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Calibrating Macroprudential Policies in Europe

Considerations Amid Rising Housing Market Vulnerability

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ABSTRACT: Housing market developments are in the spotlight in Europe. Over-stretched valuations amid tightening financial conditions and a cost-of-living crisis have increased risks of a sustained downturn and exposed challenging trade-offs for macroprudential policy between ensuring financial system resilience and smoothing the macro-financial cycle. Against this backdrop, this paper provides detailed considerations regarding how to (re)set macroprudential policy tools in response to housing-related systemic risk in Europe, providing design solutions to avoid unintended consequences during a tightening phase, and navigating the trade-offs between managing the build-up of vulnerabilities and the macro-financial cycle in a downturn. It also proposes a novel framework to measure the effectiveness of tools and avoid overlaps by quantifying the risks addressed by different macroprudential instruments. Finally, it introduces a taxonomy allowing to assess a country's macroprudential stance and whether adjustments to current policy settings are warranted—such as the relaxation of capital-based tools and possibly some borrower-based measures in the event of a more severe downturn.

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WORKING PAPERS

Calibrating Macroprudential Policies in Europe

Amid Rising Housing Market Vulnerability

Prepared by Laura Valderrama[1]

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Glossary

BBM	Borrower-based measure
BIS	Bank for International Settlements
BoE	Bank of England
CBM	Capital-based measure
CCyB	Countercyclical capital buffer
CET1	Common equity Tier 1 capital
DSTI	Debt service to income ratio
DTI	Debt to income ratio
EC	European Commission
ECB	European Central Bank
EU	European Union
GFSR	Global Financial Stability Report
IMF	International Monetary Fund
IRB	Internal-Ratings based
LGD	Loss given default
LTI	Loan to Income ratio
LTV	Loan to Value ratio
MREL	Minimum requirements for own funds and eligible liabilities for resolution
PD	Probability of default
PiT	Point in time
PTI	Price to income
PTR	Price to rent
RBNZ	Reserve Bank of New Zealand
WEO	World Economic Outlook

I. Introduction

Imbalances in housing markets are an important driver of systemic risk. When house prices exceed sustainable levels, risks of a housing market downturn increase, and so do risks for borrower and creditor—including bank—balance sheets, posing a potential threat to financial stability. This raises the question of how to set macroprudential policies to contain the build-up of vulnerabilities and strengthen the resilience of the banking system to adverse shocks, while minimizing any unintended side effects on the economy.

In many European economies, strong housing price appreciation during the Covid-19 pandemic raised concerns of over-stretched valuations, prompting macroprudential authorities to monitor more closely housing market developments and tighten a wide range of macroprudential policy tools to dampen vulnerabilities and/or their potential adverse macro-financial impact.[2] This followed a decade over which—after European rules establishing a common legal basis for macroprudential instruments came into effect in 2014—authorities had mostly tightened policy levers on the back of rising real estate vulnerabilities, except for a temporary relaxation in response to COVID-19.

More recently, higher commodity prices, rising inflationary pressures and resulting monetary policy tightening have increased risks of housing market and broader economic downturns, raising new challenges for European macroprudential authorities. The second half of 2022 recorded the fastest policy tightening in the euro are on record (250 basis points). This intensifies the tough trade-offs in calibrating macroprudential tools amid a combination of unsustainable house prices, rising interest rates, and recession risks.[3] As housing market and broader economic prospects deteriorate, getting the macroprudential stance right becomes more challenging because trade-offs may emerge between maintaining the resilience of the financial system—which may call for a tight(er) stance— and supporting the flow of credit to the economy—which may call for easing some macroprudential tools that might otherwise amplify the housing market downturn, credit contraction and the broader economic slowdown, with possible adverse feedback effects on financial stability.

Another issue for European macroprudential authorities relates to instrument choice, in a context where the toolkit has grown in size and selected tools ought to complement each other. To counter the cyclical build-up of systemic risk, policymakers have imposed capital-based measures (CBMs) or borrower-based measures (BBMs) that restrict mortgage lending for individual borrowers, of which there is a wide variety across Europe. As regards CBMs, for example, Switzerland re-activated a sectoral countercyclical capital buffer (CCyB) buffer for all those risk positions collateralized by residential real estate at 2.5 percent (September 2022), while Sweden extended the application of a minimum level of 25 percent for the average risk weight on Swedish housing loans (November 2021). As regards BBMs, Austria set an upper limit of 90 percent for LTV ratios, a 40 percent upper limit for DSTI ratios, and an upper limit of 35 years for the maturity of housing loans (August 2022), while the Czech Republic set a DTI limit ranging between 8.5 and 9.5 depending on the use of the property and the age of the borrower (April 2022) (see also ESRB, 2022). Despite the importance of the interaction between tools, CBMs and BBMs are typically calibrated independently. Notwithstanding the overlap between capital buffers (macroprudential tools) and minimum capital requirements (microprudential tools)

[2] Unlike in a typical period of stress where house prices would tend to fall, through the pandemic period there was no house price correction, but instead a further ratcheting up of prices partly as a result of shocks to preferences.

[3] The complex macro-financial environment for the conduct of macroprudential policy has been discussed in the recent publications such as the ECB statement on macroprudential policies (ECB, 2022c), the October GFSR (IMF, 2022a), and the October REO: Europe (2022b).

which is likely to limit the usability of buffers during the pandemic (BIS, 2022a; ESRB, 2021a; Mathur et al, 2023; Schmitz, 2022; Couaillier et al, 2022), a quantitative evaluation of interactions is lacking.[4]

This paper provides granular considerations regarding how to combine different macroprudential tools to address housing-related systemic risk in Europe, and whether and how to adjust the toolkit in response to evolving circumstances. The paper focuses first on how to set macroprudential policies under baseline conditions—qualitatively in line with October 2022 IMF projections for most European economies—in which activity recovers and housing markets remain resilient, before turning to the issue of whether and how to (re)set macroprudential tools should economic conditions deteriorate significantly relative to the baseline. The analysis builds and complements macroprudential policy guidance provided by the IMF (2014a, 2014b), and the ESRB (2017), the principles and recommendations for setting countercyclical buffer rates by the BIS (2010, 2019), and ESRB (2014), the stock of empirical evidence on macroprudential policy effects by Biljanovska et al (2023) and Araujo et al (2020), and the studies providing supporting evidence of unintended consequences of macroprudential policy interventions on output (Richter et al, 2019), corporate FX debt issuance (Ahnert et al, 2018), and leakages to unregulated banks (Aiyar et al, 2014).

To maximize its operational usefulness, the paper provides a taxonomy that measures how European countries perform along different key risk signals and resilience indicators. This taxonomy is based on a systematic analysis and aggregation of a set of key quantitative indicators evaluated at end-2022, consistent with the macroprudential policy stance approach advocated by the ESRB (2021b). It complements the discussion of the set of indicators that could signal the tightening or release of policy tools in IMF (2014b) by proposing approaches to further operationalize the existing guidance and evaluate the current level of systemic risk across Europe. The macroprudential policy stance is measured by assessing the balance between systemic risk related to mortgage lending standards, household vulnerabilities, banking sector exposure to the housing market, the housing cycle, the credit cycle, and the business cycle, and resilience provided by capital buffers and income-based measures. The indicators are bucketed to allow for comparable weighting and cross-country benchmarking. The performance of each dimension of risk and resilience against peer countries can be a useful starting point in guiding macroprudential policy assessment.

When the key indicators proposed in the taxonomy indicate a need for macroprudential intervention, the choice and calibration of tools can be guided by the novel framework presented in the paper aimed at measuring the relative effectiveness of policy measures, avoiding overlaps—that is, the risk that adding up tools, such as counter-cyclical capital buffers, sectoral capital buffers, risk weights and BBMs may result in double (or even triple) counting and coverage of risks—and avoiding pro-cyclicality. Specifically, to avoid overlap, the proposed calibration of any measure is derived by calculating the risk of the bank mortgage portfolio taking into account the impact of any borrower-based measure already deployed, netted out of loan loss provisions and capital measures (e.g., sectoral buffers, counter-cyclical buffers, or risk weight floors). The outcome variable to assess tool effectiveness is its capacity to safeguard banking system resilience (absorb potential future losses) by increasing buffers or decreasing the build-up of vulnerabilities in real estate (ESRB, 2017).

As regards the macroprudential policy stance, a cost-benefit analysis is proposed to guide the adjustment of the macroprudential toolkit over time, including by making active use of design features in the calibration of

[4] The heterogenous practices in calibration and utilization of macroprudential tools across EU member countries has led the European Commission (EC) to seek the views of the European Banking Authority (EBA), the European Systemic Risk Board (ESRB), and the European Central Bank (ECB) on the effectiveness, efficiency, and transparency of the macroprudential framework as well as on the design and adequate use of policy tools (EC, 2021). The ECB has called for a comprehensive assessment of the interactions between CBMs and BBMs to tailor the policy mix to the specific situation in each country, as many countries have implemented these tools simultaneously (ECB, 2022a).

macroprudential tools to minimize unintended effects (e.g., overly restricting credit growth in a downturn). The quantitative and qualitative information used for the macroprudential assessment proposed in the paper can help inform macroprudential policy action in Europe at the current challenging juncture. This analysis suggests that:

- Under baseline conditions, macroprudential authorities should continue to address existing medium-term vulnerabilities in the residential real estate sector. Countries with elevated vulnerabilities could consider tightening macroprudential policies provided that procyclical effects are avoided.
- An increase in capital buffers may be considered in case of rising interest rates from low levels that may expose (outstanding) borrowers' vulnerabilities (pushing up debt servicing ratios) particularly if banks' profitability is boosted facilitating the buildup of buffers and if banks have enough capital headroom to support the real economy.
- When systemic risk is confined to imbalances in real estate, a sectoral capital buffer can be more effective than a broad-based cyclical buffer as it helps build resilience in a targeted manner minimizing unintended side effects, e.g., on broad credit supply.
- An excessive build-up flow of mortgage debt, associated with rapid increases in house prices, may signal a loosening of mortgage underwriting standards that could lead to a material increase in the number of highly indebted households. To guard against this risk, authorities may consider introducing or tightening BBMs.
- In countries where housing prices have eased, BBMs are calibrated as a cyclical tool,[5] concerns over credit supply are emerging, and BBM limits are binding, authorities may consider temporarily easing some of these limits (e.g., DSTI ratios)—provided there is enough macroprudential policy space—to avoid keeping unduly tightened credit conditions and exacerbating a contraction in the financial system and the economy.
- If facing a sharp downturn in the financial cycle causing widespread disruptions in credit or an abrupt house price correction with potential for fire sales, authorities should swiftly relax capital-based tools to enable banks to absorb losses and support lending activity. To sustain supply of credit to financially stretched borrowers, and thereby also dampen the housing market downturn and its macro-financial impacts, cyclical BBM limits could also be eased, if they are conservatively calibrated and overly constrain the flow of credit, including by adjusting exemptions.

The rest of the paper is organized as follows. Section II discusses the challenges involved in macroprudential policy making under the current environment and documents macroprudential policy interventions in Europe since the onset of the pandemic. Section III outlines detailed policy considerations at the tightening stage, while Section IV presents a quantitative framework to assess the relative effectiveness of macroprudential tools to enhance resilience. Section V discusses the conditions warranting a relaxation of policies and provides some insights on how to manage trade-offs during the easing phase. Section VI provides recommendations on how to steer macroprudential policy in Europe in the coming months. Section VII presents a step-by-step operational approach for policy diagnostics at the country level, while Section VIII concludes.

[5] By contrast with CBMs such as the CCyB, which are cyclical in nature, BBMs can be calibrated as cyclical tools (to tame the credit and/or housing cycle) or structural (to limit the build-up of household sector vulnerabilities). Some countries use both a cyclical and structural calibration. For instance, Norges Bank uses a structural limit with a flexible quote (the regulation is adjustable) where the quota varies with the credit/housing cycle. While structural calibration does not vary across the cycle, a cyclical calibration is adjusted with the cycle.

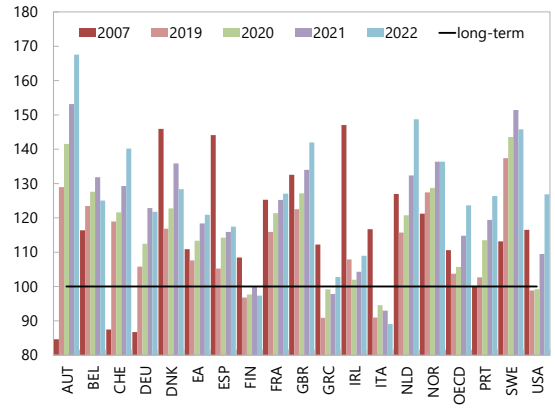
II. Why Housing Matters at the Current Juncture in Europe

There are signs of stretched valuation in real estate markets across Europe, particularly in advanced economies. The sustained upward trend of housing prices was accentuated during the pandemic, fueled by a long period of ultra-low interest rates and a pick-up in demand. As a result, price-to-income (PTI) and price-to-rent ratios are around 30 percent above long-term averages in many countries (Figure 1).

Figure 1. Europe: Housing Loans and Real Estate Indicators

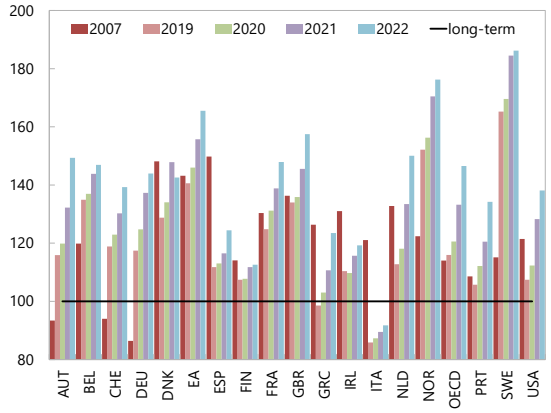
Price-to-Income

(Index; Long-term average = 100)



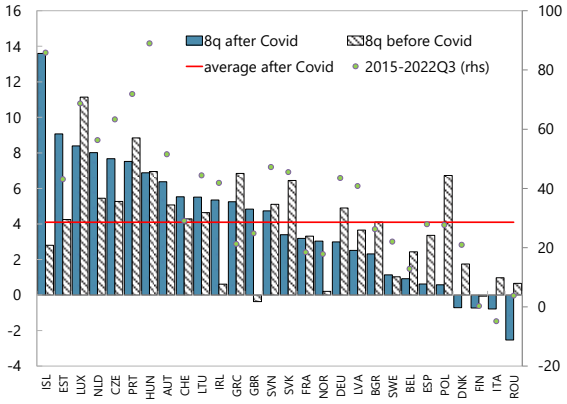
Price-to-Rent

(Index; Long-term average = 100)



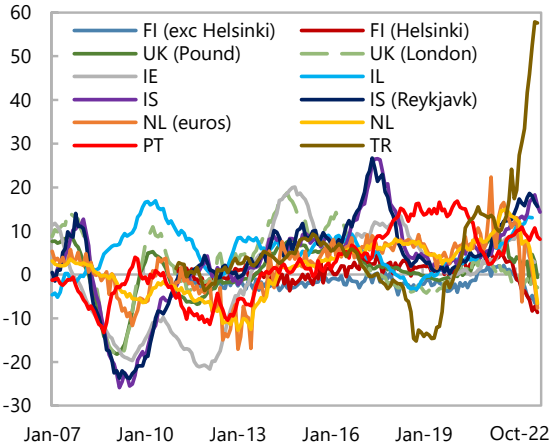
Real House Price Growth Rate

(Percent; year-on-year; annualized)



Real House Price Growth Rate

(Percent; year-on-year)



Sources: OECD, BIS; Haver; National Central Banks; author's calculations.
Note: The bottom left panel shows the average annualized growth rate of real house prices during the 8 quarters after Covid (i.e., 2020Q3-2022Q3) relative to the 8 quarters before Covid (i.e., 2018Q2-2020Q2). The bottom right panel shows monthly real house price growth rate data up to October 2022.

