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The more the merrier? Macroprudential instrument interactions and effective policy implementation

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Contents

Abstract

Macroprudential policies since the global financial crisis have been central to safeguarding financial stability. Despite the increasing use of multiple policy instruments, a detailed understanding of interactions among them is still needed to assess how instrument combinations can enhance the effectiveness of macroprudential action. This paper proposes a conceptual framework for informing the choice of combinations of macroprudential instruments, looking at the role of micro and macroeconomic transmission channels, interactions across policy objectives, the importance of country specificities and linkages with other macroeconomic or supervisory policies. It also reviews considerations related to circumvention, leakages, time of activation and communication of policies, all of which may affect the desirability of different combinations of macroprudential instruments. The paper also discusses a possible operational use of combinations of macroprudential instruments to address selected risks and provides a rich analysis of instrument interactions within the categories of borrower-based and, respectively, capital-based measures. The paper concludes that the combinations of capital and borrower-based instruments ensures a comprehensive coverage of different systemic risks and entail important synergies.

Keywords: financial stability; macroprudential policy; banks.

JEL codes: G21, G28.

Non-technical summary

An active use of macroprudential policies in years before the COVID-19 pandemic contributed substantially to strengthening the resilience of the banking sector, as demonstrated later-on during the pandemic. Building on this experience, macroprudential policies continue to play an increasingly active role in safeguarding financial stability following the pandemic. In the euro area, all countries currently implement policies in the form of capital measures (CMs), borrower-based measures (BBMs), or combinations of the two. Nevertheless, a detailed understanding of interactions among macroprudential instruments is still needed to assess how instrument combinations can enhance the effectiveness of macroprudential action.

To inform current and future macroprudential policy making and design, this paper builds on the euro area experience with the use of combinations of macroprudential instruments. It proposes a conceptual framework for informing the choices of combinations of macroprudential instruments. The framework highlights the role of micro and macroeconomic instrument transmission channels, interactions across policy objectives, the importance of country specificities and linkages with other policies such as monetary, fiscal or microprudential. It also reviews other considerations related to circumvention, leakages, time of activation and communication of policies, all of which may affect the desirability of different combinations of macroprudential instruments. In addition, the paper discusses a possible operational use of combinations of macroprudential instruments to address selected risks and provides a rich analysis of instrument interactions within the categories of BBMs and, respectively, CMs.

The analysis is informed by a dedicated survey among macroprudential authorities, the experience with the use of macroprudential instruments in the euro area prior to the pandemic and selected quantitative models. It builds on the work of a dedicated Task Force under the aegis of the ECB's Financial Stability Committee conducted in 2018-19.

The paper concludes that combinations of CMs and BBMs ensure a comprehensive coverage of different systemic risks and entail important synergies. It notes that macroprudential instrument complementarity, substitutability and synergies need to be assessed both across time and cross-sectional dimensions and that further quantitative work is needed to support the calibration and assessment of combinations of macroprudential instruments.

1 Introduction

Macroprudential policy was actively used across the euro area in the years before the COVID-19 pandemic to safeguard financial stability. By end-2019, all euro area countries had macroprudential policies in place in the form of capital measures (CMs) and/or borrower-based measures (BBMs).[1] The experience gained over the pre-pandemic period contributed to the development of frameworks and best practices for the activation and use of individual macroprudential instruments. For example, all euro area countries currently have frameworks in place for the activation of the Counter Cyclical Capital Buffer (CCyB), a key macroprudential instrument.[2] Furthermore, some countries have developed conceptual frameworks for the use of borrower-based measures.[3] However, interactions among macroprudential instruments are less well understood and relatively little work has been done to understand how macroprudential instruments could be combined to achieve policy goals. Essentially, there is no common understanding of how, for instance, capital measures and borrower-based measures could be best combined to make macroprudential action more effective.

A better understanding of interactions among macroprudential instruments is key to achieving policy goals in an effective way and exploiting the likely benefits of instrument combinations. Interactions among instruments arise for several reasons. First, some instruments operate via common transmission channels, thereby affecting the same outcome variables which are relevant for macroprudential policy (e.g. bank risk or credit growth). As a result, a degree of substitutability among certain instruments exists on the path to reaching financial stability objectives. For example, both borrower-based measures and targeted capital measures (e.g. risk weight policies or sectoral buffers on mortgage exposures) help to reduce risks from mortgage lending. Second, some instruments operate via different transmission channels, making them mutually complementary in reaching financial stability goals. For example, borrower-based measures could be used to limit the rebalancing towards mortgages that usually results from the activation of broad capital measures.[4] Third, there may be synergies (i.e. strategic complementarities) among instruments when the action of one instrument is reinforced or augmented by the activation of another instrument.

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1 See, for example, Chapter 5 of the November 2019 Financial Stability Review (FSR) for an overview of macroprudential policies enacted in the euro area and Box 8 of the November 2019 FSR for a description of the institutional setting for macroprudential policy in the euro area.

2 For information on counter cyclical capital buffer frameworks across European countries, see, for example, the Summary Compliance Report on the European Systemic Risk Board Recommendation on guidance for setting countercyclical buffer rates (ESRB/2014/1).

3 For example, the Central Bank of Ireland adopted macroprudential limits to lending standards as early as 2015 (see the Mortgage Measures Framework Review of 2021 for more information).

4 As discussed in Chapter 4, the activation of broad capital measures could incentivise banks to rebalance towards exposures that are less “capital intensive”, such as mortgages. In a situation where systemic risk also emanates from residential real estate markets, this rebalancing could call for complementary macroprudential policy actions. These might include higher capital surcharges for mortgages to limit incentives for rebalancing or borrower-based measures to contain rebalancing and/or to mitigate risk-taking by ensuring that the credit quality of loans remains appropriate.

This article draws lessons from experiences in the euro area on the use of combinations of macroprudential instruments to inform future policymaking. The analysis is informed by (i) a dedicated survey among macroprudential authorities conducted in 2019, (ii) conceptual considerations on the basis of experience in the use of macroprudential instruments in the euro area during the pre-pandemic period and (iii) results from quantitative models[5]. This article relies on the work conducted in 2018-19 by a dedicated Task Force under the aegis of the ECB's Financial Stability Committee.[6] The analysis here focuses on the use of capital and borrower-based measures when the build-up of vulnerabilities warrants the activation (or tightening) of macroprudential policy instruments. The objective of this study is to offer a conceptual framework for informing future choices on the use of macroprudential instruments in combination. The paper highlights the role of transmission channels of instruments, country specificities and interactions with other policies that may affect the desirability of different combinations of macroprudential instruments. Lastly, we present results from quantitative methods that may support the calibration of combinations of policy instruments.

The remainder of this paper is organised as follows. Section 2 reviews the limited literature on the use and effectiveness of combinations of macroprudential instruments. Section 3 presents the key insights from a survey across euro area macroprudential authorities to understand how combinations of instruments have been used. Section 4 outlines a possible framework to analyse the interaction among macroprudential instruments and inform decisions on instrument combinations. Section 5 discusses a possible operational use of combinations of macroprudential instruments to address selected risks. Section 6 concludes and presents avenues for further work. Across the sections, several boxes provide more detailed analyses and deep dives on topics relevant for the discussion. The paper is complemented by an extended appendix composed of two sections presenting a detailed discussion of the interactions among borrower-based measures (Appendix A) and capital measures (Appendix B).

5 It is worth noting that the conceptual considerations and the findings presented in this paper were an important input for the macroprudential policy analysis and policy discussions following the pandemic period (e.g. ECB response to the European Commission's call for advice on the review of the EU macroprudential framework (March 2022), macroprudential policy chapters of May and November 2022 editions of the ECB Financial Stability Review, ECB macroprudential bulletin on the interplay between real estate markets, financial stability and macroprudential policy (October 2022)).

6 The Task Force on Optimal Macroprudential Interactions (TF-OMI). The quantitative stream of work of the Task Force benefited from the work done by the ECB Task Force on Operationalising Macroprudential Research (OMR). In particular, a number of models from the OMR were critically assessed, applied and modified in order to evaluate combinations of instruments.

2 Literature review

Analytical evidence on how macroprudential instruments interact and on the effectiveness of instrument combinations remains limited and literature on the subject is incipient. However, the existing literature on macroprudential policy, which often focuses on instruments taken in isolation,[7] does provide useful insights to analyse combinations of instruments. The findings related to the transmission channels and impact of individual macroprudential instruments are taken into account for the comparative assessment of policy measures further elaborated in Chapter 4 and in the appendices of this paper.

Only a small number of studies have addressed combinations of macroprudential instruments. The incipient academic literature on combinations of instruments comprises both empirical and theoretical studies. The empirical literature mainly focuses on measuring ex post effectiveness of combinations of instruments on a number of outcome variables linked to financial stability goals. The theoretical literature focuses on ex ante effectiveness, transmission channels and welfare analysis. The empirical literature on combinations of instruments provides insights mostly on borrower-based measures, while the theoretical literature is scanter but covers broader policy combinations (e.g. borrower-based measures and capital measures).[8]

The existing empirical evidence tentatively suggests that combinations of macroprudential instruments are more effective in containing risks than instruments implemented in isolation. Crowe et al. (2013) show that individual measures have, in general, proven to be inefficient in containing real estate booms and recommend combinations of measures instead. Notably, the empirical literature focuses mostly on borrower-based measures and often relies on cross-country studies which do not provide conclusive evidence on causal links. Most of these studies provide only information on the activation and changes in instruments but not on their intensity or binding nature.[9] However, a few studies address the issue of identification in a more sophisticated way by using micro data. Specifically, Albacete et al. (2018) and Kelly et al. (2018) use micro data models with only one constraining instrument of borrower-based measure combinations (LTV, DSTI and DTI/LTI) to assess the impact of instruments.

