t=4} > 0 \\ 0, & CET1^{Reserves}_{t=4} \leq 0 \end{cases}$$

[5.1.b.ii]

$$Overcapacity^{in\,i_1(LREM)} = max\begin{cases} \left(\dfrac{CET1_{t=4} + AT1_{t=1} + +AT1^{Gain}}{T1^{Target\,ratio}} - LREM_{t=4}\right), & CET1^{Reserves}_{t=4} > 0 \\ 0, & CET1^{Reserves}_{t=4} \leq 0 \end{cases}$$

[5.2.a]

$$Match^{Delever\,CD} > 0 \Leftrightarrow \mathbb{A} \wedge \mathbb{B}\ with \begin{cases} \mathbb{A}: Match^{Delever\,CD} \subseteq Exposures^{in\,i_1\,with\,m\leq 1\,year}_{t=2} \\ \mathbb{B}: Undercapacity^{in\,i_1} - \sum_{D=1}^{N} Match^{Delever\,CD_n} - \mu = 0 \end{cases}$$

[5.2.a.i]

$$\mu \leq 0$$

[5.2.b]

$$Match^{Substitution\,CD} > 0 \Leftrightarrow \mathbb{C} \wedge \mathbb{D} \wedge \mathbb{E}\ with \begin{cases} \mathbb{C}: D\ in\ Affected^{j} = 0 \\ \mathbb{D}: Exposure^{CD}_{t} > 0 \\ \mathbb{E}: Overcapacity^{in\,i_1} - \sum_{D=1}^{N} Match^{Substitution\,CD_n} \geq 0 \end{cases}$$

[5.2.c]

$$Substitution^{\,in\,i_1} = \sum_{D=1}^{N} Match^{Substitution\,CD_n}\ in\ \mathcal{M}^{i_1} = \begin{pmatrix} 0 & | & D_1 & D_2 & & D_{n-1} & D_n \\ - & - & - & - & - & - & - \\ C_1 & | & Match^{Delever\,C_1D_1} & Match^{Delever\,C_1D_2} & & & Match^{Delever\,C_1D_n} \\ C_2 & | & & & & Match^{Substitution\,C_2D_{n-1}} & \\ & | & & & & & \\ C_{n-1} & | & & & & Match^{Delever\,C_{n-1}D_{n-1}} & Match^{Delever\,C_{n-1}D_n} \\ C_n & | & Match^{Substitution\,C_nD_1} & & & Match^{Substitution\,C_nD_{n-1}} & \end{pmatrix}$$

[5.3]

[46] Note here that the more loans are reduced by insufficiently capitalised banks, the greater the number of credit relationships, and also of sufficiently capitalised banks, that are relevant for substitution.

| $\Delta\, agg.Lending\ capacity^{in\, i_1} = \sum_{C} (Undercapacity^{in\, i_1} - \ \ Substitution^{in\, i_1})$ | |
|---|---|
| $\mu$ | Compensation value to reflect the fact that banks only reduce full exposure amounts and thus $Undercapacity^{in\, i_1}$ may be overcompensated. |
| $t$ | Index to step within the monitoring tool sequence |

## 2.6 Real economic effects of buffer use

In the final step 6, of the monitoring tool, the impact of buffer use in the banking system on real economic development in Germany is estimated for an underlying scenario using a structural vector autoregression model (SVAR). If adverse real economic scenarios arise, the lending capacity of banks usually declines. If banks do not use their buffers, the lending capacity to non-financial corporations may decline even further due to deleveraging (steps 1 to 5 of the monitoring tool). Building on this, the extent of any additional decline in real GDP is determined (in percent) in the event of banks collectively deciding not to use their buffers. For the SVAR model, a distinction is made between two situations.

- **Baseline:** banks use their buffers; the lending capacity corresponds to its baseline.
- **Counterfactual development:** banks do not use their buffers. As a result, the lending capacity declines more sharply than in the baseline.

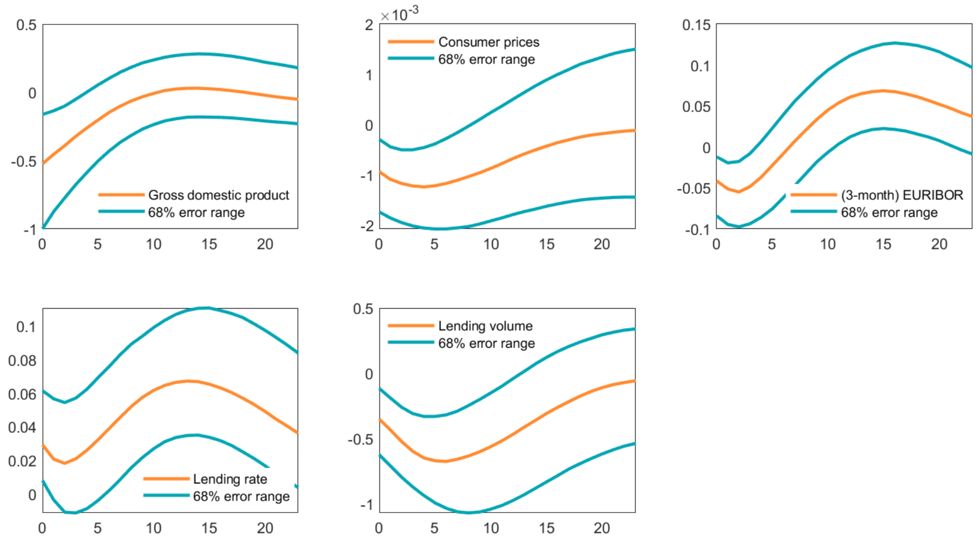
In the initial situation it is assumed for the sake of simplicity that all banks use their buffers in full. The aggregated decline in the lending capacity to non-financial corporations domestically [6.1] is a subset of the decline in the lending capacity to non-financial corporations worldwide [5.3].