House price growth in Europe has been resilient in the first half of 2022, but signs of a cooling off are emerging in many countries. Looking at monthly frequency indicators, transactions have eased in most jurisdictions, alongside price declines in some cases. For example, the market has started to cool off in Finland, Netherlands, and the UK, while remaining comparatively more resilient in Iceland, Ireland, Israel, and Portugal,

even after outstripping inflation. Against the background of elevated prices relative to fundamentals, rising interest rates and house price stickiness, there is potential for further weakness ahead, although the inflation-hedging properties of real estate assets may continue to support demand and mitigate any price declines.

The macrofinancial implications of unsustainable prices are potentially large. An abrupt correction of house prices could trigger or amplify the economic slowdown in Europe. The decrease in aggregate demand resulting from monetary tightening and a housing market crash would likely vary significantly by country depending on the institutional features of housing finance (Muellbauer, 2022). Financially stretched households could be forced to cut consumption to service their mortgage debt (cash-flow channel). Their willingness to spend could further decrease due to lower perceived wealth as real estate assets represent the bulk of household wealth (the so-called wealth effect), although the empirical literature on the magnitude of house price wealth effects remains inconclusive (Cooper et al, 2016).[6] Banks weakened by rising defaults could curtail credit to the real economy and sell off housing collateral at fire sale prices, amplifying and prolonging the recession. The systemic implications of a housing crash would be significant in Europe as a substantial part of banks' exposures is made up of mortgages (around one third of total loans as of September 2022). By contrast, while residential real estate markets are overheated in the US (Figure 1), US banks keep most securitized mortgages off their balance sheets.

The war in Ukraine and the cost-of-living crisis have made the macrofinancial situation more complex as the housing cycle has become at least temporarily out of synchronization with the business cycle – the housing market was booming during the pandemic while economic conditions have worsened --, making it more challenging for monetary policy makers to stabilize both. In line with the Integrated Policy Framework (IMF, 2020), monetary policy should focus on reaching the inflation target and internal balance while macroprudential policy should be adjusted to mitigate systemic risk and safeguard financial stability. This has put macroprudential policy in the spotlight. The challenges involved in the conduct of macroprudential policy have been acknowledged by the ECB in its latest statement on macroprudential policies in November 2022, cautioning against the risk of procyclical effects. Macroprudential authorities need to respond to accumulated vulnerabilities, while also factoring in—and standing ready to respond to the materialization of risks of a downturn. In its warning on vulnerabilities in the financial system issued in September 2022, the European Systemic Risk Board (ESRB) flagged that the probability of tail risk scenarios has increased since the beginning of 2022. The Financial Policy Committee set the UK CCyB rate at 2% in July 2022 (coming into effect in July 2023), but in its December 2022 Financial Stability Report it stressed that it would continue to monitor the situation closely and stands ready to vary the UK CCyB rate – in either direction – in line with the overall risk environment. France decided to go with the policy tightening announced in December 2021 by re-introducing the CCyB at 0.5 percent in April 2022 (with application starting in April 2023) and rose it to 1 percent in its latest macroprudential meeting.

How Have Macroprudential Policies Evolved Most Recently in Europe?

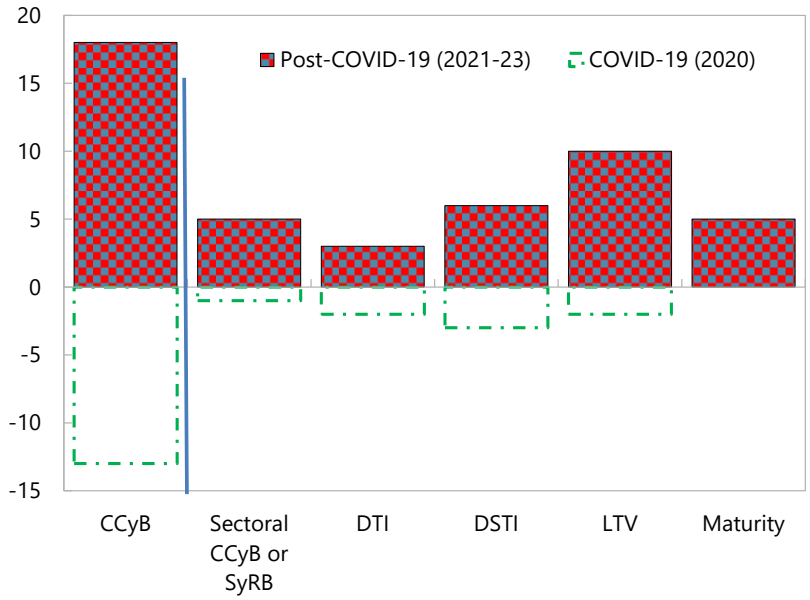
Until most recently, house price growth in excess of what can be explained by fundamentals and buoyant mortgage lending made the real estate and mortgage markets more vulnerable to shocks. Many authorities in Europe have responded to these cyclical developments by tightening macroprudential policy during 2021-23 (Figure 2). Some countries have opted to increase banking system resilience to ensure that banks have enough capital to withstand a correction Reflecting increased cyclical risks, most interventions have focused on the broad-based capital buffer. For instance, sectoral CCyB or systemic risk buffer (SyRB) have been activated

[6] Also, the impact of house prices on consumption from wealth effects is not clear-cut as a decrease in house prices could redistribute wealth within the household sector rather than boosting net aggregate wealth (IMF. 2008).

in countries such as Belgium, Germany, Lithuania, and Slovenia, and their rate has increased in other countries such as Switzerland. In other jurisdictions, such as the UK, the CCyB rate has increased to reach the neutral level announced prior to the pandemic. Table 1 shows detailed macroprudential policy decisions regarding the countercyclical capital buffer since the onset of the pandemic.

Countries that released or reduced the CCyB rate at the onset of the pandemic reactivated or increased the buffer again later on, and some opted for instruments specifically targeted at housing vulnerabilities. The average rate of the CCyB in Europe has reached 91 basis points, above the 67 basis points historical maximum (Figure 3).[7] Further, some countries have tightened targeted instruments in an attempt to curb rising vulnerabilities in residential real estate more specifically. Such instruments include sectoral capital buffers and borrower-based measures. Table 2 shows the adjustments of policy settings on tools targeting the residential real estate at the peak of the pandemic, and during the recovery phase (post-Covid-19).
For instance, in January 2022, Switzerland re-activated the sectoral CCyB at the maximum 2.5 percent level specified in its legal framework, whereas Germany introduced a sectoral systemic risk buffer of 2 percent on housing loans, in addition to increasing the CCyB to 0.75 percent. In Belgium, the macroprudential authority activated a 9 percent sectoral systemic risk buffer to replace minimum risk weight add-ons on residential real estate exposures, while Netherlands implemented risk weight floors which increase with the risk profile of mortgage loans. Regarding borrower-based instruments, the Czech National Bank re-instated a DSTI cap at 45 percent in November 2021, that had been cancelled at the start of the pandemic, and the National Bank of Slovakia tightened the DTI limit for borrowers above 40 years starting at 8 with a floor at 3 at the age of 60.

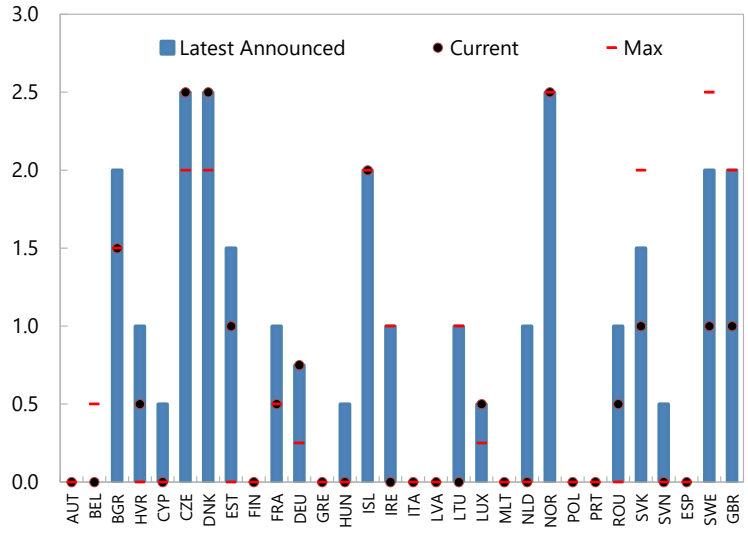
Figure 2. Changes in Macroprudential Policy Tools in RRE in 2021-23 (Number of countries; tighten (+1); relax (-1))



Sources: ESRB Macroprudential Database; IMF Integrated Macroprudential Policy Database; author's calculations.

[7] About two thirds of the countries with a CCyB measure in their toolkit have announced a positive rate higher than the pre-pandemic level, and only three countries have implemented a rate at a lower level. The remainder countries have set the CCyB rate at historical maximum. In addition, four countries have activated a sectoral systemic risk buffer (SyRB) buffer on residential real estate (Belgium, Germany, Lithuania, and Slovenia), while Switzerland has increased the sectoral CCyB rate above pre-pandemic levels.

Figure 3. Countercyclical Capital Buffer Rate, April 7, 2023
(Percent of risk weighted assets)



Sources: ESRB Macroprudential Database, IMF Integrated Macroprudential Policy Database; author's calculations
Note: 'Maximum' refers to the pre-pandemic period.

Part of the recent announcements of policy tightening have been consistent with warnings and recommendations on medium-term residential real estate vulnerabilities issued by the ESRB on the back of strong house price growth, signs of house price overvaluation, and robust mortgage lending amid some easing of credit standards. For instance, in December 2021 the ESRB recommended that Austria and Germany activate legally binding borrower-based tools and tighten capital-based measures to ensure the resilience of credit institutions.[8] In December 2021, it also issued warnings on increasing medium-term vulnerabilities in the residential real estate markets of Slovakia, Hungary, Croatia, Bulgaria, and Liechtenstein.[9]

III. Macroprudential Tool Selection and Calibration During the Tightening Phase

Macroprudential authorities[10] have the mandate to limit systemic risk and strengthen the resilience of the financial system in a preventive manner through the deployment of a variety of policy tools (Table 3).[11] Their toolkit to address systemic risks related to housing developments comprises two broad types of policies aimed at containing the build-up of vulnerabilities and strengthening bank resilience, respectively. These are discussed in turn.

[8] Since the pandemic, only Austria and Germany have received an ESRB recommendation on medium-term vulnerabilities in the residential real estate sector.

[9] In November 2016, the ESRB issued warnings on medium-term residential real estate vulnerabilities to eight countries. All these warnings became recommendations (except for the UK due to Brexit) in 2019 and 2021. Of the five new warnings issued in 2019, one became a recommendation in 2021 (Germany).

[10] The macroprudential authority can be a central bank (e.g., Slovakia, United Kingdom), the government (e.g., Switzerland), or a financial stability committee (e.g., Austria, Germany).

[11] IMF (2018) documents the increasing use of macroprudential policies in Europe. IMF (2014) provides empirical evidence on the effect of macroprudential tools in Asia drawing on a newly constructed database. Other policies that influence housing market activity and house prices include monetary policy (e.g., short-term interest rates), government actions that steer housing demand (e.g., taxes, subsidies), and structural policies that impact supply (e.g., land zoning).

Table 3. Key Policies to Address Vulnerabilities in the Residential Real Estate Market

	Policies to Contain Build-Up of Vulnerabilities	Policies to Strengthen Resilience
Objective	Keep borrowing at sustainable levels	Build bank buffers to absorb losses
Tools	Borrower-based limits: • LTV, DTI, DSTI Amortization requirements: • amortization rate, max loan maturity	Capital-based requirements: • Broad/sectoral CCyB or sectoral SyRB • Risk weight measures Regulatory provisions
Channel	Direct: Credit demand Indirect: House prices	Direct: Higher capital in good times (expected/unexpected) Indirect: Mortgage rate (credit demand); credit supply; house prices
Impact	Direct: • Decrease the number/size of loans	Direct: • Increase capital requirement in good times
	Indirect: • Increase resilience of banks and borrowers • Save regulatory capital	Indirect: • Decrease build-up of vulnerabilities (if pass-through effect) • Increase regulatory capital

Policy Tools to Contain the Build-up of Vulnerabilities

These instruments focus on keeping borrowing at sustainable levels, thereby containing risks of default and/or creditor losses in the event of default. They include BBMs such as LTV, DTI and DSTI limits, as well as amortization requirements (mandatory amortization; maximum amortization period). Because they impose lending constraints on new loans (i.e., do not affect the bulk of loans already made), and thereby take time to influence banks' lending portfolio, there is a case for activating/tightening them early in a housing boom.

LTV limits work mainly through minimizing loss given default. However, if the 'double trigger of default' theory holds,[12] they also influence default risk by making it less likely that financially stretched borrowers find themselves left with negative housing equity.[13] Debt servicing ratio tools assist to limit more extreme lending by imposing a cap on a borrower's overall mortgage debt repayment obligations, reducing the likelihood that borrowers become financially overstretched. Decisions to activate LTV limits are sometimes linked to estimated levels of house price overvaluation, while DTI/DSTI limits often respond to changes in household indebtedness, projected interest rate paths, and loan maturity profile.[14] If well-designed, BBMs can be complementary. Macroprudential authorities can choose different calibrations of tools to achieve the same level of resilience. When selecting the preferred set of limits, other factors can be considered, for example related to distributional concerns or the impact of the measure on banks' business models.[15]

These tools directly affect the number and size of loans, and thereby credit growth. They also have indirect effects on housing markets and prices. In particular, they can increase resilience of both banks and borrowers to a downturn, thereby saving regulatory capital and reducing risks of a pro-cyclical tightening of credit

[12] For a 'double trigger' defaulter, one liquidity trigger (e.g., lower income) explains why the borrower cannot service his mortgage, while a second equity trigger (a fall in house prices) explains why he cannot refinance the debt posting the home as collateral or sell the property to avoid foreclosure. The borrower defaults only if both levers are triggered.