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7 See Galati and Moessner (2018) for a review of the literature on both theoretical and empirical models to assess the effectiveness of macroprudential policy.

8 From a policy perspective, the ESRB (2017) provides a comprehensive discussion of interactions among structural capital buffers (i.e. buffers for significant institutions and the systemic risk buffer), focusing on the regulatory and country-specific factors that determine whether buffers are used as complements or substitutes. The report flags certain challenges in the use of the systemic risk buffer in the EU to top up G/O-SII buffers and also considers some overlap and reinforcement between structural buffers and the countercyclical capital buffer.

9 To explain this, consider that the same LTV limit (e.g. 90%) could have a different impact depending on the prevailing lending practices. If a large fraction of loans is granted with an LTV above 90%, then the imposition of the limit would be binding for several borrowers and have an impact on loan origination. If only a small fraction of loans is granted with an LTV above 90%, then the limit is loosely binding as it would affect only a small fraction of borrowers, with a limited impact on loan origination. Most of the cross-country studies do not control for these aspects as data on lending practices are scarce.

Empirical results also indicate that macroprudential instruments exhibit synergies in increasing resilience of banks and borrowers. For instance, Jurča et al. (2020) find complementarities between loan-to-value (LTV), debt service-to-income (DSTI) and debt-to-income (DTI) limits, as the impact of various instruments is transmitted via different channels. Therefore, combinations of borrower-based measures enhance household and bank resilience to macroeconomic shocks. Building on the integrated micro-macro model of Gross and Población (2016), analyses in Ampudia et al. (2021) and Giannoulakis et al. (2021) conclude that the resilience of households and banks improves notably as a result of implementing individual and joint borrower-based measures. The latter study looks at the gross resilience benefits (improvement in credit risk) for households and banks of implementing these measures, while accounting also for second round macro effects due to the effects of LTV, DSTI, and DTI limits on the supply of loans. The analysis distinguishes the resilience benefits across income categories and finds that policies are more effective across lower income borrowers, which are characterised by higher default risk. Cassidy and Hallissey (2016) discuss how LTV and LTI (loan-to-income) limits reinforce each other's effect in reducing the borrower's probability of default (PD): while LTI caps provide a buffer against the effects of income and employment shocks, LTV limits reduce the borrower's incentive to default in the event of house price declines. Hejlova et al. (2018) find that the introduction of DSTI or DTI limits in addition to LTV limits would not necessarily imply any further significant constraints on the total volume of loans but would enhance the credit characteristics of those loans. Generally, DSTI caps enhance the effectiveness of LTV limits in addressing excessive credit growth by restricting the use of unsecured loans to attain the minimum down payment. The LTV tool is not sufficient on its own to constrain debt levels in the context of robust increases in house prices. Therefore, an additional constraint on debt service ratios would lean against the wind in a countercyclical manner (Millard et al., 2019).

The empirical literature also shows that the effectiveness of combinations of borrower-based instruments changes along the phase of the credit/housing cycle. Kelly et al. (2018) find that the impact of LTV, LTI and DSR on house prices depends both on the level at which each instrument is set and on the timing of introduction. The authors also argue that lower LTV and LTI ratios during the build-up phase of the cycle preceding the Great Financial Crisis would have materially improved the resilience of the system and reduced losses among households, banks and taxpayers in Ireland.

Theoretical studies provide interesting insights on the relative effectiveness of instruments when modelled in combination. For instance, Grodecka (2020) studies the interactions between LTV and DSTI limits. The study shows that considering multiple constraints (LTV and DSTI limits), possibly binding at the same time, is important. The paper concludes that the effectiveness of the LTV in tackling the rise in indebtedness is likely to be lower than previously assessed on the basis of other studies focusing on individual instruments. Consistently, Greenwald (2018) finds, in a general equilibrium framework, that DSTI ratios are more effective than LTV ratios in limiting boom-bust cycles. This outcome is driven by the limiting effect of DSTI on indebtedness, which in turn slows demand for housing and curbs house

prices. In general, limits on LTV and DSTI ratios complement each other in reducing the cyclicality of mortgage demand and enhancing resilience to house price shocks and to income and interest rate shocks, respectively (International Monetary Fund, 2014).

The theoretical results also support the view that combinations of measures could be expected to be more effective (and welfare improving) than individual instruments. For example, Benes et al. (2016) discuss the role of macroprudential policy in a model where lending to the housing market, house prices, and household demand for housing are intertwined (i.e. "the deadly embrace"). The study shows that certain policy rules, based on combinations of the CCyB and LTV limits, are more effective than individual instruments in loosening the "deadly embrace". This is because the LTV limit attenuates the housing market credit cycle, while the CCyB curbs the overall credit cycle. Chen and Columba (2016) use a DSGE model to analyse the impact of capital measures (mortgage risk weights), borrower-based measures (LTV ratio and amortisation requirement) and a fiscal measure (mortgage tax deductibility). The analysis suggests that, by promoting lower consumption volatility in response to shocks, a combination of LTV and mortgage risk weight measures would achieve a higher welfare level than the application of individual instruments. Second, the sequence in which macroprudential measures are introduced matters, i.e. it is optimal to tighten amortisation and reduce tax deductibility only when the LTV on new mortgages falls below a certain level. The models of Clerc et al. (2015) and Mendicino et al. (2018) analyse capital requirements in a DSGE model with three layers of default (households, non-financial corporations and banks). Aguilar et al. (2019) use this model to examine the joint impacts of optimal capital buffers. They show that combinations of structural and cyclical capital buffers result in significantly higher welfare compared to situations when buffers are used separately. The results presented in Ampudia et al. (2021), who rely on the same modelling framework augmented with LTV limits, reveal the complementarity of collateral measures and capital requirements in reducing leverage in the economy. LTV limits are found to have a dominant role when the policymaker's objective is to affect the level of credit in the economy. Furthermore, the two instruments complement each other in reducing the volatility of total credit.

The theoretical literature also provides important information about the use of combined instruments or policies and their effects on the real economy. For instance, Clancy and Merola (2014) use a DSGE model for Ireland and assess the effectiveness of combined countercyclical and larger capital conservation buffers on limiting the impact of negative shocks to the financial system and real economy. The authors find that combinations of capital instruments help in smoothing economic fluctuations. Brandao-Marques et al. (2020) analyse the combined use of macroprudential and monetary policies. Their results suggest that given an economy with loose financial conditions, it is useful to move macroprudential and monetary policy in opposite directions, since a tightening of monetary policy conditions is too costly, while a loosening of monetary policy can offset some of the undesirable effects of macroprudential policy tightening.

The existing literature on combinations of housing-related fiscal and macroprudential measures shows that these policies could be complementary in ensuring financial stability. Macroprudential measures may have different goals than fiscal measures (e.g. stamp duties, mortgage insurance programmes or mortgage interest deduction schemes), but their interaction could stabilise the housing market (Se, 2013, Galati and Moessner, 2018). For instance, a stamp duty in Singapore proved effective in reducing real estate demand from foreigners (who did not have to meet the LTV and DSTI regulatory requirements in Singapore), and in stabilising housing prices, as evidenced by the sharp drop in the share of private residential properties owned by foreign buyers. Stamp duties and LTV requirements complement each other by requiring a certain amount of savings from a buyer/borrower and thus their joint use (alteration) could strengthen the effect on credit demand and, respectively, house prices (European Systemic Risk Board, 2019). However, stamp duties mainly affect house prices as they effectively increase the cost of purchasing a property and may lead buyers to put off buying a home or opt for cheaper housing, whereas LTV requirements operate largely through the credit channel and also affect household and bank resilience. Reducing mortgage interest tax relief and raising the LTV both reduce mortgage debt and could be viewed as substituting policies (Fell, 2019). Generally, property taxes and macroprudential instruments can have various synergies when applied together, though their interaction in addressing risks to financial stability remains relatively unexplored.

A review of the existing literature reveals that substantial gaps remain when analysing combinations of macroprudential measures. First, there has been no comparative assessment of features of macroprudential instruments that can inform policymakers on appropriate instrument combinations. Section 4 of this paper attempts to help fill that gap. Second, additional work is needed to assess the joint impact of measures from an empirical and theoretical perspective. In particular, while the empirical literature provides some insights on the relative effectiveness of instruments, it does not provide extensive evidence on their joint impact and on the strength of the various transmission channels. More broadly, a comprehensive assessment of the interplay between borrower-based measures and capital measures in strengthening bank resilience and supporting financial stability remains highly desirable. In addition, research on the potential unintended effects of combinations of macroprudential policies remains limited and should therefore be expanded.[10] This paper provides a set of initial quantitative results to help fill some of these gaps. For example, Box 1 presents the findings of an econometric analysis of the interplay between LTV and LTI at origination and the probability of default on mortgage loans using loan-level data to quantify the relative impact of borrower-based measures, and their combinations, on the riskiness of bank loan portfolios. Box 2 presents simulation results using a DSGE model featuring capital and borrower-based measures to highlight their transmission channels and their interactions in achieving policy objectives. Box 3 outlines the results of a semi-structural micro-macro approach used to explore the effect of borrower-based

[10] See the work of Georgescu and Vila Martin (2021) on the effects of borrower-based measures on wealth and income inequality.

measures on the resilience of households and banks, under an adverse macroeconomic scenario. Lastly, this paper identifies specific gaps and priorities from a modelling perspective (see Section 6, Annexes A and B).

3 National experiences in the use of combinations of macroprudential instruments before the COVID-19 pandemic

This section presents the main insights from a survey conducted among macroprudential policy authorities to gain a better understanding of how combinations of macroprudential policy instruments have been used in the euro area. The survey was conducted in mid-2019, at the "peak" of the tightening cycle of macroprudential policy prior to the COVID-19 pandemic and covers all euro area countries. The survey includes information on: (i) what combinations of macroprudential instruments were implemented in euro area countries at the time of the survey; (ii) the financial stability objectives and rationale behind implementing each combination; (iii) how interactions and complementarities among the instruments were exploited to achieve policy goals, and; (iv) the strategies (including data and models) used to activate, calibrate and monitor the impact of combinations of instruments.