Using a sequence of identified credit supply shocks, in the SVAR model a counterfactual macroeconomic development is simulated where no bank uses its buffers. The SVAR model is oriented towards the specification of similar models from academic studies that attempt to quantify macroeconomic effects of credit supply shocks (Gambetti and Musso, 2017; Hristov, Hülsewig and Wollmershäuser, 2012). The macroeconomic input variables used by the SVAR model are real GDP, consumer prices, a short-term interest rate (three-month EURIBOR), as well as interest and exposure volumes of loans to non-financial corporations. The model takes the variables' lag of three quarters into account. The model is estimated with Bayesian methodology for the period from Q1 1999 to Q3 2020. The structural (negative) credit supply shock is identified using sign restrictions that are valid for the period of one quarter. The central assumption of the identification is that the credit supply shock leads to opposite reactions of lending rates (positive) and exposure volumes (negative). In line with Gambetti and Musso (2017), it is additionally assumed that the shock lowers prices and GDP initially. It is also assumed that the lending rate and the short-term money market rate move in opposite directions. The credit supply shock is thus separated out from typical monetary policy shocks. The impulse response functions are shown in Figure 5.

The counterfactual simulations translate the decline in lending capacity caused by the non-use of available buffers into an additional decline in real GDP. If the lending capacity declines (due to banks not using available buffers) by an additional 1% after eight quarters, real GDP falls at the same point in time by a further 0.48% compared to the starting period. Eight quarters corresponds to the timeframe after which the effects determined in steps 2 to 5 of the monitoring tool materialise. If the selected reference period is longer (shorter) than eight quarters, the decline in lending capacity affects real GDP with a lower (higher) factor. For the interpretation of the results it is important in the context of the monitoring tool that the calculated GDP effect does not correspond to the absolute decline in real GDP in the underlying scenario. Instead, the additional decline arising from the transition from buffer use in the baseline to counterfactual non-use is quantified.

The calculated effect results in a constant factor $\delta$, which can also be interpreted as a type of elasticity. The factor indicates the additional percentage change in real GDP if the lending capacity to non-financial corporations declines by 1% after eight quarters solely as result of a sequence of credit supply shocks. All other things being equal, the more the non-use of buffers impacts on lending capacity, the stronger the effect on real GDP [6.2]. The additional GDP effect is linearly scalable in line with the decline in lending capacity.

Figure 5: Impulse response functions of an aggregate credit supply shock in the SVAR model




## Formula box: step 6

[6.1]

$$\Delta\, agg.\ lending\ capacity^{\,i_1,Domestic} \subseteq \Delta\, agg.\ Lending\ capacity^{\,i_1}$$

[6.2]

$$Percentage\ change\ in\ real\ GDP = \delta \times \Delta \begin{pmatrix} agg.\ Lending\ capacity^{\,i_1,Domestic} |\ \textbf{without buffer use} \\ minus \\ agg.\ Lending\ capacity^{\,i_1,Domestic} |\ \textbf{with buffer use} \end{pmatrix}$$

| | |
|---|---|
| $\delta$ | Constant factor derived from the SVAR |
| $\Delta$ | Percentage change |

| | | |
|---|---|---|
| | $\mid without\ /\ with\ buffer\ use$ | Decline in aggregate lending capacity to domestic non-financial corporations in the event of banks not using the buffers or in the event of banks using them (see also [3.1.b.i]) |

# 3 Application of the monitoring tool

The potential deleveraging and the impact on financial stability along the described sequence are estimated taking into account various stress scenarios for the first-round effects. In this section, the application of the model is shown by way of example for a baseline scenario and an adverse scenario inspired by the COVID-19 pandemic. The results are based on the balance sheet data for Q4 2020. The results of the scenarios span across a range of outcomes; in the baseline scenario the impairment is in line with the macroeconomic forecast, while in the adverse scenario the impairment of the financial system is greater as a result of the pandemic. The assumed stress scenarios and the core results of the monitoring tool are described below.

## 3.1 Scenario assumptions

The economic and societal restrictions imposed to combat the COVID-19 pandemic (e.g. lockdowns, physical or social distancing requirements) have significantly impaired real economic activity. Similarly to the German economy, the global economy was also affected. This can result in enterprises suffering a drop in sales, the extent of which can vary depending on the sector, and a worsening situation in the labour market. At the same time, the pandemic can accelerate structural changes in certain sectors, such as tourism or commercial real estate. For the banking system, these developments can lead to an increase in default risk and thus RWAs as well as to actual defaults on loans in the corporate ($i_1$) and retail ($i_2$ and $i_3$) exposure classes. Credit demand is not explicitly modelled, but it is assumed to continue to exist, as this allows economic losses to be bridged and liquid funds to be generated for structural investments.

The first-round stress effects are ascertained by application of the modules described in Section 2.2. The assumptions for the baseline and adverse scenarios are shown in Table 1. In general, the assumptions for the stress tests and the drawdown of credit lines in the baseline scenario are tied to current macroeconomic baseline forecasts via a BVAR model, or the parameters of a forecast are inputted directly as scenario variables. In the adverse scenario, by contrast, more severe stress effects occur, and it is taken into account that the subsectors of the non-financial corporate sector are affected to varying degrees.[47] For the corporate exposures portfolio (IRBA only) and real-estate secured retail business (CRSA and IRBA), the increase in the risk weights is derived in both scenarios from the risk parameters identified in the stress test. If the method of translating the risk parameters on the basis of regulatory requirements is not applicable, the risk weights increase to a certain value of the historical distribution of bank-specific, average risk weights. In contrast to the other modules, no

[47] As described in Section 2.2, sectors are subdivided into “strongly affected” and “less strongly affected” ones based in large part on available data on current sales patterns at German enterprises. Due to similar macroeconomic impacts of the pandemic worldwide, the affectedness of the domestic sectors is applied to the same sectors abroad.

distinction is made between the baseline and the adverse scenarios with regard to losses resulting from market risk.