[13] Cunningham et al (2017) show that the fracking boom in Pennsylvania reduced the risk of default by alleviating the liquidity trigger, with larger effects among homeowners with negative equity, validating the 'double trigger of default' hypothesis.

[14] In other countries decisions to activate LTV and/or DTI/DSTI are taken proactively as a structural measure and not necessarily linked to overvaluation or indebtedness.

[15] See Gornicka and Valderrama (2020), Jurca et al (2020), Valderrama (2022), and Valderrama (2021) for a quantitative calibration of different borrower-based tools under alternative macrofinancial scenarios in Austria, Slovakia, and Switzerland.

conditions that would follow if banks were forced to cut back lending to rebuild their capital position that could further amplify a possible housing downturn.

Policy Tools to Strengthen Bank Resilience

Macroprudential authorities can also regulate financial institutions' balance sheet as a whole by pushing banks to build sufficient buffers to absorb potential future losses. Common instruments under this category include capital-based requirements and loan provisioning requirements.

The main capital-based instrument designed to counter some of the pro-cyclicality of the financial system is the CCyB (broad-based or sectoral) and the sectoral SyRB. The CCyB increases the resilience of the banking system during periods of excessive credit growth. In addition, during a boom phase, the CCyB may help dampen excessive credit growth since capital is deemed to be more costly than debt (price effect). Banks may also meet higher CCyB requirements by reducing risk-weighted assets, which may tighten credit supply (quantity effect).

More broadly, indirect sectoral capital requirements take the form of an increase in the capital ratio through one of the components used in the calculation of the ratio, such as risk weights, based on past loss experience or forward-looking considerations that may warrant a larger capital base to absorb losses. Macroprudential authorities can also apply stricter criteria (sensitive risk weights) for either Internal-Ratings based (IRB) exposures or standardized (STA) exposures to make capital requirements commensurate with the risk of the exposure.[16]

Another type of instrument is dynamic provisioning on real estate exposures.[17] This measure shares similar countercyclical properties with the CCyB. The provision is built up from retained profits during a financial boom to cover realized losses during a period of financial stress. By contrast with the CCyB, its activation is linked to bank prudential behavior over the cycle (i.e., the extent to which the bank is building loan loss provisions to absorb future problem assets), rather than to the financial cycle (e.g., credit growth).

These tools increase resilience of banks by increasing capital requirements or provisions in good times. They also slow down the increase in vulnerabilities if banks' pass on higher capital costs to mortgage rates or are capital-starved and thus forced to reduce credit supply.

Broad-Based Versus Sectoral-Based Countercyclical Tools: the European Experience

Compared with broader instruments, sectoral-based tools might be more efficient as they target only the specific risk and relevant exposures, minimizing unintended side effects and improving cost effectiveness. They also increase the incentives for banks to reduce the targeted exposures. This view is reflected in both the evolution of global standards and recent changes to the regulatory framework of macroprudential tools in

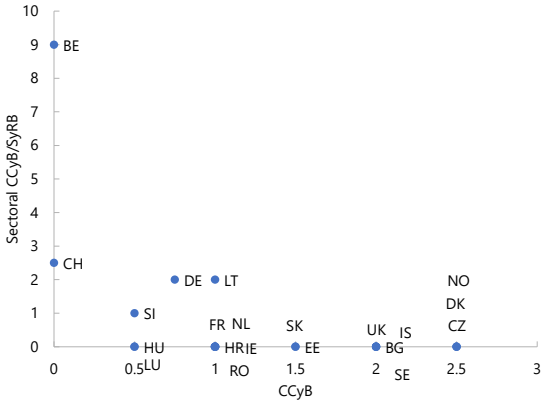
[16] For instance, the Swiss authorities apply the preferential risk weight of 35 percent to standardized exposure fully secured by residential real estate to the tranche smaller than or equal to two-thirds of the market value of the collateral; 75 percent to the tranche between two-thirds and 80 percent of the market value, and 100 percent to the tranche larger than 80 percent.

[17] This tool was introduced in Spain in 2000 (Jimenez et al, 2017). In 2012, the Spanish government approved a royal decree-law to establish additional provisions for non-subprime real estate lending to construction loans as a function on the level of development (from 7 to up to 45 percent of exposures).

Europe. For instance, the introduction of the Basel Committee's broad-based CCyB in January 2016 (as part of Basel III standards) was followed by guiding principles for a sectoral CCyB three years later.[18]

In Europe, the EU fifth Capital Requirements Directive (CRD V) transposed in 2020, allowed, for the first time, a targeted use of the SyRB to improve the cost-effectiveness of capital-based measures and improve banks' capital allocation. The CCyB and sectoral CCyB (or SyRB) may act as substitutes or complements depending on the macrofinancial environment. For instance, an exuberant real estate sector accompanied by strong overall lending growth could lead the authorities to activate both the sectoral CCyB to contain housing vulnerabilities and the broad-based CCyB to curb excessive credit growth. By contrast, a low growth environment with an overvalued real estate segment and high uncertainty about the economic outlook may warrant the activation of the sectoral CCyB while keeping the CCyB buffer to zero (Table 4). Looking across jurisdictions in Europe, the CCyB and sectoral CCyB have been treated mostly as substitute instruments (as the CCyB is meant to address broad-based credit cycle imbalances, while sectoral buffers target a specific sector), except in Germany, Lithuania, and Slovenia where both have been activated (Figure 4).

Figure 4. CCyB and Sectoral CCyB/SyRB in Selected Countries, April 7, 2023
(Percent; latest decision)



Sources: ESRB Macroprudential database; national central banks; author's calculations.

Table 4. Features of CCyB relative to Sectoral CCyB/SyRB

	CCyB	Sectoral CCyB
Goal	Build capital to absorb losses reducing the risk of credit contraction when sectoral imbalances unwind	
Target	Broad-based risks	Targeted risks
Application	All credit exposures	Credit segments of 'systemic importance' for fin stability Risk weight density adequate (could complement risk weight floor)
Conditions	Widespread imbalances	Confined imbalances; low credit growth, high uncertainty
Indicators	Credit growth to GDP gap; others	Broader set of indicators: credit gap; credit growth; asset prices (PTI; PTR); risk indicators (credit conditions; spreads)
Cross-border banking	Basel standard (subject to mandatory reciprocity up to 2.5%)	No Basel standard (voluntary reciprocity)
Side effects	• Could lean against the wind • Could unduly constrain credit	• Could lean against the wind • Could unduly constrain credit • Could change the relative pricing of loans (+/-)
Activation	Lead time of up 12 months, except for sectoral SyRB (shorter at national discretion or exceptionally)	
Release	Immediate (sharp downturn); Gradual (dissipation of systemic risk)	

[18] Switzerland became the first country to apply a sectoral CCyB buffer in February 2013, currently set at 2.5 percent of risk-weighted positions secured by domestic residential property.

Addressing Unintended Consequences of Tools by Adjusting Design Settings

Any macroprudential solution should include a cost-benefit analysis, but there are many challenges involved in quantifying unintended policy impacts.[19] While only ex-post analysis can reveal unexpected effects, a careful evaluation of ex-ante design options and rigorous calibration can help contain the cost of macroprudential tools. A key concern of borrower-based tools relates to distortions in allocative efficiency and distributional effects. This is because LTV restrictions and debt serviceability constraints may limit market access to otherwise creditworthy borrowers and have adverse distributional impact as they tend to exclude low-income households from the mortgage market. Decisions related to BBM instruments may require legislation approval and therefore can be less agile than adjustments to CBM tools. Table 5 outlines some unintended consequences of macroprudential tools and points at design solutions to minimize these, based on European countries' experience.[20]

Table 5. Design Solutions During the Tightening Phase

Unintended Effects of Macroprudential Tools	Design Solutions
Constrained credit to otherwise creditworthy borrowers	Impose mortgage restrictions only on *high-risk loans*, defined by their combined risk characteristics (rather than by one single metric); for instance: • Set minimum interest-rate fixation period for high LTV loans (Denmark; at least 5y fixation period for loans with LTV>60%); • Impose amortization rate add-ons for high DTI loans (Sweden; amortization rate add-on of 1 percent for loans with LTI>4.5)
Distributional impact: • Delay age of home purchase mortage borrowers • Limit market access of first time home buyers	Use different approach across borrowers and type of property: • Less stringent LTV and DSTI limits for young borrowers (Czech Republic), or exemptions to DTI caps for young borrowers (Slovakia) • Softer LTV and DTI rules for first time buyers (Israel), and higher LTV caps for permanent residence (Portugal)
Overly restrictive credit growth	Consider a gradual approach: first introduce guidance/recommendations; conduct ex-post policy evaluation; re-calibrate; then introduce legally binding measures if needed (Austria)
Investors crowd out owner-occupiers	Impose tighter restrictions on the investment-led or buy-to-let segment (Ireland, Latvia, Switzerland)
Tools weaken banks' incentives to conduct risk assessment	Use exemptions to regulatory limits (Norway)
Leakages to other asset classes	Introduce macroprudential caps on other retail lending segments. This option warrants careful monitoring of consumer loans to avoid undue tightening (Slovakia)
Minimum risk weights make risky mortgages more attractive	Make the risk-weight floor risk-sensitive (Netherlands)
Increase in administrative costs for banks	Lower implementation and enforcement costs by imposing restrictions on loan characteristics that are included in regulatory reporting, and give lead time to adjust policy settings (e.g., Belgium)
Regulatory arbitrage	Broader regulatory perimeter. Consistent application of tools by domestic and foreign banks operating in a jurisdiction, including cross-border lending.

Note: Regulatory exemptions to regulatory limits have been used widely in Europe, including in Austria, Estonia, Portugal, etc.

[19] Unlike for monetary policy, simple numerical targets are not readily available for financial stability.

[20] Another unintended effect would be an increase in loan servicing cost when base interest rate is increased, in case of variable rate loans. A design solution includes applying DSTI requirement with a mandatory interest rate stress (Estonia, Portugal).

The scope of application of macroprudential tools is also key to improving cost-efficiency trade-offs, with targeted instruments often seen as performing better and thereby being increasingly used across Europe.[21] As an illustration of the growing trend towards more targeted tools, in November 2021 (active in April 2022) the Czech Republic re-activated the DTI upper limit which had been cancelled since April 2020, but introduced a differentiation by type of borrowers in an attempt to minimize associated distortions. Specifically, in contrast to a broad-based DTI upper limit of 9 set prior to the pandemic, the Czech authorities set a higher 9.5 DTI limit for owner-occupied mortgages by—typically more credit-constrained—young borrowers, and a stricter 8.5 DTI limit for any other mortgage credit (i.e.., loans to finance owner-occupied investment by older borrowers, or to buy-to-let residential property by any applicant). This trend towards targeted instruments is also reflected in the introduction of risk-weight floors which have been increasingly differentiated across types of exposures. For example, in Netherlands, the macroprudential authority introduced differentiated minimum risk-weights for the calculation of capital requirements by LTV (i.e., 45 percent risk weight for the portion of a loan exceeding 55 percent LTV and 12 percent otherwise) which entered into force by end 2020.

Other design considerations when seeking to minimize macroprudential tools' unintended effects include:

- *Quantitative guidance versus hard limits.* Quantitative guidance can be implemented as a first step, before considering hard limits in a second step, when there is large uncertainty over macroprudential policy impact. For instance, in 2018, Austria stipulated quantitative criteria for sustainable lending in real estate financing on LTV, DSTI, and loan maturity. This allowed the collection of additional data on the risk profile of new mortgage flows which subsequently helped calibrate the instruments. In June 2022 (effective in August 2022) the Financial Market Authority set an upper limit of 90 percent for LTV, 40 percent for DSTI and 35 years for the maturity of loans with some exemption buckets, following an ex-post policy evaluation analysis on a sufficiently granular database.

- *Introduction of flexible quotas ("speed limits").* Flexible quotas on new loans set the maximum volume of high-risk lending that can exceed the limits set by the macroprudential authority. A benefit of this solution is to give banks flexibility in customer allocation and increase credit market efficiency. For instance, in Norway, 10 percent of new mortgages outside Oslo is allowed not to meet regulatory DTI, LTV, and amortization rate requirements; the quota is stricter in Oslo at 8 percent. Another benefit of speed limits is to reduce social gaps. For instance, in Slovakia, 5 percent of loans exceeding a DTI ratio of 8 but not greater than 9 can be granted to borrowers not older than 35 years with income below 1.3 times the average wage.

- *Temporary versus permanent restrictions.* Cyclical buffers are temporary tools by design, to be adjusted throughout the financial cycle. Borrower-based limits may also be relaxed when systemic risk eases and imbalances recede (e.g., New Zealand in 2017) or in the face of extreme uncertainty posed by a recessionary environment to support lending to the real economy (e.g., Czech Republic in 2020). Some countries instead have tended to consider BBMs mainly as structural caps and favored adjusting 'speed limits' over the cycle (e.g., Norway). Considerations of whether to adjust BBMs' upper limits or the exemption buckets across the cycle include, among others (see also Section V below) the volatility of the business cycle, fluctuations in underwriting standards, and the uncertainty of transmission channels. Countries hit by larger and more frequent shocks and facing larger fluctuations in

[21] This is because episodes of financial crises suggest that imbalances are often confined to a specific segment, and financial excesses are often not very synchronized across markets.

underwriting standards may benefit more from resetting BBMs limits, whereas in countries with more uncertain transmission (for instance, due to greater use of mortgage loans to finance consumption) it may be preferable to adjust the BBM flow limit (i.e., the number of mortgages that can be extended at or above the upper threshold).

IV. How to Compare the Interaction and Effectiveness of Macroprudential Tools to Enhance Resilience

Macroprudential tools are designed to address the procyclical bias of capital requirements and loan loss provisions. This is due to the mismatch between cyclical risks and the reserves built to absorb future losses in the form of regulatory capital and provisions. During an economic boom, the loan portfolio quality generally improves. This results in lower capital reserves (as capital requirements rise with the riskiness of the exposure) and a drop in provisions. The cyclical underestimation of expected losses and a lower risk premium leads to higher credit growth sowing the seeds of the downturn. While the introduction of IFRS 9 should limit the procyclicality of provisions, the benefits of using the expected credit loss (ECL) approach depends on banks' ability to forecast the future materialization of credit risk. As the COVID-19 pandemic has shown, some banks may have underestimated future credit losses at an early stage, relying mainly on days past due as a trigger for a significant increase in credit risk.