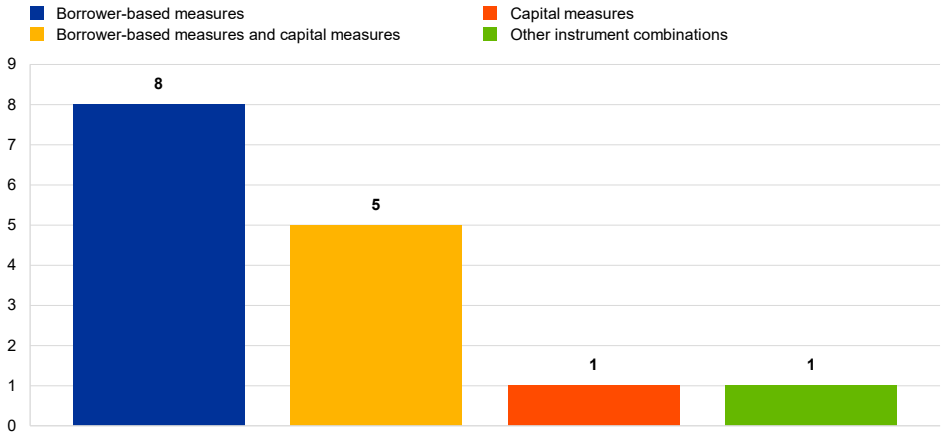
While several countries had a mix of active macroprudential policy instruments at the time of the survey, only a fraction of instrument combinations was adopted with the intention to reap the benefits of instrument interactions (Chart 1). The stock taking exercise identified 15 relevant combinations of instruments, implemented in ten SSM area countries.[11] Eight of these combinations included only borrower-based measures while five combined borrower-based and capital-based instruments. The remaining two referred to a combination of capital-based measures in Finland and a combination of borrower-based and tax measures in the Netherlands. The most common instrument used in combination with others was the LTV limit. All countries that implemented DSTI or LTI/DTI limits, or amortisation requirements/maturity limits, also had LTV limits in place. Notably, the countries that implemented amortisation requirements/maturity limits also activated DSTI limits as the former prevent the circumvention of DSTI limits by extending the duration of the loan contract. Meanwhile, combinations of borrower-based and capital instruments most frequently consisted of a CCyB or risk-weight surcharges (on residential real estate exposures) in combination with a mix of borrower-based measures.

[11] For the survey, "relevant policy combinations" are defined as instrument combinations that were adopted with the intention to benefit from interactions among macroprudential instruments in order to achieve a financial stability goal. The combination of instruments could be the result of the simultaneous activation of instruments within one policy package or it could be the result of a sequencing of instruments over time.

Chart 1

"Relevant" combinations of macroprudential policy instruments in the SSM

("relevant" combinations of macroprudential policy instruments are those that were adopted with the intention to exploit the interaction among instruments to achieve policy goals)



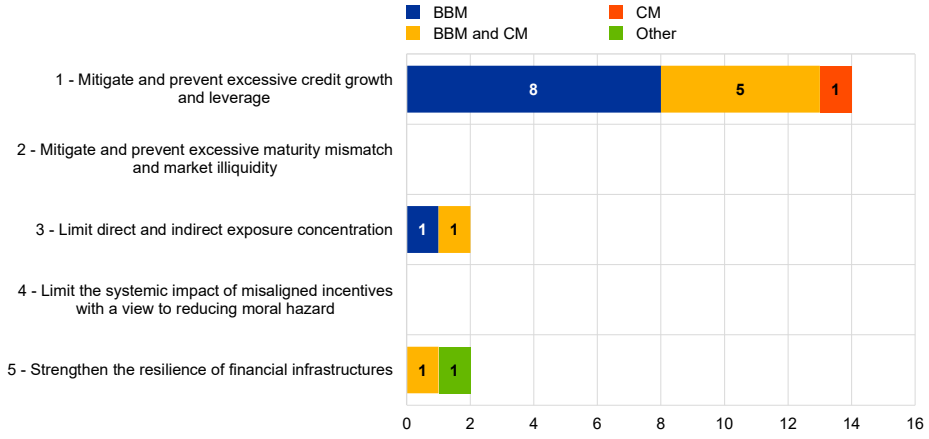
Sources: ECB – Survey conducted in 2019 by the Task Force on the Optimal Macroprudential Interaction of Instruments among euro area macroprudential authorities.

In all but one case, the combinations of instruments aimed to mitigate and prevent risks stemming from excessive credit growth and leverage (Chart 2) by increasing resilience of banks and borrowers. The primary importance of the resilience objective (i.e. strengthening the ability of banks and borrowers to absorb shocks) emerges from a more specific breakdown (Chart 3) that also shows that taming the financial cycle (i.e. reducing credit growth and leverage) is considered as a secondary objective. Specifically, the objectives of Chart 3 can be grouped in two categories: objectives that target bank and borrower resilience (nos. 2, 7, 9, 10 and 11) and objectives that aim to moderate the financial cycle (nos. 1, 3, 4, 5, 6 and 8). This grouping, in combination with the explanations provided in the survey by the authorities for the activation of combinations of macroprudential measures, shows that most measures targeted the broad objective of preventing risks stemming from excessive credit growth and leverage from both the resilience and the financial cycle perspective, though with a prominent role for the resilience objective. For example, the most frequently used combination of LTV and DSTI limits (e.g. in Cyprus, Estonia, Lithuania, Portugal, Netherlands, Slovenia and Slovakia) mitigates and prevents systemic risks in two ways: (a) by increasing the resilience of credit institutions and households against losses in adverse scenarios, thereby reducing macroeconomic volatility; and (b) by mitigating the risk of excessive credit growth during the expansionary phase of the credit cycle. According to the explanations provided in the survey, LTV limits are intended to reduce the potential loss for the bank in case the borrower defaults (lower LGD), while DSTI limits reduce the probability that the borrower will default (lower PD). Meanwhile, LTV and DSTI limits are intended to curb excessive credit growth and leverage by reducing the funding available to borrowers. Less frequent combinations included capital instruments, such as the positive CCyB rate in Ireland that complemented the existing LTV and LTI limits: while the borrower-based instruments aimed to improve resilience among banks and borrowers, the activation of the CCyB had the complementary effect of mitigating the impact of risk taking in non-mortgage lending.

Chart 2

Financial stability objectives of the policy (high level)

(based on ESRB Recommendation ESRB/2013/1 on intermediate objectives and instruments of macro-prudential policy)

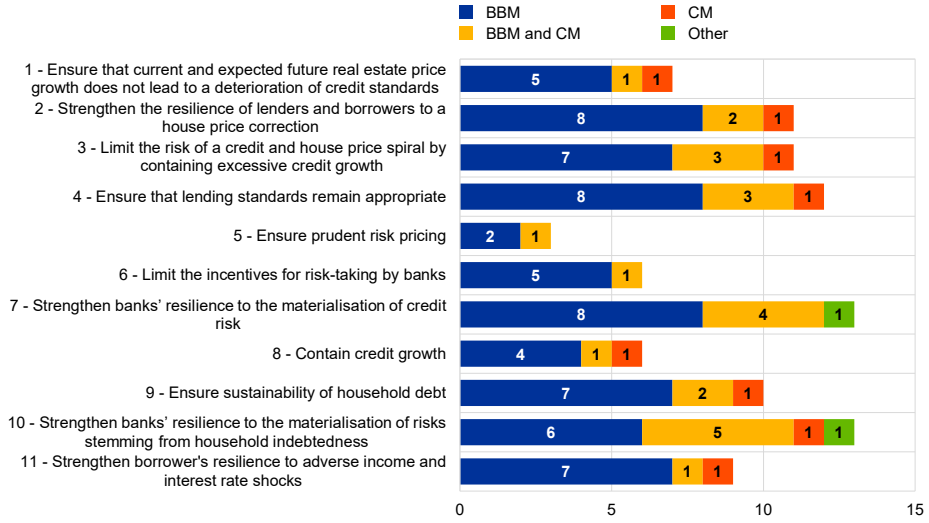


Sources: ECB – Survey conducted in 2019 by the Task Force on the Optimal Macroprudential Interaction of Instruments among euro area macroprudential authorities.

Chart 3

Financial stability objectives of the policy (detailed)

(based on ESRB (2019))



Sources: ECB – Survey conducted in 2019 by the Task Force on the Optimal Macroprudential Interaction of Instruments among euro area macroprudential authorities.

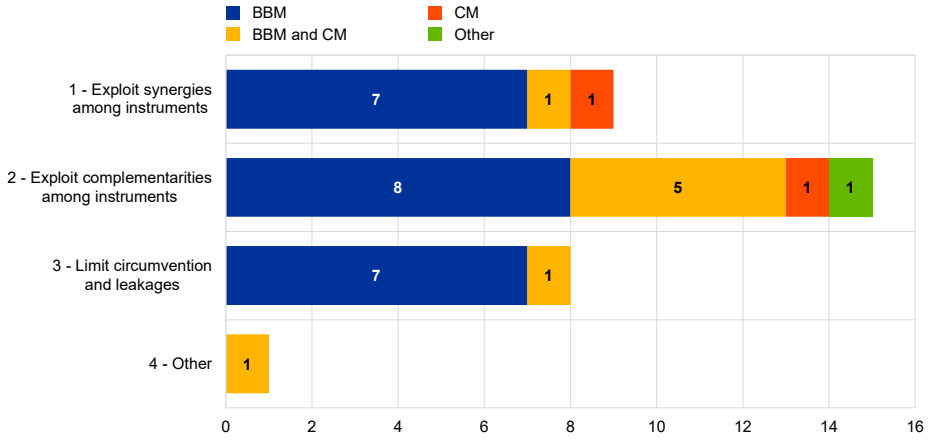
In all cases, the survey reveals that combinations of macroprudential instruments aim primarily to exploit complementarities among instruments (Chart 4). This holds for both combinations of borrower-based measures and combinations that include capital instruments. For example, in Ireland, LTV and LTI measures were implemented in combination to exploit the complementarities of the instruments. They operate through various channels to increase the resilience of both households and banks. From a bank perspective, LTV limits reduce the LGD while LTI limits reduces the PD. From a household perspective, LTV restrictions provide protection against declines in house prices, while LTI limits promote

resilience against an income shock. A similar narrative applies to the frequent combination of LTV and DSTI measures, which complement each other by affecting, respectively, borrowers' LGD and PD. Lastly, while not a primary motivating factor in the setting of the CCyB rate, the increase of the CCyB in July 2018 in Ireland aimed to complement the BBMs by mitigating the impact of risk-taking in non-mortgage lending.