Table 1: Overview of scenario assumptions

| Scenario assumptions | Baseline | Adverse |
|---|---|---|
| Drawdown of credit lines $\alpha^j$(=share of drawn irrevocable credit commitments per sector) | Projections regarding the drawing down of credit lines along a current macroeconomic baseline forecast[48] are applied at the individual bank level. | Sector-specific:<br>o Strongly affected sectors with cash to fixed costs < 25%: $\alpha^j = 50\%$<br>o Strongly affected sectors with cash to fixed costs > 25% or less strongly affected sectors with cash to fixed costs < 25%: $\alpha^j = 25\%$<br>o Less strongly affected sectors with cash to fixed costs > 25%: $\alpha^j = 0\%$ |
| Stress test $i_1$ | Projections of credit losses along a current macroeconomic baseline forecast are applied at the individual bank level. | Sector-specific:<br>o For strongly affected sectors, the loss rate increases to the historical maximum.<br>o For less strongly affected sectors the current loss rate increases by one standard deviation. |
| Stress test $i_3$ | Parameters of the Bundesbank's current macroeconomic baseline forecast[49] are used as scenario variables to determine the credit losses in $i_3$ . | Cumulative decline of 30% in residential real estate prices and increase of 10% in the unemployment rate. |
| Increase in risk weights $i_1$ | IRBA: The risk parameters for PD identified in the stress test $i_1$ are translated into an increase in risk weights based on regulatory requirements.<br>CRSA: Projections along the macroeconomic baseline forecast of the Joint Economic Forecast (April 2021) are applied at the individual bank level. | IRB: The risk parameters for PD identified in the stress test $i_1$ are translated into an increase in risk weights based on regulatory requirements.<br>CRSA: Increase to the 75th percentile of the bank-specific historical data. |
| Increase in risk weights $i_2$ | IRBA: Projections along the macroeconomic baseline forecast of the Joint Economic Forecast (April 2021) are applied at the individual bank level.<br>CRSA: Increase to the 50th percentile of the bank-specific historical data.[50] | CRSA and IRBA: Increase to the 75th percentile of the bank-specific historical data. |
| Increase in risk weights $i_3$ | CRSA and IRBA: The risk parameters for PD, LGD and the LTV ratio identified in the stress test $i_3$ are translated into an increase in risk weights based on regulatory requirements. | |
| Market risk losses | A similarly sharp (renewed) slump in asset prices as observed at the beginning of the pandemic in March 2020 is assumed. | |

[48] Depending on the date of the assessed balance sheet data, either the current macroeconomic baseline forecast contained in the Joint Economic Forecast (publication dates: spring and autumn) or the current Bundesbank macroeconomic forecast (publication dates: summer and winter) is used to determine the stress effects in the baseline scenario. The baseline forecast of the Joint Economic Forecast published in April 2021 was used for the evaluation of the balance sheet data from Q4 2020.

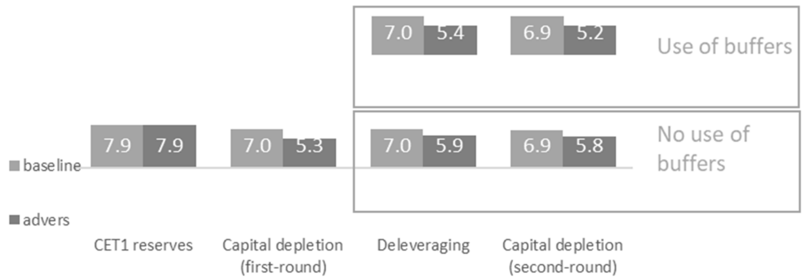
[49] The baseline forecast of the Joint Economic Forecast does not include projections on the parameters of the residential real estate stress test.

[50] The CRSA risk weights of exposure class $i_2$ are virtually constant over the historical period, which is why no projections can be made along a predefined macroeconomic forecast.

## 3.2 Results

Taking into account the scenario assumptions, the sequence of the analytical steps in the monitoring tool is now applied to the balance sheet values of German banks on the reporting date of 31 December 2020 (Q4 2020). The tool thus includes results from 1,394 banks that, combined, comprise around 94% of the reported RWAs and about 91% of the banking system's total assets.[51] The results for each step in the aggregate of the banks under consideration are shown in Figure 6. Details on the aggregated results in steps 1 to 5 are shown in the results tables A1 to A5 in the annex.

Figure 6: Results of steps 1 to 4




In the **starting situation** the aggregated CET1 reserves amount to 7.9% of RWAs (of which 3 percentage points are attributable to buffers and 4.9 percentage points to surplus capital). The CET1 reserves result from the difference between the CET1 ratio of 16.4% and the CET1 minimum requirement of 8.5%. 0.8 percentage point of the CET1 minimum requirement stems from the P2R and 3.3 percentage points stem from the AT1/T2 gap, in which the leverage ratio requirements are also taken into account. In the monitoring tool, therefore, around 8% of banks' RWAs are available to them to cover higher capital requirements resulting from RWA increases and to cover losses. Since the global financial crisis in 2008-09, regulatory reform has led to a strong improvement in banks' capital reserves.