Comparing the effectiveness of different tools is a complex matter that requires, as a starting point, a clear metric. A full welfare analysis factoring in the costs and benefits—including the gains from smoother business cycle fluctuations—of the different tools is beyond the reach of this paper.[22] Also, the measurement of effectiveness should be interpreted with caution as it depends on the scenario considered in the analysis and is subject to model uncertainty. Rather than the impact of macroprudential policy on broader welfare, or credit growth or house prices, the focus here is on systemic risk and financial system resilience. Protecting the banking sector from periods of financial exuberance associated with the build-up of system-wide risk is the stated ultimate objective of macroprudential policy (BIS, 2010, ESRB, 2017).[23]

Comparing the effectiveness of CBMs and BBMs is challenging. BBMs act through quantity restrictions on *new flows* of lending while capital measures work through higher capital requirements on the *stock* of exposures. As such, BBMs enhance resilience with a lag depending on the replacement rate of the portfolio. We therefore need a common measure that quantifies BBMs' reduction of systemic risk against CBMs' loss absorption capacity. Figure 5 illustrates qualitatively the transmission channels of macroprudential tools. During an economic boom, the loan portfolio quality improves. This results in low loan loss provisions (grey triangle on the left) relative to potential losses (red curve on the right). At the same time, the cyclical underestimation of expected losses (and the lower risk premium) leads to high credit growth sowing the seeds of the downturn

[22] Capital-based tools are unlikely to have a major dampening effect on house prices. This is because when macrofinancial conditions are favorable, banks are less likely to constrain credit supply (ECB, 2022). BBMs may contribute to taming the real estate cycle by directly constraining the origination of high-risk household credit, although some bunching of new loans just below regulatory limits has been observed. The analysis presented in this section takes into account the evolution of house prices in the baseline/adverse scenario used to compute future losses but does not model explicitly feedback loops between macroprudential tools and macrofinancial conditions.

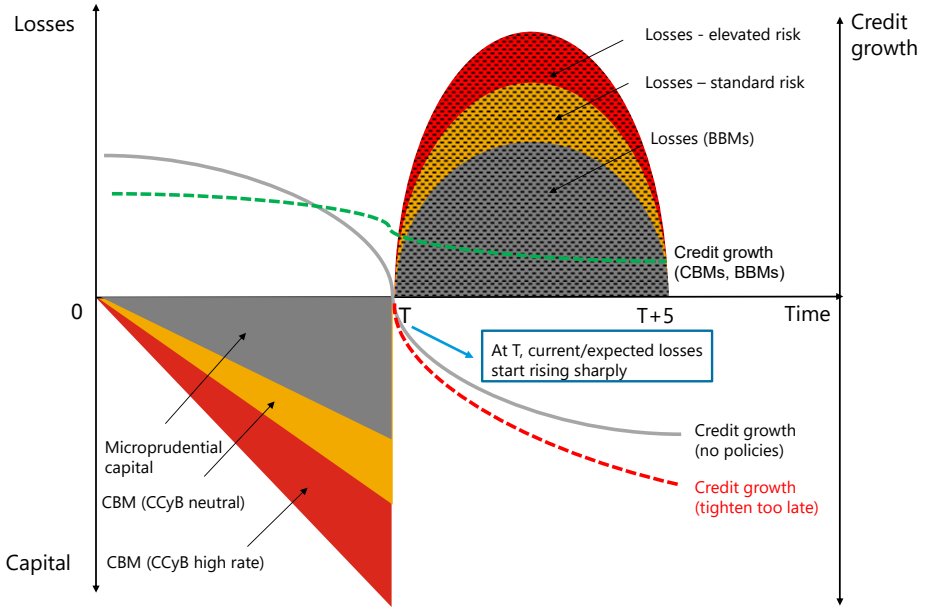
[23] According to the ESRB (2017), the objective of macroprudential policy is to contribute to the safeguarding of the stability of the financial system. This includes strengthening the resilience of the financial system and decreasing the build-up of vulnerabilities. In selecting instruments, authorities can also target intermediate objectives relevant for safeguarding the stability of the banking sector related, for instance, to credit growth and leverage.

(grey line, with “no policies”). Assume that between 0 and T, the economy is in the build-up phase of systemic risk. At T, the cycle turns, and asset quality starts to deteriorate. In this illustrative example, ex-post losses will turn higher than ex-ante provisions (i.e., the patterned red area exceeds the grey triangle).

The macroprudential authority can bridge the difference by: (i) increasing CBMs (solid orange or red; depending on the risk environment; whether ‘neutral’ or ‘elevated’); or (ii) activating BBMs to decrease the level of risk (pattern grey) by putting a lid on the risk profile of new mortgage loans (the tightness of the BBM caps will depend on the distance of the losses without or with measures: distance between red and grey; or distance between orange and grey). The adjustment of macroprudential settings through the cycle will likely have an impact on credit growth. It will reduce credit in the boom and support credit in the downturn. The effect can be asymmetric across CCBs and BBMs. In the tightening phase, BBMs tend to have more impact on credit growth than CBMs as they operate through quantities.

In the loosening phase, the impact of relaxing tools will depend on the: (i) nature of the shock, whether it’s supply or demand; (ii) banks’ capital headroom; and (iii) the interaction with other capital requirements. For instance, some evidence on loan data from the euro area suggests that banks with less capital headroom tended to lend less during the pandemic, pointing a higher effectiveness of capital buffer releases for capital constrained banks, as well as for banks that did not breach other capital measures (such as leverage ratios, or MREL – minimum requirements for own funds and eligible liabilities for resolution) (Couaillier et al, 2022).

Figure 5. Interaction between Microprudential Capital, CBMs, and BBMs



Sources: Author’s elaboration. The chart shows the capital built during the expansionary phase (t<T) relative to the losses realized during the bust (t>T) under different risk environments. The grey line shows the procyclicality of credit growth, in the absence of macroprudential policy. The use of macroprudential tools stabilize the provision of credit through the cycle (green dashed line). If policies are tightened too late in the cycle, they exacerbate the procyclicality of credit provision (red dashed line).

If vulnerabilities are rising, but policymakers are uncertain about the position in the cycle, they may adopt a cost-benefit approach to tightening. On the cost side, if they tighten too late in the cycle (when financial conditions have already deteriorated, and risk has started to crystallize), credit growth may retrench further (dashed red line). The impact is expected to be more severe if they tighten BBMs (as the impact feeds directly into credit restrictions rather than into pricing). On the other hand, the benefit of raising the CCyB buffer is likely

to be greater than that of tightening BBMs. This is because it increases the reserves of banks to absorb losses and will not reduce credit as much, particularly if banks have enough capital headroom. By contrast, a tightening of BBMs will have no impact on the realization of immediate losses (as it applies only to new flows, which are already subject to tighter conditions in a downturn) and may constrain credit growth further.

Next, we outline some practical stages which help operationalize the assessment of macroprudential tool effectiveness, taking into account their interaction with minimum capital requirements and bank provisions. Annex 1 provides a quantitative example based on mortgage risk parameters of a major European banking system.

a) *Assessing the current risk of the mortgage portfolio*. The risk characteristics of the stock of mortgages serve to calculate the amount of regulatory capital and loan loss provisions that have been already built up to absorb future losses (micro perspective).
b) *Evaluating the system-wide risk environment.* The vulnerabilities that could crystallize in a severe downturn at the macro level, considering the broader systemic risk from spillovers, will typically differ from the risk reserves built by banks at the individual level (analyzed in stage a).
c) *Calculating losses in a severe downturn.* Two approaches can be followed to estimate the amount of credit losses that could realize when systemic risk materializes. First, future losses can be calibrated looking at historical bank losses in periods of elevated risk. Alternatively, losses can be estimated by translating a macro severe scenario into micro parameters (e.g., PD, LGD), which are then applied to banks' mortgage exposures. The scenario can be benchmarked to a historical recession-like scenario (e.g., Federal Reserve) or to the current exuberance of credit and financial markets (e.g., Bank of England).[24]
d) *Computing the capacity of CBMs to cover future losses.* This requires calculating the capital buffer, in nominal terms, corresponding to activating CBMs, taking into account the scope and calibration of the measure. The size of the capital buffer can be compared against the future losses calculated in stage (c) net of the provisions set aside by banks in stage (a), to measure effectiveness.
e) *Quantifying the risk profile of new flows relative to the outstanding portfolio.* Given that BBMs are applied to the flow of new mortgages, we need to measure the credit risk of new issuances if no policies are deployed against the risk of new flows subject to BBM restrictions. The difference between the loss of the loan portfolio with and without BBMs will pin down the reduction in systemic risk achieved by the activation of the BBMs. A simplified or a modeling approach can be followed to estimate credit losses at the vintage level (Annex 2).
f) *Comparing the loss absorption capacity of CBMs against the reduction in systemic risk by BBMs.* To measure the effectiveness of CBMs relative to BBMs, we need to apply information on the replacement rate of the mortgage portfolio (i.e., the rate at which the outstanding mortgages amortize, and they are replaced by new mortgages), the rate of additional loan creation, and the time during which the BBMs are activated.[25] This helps translate the impact on flows into the expected effect on stocks. A higher replacement rate and an early activation of BBMs relative to the materialization of systemic risk will enhance their capacity to absorb future losses.

[24] This is the approach followed by the Bank of England in their annual concurrent stress test. Details are available at https://www.bankofengland.co.uk/stress-testing

[25] The replacement rate depends on the time to maturity of outstanding mortgages. In Annex 1 we assume a replacement rate of 10 percent based on supervisory information from a major European country.

Capital-Based Tools

To avoid unnecessary redundancy and instead ensure complementarity, additional CBMs (in good times) can be assessed based on their capacity to cover additional risks that banks could suffer (in bad times). Peak losses during a real estate crisis (at the trough) can exceed losses expected under baseline conditions (at the peak). In the illustrative example provided in Annex 1, assuming a size of outstanding mortgages of 100, if tail risk (the trough) were to materialize, mortgage losses would amount to 0.68, exceeding the 0.09 booked as loan loss provisions. If the build-up of risk were to continue over 5 years, losses net of provisions would reach 0.93.

Results suggest that both a sectoral CCyB (or SyRB) buffer (activated during the run up to the peak and released gradually between the peak and the trough, or at the trough in response to a sharp downturn) and minimum risk weights on banks' IRB models can build resilience during the expansionary phase of the cycle when housing risks are underestimated. Both capital-based tools become binding during the upturn and are not binding during the trough.

BBMs

To estimate the expected impact of BBMs on building resilience, we proceed in four steps. First, using the Basel III IRB supervisory formula, we back out the effective maturity of loans that match banks' risk-weights using banks' reported PDs and LGDs. Second, we use a semi-structural model to project PDs and LGDs of new vintages (no policy) and plug them into the IRB formula to compute capital requirements. Third, we calibrate regulatory limits on BBMs (LTV, DTI, DSTI, amortization requirements) to match the risk of new vintages to the average risk of the outstanding portfolio.[26] Fourth, we use information on the replacement rate of the portfolio to assess the capacity of BBMs tools to reduce the tail risk of the portfolio over time.

Quantifying Relative Effectiveness

Different combinations of tools can achieve a similar level of performance. For instance, in the results shown in Table 6, a floor for average risk weights of 25 percent could cover over 85 percent of the losses realized 5 years after the introduction of the measure. A similar level of loss absorption capacity could be achieved by combining a 20 percent minimum risk weight with a 2.5 percent CCyB buffer.[27] This implies that policymakers can choose between different calibrations of macroprudential tools to enhance resilience.[28] When selecting the preferred set of limits, other factors can be considered – for example, the ease of implementation, the impact on banks' business models, and possible unintended effects (Section VII). On the other hand, the introduction of BBM limits calibrated to stabilize the risk of new originations to the outstanding portfolio could reduce losses by about 60 percent, while a sectoral CCyB/SyRB buffer could absorb 40 percent of loan losses.

[26] Arguably, the tightness of the measures is linked to the increase in the size of vulnerabilities and to the timing of implementation. Given significant transmission lags, macroprudential authorities should act early to limit further deterioration in the risk profile of new mortgages relative to the outstanding portfolio. This was, for instance, the approach followed by the Bank of England when it introduced an LTI limit of 4.5 with 15 percent speed limit in 2014. The calibration was designed to provide insurance against the risk of a market loosening in underwriting standards in new loans compared to past production. This approach also contained the impact on banks' lending strategies.

[27] This combination is, for instance, applicable in Norway, where residential real estate exposures are subject to a risk weight floor of 20 percent and a 2.5 percent CCyB rate will be set from March 31, 2023.

[28] The exact calibration and combination of tools that can yield similar levels of resilience depend on the PD and LGD parameters of the portfolio and the risk profile of new mortgages.

Choice of Tools

The final choice and combination of tools can be guided by their effectiveness in locking-in resilience to the predominant risks that threaten the resilience of the financial sector. For instance, if imbalances are driven by the loosening of lending standards, reflected in sustained increases of LTV, DTI, DSTI ratios or the lengthening of loan maturities, BBMs can be more effective than capital-based tools in constraining further deterioration in underwriting standards. By contrast, an increased likelihood of the materialization of systemic risk affecting the stock of mortgage exposures (e.g., as reflective in excessive credit growth, unsustainable house prices, or higher repricing rates), may warrant the activation of capital buffers to absorb prospective portfolio losses. Tightening macroprudential policy late in the cycle also calls for prioritizing capital-based measures as they apply to outstanding exposures and therefore operate with fewer lags than BBMs. Also, a reversal of the cycle will generally lead to a tightening of underwriting standards, which will limit the riskiness of new vintage flows.

Table 6. Relative Effectiveness of Macroprudential Tools: An Illustrative Example

Tool	Losses (Billion)	Additional capital (Billion)	Effectiveness (Percent of Losses)
RW Floor=25%	0.93	0.81	87%
SCCyB=2.5%	0.93	0.37	40%
BBMs to anchor risk of portfolio	0.59	N/A	58%
RW Floor=20% SCCyB=2.5%	0.93	0.78	84%

Note: The first column shows the losses net of provisions that can materialize in a downturn, five years after the activation of macroprudential tools. In the absence of BBM limits (rows 1, 2, 4), the net loss is the exposure weighted loss of existing mortgages and of new loans. Net losses from the non-amortized outstanding portfolio amount to half of 0.59 billion (given 10 percent annual replacement rate). Losses from new issuances amount to half of 1.275 billion (see Annex 1 for detailed calculations). The implementation of BBM limits (third row) reduces the amount of future losses by anchoring the risk of new mortgages to the outstanding portfolio. For risk-weight tools, the additional capital is computed as the difference between the risk weight floor and banks' derived risk weights given the PD and LGD of the portfolio, applied to the mortgage exposure. The capital buffer loss absorption capacity is calculated as the buffer rate multiplied by the risk weighted assets of the mortgage book. For capital tools, the effectiveness is measured as the ratio of future losses covered by the measure. For BBM limits, the effectiveness is evaluated as the change in the amount of future losses brought by the activation of the measure, as a share of future losses.