Combinations of macroprudential tools also aim to limit circumvention and leakages (Chart 4). This is particularly true for combinations of borrower-based instruments. For example, DSTI limits have often been accompanied by maturity and/or amortisation requirements, to prevent the potential circumvention of DSTI limits by lengthening loan maturities and/or reducing the amortisation of the loan principal (e.g. in Estonia, Lithuania, Portugal, Netherlands and Slovakia).

Chart 4

Rationale for choosing a mix of instruments



Sources: ECB – Survey conducted in 2019 by the Task Force on the Optimal Macroprudential Interaction of Instruments among euro area macroprudential authorities.

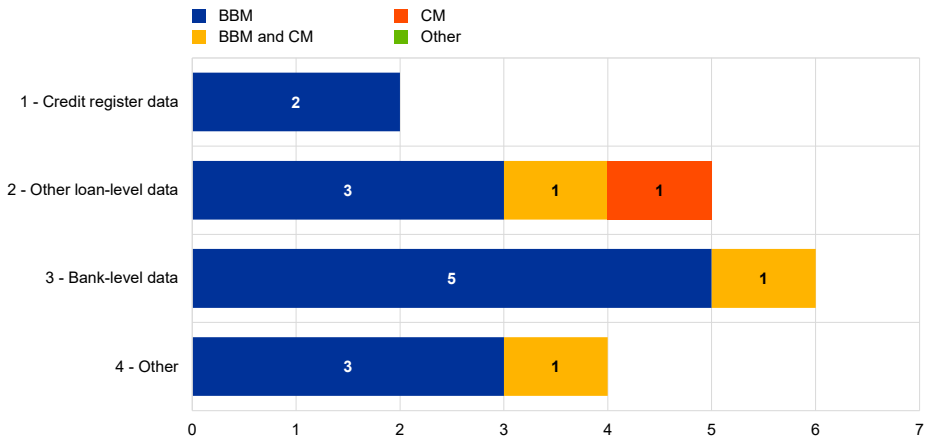
Regarding borrower-based measures, the survey results indicate that information on credit standards is crucial to guide the implementation of combinations of instruments. Bank-level data[12] were most often used, especially to inform the introduction of combinations of BBMs, while credit-register or other loan-level data were also used in several cases (Chart 5). The results also reveal that, in most cases, information on the distributions of the relevant lending standard indicators was available when combinations of borrower-based (BB) instruments were introduced.[13] This information is crucial to understand the effects of combinations of instruments on the overall population of borrowers.

12 Bank-level data on credit standards mostly consist on averages of lending standards indicators for mortgage loans by bank or distributions of mortgage loan volumes according to specific intervals of lending standards.

13 Until recently, the availability of granular information on lending standards has been scarce (Dierick et al. (2017)). EU-wide initiatives such as the ESRB Recommendation ESRB/2019/3 (amending Recommendation ESRB 2016/14) has improved the availability of comprehensive and homogeneous information on lending standards across EU countries.

Chart 5

Which micro data on credit standards were used to calibrate combinations of instruments?

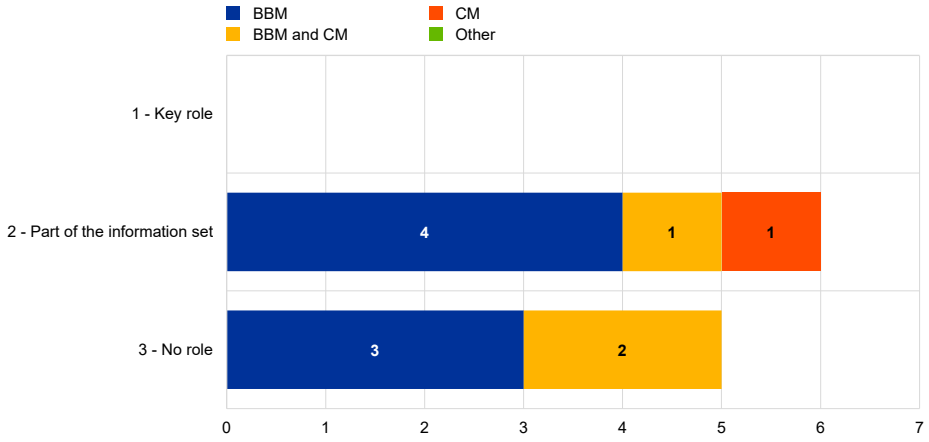


Sources: ECB – Survey conducted in 2019 by the Task Force on the Optimal Macroprudential Interaction of Instruments among euro area macroprudential authorities.

The survey also highlights the limited role of quantitative models in guiding the joint calibration of instruments. Specifically, quantitative tools were reported to have played an informational role in the policy mix in six cases, four of which referred to combinations of borrower-based measures, with the remaining two also including capital measures (Chart 6). References to quantitative tools range from simple analyses of the real estate and credit cycle to advanced quantitative models. For example, Banco de Portugal used information on the distribution of lending standards at the loan level to evaluate ex ante the impact of different combinations of DSTI, LTV and maturity limits to inform calibration levels of the instruments. In addition, a Bayesian Vector Autoregression (BVAR) framework built for a sample of banks was used to assess the impact of restrictions of credit standards on macroeconomic and financial variables, such as GDP, house prices, credit and bank solvency ratios.

Chart 6

What was the role of quantitative tools in the joint calibration of instruments?

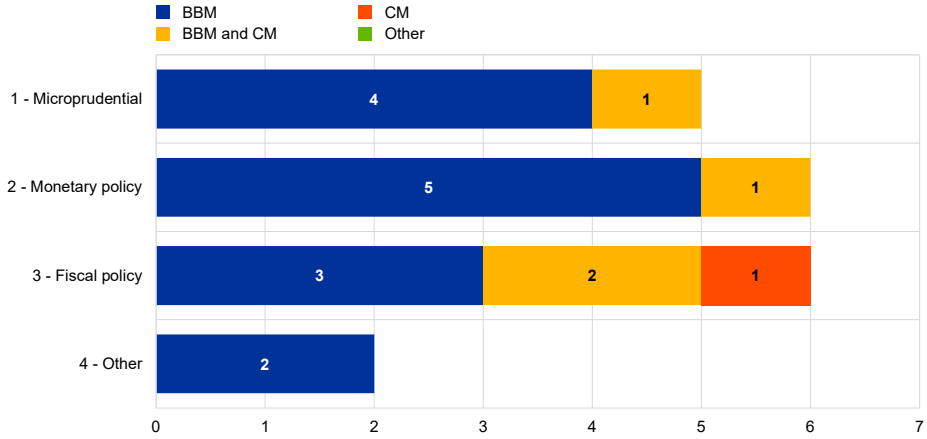


Sources: ECB – Survey conducted in 2019 by the Task Force on the Optimal Macroprudential Interaction of Instruments among euro area macroprudential authorities.

Due to their potential interaction with macroprudential instruments, other policies (microprudential, monetary and fiscal) were taken into account when introducing combinations of instruments (Chart 7). Specifically, several authorities (e.g. Lithuania, Portugal, Slovakia) took into consideration the historically low interest rate environment in their assessments. Furthermore, fiscal policies such as tax-deductible mortgage payments and negligible property tax in Slovakia or the Finnish government's initiative to gradually reduce the tax deductibility of interest payments on housing loans have been taken into account in combinations of borrower-based measures and borrower-based and capital measures respectively. Also, the macroprudential authorities often collaborated closely with the relevant microprudential authorities when considering the choice or calibration of instrument combinations (Chart 8).

Chart 7

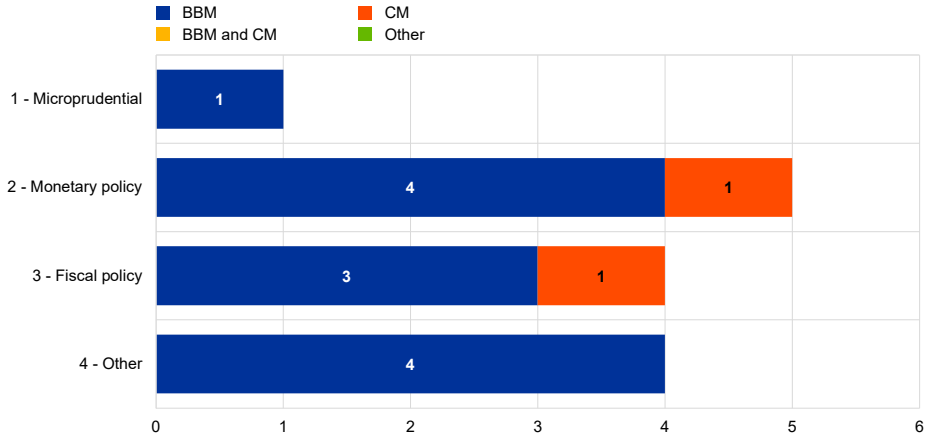
Which other policies were considered as influencing the choice of the selected instruments?