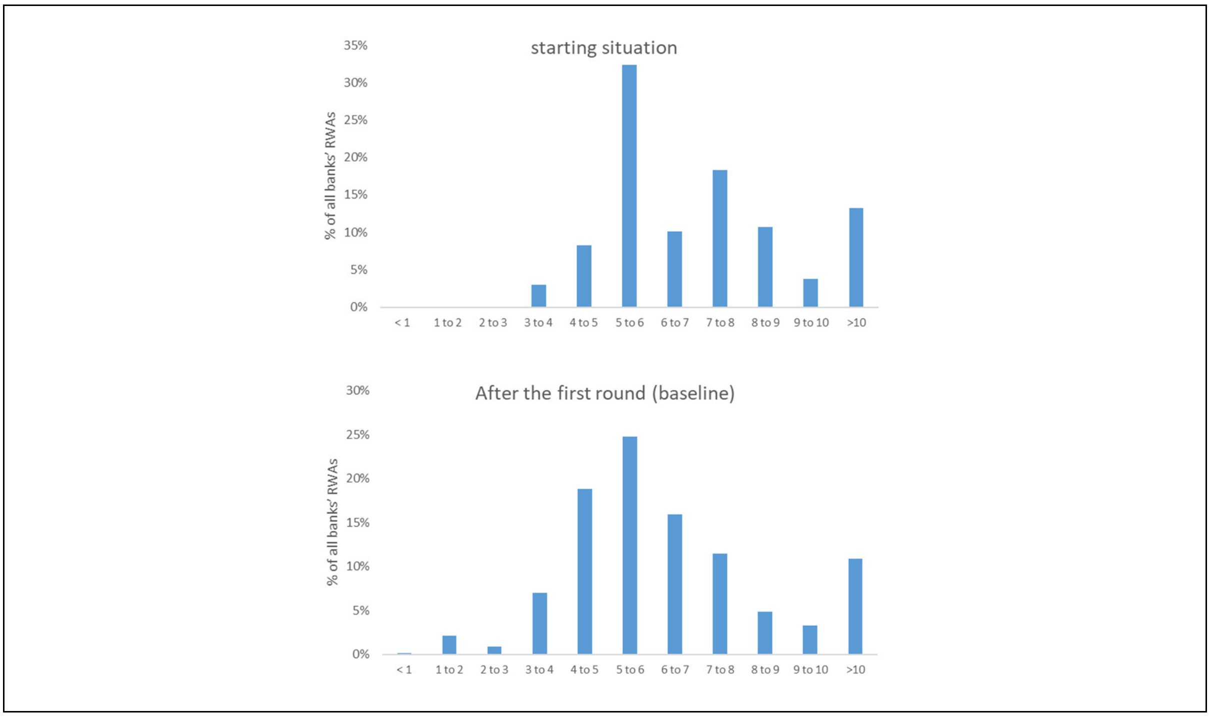
In the baseline scenario, the **first round** leads to an increase in RWAs of 0.9% and losses of 0.8% of the aggregated RWAs in the starting situation. In the adverse scenario, it leads to an increase of RWAs of 11.4% and losses of 1.5%. At the same time the CET1 minimum requirement falls, owing to lower AT1/T2 gaps, by 0.1 percentage point (baseline) and 0.4 percentage point (adverse). Together this creates a depletion of CET1 reserves of 0.9 percentage points in the baseline scenario and 2.6 percentage points in the adverse scenario, with stronger stress effects for the O-SIIs at 1.0 percentage point (baseline) and 3.2 percentage points (adverse). In the baseline scenario, three-quarters of the RWA increase result from exposure to enterprises, including the drawn credit lines. In the adverse scenario, by contrast, the share of exposures in real estate-secured retail business is responsible for the bulk of the RWA increase in the first round. The losses mainly stem from the rise in defaults on loans to enterprises and from market risk. After taking the first-round effects into account, in the baseline scenario 26 institutions, with a balance sheet weighting of 3.6% of the aggregate of all banks (including one O-SII), undershoot the CBRs and eight banks (0.6%) are below the

[51] The tool does not include banks for which the relevant reporting items are unavailable (mostly guarantee banks) or credit institutions with public legal forms performing special functions (promotional banks). In Q4 2020, this category of banks included eight institutions subject to supervisory requirements.

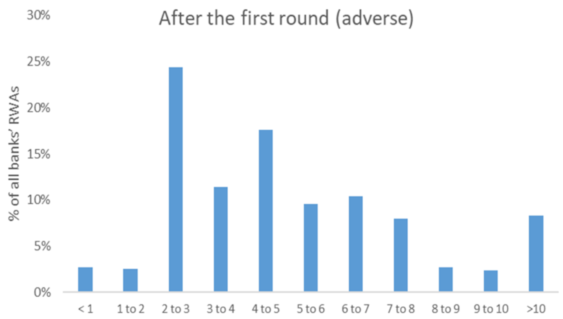
minimum requirements. In the adverse scenario 133 banks, including seven O-SIIs, with a balance sheet weighting of 45%, undershoot the CBRs and 40 banks, including one O-SII, cannot meet the minimum requirements.

Figure 7 shows the distribution of CET1 reserves in the **starting situation** (top) and after the **first round** in the baseline scenario (centre) and in the adverse scenario (bottom). The CET1 reserves are distributed heterogeneously and have an impact on how strongly a bank is affected by the stress period. For the group of twelve O-SIIs, the CET1 reserves, at 7.4% of their RWAs, are lower than those at other banks.[52] The largest group (more than 30% of all banks weighted according to RWAs) in the starting situation are banks with CET1 reserves of between 5% and 6% of their RWAs. However, many banks are also located at the edges of the distribution. The more severe the first-round stress effects, the stronger the increase in the heterogeneity of the distribution of CET1 reserves. The increase in risk weights in the first round affects those banks, in particular, that have received approval to use the IRBA and which therefore, for the most part, use internal models to calculate their capital requirements. These are above all O-SIIs. The O-SIIs are also disproportionately affected by losses from market risk, as they hold a comparatively large amount of securities and have large trading books. Together, this leads to a strong depletion of CET1 reserves amongst O-SIIs. The largest group (more than 25% of all banks weighted according to RWAs) in the adverse scenario following the first round are banks whose CET1 reserves are between 2% and 3% of their RWAs.