V. Considerations on Macroprudential Policy Loosening if Economic Conditions Were to Deteriorate

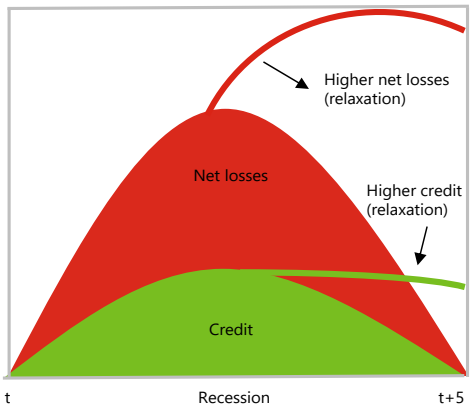
During the expansionary phase of the housing cycle, both microprudential and macroprudential policies pull in the same direction by containing excessive credit growth associated with strong macroeconomic performance, robust asset prices and easy financial conditions. But when the cycle turns, getting the stance of these policies right becomes more difficult due to the inherent trade-offs between credit expansion and resilience to shocks.

When Should Macroprudential Policies Be Relaxed?

The purpose of tool relaxation is to give banks more flexibility in granting credit to cushion the impact of an economic downturn (Nier and Olafsson, 2020). Decisions to relax a policy tool should take effect immediately to support the real economy in a downturn. This section builds on IMF (2014a), IMF (2014b) which advocate that a relaxation of macroprudential policy tools should be considered if systemic risk dissipates or if it materializes and the tightening of financial conditions is a drag on the real economy. Factors that may warrant a release include:

Low banks' balance sheet capacity: bank losses exceed their management buffers (due to thin buffers or large losses), which would force banks to breach macroprudential requirements if they were to keep lending.
Tight lending conditions: banks' lower risk appetite has tightened underwriting standards, hindering the ability of households and businesses to meet their financing needs. While a relaxation of macroprudential tools will not increase banks' risk appetite, it may facilitate the provision of credit to otherwise creditworthy borrowers.
Reduced imbalances. the mortgage and real estate markets have cooled off (i.e., house prices have become sustainable; the size of overvaluation has decreased). It is worth mentioning the difficulty to properly evaluate the equilibrium level of housing prices and the risk that some countries may loosen BBMs under lobbying pressures, potentially hampering the needed downward adjustment of overvalued housing prices after a boom.
Policy space: macroprudential tools were calibrated tightly so that a relaxation still offers appropriate protection.
Temporary shock: a temporary economic disruption—such as a predictably short-lived recession—mitigates the trade-offs between balance sheet expansion and resilience. The cost of a relaxation of policies which enhance banks' resilience to future losses is likely to rise as the recession lengthens, because adverse developments increase the risk of default of all outstanding exposures (stock), while a relaxation of policies impacts new credit (flow). This effect can be, however, offset if the likelihood that future losses materialize decreases with the pace of credit growth to the real economy. Overall, the calibration of the relaxation should be according to the likely persistence of the shock. In Figure 6, as the length of the recession increases (i.e., the peak of the shaded red area approaches t+5), the cost of relaxing early increases as the size of future credit losses escalates (depicted by the area below the upper red curve), partly offset by the higher rate of credit growth (denoted by the upper green line) which reduces the likelihood of the tail-risk scenario.

Figure 6. Costs and Benefits of Relaxation



Source: Author's calculations.

Which Macroprudential Tools Can Be Relaxed?

Capital buffers: These include the Basel III CCyB buffer, the sectoral CCyB buffer (Switzerland), and the sectoral SyRB buffer (Belgium, Germany, Lithuania, and Slovenia). Due to their countercyclical nature, these buffers can be released to absorb losses and avoid that the provision of credit is overly constrained in a downturn. An indicator of credit constraints is the level of bank capital headroom. Recent empirical evidence suggests that proximity to minimum capital requirements is significantly related to lending to the real economy. During the pandemic, banks with lower distance to minimum requirements benefited more from the release of capital buffers relative to banks with stronger capital positions (Couaillier et al, 2022; BIS, 2022).

Risk weight tools: Policy measures that increase risk weights for IRB banks' exposures due to higher intensity of systemic risk (e.g., risk weight floor in Estonia, Norway and Sweden; risk weight add-on in Belgium which was discontinued and replaced by the sectoral SyRB in May 2022; LTV-sensitive risk weights in Netherlands) could potentially be released in a downturn but only as a measure of last resort provided systemic risk has dissipated. By relaxing the risk floors, banks can use the released capital to absorb losses as long as the slump persists.

Borrower-based tools: The choice of which tool to relax should be guided by its expected effectiveness in relieving supply constraints in credit provision. Tools that become binding in a downturn should be relaxed first. The likelihood that a tool becomes binding depends on:

- The stress scenario: An inflationary scenario characterized by sharp interest rate increases tightens debt serviceability constraints, warranting a relaxation of DSTI or maturity caps, all else equal. By contrast, a recession scenario *not* associated with higher interest rates—and indeed often followed by interest rate cuts—typically results in prolonged income losses, thereby tightening the leverage constraint (DTI), which becomes more binding. In a stagflation scenario, featuring both large upward shifts to mortgage rates and lower incomes from reduced activity or employment, both the debt servicing and the DTI upper limits are likely to become more binding, calling for a relaxation of both regulatory limits, all else equal. At the same time, borrower-based measures do not need to be relaxed or increased in relation to credit developments. They can be implemented as a structural backstop during the whole loan cycle
- The interaction between the business and housing cycles: A housing cycle downturn that leads the business cycle relaxes the DTI constraint. By contrast, a recession driven by a large exogenous shock depressing economic activity but not the housing market (e.g., pandemic shock) may make banks overly cautious with lending to creditworthy borrowers (given the uncertainty around the outlook) and may all for a temporary relaxation of LTV limits (e.g., RBNZ, April 2022).

How to Manage Trade-offs in a Downturn?

During a downturn, the new credit may have a simulating effect on the economy but the increase in leverage allowed by a relaxation of existing tools could weaken borrowers' balance sheets and the financial position of banks, sharpening macroprudential policy trade-offs.

A decision to relax existing tools should be supported by a careful cost-benefit analysis. The cost of relaxing the tools comes mainly in the form of lower resilience, while the *benefit* of relaxing depends on how much extra lending the relaxation can support, and how much that extra lending would help stabilize the economy and, through this channel, support financial stability. In its recent response to the European Commission's call for advice on the review of the macroprudential framework, the ECB called for more macroprudential policy space in the form of higher amount of releasable capital buffers. Assuming that macroprudential authorities have built the maximum 2.5 percent CCyB buffer (under mandatory reciprocity) during the activation phase and decide to release it during a downturn, banks could support an increase in new lending depending on the risk profile of the new credit exposures. However, given that the risk density of loans to the real sector is typically higher than that of other credit risk exposures (e.g., financial, sovereign), and that the new risk environment warrants higher risk weights on new loans, the balance sheet capacity to fund new loans will be significantly reduced.

The required cost-benefit analysis when considering a possible relaxation should also factor in other, complementary policies to mitigate costs. The authorities can lower the cost of relaxation—in terms of reduced resilience to future shocks—through recommendations on conservative dividend policies or other capital

distributions, as well as close monitoring of individual institutions' underwriting standards. Also, monetary policy and fiscal policy can complement macroprudential relaxation in facilitating credit provision by easing financial conditions and enhancing the financial situation of borrowers.

To ensure that policy relaxation is effective in supporting credit in a downturn, banks should be encouraged to use the policy space created by the easing of policy requirements, as they otherwise tend to use a cautious approach to collateral valuation in a downturn. For instance, Czech banks continued restricting loans at high LTV despite the suspension of the measure in 2020. In other cases, banks were unwilling to use the capital buffers due to the interaction of macroprudential measures with other capital requirements, such as the leverage ratio, and MREL requirements, to avoid breaching the combined buffer requirement that could entail restrictions in capital distributions.[29] A crucial lesson from the pandemic is the importance of *buffer usability* as most banks maintained capital ratios well above the minimum requirements even after macroprudential authorities released buffers. Evidence suggests that banks may have been hesitant to use their capital buffers; yet it is unclear whether this reluctance reflects concerns related to future losses or the wide market stigma that results if a bank uses its buffers (Basel, 2021). To make the relaxation of buffers operational, macroprudential authorities should clearly communicate the objectives of the buffer release and expectations around the duration of the policy to provide market confidence and encourage banks to make use of the released buffers.[30]

VI. How Should Policy Tools Be Adjusted in the Months Ahead in Europe?

This depends on how macrofinancial conditions evolve:

- *Under baseline conditions*—that is, under the sharp growth slowdown but absence of any sharp recession embedded in the January 2023 *IMF World Economic Outlook* update, macroprudential authorities should continue to address existing medium-term vulnerabilities in the residential real estate sector. Countries with rising vulnerabilities in the mortgage and housing markets might consider tighten macroprudential tools where these are not already tight, provided that procyclical effects are avoided. The relevance and magnitude of such procyclical effects will vary across jurisdictions; for instance, it will be greater in banking systems with more limited capital headroom, all else equal, as banks may then respond to a tightening by constraining credit, further weakening the economy. Also, rising interest rates may mechanically tighten debt serviceability constraints, cautioning against lowering the macroprudential upper limit on DSTIs. The authorities should identify the set of sectoral exposures that are contributing to a rise in systemic risk and to the persistence of macrofinancial vulnerabilities, and primarily tighten targeted tools (see Section 7 for operational guidance).
- *If economic conditions were to deteriorate* sharply, but house prices remain strong, macroprudential policies should pause further tightening. If mortgage credit supply slows sharply, and borrower-based measures become more binding, authorities could relax gradually, keeping some policy space to absorb further shocks in both directions.
- *A severe house price correction* could warrant immediate relaxation of capital-based tools to enable banks to absorb losses and create incentives to support ongoing lending activity (provided unexpected

[29] In April 2022, EBA published its response to the European Commission's call for advice on the review of the macroprudential framework which includes the recommendation to undertake a comprehensive evaluation of the interaction of macroprudential tools and other capital requirements to improve buffer usability.

[30] Understanding banks' balance sheet optimization behavior would help estimate the impact of capital buffer release on balance sheet expansion during a downturn.

loan losses increase significantly). To sustain demand for credit and avoid fire sales of financially stretched borrowers where these represent a material risk, binding borrower-based measures could also be eased. Easing should only be considered if BBMs were tightened beforehand for cyclical reasons. Also, if real estate prices drop, BBMs might become less binding.

To guide the decision of whether an adjustment to macroprudential settings may be warranted, a useful starting point is the quantification of financial stability risks related to residential real estate net of the resilience built through, for example, current macroprudential policy interventions. This requires identifying the necessary dimensions of risk and resilience, and their associated metrics. [31]

To operationalize the framework, we need to measure a set of relevant indicators pointing to imbalances associated with system-wide risks. Judgment is likely to play an important role given data constraints (in the cross-section and time series). In line with BIS (2010), setting macroprudential policy can be based on a 'guided discretion' approach based on:

- A systematic analysis and aggregation of key quantitative indicators (rules-based component); when these indicators depict a homogenous picture of imbalances building up in the system, the authorities' decision can rely on this signal. When the key indicators convey a heterogeneous picture of the situation, more discretion should enter into the decision-making process.
- The analysis of a broader set of additional quantitative and qualitative indicators (discretionary component). Indicators signal the increase in imbalances when they reach high levels by both historical and international standards, and when the trend is deteriorating. Once a tool is activated, its level should be adjusted to the size of imbalances.

We identify relevant risk and resilience metrics based on the empirical literature on financial crisis drivers and ESRB guidance. Vulnerability indicators include the level of underwriting standards (average and tail values for DTI, DSTI, and LTV in new loans), household vulnerabilities (household debt; financial wealth; share of floating rate mortgages[32]), banks' exposure to real estate (share of mortgage loans to total loans to private non-financial sector), the state of the housing cycle (deviation of PTI from long-term averages; real house price growth accumulated since the pandemic), the credit cycle (credit to GDP gap[33]; credit growth; mortgage growth), and the business cycle (output gap). As regards resilience indicators, we focus on metrics that are under the control of the macroprudential policymaker, namely the size of capital buffers (CCyB) and the restrictions associated with BBMs.

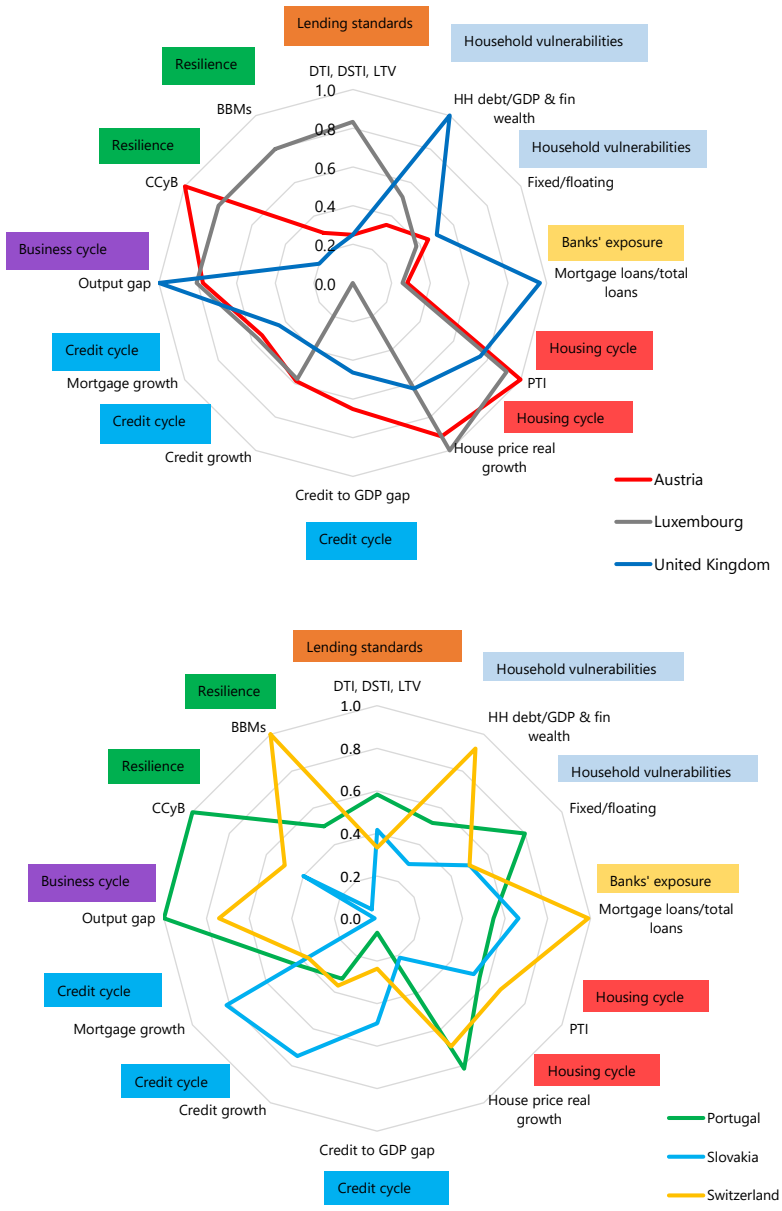
The next step is to identify the relevant indicators and to bucket them to allow for comparable weighting across indicators. To protect the bucketing from extreme values, we use trimmed percentiles of each variable, and apply the following transformation:

[31] This is in line with recommendations by the Expert Group on Macroprudential Stance (ESRB, 2021b).