Sources: ECB – Survey conducted in 2019 by the Task Force on the Optimal Macroprudential Interaction of Instruments among euro area macroprudential authorities.

Chart 8

Which other policies were considered as influencing the joint calibration?

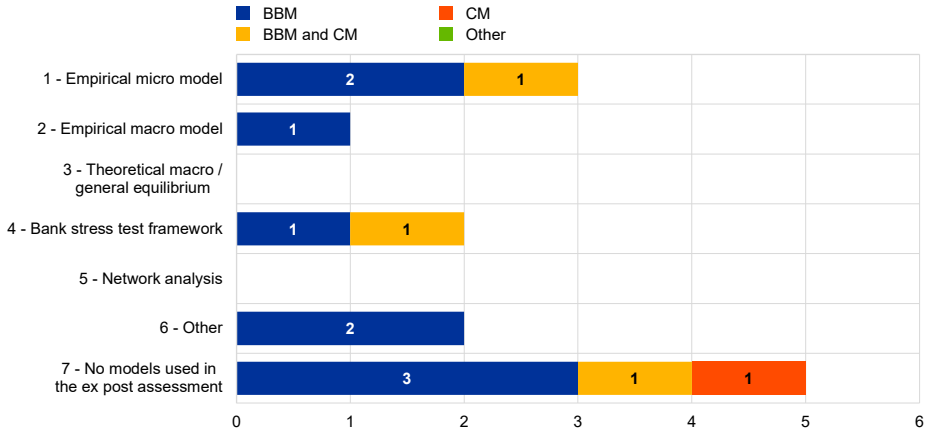


Sources: ECB – Survey conducted in 2019 by the Task Force on the Optimal Macroprudential Interaction of Instruments among euro area macroprudential authorities.

Lastly, the use of quantitative models for monitoring the effectiveness of instrument combinations was still limited at the time of the survey (Chart 9). Macroprudential authorities in some euro area countries are regularly monitoring and assessing the impact of the combinations of measures to have been implemented. For example, Ireland uses loan-level data and a variety of micro-models and stress-testing frameworks in reviewing its borrower-based instruments (see Kinghan et al., 2016). Lithuania performed an ex post impact analysis of the adoption and later amendments of their borrower-based measures using empirical distributions of lending standards, empirical analysis of housing and credit market data as well as ex post assessments of the impact of LTV caps on GDP, real estate prices and household credit growth using micro-level data and a BVAR model (Reichenbachas, 2020).

Chart 9

Which models assisted the ex post assessment of the impact of the measure?



Sources: ECB – Survey conducted in 2019 by the Task Force on the Optimal Macroprudential Interaction of Instruments among euro area macroprudential authorities.

4 Assessing interactions among macroprudential instruments

This section introduces a possible framework for analysing interactions among macroprudential instruments. Certain elements of the framework are considered in practical policymaking when discussing and implementing individual macroprudential policies. However, this chapter aims to bring together and unify the different elements that should inform decision-making on combinations of macroprudential instruments. In addition, for the purpose of this chapter, interactions are discussed both across classes of macroprudential instruments (borrower-based versus capital-based measures) as well as among instruments within each class.

The section is organised as follows. First, it summarises the key elements of the proposed framework to analyse the interaction of macroprudential instruments. Second, it assesses how instrument interactions should be considered across the specific dimensions of the framework, such as the micro and macroeconomic transmission of policies, instrument interactions across policy objectives, the role of country-specific factors as well as monetary, fiscal and microprudential policies and other considerations related to policy circumvention, leakage, timing and communication.

4.1 A framework to assess combinations of macroprudential instruments

A unified framework enables a structured discussion of macroprudential instrument interactions and supports policy choices for combinations of instruments. The framework brings together essential criteria that should be considered when using instruments in combination and complements existing analyses on the use of individual instruments (Figure 1). The key elements of the framework are: (i) a comparative assessment of the micro and macroeconomic transmission of instruments; (ii) the interaction of instruments across policy objectives; (iii) the way country-specific features as well as monetary, fiscal and microprudential policies affect the desirability of certain instrument combinations; and (iv) other considerations related to circumvention, leakage, time of activation and communication of policies.

The discussion of instrument combinations along the above criteria also aims to identify the degree of substitutability, complementarity or synergy (i.e. strategic complementarities) among instruments. Macroprudential instruments can *substitute* one another when they are equally effective in achieving the same policy objective. Instruments *complement* one another when both are needed to achieve the policy objective. Lastly complementary instruments are also *synergic* when their joint impact on the policy objective is greater than the sum of their

individual effects. These attributes should inform the appropriateness of combinations in achieving policy goals.

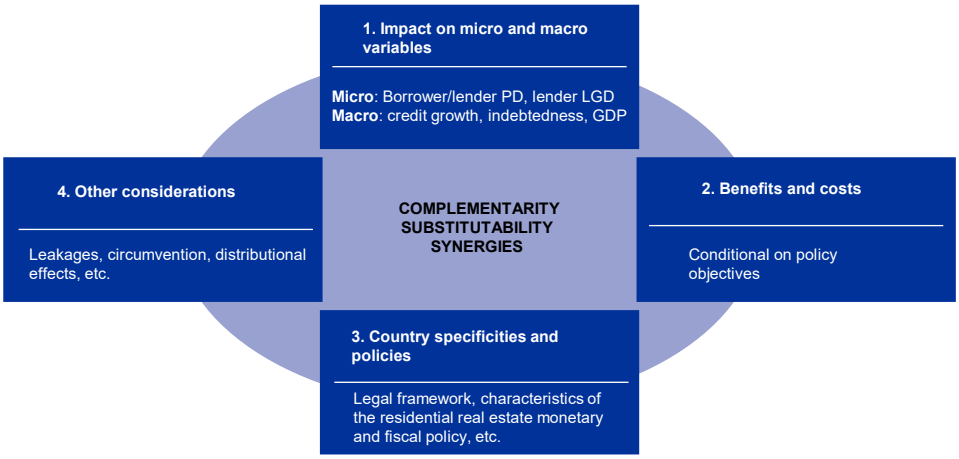
A comparative assessment of transmission channels of different instruments is important in understanding the micro and macroeconomic dimensions of interactions. On the micro side, policymakers aim to improve the resilience of both banks and borrowers to adverse shocks (while minimising distributional effects). Therefore, the transmission of instruments to borrowers and lenders is assessed through the effect of their probability of default and loss given default on (mortgage) loan portfolios. On the macroeconomic side, instruments can affect a variety of variables such as: GDP, credit, house prices, leverage and the overall dynamic response of the economy (or of borrowers) to economic shocks.

Importantly, whether the impact of a policy on some of the variables is considered a benefit or a cost depends on the objectives of the policymakers. As a case in point, a reduction in lending might be a benefit (or even goal) of activating a macroprudential instrument when lending developments are considered excessive. Conversely, a reduction in lending could be a cost of activating a macroprudential instrument when the policy goal is to increase bank resilience and lending is weak. Against this backdrop, the framework examines the transmission of instruments to macroeconomic variables such as mortgage credit growth, house price growth, household indebtedness and, more broadly, GDP. In addition, macroprudential instruments ultimately interact among each other across policy objectives because they affect outcome variables used to assess the achievement of the policy objectives of other macroprudential instruments. For example, both LTV limits and the CCyB may impact house price growth: while dampening excessive house price dynamics may be an explicit objective of LTV limits, the primary objective of the CCyB is to increase bank resilience in periods of exuberant credit growth. However, when able to curb credit dynamics, the CCyB may also dampen real estate prices, thereby interacting with LTV limits.

National specificities and other policies (such as fiscal and monetary) can also condition the impact of instruments. In particular, some country-specific features (e.g. structure of the banking system) might affect more strongly the transmission of one instrument compared to others. For instance, in a heavily competitive banking sector, banks might be more reluctant to pass through the increased cost of capital resulting from higher capital requirements to customers via higher lending rates. Conversely, the role of bank competition in the transmission of borrower-based measures is negligible. In turn, this has implications for the desirability of a specific combination of instruments. Lastly, other considerations related to circumvention, leakage, timing and communication can influence the design and use of combinations of macroprudential instruments.

Figure 1

Building blocks of a framework for assessing combinations of macroprudential instruments



Source: ECB.

4.2 Micro and macroeconomic transmission of combinations of macroprudential instruments: capital measures and borrower-based measures

A comparative assessment of the transmission channels of different macroprudential instruments is the first step to inform possible decisions on instrument combinations. This section offers a comparative assessment of the transmission of borrower-based measures versus capital measures to key outcome variables. The comparative assessment is informed by the literature of macroprudential policy, theoretical considerations and practical experience in policymaking. Appendix A offers a comparative assessment among different borrower-based instruments while Appendix B covers capital measures.