Figure 7: Distribution of CET1 reserves (as a percentage of RWAs)




[52] The group of O-SIIs under consideration include the 13 institutions which were classified as otherwise systemically important for 2021, minus one O-SII which is not examined in the monitoring tool as it belongs to the group of credit institutions with a public legal form performing special functions.




**Deleveraging** enables banks to stabilise their capital ratios and increase their CET1 reserves relative to RWAs, which had previously come under pressure in the first round. However, since in the baseline scenario only a small number of banks, whose collective weight in the aggregate of all banks is also negligible, undershoot their CET1 target ratios, the effect of deleveraging ends up being only marginal and CET1 reserves remain at 7%, with and without buffer use. In the adverse scenario, results can vary depending on whether or not banks are willing to use their buffers. If banks use their buffers and accordingly strive for a CET1 ratio just above their minimum requirements, CET1 reserves rise by around 0.1 percentage point and the number of banks undershooting their minimum requirements drops to 35 (0.8% in balance sheet-weighted terms). 133 banks (44.7% in balance sheet-weighted terms), including 7 O-SIIs, still undershoot the CBR. If banks do not use their buffers and strive for a CET1 ratio equal to the minimum requirement and the CBRs, CET1 reserves rise by around 0.6 percentage point in the adverse scenario. The number of banks undershooting their CBR consequently falls to 80 (14.2%). The number of banks undershooting their minimum requirements likewise goes down to 35 (0.8% in balance sheet-weighted terms).[53]

The results for **deleveraging** in the adverse scenario show the trade-off involved in buffer use: although banks improve their solvency by not using their buffers, this comes at the expense of lending. If banks use their buffers, RWAs equating to 0.5% of aggregate RWAs are reduced following the first round, stabilising CET1 ratios in the adverse scenario. The main reason for this reduction is that, in retail business, new loans are not issued once the residual maturity has expired. If banks don't use their buffers, the CET1 ratios are stabilised by reducing RWAs by 3.4% of aggregated RWAs after the first round; this reduction is attributable largely to corporate exposures. The reason for the strong rise in RWA deleveraging at the expense of corporate exposures when buffers are not used is this: banks which undershoot their target ratio of minimum requirements plus CBRs have a higher potential for deleveraging loans to enterprises. These are also the loans they wish to prioritise in deleveraging, in line with the sequence substantiated in Section 2. In the buffer use world, by contrast, a small number of banks are below their target ratios of just above the minimum requirements. They also have relatively less potential to deleverage corporate exposures, which is why they resort to other exposure classes.

In the **second round**, CET1 reserves are depleted further to 6.9% in the baseline scenario and 5.2% in the adverse scenario if, in each case, banks use the buffers previously. If banks

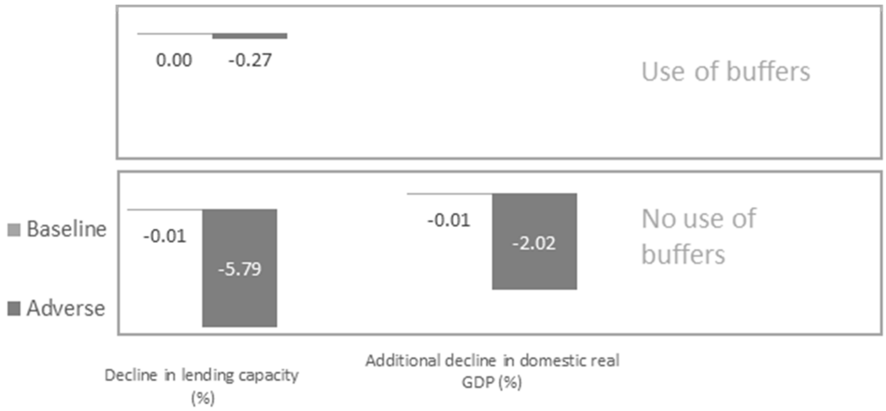
[53] Not every bank has sufficient deleveraging potential. For that reason, some banks, even if they are striving for a higher target capital ratio, may not be able to offload enough RWAs in order to go back above the minimum requirements.

do not use the buffers, they enter the second round with slightly improved solvency and the decline in CET1 reserves in the adverse scenario is smaller, at 0.6 percentage point. The depletion of CET1 reserves is the outcome of an additional increase in RWAs by 0.1% in the baseline scenario and by 0.7% in the adverse scenario if banks use the buffers. If banks do not use their buffers, the rise in RWAs is 0.1% in the baseline scenario and 0.4% in the adverse scenario. The losses from the second round amount to a rounded 0% of RWAs (baseline) and 0.1% (adverse) whether banks use or do not use their buffers. Thanks to these additional stress effects, in the baseline scenario one more bank falls below its CBR compared to the post-deleveraging situation; if buffers are used, two banks fall below their CBR. In the baseline scenario, however, no further banks fall below their minimum requirements following the second round. In the adverse scenario, however, the CBR is undershot by an additional ten banks (by a total of 44.8% in balance sheet-weighted terms) if the banks use the buffers and by 26 banks (by a total of 16.4% in balance sheet-weighted terms) if the banks do not use the buffers. After the second round, in the adverse scenario three further institutions (around 1.1% in balance sheet-weighted terms) drop below the minimum requirements when using the buffers and two further institutions (around 1.1% in balance sheet-weighted terms) when not using the buffers.