[32] Data on the prevalence of floating-rate mortgages is sourced from Hypostat (2022). The indicator captures the share of outstanding mortgages with adjustable rates withing the next two years.

[33] The 'credit to GDP gap' is calculated following ESRB recommendation ESRB/2014/1 on guidance for setting the CCyB (ESRB, 2014, Annex, Part I).

Figure 7. An Illustrative Heat Map of the Residential Real Estate Market in Selected Countries



Sources: ESRB Macroprudential Database, Haver Analytics, OECD; BIS; national central banks; WEO; author's calculations.
Note: The figure presents two radar charts highlighting the state of each component of vulnerability and resilience for six European countries as of October 2022. The top chart includes Austria, Luxembourg, and the UK, where price-to-income ratios exceed long-term averages by more than 40 percent. The bottom chart groups Portugal, Slovakia, and Switzerland, where price-to-income ratios are at least 20 percent above their long-term values. Each chart conveys quantitative measures of each component of vulnerability (upper, left, bottom and bottom left), as well as resilience (upper left). Each relevant indicator has been bucketed to allow for comparable weighting across indicators. This transformation normalizes the value of each indicator between 0 and 1, with low values signaling low risk (or high resilience) and high values showing high risk (or low resilience).

$I = \frac{X^{trimmed} - X^{trimmed}_{\min}}{X^{trimmed}_{\max} - X^{trimmed}_{\min}}$ for the risk variables and $I = \frac{X^{trimmed}_{\max} - X^{trimmed}}{X^{trimmed}_{\max} - X^{trimmed}_{\min}}$ for the resilience variables.[34]

This transformation serves to normalize the value of each indicator between 0 and 1, with low values signaling low risk (or high resilience) and high values showing high risk (or low resilience).

Figure 7 shows the resulting illustrative spider charts for two sets of countries grouped in terms of their residential real estate pressures. The top chart includes Austria, Luxembourg, and the UK, where price-to-income ratios exceed long-term averages by more than 40 percent. The bottom chart groups Portugal, Slovakia, and Switzerland, where price-to-income ratios are at least 20 percent above their long-term values.

The top chart identifies robust growth in residential real estate prices as the main vulnerabilities in both Austria and Luxembourg pointing at a relative deterioration in lending standards in Luxembourg. Austria has built resilience by introducing legally binding BBMs in 2022, and Luxembourg activated an LTV limit in 2021 differentiated across different categories of borrowers; in addition, it has kept CCyB at 0.5 percent. In the UK, household leverage is relatively high, and banks are significantly exposed to the mortgage market, but the housing cycle has started to cool off and resilience has strengthened with the recent increase in the CCyB rate.

The bottom chart suggests that systemic risk in residential real estate in Switzerland stems from banks' real estate exposure and elevated household indebtedness, partly mitigated by high financial wealth. At the same time, mortgage volume has moderated, and some resilience has been built through the re-introduction and increase of the sectoral CCyB. This contrasts with Portugal, where real house price growth has accelerated since the pandemic despite limits in LTV, DSTI, and loan maturity, households are vulnerable to interest shocks on euribor-linked mortgages, and capital buffers have not been activated. In Slovakia, the risk of fast mortgage growth has been offset by a further increase in BBM limits which have tightened lending standards and eased the growth of household indebtedness.[35]

Table 7 provides an overview of a broad range of indicators signaling vulnerabilities and resilience in mortgage and residential real estate markets in Europe. The trend and value of these indicators could feed into the initial assessment of the macroprudential policy stance. The calibration and choice of macroprudential tools can be guided by the framework specified in Section VII.

VII. Operationalizing Macroprudential Policy Diagnostics at the Country Level

Sections III and V have outlined considerations to think whether current macroprudential settings are expansionary or contractionary under the current macrofinancial conditions in Europe. Section IV has shown the importance to take into account the interaction of macro- and microprudential tools to calibrate policy, while Section VI has presented a set of indicators to quantify current vulnerabilities in residential real estate markets across Europe. This section shows granular steps that can be followed to come up with a macroprudential stance assessment tailored to a specific country circumstances and the potential need to adjust policy settings.

[34] Where $X^{trimmed} = \max\left(X, X^{trimmed}_{\max}\right)$ if $X^{trimmed} > X^{trimmed}_{\max}$ and $X^{trimmed} = \min\left(X, X^{trimmed}_{\min}\right)$ if $X^{trimmed} < X^{trimmed}_{\min}$,

[35] It is worth noticing that in Slovakia, part of the increase in mortgage growth is linked to refinancing of existing mortgages and top-up loans for consumption.

STEP 1. Use a set of indicators to come up with an initial assessment of systemic residential real estate-related vulnerabilities.[36] In line with the macroprudential policy objective, an effective operationalization of tools requires to assess first whether current housing market imbalances are of systemic importance from a financial stability perspective, considering the following segments:

- *Real estate market*. Look at house price developments: growth rate; growth rate relative to fundamentals (income growth; working age population growth); indicators of overvaluation (deviation from long-term averages in PTI, PTR; model-based indicators such as user-cost model).
- *Mortgage market*. Look at mortgage credit growth; change in mortgage-to-GDP ratio. It is important to strip out refinanced loans from mortgage issuance. In many countries an increase in new originations has been driven by increasing shares of refinanced loans as borrowers lock-in lower lending rates (e.g., Belgium, Slovakia, Switzerland), although the stock should not be affected.
- *Banks' balance sheets*. Look at the share of mortgages in the loan book relative to assets, relative to capital, and identify possible concentration risk in the system (e.g., lack of diversification of business models, geographical concentration of mortgages).
- *Households' balance sheets*. Look at level/trends in debt to GDP ratio; if possible, look at the most vulnerable households (low income), and account for mitigating factors (e.g., financial wealth).

STEP 2. Identify key drivers of real estate imbalances. This will feed into considerations regarding policy options:

- *Loose credit standards*. Higher demand than that justified by fundamentals (e.g., income, population growth, interest rates) may be driven by loose credit standards due to intense competition on the mortgage loan market. Look at trends in banks' net interest margins, pass-through from policy rates to mortgage rates, activity by new entrants (including insurance firms, pension funds, and fintech), and changes in housing finance (e.g., securitization, role of non-bank financial intermediaries).
- *Search-for-yield*. In historically low interest rate environments, search for yield may drive investors (both households and corporates) to build up their residential property portfolios. Look at signs of overheating in income-producing residential real estate (IPRRE) relative to the owner-occupied segment.
- *Lax monetary policy*. An increase in housing demand could be due to ultra-low interest rates in many countries. Construct a simple indicator of the financial and business cycle, looking for instance at credit gap and output gap, respectively. If the financial and business cycles are out of sync, monetary policy could be too accommodative from a financial stability perspective (too low interest rates).
- *Accommodative macroprudential policy*. Macroprudential policy loosened in most countries during the pandemic by easing capital requirements, removing regulatory limits, and directly encouraging lending. Look at policy changes and the impact on lending rates and credit volumes.
- *Fiscal incentives*. Housing ownership rates vary across countries determined in part by the relative cost of buying versus renting, and government policies to encourage ownership. Look at changes in housing taxation (e.g., tax mortgage interest tax relief, tax rate on transfer of property, imputed rent taxation, recurrent property tax in dwellings, capital gains tax on selling property); and government subsidies (e.g., for low-income households).
- *Supply constraints*. Tighter housing supply (lower construction volumes); rising construction costs (e.g., due to tighter building standards; commodity price shock); and tougher regulation (zoning restrictions).

[36] In the EU, the ESRB issues a warning or a recommendation to authorities as part of its regular monitoring of residential real estate risks across Europe if current policies are not considered appropriate to address rising vulnerabilities.

STEP 3. Quantify the level of housing risk to which the financial system is, or might be, exposed (adjusted for authorities' risk appetite as needed), based on:

- *A forward-looking approach*: Project loan loss rates on mortgage loans (using own model, or authorities' stress testing results) under an adverse scenario with a real estate correction calibrated to past crises in the country (or in peer countries) or to the estimated size of overvaluation.
- *A historical approach*: Use historical losses in the mortgage book during a real estate crisis in the country or in peer economies, and adjust as needed for structural changes, and policy interventions.

STEP 4. Calibrate the most suitable macroprudential tool. [37] Use the following approach:

- *Look at the risk profile of recent mortgage flows*. Main risk parameters include LTV, DTI, DSTI, maturity, amortization rate, and repricing schedule. Identify increases in affordability risks measured by lower downpayment (higher LTV), higher DTI, higher DSTI (evaluated at long-term mortgage rates), or longer amortization rates.[38] It is important to look at the tail of the distribution to unveil pocket of vulnerabilities (e.g., at the 75th, 90th percentile of the distribution). In countries where BBMs have been applied, typically there is bunching just below regulatory limits.
- *Conduct a vintage assessment*. A vintage analysis allows for a deep understanding of the effects of loan amortization and external factors such as changes in real estate prices, interest rates, and disposable income on credit risk. This analysis tends to show a dispersion of delinquency between more recent vintages originated during a run-up of housing prices and older, more established vintages that were originated before the expansionary phase of the cycle. Identify outstanding mortgages by vintage in banks' portfolios drawing on regulatory data provided by the authorities.
- *Convert risk parameters from 'origination' to 'Point-in-time (PiT)*. This step is needed to capture the life cycle of the loan and the impact of the housing/business cycle. Newer borrowers are generally more vulnerable as they have repaid less principal, experienced smaller home equity gains, and had their debt service assessed at lower rates. Credit risk of the loan portfolio depends on PiT risk parameters of mortgage vintages. A procedure is described in the Annex 3.
- *Project the loss absorption /reduction of risk capacity across tools.* Use the framework laid out in Annex 1 to compare the effectiveness of policies through the cycle. Policymakers need to be forward-looking as they activate tools at the peak to absorb/reduce losses at the trough. Regarding timing, while capital-based instruments strengthen resilience as soon as they become effective, BBMs take time to build resilience as they apply only to new flows, therefore they need to be activated well before tail risk materializes. Figure 8 shows a timeline of the mortgage cycle. Risks build up between 0 and T+2. BBMs are introduced at time T and become binding for new vintages issued between T and T+2 under baseline conditions (green). CBMs become effective at T+2 (given lags in implementation) and apply to all mortgages including the outstanding portfolio and the newly granted mortgages. Between T+2 and T+5 losses materialize (red).

STEP 5. *Conduct a cost-benefit analysis of different tools.* Potential criteria include: (i) financial soundness (need to build capacity to improve resilience); (ii) allocative efficiency (minimize credit restrictions to otherwise creditworthy borrowers; and (iii) administrative costs (assess whether the proposed tools are easy to implement in terms of reporting and compliance). [39] For instance, in the example presented in Section IV, the most

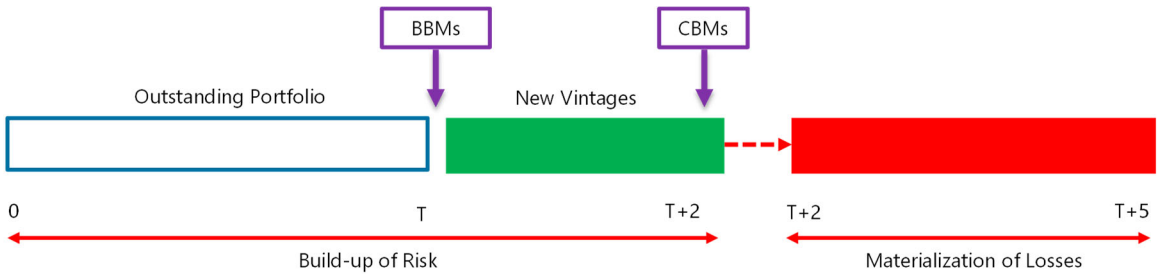
[37] Depending on the source of housing imbalances, macroprudential policies may need to be combined with other policies to ensure financial system resilience

[38] Affordability risk is high when imputed costs from mortgage servicing (amortization, interest, maintenance) exceed one-third of income (owner-occupied segment) or rental income (investment-led segment) at through-the-cycle mortgage rates.

[39] See RBNZ (2021) for a discussion of potential benefits of policy tools to sustain house price sustainability.

effective tool to strengthen resilience is to set a risk weight floor of 25 percent. This hinges on the assumption that banks using IRB models are underestimating the current systemic risk. However, if the risk profile of the mortgage portfolio is very heterogenous across banks, this could penalize high-rated portfolio banks relative to their low-rated peers, increasing the suitability of activating a sectoral CCyB.

Figure 8. Timeline of Macroprudential Policy Intervention



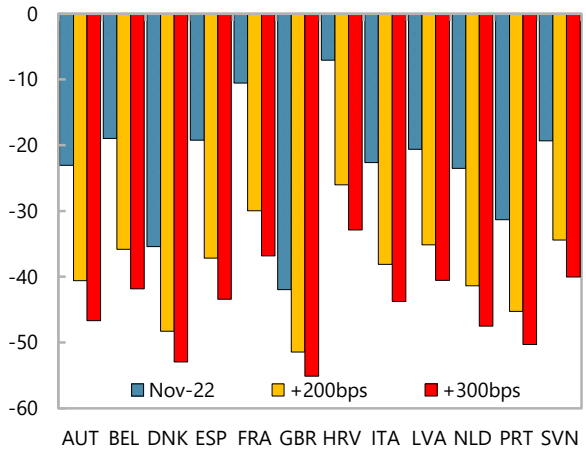
Source: Author's calculations.

In the current cost-of-living crisis, housing buying power in main cities across Europe has already decreased as mortgage rates have risen sharply (Figure 9) In this environment, tightening DSTI ratios to level off the risk of new vintages to the risk of the portfolio can be overly restrictive as it is unlikely that prices will drop at the buying power pace. In addition, the cost of further tightening would fall disproportionally on low income or young borrowers with social/distributional consequences. When selecting the macroprudential measure, authorities should consider whether the requested data to compute the buffer is already available from current sources (e.g., regulatory data) to reduce costs and encourage reciprocity. For BBMs, unintended consequences of unduly restricting market access can be addressed by using 'speed limits'.[40] Depending on the sources of risks, authorities may need to activate one tool (e.g., sectoral CCyB) or combine it with additional tools (e.g., LTV, DTI, DSTI) as discussed in Section 4.