On the micro side, both borrower-based and capital measures may increase the resilience of banks (Figure 2). Capital measures strengthen bank loss absorption capacity and thereby decrease bank default probabilities.[14] As capital measures relate to outstanding exposures, their effect on bank resilience is "immediate".[15] Conversely, the effect on bank resilience of borrower-based measures acting on the flow of new lending to households is "indirect" and "partial" as it materialises over time. Borrower-based measures (income measures in

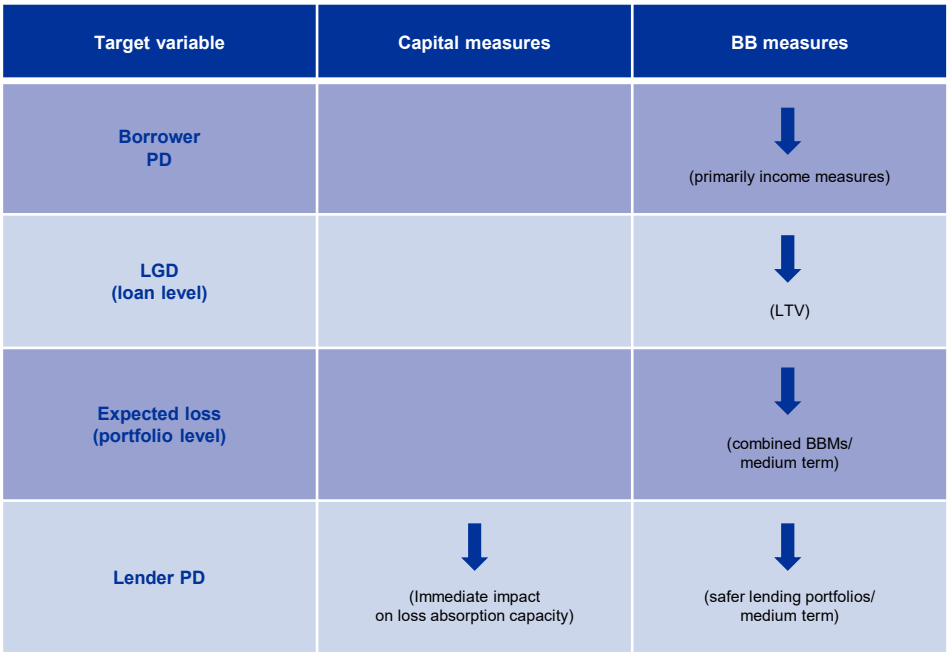
[14] Banks might use (reduce) voluntary buffers to absorb new capital requirements. In this case, the overall loss absorption capacity does not increase and the immediate impact on resilience is limited. Nevertheless, capital measures may be useful to earmark capital to specific risks and to ensure that capital remains available until risk materialise. Therefore, even in a situation when voluntary buffers decrease to absorb new macroprudential capital requirements, banks might be more resilient in adverse scenarios compared to a no-policy counterfactual.

[15] To mitigate the effect of an abrupt increase in capital requirements and to give more time to banks to comply, capital measures are usually introduced gradually, over a phase-in period. The longer the phase-in period, the longer the time lag necessary for the measures to become effective and the benefits on resilience to materialise fully.

particular) increase the resilience of new borrowers. As the new, safer loans feed into the stock of loans over time, they also indirectly increase the resilience of banks by improving the overall quality of lending portfolios ("indirect effect"). Furthermore, the effect is "partial" as the indirect improvement in bank resilience stems from the better quality of only a fraction of total bank assets (lending to households).

Figure 2

Micro impact of capital and borrower-based measures



Source: ECB.
Note: The impact of BBM and CM depends on the calibration and, for CM, on how banks adapt to new requirements.

Micro transmission channels differ across types of borrower-based measures (while being similar in the case of capital measures). Borrower-based measures impact bank resilience over the medium term by lowering the expected losses in banks' lending portfolios via two separate channels: (a) a probability of default (PD) channel (affected primarily by income-based measures); and (b) a loss given default (LGD) channel (affected primarily by loan-to-value (LTV) policies); see Box 3. Income-based instruments are more likely to affect household default probabilities than LTV limits since they condition borrowing capacity to overall repayment capacity (debt-to-income (DTI) limits) and to the "liquidity" of the borrower (debt service to income (DSTI) limits). The LTV instead operates through various incentives: by requiring borrowers to put more "skin in the game" (i.e. equity) it may limit strategic defaults (i.e. where the borrower decides to default on the mortgage loan when the value of the residence falls below the remaining mortgage debt, even though their current income is sufficient to continue payments)[16]. While analytical evidence based on micro data confirms that income measures have a stronger impact on probabilities of default, it also shows that there is merit in combining LTI and LTVs to

[16] Strategic defaults are relatively infrequent, especially across Europe where loans are "full recourse" (i.e. beyond the value of the primary residence, the borrower is also liable with its additional assets and income).

reinforce the action on PDs (Box 1). Lastly, LTV ratios reduce the loss given default of lenders, by requiring higher collateralisation of loans.

Box 1
LTV, LTI and loan defaults: insights using micro data

This box presents the findings of an econometric analysis of the interplay between LTV and LTI at loan origination and the probability of default on mortgage loans using loan-level data for the Netherlands. The ultimate objective is to quantify the relative impact of borrower-based measures, and their combinations, on the riskiness of banks' loan portfolios.

The sample comprises a cross-section of over two million securitised residential mortgage loan contracts in the Netherlands, originated between 2000 and 2018. The data is sourced from the European Data Warehouse and reports, for each loan, its characteristics at origination (loan amount, value of the collateral, income of the borrower, financial institution originating the loan), as well as the history of outstanding balances, interest rate and delinquency status since 2013. In this analysis, only loans taken by individuals (households) for home purchases are considered.

The probability of default is modelled through a logistic regression, controlling for indicator variables reflecting different LTV and LTI buckets at loan origination, other loan and borrower characteristics and macroeconomic variables. The dependent variable is equal to one when the loan is flagged as "in arrears" or defaulted and zero when the loan has been repaid and is, therefore, redeemed.[17] Other control variables include the borrower's income at origination, the original loan balance, the valuation of the collateral property and a series of dummy variables for borrower characteristics (e.g. employment status) and loan characteristics (e.g. interest rate fixation, additional guarantees). Time fixed effects are used to control for macroeconomic conditions at origination. All specifications include bank dummies to control for bank-specific effects (e.g. other unobserved features that affect the quality of loans at origination for a specific bank).

The results point towards a significant increase in the probability of default for loans with high LTV or LTI ratios at origination, with high LTI ratios having a stronger impact. Loans with high LTV (between 90% and 100%) or high LTI (between 3 and 4) ratios at origination are associated with a probability of default which is 0.6 to 1.6 percentage points higher than that associated with loans in the lowest LTV or LTI bucket (Chart A, left-hand panel).[18] Regression estimates[19] show that mortgage default probabilities increase monotonically for higher LTI buckets: loans with LTI>4 exhibit a probability of default twice as high as loans in the lowest LTI bucket. The probability of default for loans in the highest LTV bucket increases by up to one third compared to the reference (lowest) LTV bucket.

Lastly, loan default probabilities increase significantly (by up to 2%) when loans feature high LTV coupled with high LTI ratios at origination. The right-hand panel of Chart A shows the marginal increase in mortgage default probability when moving to higher LTI buckets, conditional on the LTV being in the IV (between 90% and 110%) and the V (above 110%) buckets, relative to loans in the lowest LTV bucket (blue bars). Vice versa, the yellow bars indicate the marginal effect of

[17] Loans that are currently performing are excluded from the analysis, as they retain an intrinsic likelihood to default and cannot be considered redeemed.

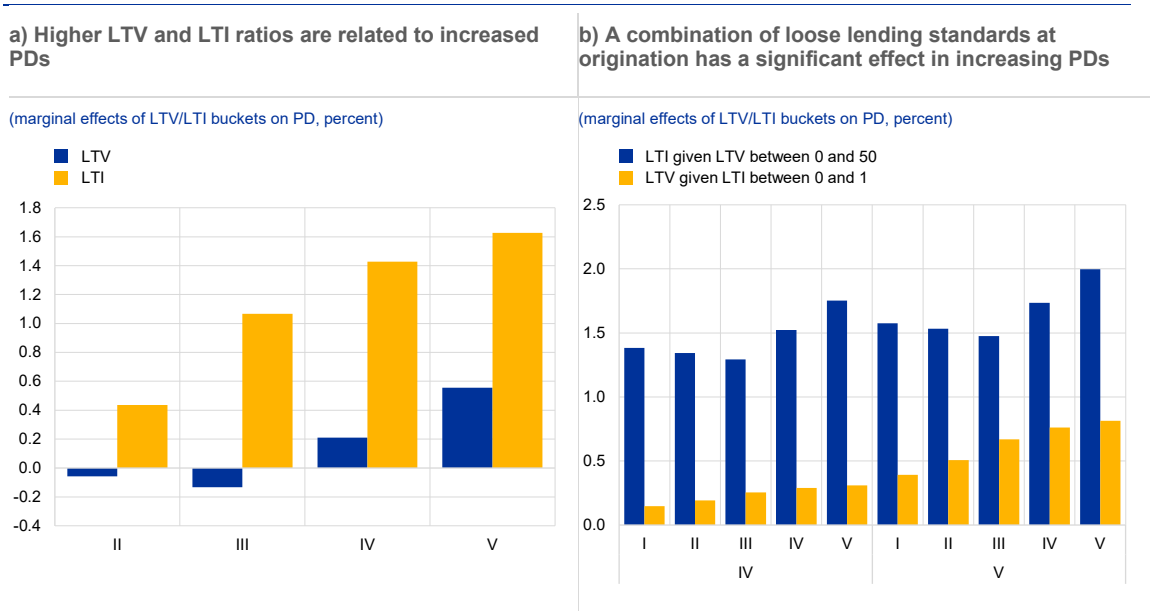
[18] The baseline probability of default (absent any other effect) in the sample is 2.6%.

[19] Not reported due to space constraints but available upon request.

moving to higher LTV buckets conditional on the LTI being in the IV (between 3 and 4) or the V (above 4) buckets, with respect to loans in the lowest LTI bucket.

Chart A

Relationship between lending standards at origination and probabilities of default



Sources: European Data Warehouse, ECB calculations.
Notes: The marginal effects are to be read as the percentage change in the probability of default of loans with respect to loans in the lowest LTV/LTI bucket. LTV buckets are (I) 0-50 (II) 50-70 (III) 70-90 (IV) 90-110 (V) 100+. LTI buckets are (I) 0-1 (II) 1-2 (III) 2-3 (IV) 3-4 (V) 4+.