If banks do use buffers, **lending capacity to non-financial corporations** falls only marginally after incorporating substitution effects, declining by less than 0.1% in the baseline scenario and by 0.3% in the adverse scenario (Figure 8, left panel). On the other hand, if the banks do not use their buffers, lending capacity to non-financial corporations drops by less than 0.1% in the baseline scenario and by 5.8% in the adverse scenario. These results show the flip side of the trade-off of buffer use since the use of buffers can stabilise banks' lending in a crisis period. Using the buffers can also increase the magnitude of the substitution effects since, owing to their lower target capital ratios, banks can generate more unused lending capacity. Owing to the restrictions on substitution described in Section 2.5, only part of the unused lending capacity is used, however. Therefore, either with or without buffer use, it is possible to substitute only around 20% of the fall in lending caused by capital-constrained banks shrinking their balance sheets and forgoing new lending when they undershoot their minimum requirements. After evaluating the distributional metrics for substitution, we find that, in both scenarios, substitution is not focused on a few banks but is broadly distributed throughout the banking system, both with and without buffer use.

If banks do not use their buffers, their lending capacity to domestic non-financial corporations decreases more sharply, thereby triggering an **additional decline in domestic real GDP** (Figure 8, right panel). In the adverse scenario, the stronger decline in lending capacity causes an additional decline in domestic real GDP (in %) of 2.02%. On the other hand, in the baseline scenario GDP falls by an additional 0.01% if banks do not use their buffers. These values do not correspond to the absolute decline in real GDP in the underlying scenario. Instead, the additional decline resulting from the transition from buffer use to buffer non-use is quantified.

Figure 8: Results of analytical steps 5 and 6




## 4 Conclusion

The insights provided by the monitoring tool have a bearing on financial stability surveillance and benefit macroprudential policymaking. The monitoring tool estimates the potential for deleveraging in the German banking system and the resultant impact on financial stability through a sequence of six analytical steps which incorporate various first-round scenarios. The sequence comprises (i) the loss-absorbing capacity of banks in the starting situation, (ii) the banking system's key stress channels, (iii) deleveraging as a bank response to a reduction in their loss-absorbing capacity, (iv) second-round effects in the interbank market, and (v) the resulting effects on lending capacity to non-financial corporations, allowing for substitution effects. Two situations are analysed in the scenarios in order to identify the importance of macroprudential buffers and their usage. The first assumes that banks use their buffers. These results are then compared with the results of the situation in which banks do not use their buffers. This comparison allows us, last of all, (vi) to estimate the real economic effect of buffer use. The illustrative application of the monitoring tool presented here shows that using the buffer entails a macroeconomic trade-off: banks would have a higher PD and, for a time, a lower level of resilience. At the same time, though, they would not have to restrict their lending as severely, which could potentially avoid an additional slump in real GDP.

# 5 Appendix

**Module box A: Risk weights for residential real estate loans**

[2.1.g.iii]

$$LGD^{i_3} = f(CLTV^{i_3})$$

[2.1.g.iv]

$$LTV^{i_3} = f(CLTV^{i_3})$$

[2.1.g.v]

$$PD^{i_3} = f(UR;\ Residential\ real\ estate)$$

[2.1.g.vi]

$$CLTV^{i_3} \equiv \frac{ILTV \cdot (1 - Amort)}{(1 + \Delta P)}$$

[2.1.g.vii]

$$\mathrm{LGD} = \max(0.1; 1 - \min\left(1; \frac{1}{\mathrm{CLTV}}\right))$$

[2.1.g.viii]

$$\mathrm{LTV} = \mathrm{CLTV}/0.95$$

[2.1.g.ix]

$$RW^{\ in\ i_3\ (IRBA)} = \left(LGD\mathrm{N}\left(\frac{1}{\sqrt{1-R}} \cdot \mathrm{G}(PD) + \sqrt{\frac{R}{1-R}} \cdot \mathrm{G}(0.999)\right) - PD \cdot LGD\right) \cdot 12.5$$

[2.1.g.xi]

$$RW^{\ in\ i_3\ (CRSA)} = 100\% * \frac{EaD_{CRSA}^{RW=100}}{EaD_{CRSA}} + 35\% * (1 - \frac{EaD_{CRSA}^{RW=100}}{EaD_{CRSA}}).$$

A module which leads to further depletion of CET1 reserves in step 2 of the monitoring tool is the recognition of higher risk-weighted assets (RWAs) owing to stressed risk weights (RWs) for residential real estate loans ([2.1.g.i] and [2.1.g.ii] in the formula box for step 2). To this end, the risk parameters for PD, LGD and LTV in the exposure class $i_3$ motivated in the residential real estate stress test are translated into an increase in risk weights (RWs) based on regulatory requirements.[54] The modelling incorporates the specific supervisory rules for calculating RWs for banks using an internal ratings-based (IRB) approach and banks using the credit risk standardised approach (CRSA). The stressed risk weights are then applied to the exposure class "real estate-secured retail business".[55]

As shown in [2.1.g.i] and [2.1.g.ii], the modelled RW are functions of the probability of default (PD) and loss given default (LGD) of the exposures in $i_3$, where the exposure is an IRB exposure, or the LTV ratio (LTV)[56] of the exposures in $i_3$, where valued using CRSA. RWs are related with residential real estate prices by modelling the dependency of the current loan-to-value ratio (CLTV) on regional residential real estate prices. Since the model prices credit collateral at market prices, falls in prices cause a rise in the CLTV for the stock of loans, which leads to an increase in LGDs [2.1.g.iii] on IRB exposures, as well as in LTV

[54] Additional details on estimating risk parameters can be found in Barasinska et al. (2019).