STEP 6. *Set timing of application and consider positive cycle-neutral limits.* Give lead time during the build-up phase and plan for an immediate release during a crisis. Prospective CCyB needs a lead time of up to 12 months, according to Basel rules. This is to give banks time to meet the additional requirements before they take effect. At the same time, a gradualist approach to set the CCyB rate is likely to make the level needed to absorb losses difficult to achieve before risks crystallize. To address uncertainty of impact of BBMs, a gradual calibration approach may be preferable. For instance, in Annex 1, the macroprudential authority could re-assess the risk profile of new mortgages between t and t+5. This would give the option to adjust the BBM limits – both up and down- in line with the evolution of economic conditions, the overall risk environment, and the observed pass-through to bank lending and expected loan losses. When there is a decrease in capital buffers or regulatory limits, banks can apply the revised rules immediately to absorb losses and reduce the risk that the supply of credit is constrained during a downturn. When sectoral cyclical risks do not materialize but are judged to recede slowly, a gradual release may be appropriate. The authorities could consider a positive neutral CCyB buffer when risks are judged to be neither subdued nor elevated. This would allow to release the capital buffer in times of acute stress (BIS, 2022b). This approach could also address the time lag in building resilience and the inherent uncertainty in measuring cyclical systemic risks. In Europe, the UK and other seven countries in the EEA have introduced a positive cycle neutral CCyB to the macroprudential toolkit (Table 1).

[40] A 'speed limit' allows for a certain proportion of the volume of new loans to be exempt from a particular measure. These limits could be unconditional or targeted to specific types of loans (e.g., first-time home buyers, green mortgage loans, etc.).

Figure 9. Decrease in Housing Buying Power due to Rising Mortgage Rates



Sources: Statista; Hypostat 2022; Haver; national central banks, author's calculations.
Note: The chart shows the reduction in the size of a mortgage loan in November 2022 under current mortgage rates (blue bars) and under stylized interest rate shocks (yellow and red bars), in order to keep the debt servicing ratio at end-2021 levels. The analysis uses information on the average LTV ratio and standard maturity contract by country, as well as the average price in apartments in the most important cities in each geography.

VIII.Concluding Remarks

Macroprudential policy in Europe is at a critical juncture. Authorities are refining their thinking as issues related to the design and use of instruments have become apparent over recent years and, in particular, during the Covid-19 crisis – the first test of macroprudential policy in a major global economic crisis (EC, 2021). The forthcoming review of the EU macroprudential framework by the European Commission aims to improve macroprudential rules by focusing on their effectiveness, on the back of ongoing discussions at the international level taking into account the interaction with microprudential frameworks. National authorities are pondering whether to adjust policy settings in a context of elevated housing vulnerabilities, tightening monetary policy, and looming recession prospects. The complexity of the macrofinancial environment is unprecedented for European macroprudential policymakers since policy frameworks were first developed after the Global Financial Crisis and the common legal basis for macroprudential instruments in the EU came into effect in 2014.

This paper sheds light on these questions by providing granular operational considerations to assess whether macroprudential settings are expansionary or contractionary under current and evolving macrofinancial conditions in Europe. If housing market vulnerabilities rise but uncertainty about the cyclical position of the economy persists, cost-benefit considerations suggest that increasing targeted capital-based measures may be preferable to tightening BBM tools. The materialization of a sharp downturn in the financial cycle, causing wide-spread disruptions in credit, would warrant the immediate relaxation of capital-based tools. To avoid so-called doom loops between asset—in this case, housing—prices and credit supply, cyclical BBMs could also be eased, provided they become overly constraining and there is enough macroprudential policy space. The challenge is that there is no approach for assessing their normal level, but the Covid experience could shed some light into the interaction between policy relaxation and the housing cycle.

To inform policy choices, the paper also provides a taxonomy of relevant risk and resilience indicators for a broad range of European countries evaluated at end-2022. Further, it presents a novel approach to calibrate macroprudential instruments and measure their effectiveness in building resilience taking into account banks' provisioning practices. This analysis shows how instruments could be calibrated to reduce overlaps with other macroprudential tools and microprudential minimum capital requirements. Different combinations of tools can yield similar levels of resilience; in selecting the most appropriate combination, authorities should favor tools that are highly effective and have a low social cost, and design them in ways that minimize negative impacts, particularly on first-home buyers.

Additional research is needed to enhance the effectiveness of macroprudential frameworks. As the macroprudential policy paradigm expands its focus from building resilience, as initially intended (BIS 2010), to adding elements of financial cycle management—by calibrating buffers to smooth the impact of shocks, some countries have chosen to implement positive cycle-neutral CCyB rates, under which authorities aim for a positive CCyB when risks are estimated to be neither subdued nor elevated (BIS, 2022b). As the paper shows, circumstances vary across European countries, including their macroeconomic conditions and the range of available macroprudential tools. The calibration of a neutral CCyB rate and its adjustments through the cycle will therefore become a challenging task for policy makers to ensure that the most appropriate policy mix is implemented at any point in time. This calls for further reflection on the proper calibration and the degree of interaction between new and existing buffers, minimum requirements, and other prudential policies. Authorities will also need to explain how more macroprudential tools combine in total to a neutral long-term setting to support financial stability through the cycle.

Table 1. Macroprudential Policy Decisions on the CCyB Buffer since the onset of COVID-19 in Europe

	Max rate pre-pandemic	*Current rate as of April 7, 2023* [1/]	*Latest announced rate*	*COVID-19 (2020)*			*Post-COVID-19 (2021-23)*			*Positive neutral rate* [2/]
Country	*Percent*	*Percent*	Percent	Confirmed	Decreased	Increased	Confirmed	Decreased	Increased	Percent
Austria	0	0	0	✓			✓			N/A
Belgium	0.5	0	0		✓		✓			N/A
Bulgaria	1.5	1.5	2		✓				✓	N/A
Croatia	0	0.5	1	✓					✓	N/A
Cyprus	0	0	0.5	✓			✓			0.5
Czech Rep.	2	2.5	2.5		✓				✓	1
Denmark	2	2.5	2.5		✓				✓	N/A
Estonia	0	1	1.5	✓					✓	1
Finland	0	0	0	✓			✓			N/A
France	0.5	0.5	1		✓				✓	N/A
Germany	0.25	0.75	0.75		✓				✓	N/A
Greece	0	0	0	✓			✓			N/A
Hungary	0	0	0.5	✓					✓	N/A
Iceland	2	2	2		✓				✓	N/A
Ireland	1	0	1		✓				✓	1.5
Italy	0	0	0	✓			✓			N/A
Latvia	0	0	0	✓			✓			N/A
Lithuania	1	0	1		✓				✓	1
Luxembourg	0.25	0.5	0.5	✓			✓			N/A
Malta	0	0	0	✓			✓			N/A
Netherlands	0	0	1	✓					✓	2
Norway	2.5	2.5	2.5		✓				✓	N/A
Poland	0	0	0	✓			✓			N/A
Portugal	0	0	0	✓			✓			N/A
Romania	0	0.5	1	✓					✓	N/A
Slovakia	2	1	1.5		✓				✓	N/A
Slovenia	0	0	0.5	✓					✓	N/A
Spain	0	0	0	✓			✓			N/A
Sweden	2.5	1	2		✓				✓	2
United Kingdom	2	1	2		✓				✓	2

Sources: ESRB Macroprudential Database; national macroprudential source; author's calculations.
1/The implementation date for Czech Republic is April 1, 2023; for Denmark and Norway, March 31, 2023; and, for France, April 7, 2023. 2/ Under this approach, the CCyB has two components: the neutral rate, which is the base requirement prevailing under a standard risk environment, and the cyclical component, which is related to cyclical risks (e.g., high credit growth).

Table 2. Macroprudential Policy Decisions on BBMs and the Sectoral CCyB/SyRB Since the Onset of COVID-19 in Europe

Tool	Country	*Date of latest annoucement*		*COVID-19 (2020)*		*Post-COVID-19 (2021-22)*	
		Announcement	*Application*	Relaxed	Tightened	Relaxed	Tightened
DTI	Czech Republic	4/1/2020	4/1/2020	✓			
	Czech Republic	11/26/2021	4/1/2022				✓
	Latvia	11/27/2019	6/1/2020				✓
	Norway	12/10/2020	1/1/2021	✓			
	Slovakia	8/23/2022	1/1/2023				✓
DSTI	Austria	6/17/2022	8/1/2022				✓
	Czech Republic	7/1/2020	7/1/2020	✓			
	Czech Republic	11/26/2021	4/1/2022				✓
	France	1/27/2021	1/28/2021			✓	
	France	9/29/2021	1/1/2022				✓
	Iceland	9/28/2021	12/1/2021				✓
	Iceland	6/15/2022	6/16/2022				✓
	Latvia	11/27/2019	6/1/2020				✓
	Portugal	4/1/2020	4/1/2020	✓			
	Slovenia	4/1/2022	7/1/2022	✓			
LTV	Austria	6/17/2022	8/1/2022				✓
	Cyprus	11/9/2020	3/19/2021				✓
	Czech Republic	4/3/2020	4/3/2020	✓			
	Czech Republic	11/26/2021	4/1/2022				✓
	Finland	6/29/2020	6/29/2020	✓			
	Finland	6/29/2021	10/1/2021				✓
	Iceland	6/29/2021	7/30/2021				✓
	Iceland	6/15/2022	6/16/2022				✓
	Latvia	11/27/2019	6/1/2020				✓
	Luxembourg	12/7/2020	1/1/2021				✓
	Romania	2/2/2022	4/1/2022				✓
	Slovenia	4/1/2022	7/1/2022				✓
Maturity	Austria	6/17/2022	8/1/2022				✓
	France	9/29/2021	1/1/2022				✓
	Latvia	11/27/2019	6/1/2020				✓
	Portugal	1/29/2020	4/1/2020				✓
	Portugal	1/25/2022	2/1/2022				✓
Sectoral CCyB / SyRB	Belgium	2/21/2022	5/1/2022				9%
	Germany	12/1/2022	2/1/2023				2%
	Lithuania	11/25/2021	7/1/2022				2%
	Slovenia	4/29/2022	12/31/2023				1%
	Switzerland	3/27/2020	3/27/2020	0%			
	Switzerland	1/26/2022	9/30/2022				2.5%

Sources: ESRB Macroprudential Database; national macroprudential source; author's calculations. Note: Slovenia has two sectoral SyRB in place: 1 percent for all retail exposures secured by residential immovable property; and 0.5 percent for all other exposures to natural persons. In Latvia, a recent amendment of previous BBM measures includes in the scope credit institutions that offer financial services via branch and direct cross-border.

Table 7a. Taxonomy of Vulnerability Indicators and Macroprudential Policy Stance Framework in Europe

	VULNERABILITIES															RESILIENCE				
	Lending Standards (Percent of New Mortgage Loans)						Household sector	Banking sector	Housing cycle			Credit cycle			Business cycle	ESRB warning	ESRB recom.	Banking sector				Household sector
	LTV average	LTV tail	DTI average	DTI/LTI tail	Most common mortgage	Mortgage rate[1/] (Percent)	HH Debt/GDP (Percent)	Morgages (Percent loans)	Price growth (yoy)	Real house price growth (cum 2020Q1-2022Q2;	PTI (deviation from long-term average)	Credit to GDP gap (Percent)	Credit growth (y/y)	Mortgage growth (y/y)	Output gap (Percent)			CCyB (current) (Percent)	CCyB (latest announced) (Percent)	Sectoral CCyB (current) (Percent)	Sectoral CCyB (latest announced) (Percent)	Net weatlh/GDP (Percent)
ALB																						
AUT	60%				Floating (45% flow)			33.2		8.3	163.4	2.5			0.6	✓	✓	0.0%	0.0%			
BLR		>80% (40%)														✓						
BEL					Fixed			53.1		3.0	129.1	4.8			0.3	✓	✓	0.0%	0.0%	9.0%	9.0%	
BIH															0.6							
BGR	75%				Floating			22.9		2.9					1.1			1.5%	2.0%			
HRV	75%															✓		0.5%	1.0%			
CYP	75%				Floating										1.3			0.0%	0.5%			
CZE	85%				Fixation for 7-10y					11.9					0.5	✓		2.5%	2.5%			
DNK								74.4		7.1	132.7				1.4	✓	✓	2.5%	2.5%			
EST					Floating					6.9					-0.9			1.0%	1.5%			
FIN	80% (FTB)				Floating					1.7	98.8				0.1	✓	✓	0.0%	0.0%			
FRA	82.9%	>100% (23.9%)			Fixed			44.6		4.5	126.8	1.7			-0.8	✓		0.5%	1.0%			
DEU	80%				Fixation for 10-15y			46.4		7.2	129.0	7.9			0.4	✓	✓	0.75%	0.75%	2.0%	2.0%	
GRC					Floating (56% flow)					3.6	100.2							0.0%	0.0%			
HUN	60%	>70% (32%)						22.5		7.0					0.3	✓		0.0%	0.5%			
ISL					Floating (45% flow)			47.8		9.8					0.9	✓		2.0%	2.0%			
IRL	80.8% (FTB)		3.1 (FTB)		Floating [2/]					5.0	108.8				0.5			0.0%	1.0%			
ISR															2.2							
ITA					Fixed					0.5	91.2				0.6			0.0%	0.0%			
KOS																						

Sources: OECD, Haver Analytics, Eurostat, ESRB, and national central banks. Data are shown as of December 21, 2022 (except for CCyB, April 2023).
Note: This table conveys a "risk-resilience framework" approach to assess macroprudential stance in Europe by considering the balance between systemic risk from vulnerabilities in the residential real estate market relative to resilience of the banking system and households. This approach is in line with the recommendations of the ESRB report of the Expert Group on Macroprudential Stance (ESRB, 2021b). Indicators are as of 2022Q2 or latest available. FTB denotes first time buyers.1/ Benchmark mortgage rate, 10-year fixed. 2/ By end of 2021, the split is the following: 31.6% on tracker rates linked to the ECB base rate; 24.3% floating/one year; and 44.1% fixed rate greater than one year. To assess the housing cycle, three simple indicators are constructed, namely the nominal real estate price growth, the real house price growth cumulative since the onset of the pandemic annualized, and the deviation of the price-to-income ratio from long-term averages for those countries with observations at least starting in 2000, drawing on BIS data. To evaluate the credit cycle, the table shows the domestic credit-to-GDP gap which is calculated as the deviation of the ratio of domestic non-financial private sector credit to nominal GDP from its recursive one-sided Hodrick-Prescott trend, using a smoothing parameter lambda set to 400,000. This is in line with ESRB recommendation ESRB/2014/1. This indicator is complemented by two other relevant variables, i.e., the annualized credit growth rate, and the annualized mortgage growth rate.