The macroeconomic transmission of macroprudential instruments is characterised by a greater degree of uncertainty and heterogeneity across instruments. As highlighted by the literature (see, for example, Araujo et al., 2020), the transmission of macroprudential policy instruments strongly depends on the specific instrument considered, the outcome variables and the instrument calibration. For example, the impact of capital measures on lending strongly depends on banks' choices regarding the funding of the additional required capital, which are difficult to predict ex ante. Should banks satisfy these additional requirements with retained earnings or by drawing down voluntary buffers, the overall impact on lending would be reduced. Similarly, the impact of LTV limits on mortgage lending is influenced by the availability of savings among household that can be used to satisfy the additional down payment requirements. Generally, a more binding calibration is expected to result in a stronger effect on aggregate variables. In addition, country specificities (such as competition in the banking sector, bank capital headroom above minimum requirements, the presence of fiscal incentives to mortgage borrowing) may affect the extent to which macroprudential instruments affect macroeconomic variables, thereby affecting their overall macroeconomic impact.

On the macro side, borrower-based measures may be relatively better placed to address the build-up of vulnerabilities in real estate markets (Figure 3). Borrower-based measures directly limit mortgage lending and therefore they appear more suitable in limiting the overheating of the real estate sector.[20] Targeted capital measures (e.g. risk weight policies or sectoral buffers) might achieve the same outcome but with more uncertainty and possibly significantly stricter calibrations, as they affect the price of loans. Moreover, the impact of broad capital measures (e.g. CCyB or) on mortgage lending may even be positive if banks increase the share of lower risk-weighted residential real estate (RRE) lending.

Capital and borrower-based measures contribute, via different channels and with different time lags, to reducing macroeconomic volatility over the medium term, especially in adverse scenarios. Capital measures "stabilise" banks (by lowering the probability of bank distress) and smooth the supply of credit (i.e. by limiting de-leveraging and pro-cyclical financial amplification)[21] while borrower-based measures limit the excessively risky indebtedness of households and support a more stable consumption path (Box 2). More precisely, borrower-based measures help to reduce macroeconomic volatility via two separate channels. First, they lower household default rates and loan losses for banks in adverse scenarios (Box 3), thus also helping to limit bank distress and stabilising the supply of credit. Second, sounder borrowers might also be more resilient to shocks and, therefore, have a more stable expenditure path. This in turn lowers the risk of spillovers from the household sector to the rest of the economy, thus providing further assistance in containing bank distress. However, while borrower-based measures may smoothen the impact of some shocks, they may lead to increased macroeconomic volatility in other cases, due to the potential rebalancing of banks towards corporate lending (Box 2).

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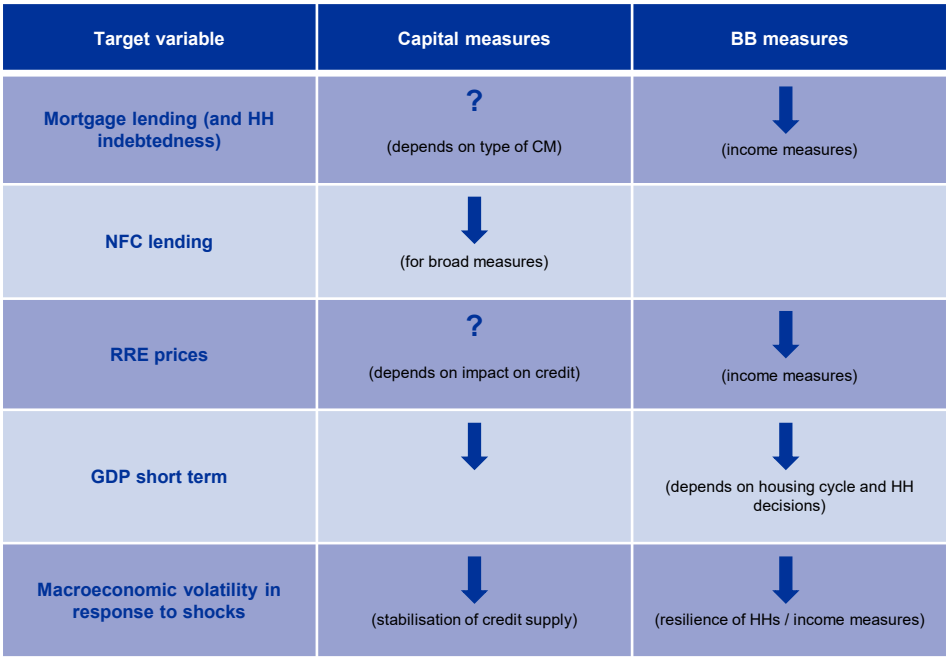
20 See, for example, Araujo et al. (2020) and Gadea and Pérez-Quirós (2021). Evidence for Israel shows that the introduction of LTV limits (75% for first-time buyers, 70% for upgraders and 50% for investors with two or more homes) affected their purchasing choices. Investors (most affected by the policy change) purchased houses that were 22% less expensive, 14% smaller, 24% farther form the centre and 18% lower quality neighbourhoods (Tzur-Ilan, 2017). The IMF (2013) estimated that a 1 p.p. reduction in maximum LTV delivered a 0.4 p.p. reduction in credit growth in Canada.

21 Some macroprudential capital buffers, such as the CCyB, can be released if needed. These can provide banks with extra "breathing space" in adverse scenarios and help to avoid the risk of de-leveraging and financial sector amplification mechanisms (see, for example, the ECB Financial Stability Review, May 2019, Special Feature A).

Figure 3

Macroeconomic impact of capital and borrower-based measures



Source: ECB.
Note: The impact of BBMs and CMs depends on the calibration and, for CMs, on how banks adapt to new requirements.

The relative macroeconomic impact differs across types of borrower-based measures. While both income measures and LTVs could be expected to affect house prices and mortgage lending, the effect of income measures may be stronger as they closely link borrowing capacity to income.[22] Therefore, income measures are expected to have beneficial effects on the evolution of key debt ratios of households and to result in more resilient borrowers in adverse scenarios.[23]

The relative macroeconomic impact of different capital instruments depends on the scope of the measure. The overall impact of all capital instruments is contingent on the state of the economy (with notable macroeconomic effects when releasing buffers in downturns but a possibly muted impact during upturns). During downturns, capital measures that can be released (most notably the CCyB) have stronger stabilising effects on credit as banks are more willing to use released capital than the capital that is constrained by the combined buffer requirement. In fact, using released capital does not entail any breach of the combined buffer requirement, thus not triggering automatic restrictions on distributions, including dividends and bonus

22 There is mixed evidence on the effect of LTV, LTI/DTI and LSTI/DSTI limits on credit growth, house prices and GDP. Relying on a large panel of 56 countries, Richter et al. (2018) find that a 10 percentage point reduction in the maximum LTV ratio lowers output by about 1.1% after four years. Using a cross-regional global VAR model for South Korea, Kim et al. (2015) find that a 10 p.p. decrease in the LTV limit lowered the level of mortgage credit by about 2%, house prices by about 3%, and real GDP by 0.8% in the long run. Empirical evidence for Hong Kong finds no significant effect of LTV limits on the growth of mortgage credit and house prices (Ahuja and Nabar, 2011). Jácome and Mitra (2015) find that, in a panel of six countries, tighter LTV limits yield small effects on mortgage credit levels and non-significant effects on house prices.

23 See also O'Brien and Ryan (2017).

payments.[24] The relative impact of broad vs. targeted capital measures (i.e. risk weights and sectoral buffers) on the credit cycle depends on the extent of portfolio rebalancing.[25] Specifically, broad measures may lead to rebalancing from high (e.g. NFC lending) to lower risk weight exposures (typically mortgage lending, see also Box 2). Regarding the impact on macroeconomic volatility, targeted capital measures might be effective in limiting bank distress when risks remain contained in the lending sector targeted by the measures.

Box 2

Transmission of capital and borrower-based instruments in the 3D DSGE model[26]

The 3D model is a micro-founded DSGE model with financial frictions developed by Clerc et al. (2015)[27] to quantitatively assess the impact of macroprudential policy instruments on financial intermediaries and the economy. In the model, borrowing households, entrepreneurs and banks may all default on their liabilities. Borrowing households finance house purchases with bank loans. Households default on their mortgage loans when the value of the collateral is lower than the outstanding debt obligations. Entrepreneurs engage in capital investment, financing their capital purchases with entrepreneurial wealth and bank loans. Entrepreneurs default on their loans when the return on their investments is lower than the contractual debt obligations. The financial system is populated by two types of banks, one specialised in lending to households and one specialised in lending to entrepreneurs. Each type of bank raises equity from shareholders and deposits from saving households to finance their loan portfolio. Banks fail when the realised return on the loan portfolio is lower than the banks' deposit repayment obligations.

The macroprudential authority sets both capital and borrower-based instruments. Borrower-based macroprudential instruments are introduced in the form of a constraint on the LTV ratio of borrowing households (HHs). The model returns the following implicit LTV ratio on outstanding loans:

$$\mathrm{LTV}_t = (1 - \tau_{\mathrm{LTV}}) \frac{\text{HH loan}}{\text{value of real estate collateral}}$$

The policy parameter τ_{LTV} is added to the baseline model to introduce borrower-based measures. This parameter represents a "tax" levied on borrowing households which reduces the amount they can borrow against the value of the property. A negative τ_{LTV} translates into a relaxation of the LTV limit, while by increasing the value of τ_{LTV} more stringent LTV limits can be imposed, in order to reduce the amount of household mortgages until reaching the desired LTV ratio. Capital regulation forces banks to hold a larger fraction of (more expensive) equity to fund their loan portfolio. On the one hand, capital regulation exerts an expansionary effect on the economy by reducing bank riskiness, thereby reducing the cost of deposit funding and allowing banks to increase their loan supply (risk reduction channel); on the other hand, the use of more expensive equity increases

[24] See Behn et al. (2020) for details on the objectives and usability of macroprudential capital buffers. See Couaillier et al (2021) for an empirical evaluation of the impact of the regulatory capital relief measures implemented during the pandemic on lending.