[55] The supervisory definition of the exposure class "real estate-secured retail business"$i_3$ (COREP) and the banking statistics definition of housing loans (based on the borrowers statistics as the reference dataset) are not fully identical. However, they are both used synonymously in this analysis in order to make the estimated losses and RWA increases in the residential real estate loan portfolios comparable with CET1 reserves (based on COREP as the reference dataset).

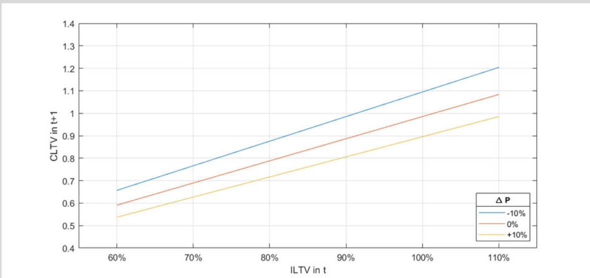
[56] Defined as the ratio of the exposure amount and the LTV ratio of residential real estate collateral.

[2.1.g.iv] on CRSA exposures. RWs are then consequently adjusted for IRB and CRSA exposures. Moreover, an additional satellite model is used to convert the macroeconomic scenarios into PDs, which means that IRB banks' RW additionally depends on the unemployment rate ([2.1.g.v].

The CLTV, which forms the basis for calculating LGD for IRB exposures and LTV for CRSA exposures, is calculated based on the methodology used for the residential real estate stress test, in which the portfolio of residential real estate exposures is broken down into sub-portfolios by initial LTV (ILTV) and loan vintage. CLTV is then calculated for each sub-portfolio and is a function of ILTV, the amortised share of exposures since origination (Amort) and cumulative price developments for residential real estate in the respective bank's business area since loan origination (ΔP) [2.1.g.vi].[57]

Figure 9 shows, as an example, the CLTV of loans with various ILTVs and ΔP at an amortisation rate of 2.4%.[58] This shows that the effect of price developments on the CLTV is a function of ILTV. For higher ILTVs, a price decline will cause the CLTV to rise more strongly than in the case of low ILTVs:

Figure 9: Trajectory of CLTV as an example




The price growth ΔP realised during the observation period is used to calculate the CLTV. The forward-looking scenario analyses are based on scenario-dependent price development paths. For ILTVs and amortisation rates, the distributions last observed for scenario analyses are extrapolated into the future.

The LGD and LTV risk parameters both increase in line with the CLTV. For LGD the relationship can be shown as described in [2.1.g.vii].[59] The LTV is derived from the fair value-based CLTV under the assumption that the LTV can be calculated via a constant 5% haircut applied to the fair value [2.1.g.viii].

When calculating the RW for IRB exposures, the rise in PD is additionally calculated for the stressed scenario. The rise is projected as a function of the macroeconomic scenario based on the residential real estate stress test methodology. To do this, we use the relationship between PD and residential real estate price developments and the unemployment rate,

[57] This is a simplified overview. A detailed explanation can be found in Barasinska et al. (2019).

[58] Corresponds to the average initial amortisation rate in new lending in 2019. Source: Bundesbank calculations based on data provided by Europace: https://report.europace.de/alle-news/europace-ebix/

[59] 10% corresponds to the regulatory minimum LGD. This is a simplified overview. For details, see equations 5 and 6 as well as Table 4 in Barasinska et al. (2019).

calculated based on a panel VAR model, in order to calculate the scenario-consistent rise in average PDs in the banking system. The size of the respective bank's stressed PD is ultimately obtained as the sum of starting PD immediately prior to the stressed period and the calculated PD rise.

In a last step, in order to determine RW for IRB exposures, the PDs and LGDs obtained are inserted into the risk weight function mandated by Art.154 of CRR[60] described in [2.1.g.ix]. In the case of CRSA exposures, RWs are determined based on the requirements of Articles 124 and 125 of the CRR [2.1.g.x]. This means that loans secured by mortgages on residential property are assigned a privileged RW of 35% up to a LTV ratio of 80%. The portion above that is assigned a risk weight of 100%. The outstanding credit assigned a privileged RW of 35% ($EaD^{RW=35}$) respectively a RW of 100% ($EaD^{RW=100}$) is consequently calculated based on the assumption that banks conduct loan splitting.

[60] Capital Requirements Regulation

**Figure A1: Results table for step 1 of the monitoring tool**

| (1) Capitalization (% RWAs) | | |
|---|---|---|
| **CET1 ratio in Q4 2020** | | **16.43** |
| - Minimum requirements | | 8.55 |
| - of which: P2R | | 0.84 |
| - of which: AT1/T2 gap | | 3.21 |
| - Combined buffer requirements (CBR) | (a) | 3.00 |
| - Excess capital (incl. P2G) | (b) | 4.88 |
| - Foreseeable capital issuance | (c) | - |
| **CET1 reserves (% RWAs)** | **(a)+(b)+(c)** | **7.88** |
| *- O-SIIs* | | 7.40 |

Assumption: Aggregate RWAs at the respective point in time are the benchmark; where banks have an AT1/T2 gap, it needs to be plugged using CET1; foreseeable capital issuance = capital issues announced for the future or already conducted but still not post as equity.