Table 7b. Taxonomy of Vulnerability Indicators and Macroprudential Policy Stance Framework in Europe

	VULNERABILITIES															RESILIENCE				
	Lending Standards (Percent of New Mortgage Loans)						Household sector	Banking sector	Housing cycle			Credit cycle			Business cycle	ESRB warning	ESRB recom.	Banking sector				Household sector
	LTV average	LTV tail	DTI average	DTI/LTI tail	Most common mortgage	Mortgage rate[1/] (Percent)	HH Debt/GDP (Percent)	Mortgages (Percent loans)	Price growth (yoy)	Real house price growth (cum 2020Q1-2022Q2;	PTI (deviation from long-term average)	Credit to GDP gap (Percent)	Credit growth (y/y)	Mortgage growth (y/y)	Output gap (Percent)			CCyB (current) (Percent)	CCyB (latest announced) (Percent)	Sectoral CCyB (current) (Percent)	Sectoral CCyB (latest announced) (Percent)	Net weatlh/GDP (Percent)
LVA		>90% (27%)								4.5					-0.2			0.0%	0.0%			
LTU	80%				6m euribor					8.9					1.5			0.0%	1.0%	2.0%	2.0%	
LUX	76%		10.0		Fixed (62% flow)			31.9		11.1		-8.0			0.7	✓	✓	0.5%	0.5%			
MKD																						
MLT	80%														0.9			0.0%	0.0%			
MDA															-0.8							
MNE																						
NLD	79.6%		3.6		Annuity/interest only					10.7	149.7				0.7	✓	✓	0.0%	1.0%			
NOR	65%				Floating			68.8		6.5	135.7				0.8	✓		2.5%	2.5%			
POL		>80% (30.5%)			Floating			43.4		3.4					2.2			0.0%	0.0%			
PRT		>80% (51%)			12m ibor (90% stock)			48.6		7.4	123.9	-6.0			1.5			0.0%	0.0%			
ROU	78%									-3.1					0.4			0.5%	1.0%			
RUS								15.3							-0.9							
SMR																						
SRB																						
SVK	72%				Fixation for 3-5y			55.3		2.2		0.2			-2.1	✓		1.0%	1.5%			
SVN	63.4%	>80% (11%)								7.9					3.3			0.0%	0.5%	0.0%	1.0%	
ESP	65%				12m euribor (stock)					1.5	118.9				-0.5			0.0%	0.0%			
SWE	64.5%				Floating (43.5% flow)			51.7		6.1	153.2				0.9	✓	✓	1.0%	2.0%			
CHE		>80% (14%)		>6 (47%)	Fixation for 2-15y		132.3	74.2		6.3	134.0	-3.5	3.3	3.1	0.5			0.0%	0.0%	2.5%	2.5%	583.0
TUR															2.2							
UKR																						
GBR				>4.5 (15%)	Fixation for 5y		125.0	68.5		5.8	142.0	-0.2			1.8	✓		1.0%	2.0%			

Sources: OECD, Haver Analytics, Eurostat, ESRB, and national central banks. Data are shown as of December 21, 2022 (except for CCyB, April 2023).
Note: This table conveys a "risk-resilience framework" approach to assess macroprudential stance in Europe by considering the balance between systemic risk from vulnerabilities in the residential real estate market relative to resilience of the banking system and households. This approach is in line with the recommendations of the ESRB report of the Expert Group on Macroprudential Stance (ESRB, 2021b). Indicators are as of 2022Q2 or latest available. FTB denotes first time buyers.1/ Benchmark mortgage rate, 10-year fixed. 2/ By end of 2021, the split is the following: 31.6% on tracker rates linked to the ECB base rate; 24.3% floating/one year; and 44.1% fixed rate greater than one year. To assess the housing cycle, three simple indicators are constructed, namely the nominal real estate price growth, the real house price growth cumulative since the onset of the pandemic annualized, and the deviation of the price-to-income ratio from long-term averages for those countries with observations at least starting in 2000, drawing on BIS data. To evaluate the credit cycle, the table shows the domestic credit-to-GDP gap which is calculated as the deviation of the ratio of domestic non-financial private sector credit to nominal GDP from its recursive one-sided Hodrick-Prescott trend, using a smoothing parameter lambda set to 400,000. This is in line with ESRB recommendation ESRB/2014/1. This indicator is complemented by two other relevant variables, i.e., the annualized credit growth rate, and the annualized mortgage growth rate.

Annex I. Quantitative Illustration of the Interaction and Effectiveness of Macroprudential Tools

To illustrate the stages laid out in Section IV, consider the following numerically example inspired by a real estate crisis in Europe. The expansionary phase of the cycle is proxied by the current risk environment as of 2022Q3. The risk of the mortgage portfolio is based on banks' reported IRB parameters on their exposures secured by immovable property, with some adjustments.[1] The analysis is designed to help macroprudential authorities assess the relative effectiveness of a range of macroprudential tools to absorb future mortgage losses under a housing market correction:

CCyB buffer: 2.5 percent CCyB rate on mortgage exposures.

Risk weight floor: 25 percent sectoral risk weight.

BBMs: a combination of DTI, LTV, and DSTI limits that anchors the risk of new mortgages to the average risk of the outstanding portfolio.

The thrust of the analysis starts with the recognition that mortgage risk varies throughout the $cycle \in \{i, j\}$ where *i* denotes the *peak* and *j* captures the *trough* of the cycle. The outstanding mortgage book is denoted by α whereas the flow of new mortgages is denoted by β.

The size of outstanding mortgages is 100 billion. At the *peak*, the average PD of the mortgage portfolio is 0.9 percent, whereas the LGD is 10 percent (*stage a*). This implies that banks have set aside 0.09 billion in the form of provisions:

$$\text{Provisions}_i^{\alpha} = PD_i^{\alpha} \cdot LGD_i^{\alpha} \cdot EAD$$

In a severe downturn, the risk of the portfolio increases. At the *trough*, the average PD of the portfolio surges to 2.3 percent, while the LGD rises to 30 percent (*stage b*). The realization of the adverse scenario would lead to future losses of 0.68 (*stage c*).

While these parameters draw on IRB banks' reported risk parameters through the cycle, they could be calculated using a modeling approach (structural; regression) linking core macrofinancial variables under baseline/adverse conditions to the default and recovery rate of the portfolio

In *stage (d)*, we calculate the capital reserve implied by a 2.5 percent CCyB on mortgage exposures. We translate the risk parameters PD, LGD, and EAD into capital requirements using Basel supervisory mapping function[2]:

$$Cap\,\text{Required}_j^{\alpha} = \left[N\left[\frac{G\left(PD_j^{\alpha}\right)}{\sqrt{1-R}} + \sqrt{\frac{R}{\sqrt{1-R}}} \cdot G\left(0.999\right) \right] \cdot LGD_j^{\alpha} - PD_j^{\alpha} \cdot LGD_j^{\alpha} \right] \cdot M_j^{\alpha}$$

[1] We use regulatory data reported by Spanish banks in the COREP C9.02 template and published by EBA in 2013Q1 (crisis), and 2022Q3 (current). For the purpose of the analysis, some adjustments have been made to the regulatory data.

[2] The supervisory mapping function is used to transformed bank-reported average PD, into conditional PDs which reflect default rates given a conservative value of the systematic risk factor. To derive the conservative value of the systematic factor, a 99.9 percent of confidence level is applied. For further details, see BIS (2005).

$M_j^\alpha = 1 - \frac{\left(1+(M-2.5)\cdot b\left(PD_j^\alpha\right)\right)}{1-1.5\cdot b\left(PD_j^\alpha\right)}$ and $b\left(PD_j^\alpha\right) = \left(0.11852 - 0.05478\cdot \log\left(PD_j^\alpha\right)\right)^2$

where $G(\cdot)$ is the Normal distribution; M_j^α is a maturity adjustment as a function of the probability of default and the maturity of the exposure, and $b(\cdot)$ is a regression maturity adjustment smoothed over PDs. This yields a capital requirement ratio of 1.2 percent, which applied to the size of the portfolio amounts to 1.2 billion in nominal terms. In order to derive risk weighted asset, the capital ratio must be multiplied by EAD and the reciprocal of the minimum capital ratio of 8 percent, i.e., by a factor of 12.5:

$$RWA_j^\alpha = 12.5\cdot Cap\,\mathrm{Re}\,q_j^\alpha \cdot EAD = 14.8$$

To compute the risk weight density, we divide risk weighted assets by the size of the exposure:

$$RW_j^\alpha = \frac{RWA_j^\alpha}{EAD} = 0.148$$

As $RW_j^\alpha < 0.25$, it follows that the macroprudential risk weight floor is binding at the *peak*. The additional capital built by this measure is given by:

$$\Delta Cap_{floor=25\%} = \left(0.25 - RW_j^\alpha\right)\cdot EAD = 0.8$$

The activation of a sectoral CCyB of 2.5 percent would yield a capital reserve of:

$$\Delta Cap_{CCyB=2.5\%} = 0.025\cdot RWA_j^\alpha = 0.4$$

In stage (e), we quantify the riskiness of new mortgage loans. Using the modeling approach described in Annex 2, we compute the PD and LGD of new mortgages under baseline conditions at 1.3 percent, and 15 percent, respectively (*peak*). Under adverse conditions, these values increase to 4.2 and 35 percent, respectively (*trough*). We then apply a combination of BBMs that would limit the riskiness of new mortgage loans. A simple approach is to compare the expected losses on new mortgages (those subject to macroprudential limits) with those of older mortgage vintages, granted before the limits are introduced. In this example, we anchor the risk profile of new mortgages to the risk of the portfolio with a combination of LTV=80 percent, and DSTI=40 percent on new mortgages.

To compare the relative merits of different tools (*stage f*), we use data on the annual replacement rate of the portfolio that we assume at 10 percent. We suppose that BBMs are introduced 5 years before the tail-risk scenario materializes. The reduction of losses achieved by the activation of BBMs can be computed as:

$$\partial Losses_{BBMs} = 0.5\cdot\left[\left(Losses_j^\beta - \mathrm{Pr}\,ovisions_i^\beta\right) - \left(Losses_j^\alpha - \mathrm{Pr}\,ovisions_i^\alpha\right)\right] = 0.3$$

Annex II. Approaches to Calculate the Risk Profile of New Mortgages

Quantifying the impact of BBMs on mortgage risk warrants a vintage analysis. This method enables to evaluate the credit quality of loans by analyzing the potential charge-offs in a given mortgage pool there the loans share the same origination period. This step is required because BBM limits apply only to new vintages. The risk of new loans may be higher than that of outstanding mortgages for three reasons: (i) a change in underwriting standards; (ii) the life cycle of the loan; and (iii) cyclical fluctuations in house prices, interest rates, and household income. First, mortgage loans issued during the expansionary phase of the cycle are often subject to a relaxation of lending standards triggered by an increase in demand for loans (Dell'Ariccia et al, 2012). This is typically reflected in higher leveraged loans or in a larger size of loans relative to the market value of the collateral. Second, current mortgage holders are typically less vulnerable to economic shocks as they have repaid part of the principal after origination relative to new borrowers. Third, in the current macrofinancial context in Europe, current mortgage owners have benefited from favorable cyclical conditions since the inception of the loan, in the form of higher home equity gains, higher income, and lower refinancing rates. This contrasts with new mortgage borrowers that are subject to higher payments for a home loan as real estate prices have skyrocketed, and mortgage rates soared. The challenge is that credit risk parameters are available at the portfolio level (outstanding mortgages) rather than at the vintage level (flow of mortgages)[3].To calculate the risk profile of new mortgages, we can follow two approaches:

A simplified approach: This approach uses the risk characteristics of loans at origination (in the form of DTI, DSTI, LTV or maturity), drawing on mortgage surveys collected by authorities for macroprudential purposes, and applies the procedure detailed in Annex 3 to convert the risk parameters (at origination) to point-in-time (PiT). This allows controlling for the amortization of existing mortgages, as well as for the impact of the business/financial/housing cycle on current loans. Then an adjustment factor between the risk parameters of the outstanding portfolio (PiT) and new issuances, is calculated to account for differences in their risk profile that could predict different loss curves for future periods. Finally, we collapse the dimensionality of the credit parameters evaluated PiT to obtain a single indicator I, using a simple weighting methodology. The probability of default (PD) of new loans (β) relative to outstanding mortgages (α) can be computed as:

$$PD^{\beta} = \frac{I^{\beta}}{I^{\alpha}} \cdot PD^{\alpha}$$

A similar approach can be used to compute loss given default (LGD). It is worth noticing that, due to the life cycle of the loan, everything else equal, it follows that $PD^{\beta} > PD^{\alpha}$ and $LGD^{\beta} > LGD^{\alpha}$.

A modelling approach: We can use a semi-structural model of default risk as a function of loan and borrower characteristics, macrofinancial drivers, and the regulatory environment. The model can be calibrated at the risk bucket and vintage level to take account of the evolution of underwriting standards over time, the loan life cycle, and the housing and economic cycles. The assessment of credit risk can be done through simulations of default rates and expected losses. In this modeling approach, a behavioral model of default links the probability that a borrower is in financial distress to its debt servicing capacity and negative home equity, and the loss given default to the value of outstanding commitments net of sale proceeds of foreclosed assets. For details of the model, see Gornicka and Valderrama (2020).

[3] This is because IRB banks need to model risk parameters (PD, LGD) on the stock of exposures for capital requirements, rather than on flows of exposures for macroprudential purposes.

Annex III. From Origination to Point-in-Time (PiT) Risk Parameters of Housing Loans

To calculate PiT risk parameters of vintage loans we use information on the characteristics of the loans at origination using supervisory data on LTV, DTI, DSTI, maturity, and amortization rates. We match these data with a time series on household disposable income, interest rates, and real estate prices. We denote the time of issuance as *s*, the current period as *t*, and the maturity of the loan as *T*. First, we compute the PiT LTV ratio by backing out the outstanding principal of the loan net of repayments at time t and repricing the collateral:

$$LTV_{s,t}^{PiT} = \frac{\left(LTV_s^{Orig} \cdot P_s\right) \cdot \left(\frac{T-t}{T-s}\right)}{P_t} \quad \text{(A.1)}$$

Then, we compute the income PiT using information extracting income at origination from DSTI and lending rates at origination i_s^{Orig}, and quarterly income growth g:

$$Income_s = \frac{\left(\frac{1}{T} + i_s^{Orig}\right) \cdot \left(LTV_s^{Orig} \cdot P_s\right)}{DSTI_t} \quad \text{(A.2)}$$

$$Income_t = Income_s \cdot (1+g)^{t-s} \quad \text{(A.3)}$$

This allows us to compute DSTI and DTI PiT as:

$$DSTI_{s,t}^{PiT} = \frac{\left(LTV_s^{Orig} \cdot P_s\right) \cdot \left(\frac{1}{T-s} + i_{s,t}^{s+k}\right)}{Income_t} \quad \text{(A.4)}$$

$$DTI_{s,t}^{PiT} = \frac{\left(LTV_s^{Orig} \cdot P_s\right) \cdot \left(\frac{T-t}{T-s}\right)}{Income_t} \quad \text{(A.5)}$$

where $i_{s,t}^{s+k}$ is the lending rate as of *t* of a mortgage issued in *s* and with the last re-setting period of interest rate in *s+k*. During the stress testing horizon at time *t+j*, we compute the shock to DSTI as:

$$\Delta DSTI_{s,t+j}^{PiT} = \frac{\left(LTV_s^{Orig} \cdot P_s\right) \cdot \left(\frac{1}{T-s} + i_{s,t+j}^{s+\lambda}\right)}{Income_t \cdot \left(1+shock_j\right)} \quad \text{(A.6)}$$

where $i_{s,t+j}^{s+\lambda}$ is the lending rate as of *t+j* of a mortgage issued in *s* and with the last re-setting period of interest rate in $s + \lambda$.

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