**Figure A2: Results table for step 2 of the monitoring tool**

| | (2) First-round effects: capital depletion (% RWAs) | | |
|---|---|---|---|
| | **scenario:** | **1** | **2** |
| Assets | **Increase in RWAs (%)** | | |
| | - Balance sheet effect of losses | -0.19 | -0.54 |
| | - Drawn credit lines | 0.10 | 0.27 |
| | - Risk weight increase | 0.94 | 11.67 |
| | - of which: corporates | 0.68 | 3.07 |
| | - of which: retail business* | 0.26 | 8.60 |
| | Σ | *0.85* | *11.40* |
| Liabilities | **CET1 losses (% RWAs)** | | |
| | - Credit risk increase | 0.31 | 0.93 |
| | - of which: corporates | 0.22 | 0.60 |
| | - of which: commercial RE** | 0.05 | 0.10 |
| | - of which: residential RE | 0.03 | 0.23 |
| | - Market risk increases | 0.54 | 0.54 |
| | Σ | *0.85* | *1.47* |
| | - Δ **AT1/T2 gap** (% RWAs)*** | -0.07 | -0.43 |
| **Δ CET1 reserves (% RWAs)******** | | **-0.91** | **-2.57** |
| | *- O-SIIs* | -0.98 | -3.18 |

Notes: RWAs before stress are the benchmark (as at Q4 2020).* Sum of consumer and RRE lending .** Only domestic share. *** Banks that do not have sufficient AT1 must plug the AT1/T2 gap using CET1, which lowers CET1 capital reserves. **** Δ CET1 capital reserves are made up of Δ CET1 ratio minus Δ AT1/T2 gap.

## Figure A3: Results table for step 3 of the monitoring tool

**(3) Deleveraging of RWAs**

**World with buffer use: target CET1 ratio = just above minimum requirements**

| | | scenario: 1 | 2 |
|---|---|---|---|
| Assets | **Decrease in RWAs (%)** | | |
| | - Corporate exposure | 0.00 | 0.09 |
| | - Level 2 assets | 0.00 | 0.00 |
| | - Retail exposure | 0.02 | 0.21 |
| | - Real estate exposure | 0.00 | 0.18 |
| | Σ | *0.02* | *0.48* |
| | - Δ AT1/T2 gap (% RWAs)* | *0.00* | *-0.01* |
| **Δ CET1 reserves (% RWA)** | | **0.00** | **0.07** |
| | *- O-SIIs* | 0.00 | 0.14 |

**World without buffer use: target CET1 ratio = minimum requirements + CBR**

| | | scenario: 1 | 2 |
|---|---|---|---|
| Assets | **Decrease in RWAs (%)** | | |
| | - Corporate exposure | 0.01 | 2.23 |
| | - Level 2 assets | 0.00 | 0.05 |
| | - Retail exposure | 0.02 | 0.69 |
| | - Real estate exposure | 0.00 | 0.48 |
| | Σ | *0.03* | *3.44* |
| | - Δ AT1/T2 gap (% RWAs)* | *0.00* | *-0.07* |
| **Δ CET1 reserves (% RWAs)** | | **0.00** | **0.55** |
| | *- O-SIIs* | 0.00 | 1.16 |

* Δ CET1 capital reserves are made up of Δ CET1 ratio minus Δ AT1/T2 gap.

## Figure A4: Results table for step 4 of the monitoring tool

**(4) Second-round effects: capital depletion (% RWAs)**

**World with buffer use: target CET1 ratio = just above minimum requirements**

| | scenario: 1 | 2 |
|---|---|---|
| **Increase in RWAs** | *0.07* | *0.71* |
| **CET1 losses** | *-0.02* | *-0.08* |
| **Δ CET1 reserves (% RWAs)** | **-0.03** | **-0.14** |
| *- O-SIIs* | -0.04 | -0.15 |
| **After first-round effects, deleveraging, and second-round effects** | | |
| **Δ CET1 reserves (% RWAs)** | **-0.94** | **-2.64** |
| *- O-SIIs* | -1.02 | -3.18 |

**World without buffer use: target CET1 ratio = minimum requirements + CBR**

| | scenario: 1 | 2 |
|---|---|---|
| **Increase in RWAs** | *0.07* | *0.36* |
| **CET1 losses** | *-0.02* | *-0.08* |
| **Δ CET1 reserves (% RWAs)** | **-0.03** | **-0.11** |
| *- O-SIIs* | -0.04 | -0.14 |
| **After first-round effects, deleveraging, and second-round effects** | | |
| **Δ CET1 reserves (% RWAs)** | **-0.93** | **-2.13** |
| *- O-SIIs* | -1.02 | -2.15 |

## Figure A5: Results table for step 5 of the monitoring tool

**(5) Decline in lending capacity**

**World with buffer use: target CET1 ratio = just above minimum requirements**

| | scenario: 1 | 2 |
|---|---|---|
| **Corporate lending** | | |
| - Decline credit supply (bn EUR) | 0.1 | 6.7 |
| - Credit substitution (bn EUR) | 0.1 | 1.3 |
| **Δ Corporate lending (bn EUR)** | 0.0 | -5.4 |
| – *% of corporate loans ** | 0.00 | -0.27 |
| **Information on distribution of credit substitution** | | |
| - Number of substituting banks | 27 | 144 |
| - Herfindahl-Index of substitution** | 0.04 | 0.07 |
| - Remaining lending capacity*** | 3080/3081 | 2459/2461 |

**World without buffer use: target CET1 ratio = minimum requirements + CBR**

| | scenario: 1 | 2 |
|---|---|---|
| **Corporate lending** | | |
| - Decline credit supply (bn EUR) | 0.4 | 150.5 |
| - Credit substitution (bn EUR) | 0.1 | 36.2 |
| **Δ Corporate lending (bn EUR)** | -0.3 | -114.4 |
| – *% of corporate loans ** | -0.01 | -5.79 |
| **Information on distribution of credit substitution** | | |
| - Number of substituting banks | 72 | 805 |
| - Herfindahl-Index of substitution** | 0.02 | 0.05 |
| - Remaining lending capacity*** | 2229/2229 | 1318/1354 |

* % of total scenario-based corporate loans; ** index can rise as high as 1; the higher the index, the more substitution is concentrated at a small number of banks; *** unused lending capacity before and after substitution in € billion (allowing for stress effects and target capital ratios).

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