[25] Bridges et al. (2014), Noss and Toffano (2014) and Meeks (2014).

[26] See Boxes 3.2 and 4.1 in Appendices A and B for a more detailed discussion.

[27] Clerc, L., Derviz, A., Mendicino, C., Moyen, S., Nikolov, K., Stracca, L., Suarez, J. and Vardoulakis, A.P. (2015), "Capital regulation in a macroeconomic model with three layers of default", *International Journal of Central Banking*, Vol. 11, No 3, pp. 9-63.

banks' cost of funding and exerts downward pressure on their loan supply (bank balance sheet channel). The overall effect depends on which of the two effects prevails.

In the 3D model, capital regulation forces banks to hold a larger fraction of (more expensive) equity to fund their loan portfolio. The model includes three types of capital-based macroprudential instruments: a minimum fixed capital requirement, a risk weight for household mortgages[28] and a time-varying capital requirement, which is a function of the deviation of total bank loans from trend (the CCyB). In the model, all banks are required to retain equity in proportion to the amount of loans issued.

In the long run, borrower-based measures are effective in increasing borrower resilience, by reducing defaults, leverage and indebtedness of borrowing HHs. The left panel of Chart A shows the steady state effects of tightening (negative values of the x-axis) and loosening (positive values of the x-axis) the LTV ratio on the main model variables, starting from the baseline calibration.[29] The reduction in credit to households required to achieve more stringent LTV caps reduces the leverage of borrowing households, making them less likely to default. At the same time, the lower demand for housing resulting from the tighter credit conditions reduces residential investment, which, in turn, has a negative effect on GDP.

In the long run, capital-based measures are effective in increasing bank resilience, by reducing bank leverage and the probability of bank defaults. The right panel of Chart A shows the steady state effects of loosening (negative values of the x-axis) and tightening (positive values of the x-axis) capital requirements on selected model variables, starting from the baseline calibration for the euro area. The reduction in bank average default leads to lower costs of deposit funding. In addition, due to the lower risk weights on mortgage loans, banks shift away from corporate and into mortgage loans. Therefore, the slight reduction in total credit results from a combination of increased mortgage credit and lower corporate credit. As mortgage loans increase, so does aggregate household indebtedness.

[28] Risk weights for mortgage loans are calibrated at 50%, while risk weights for corporate lending are calibrated at 100%.

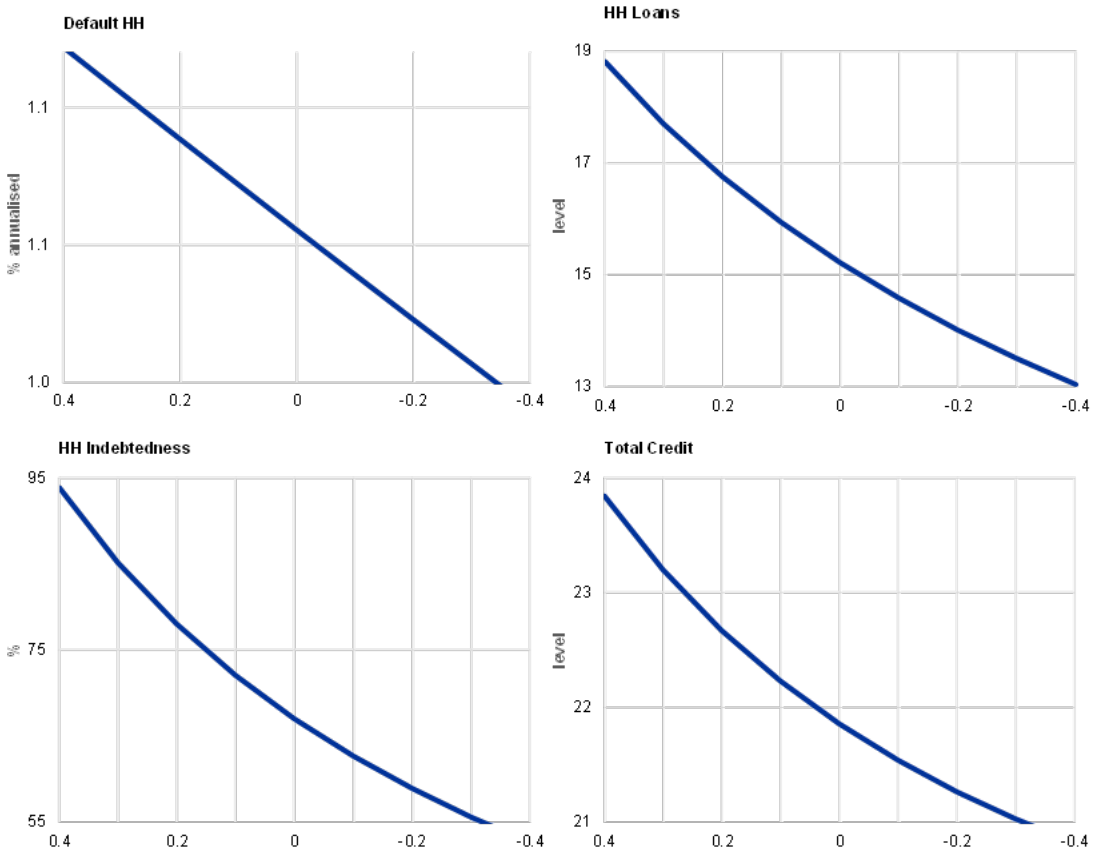
[29] The model is calibrated to match the first and second moments of euro area variables.

Chart A

Steady-state impact of changing LTV limits and bank capital requirements

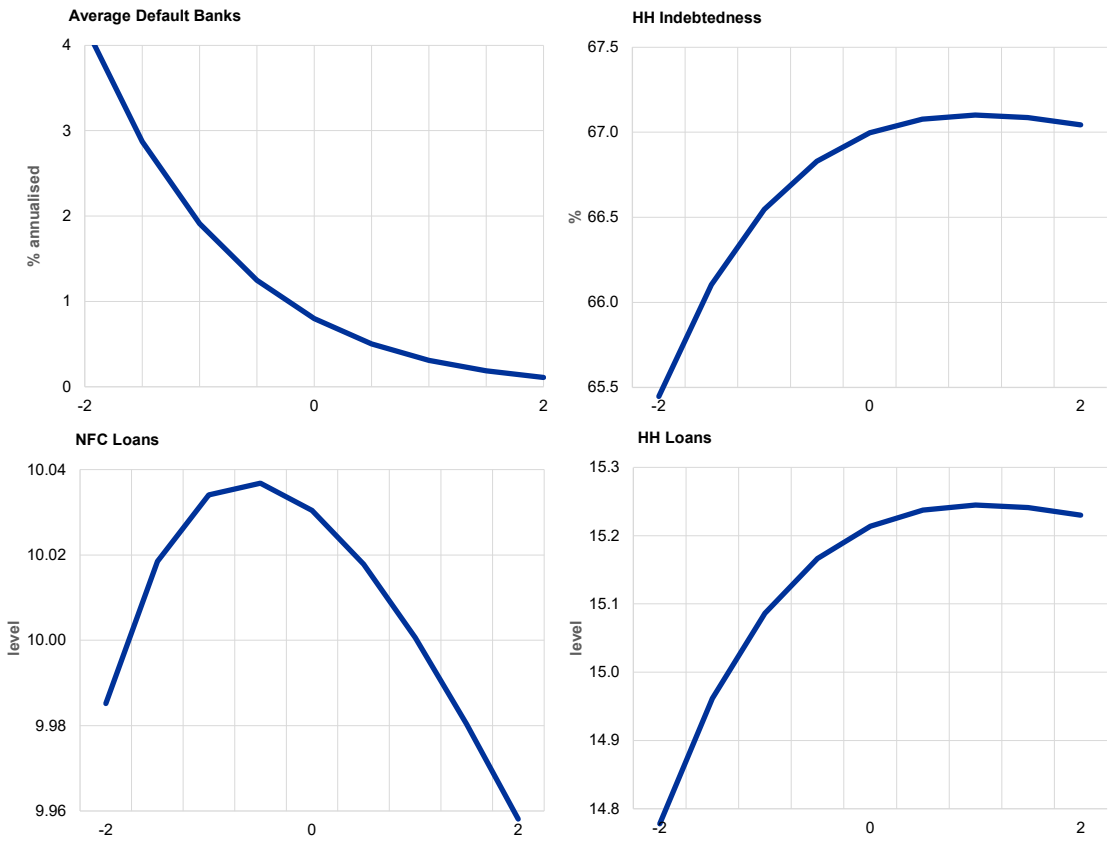
a) Steady-state impact of changing the LTV ratio

(x-axis: policy change (in percentage points). Negative values represent a tightening of the LTV ratio, positive values a loosening



b) Steady-state impact of changing bank capital requirements

(x-axis: policy change (in percentage points). Positive values represent a tightening of capital requirements, negative values a loosening



Notes: Such steady state impacts should be interpreted as the long-term impacts of the policy, rather than short-term effects. Therefore, this analysis does not allow us to examine the short-term costs of activating different macroprudential instruments.

Macroeconomic volatility is contained by borrower-based and capital-based measures depending on the source of shocks. Specifically, LTV limits reduce the volatility in response to shocks affecting the housing sector while higher capital requirements reduce the volatility in response to bank risk, technology and entrepreneur risk shocks. This is due to the fact that tighter LTV limits constrain the demand for mortgage credit, thereby reducing the volatility of household credit that passes through to total credit (Chart B, panel a). However, tighter LTV limits do not result in an overall lower volatility of total credit as the sensitivity of this variable to entrepreneurial risk increases. This effect results from the substitution of investment as the LTV limit is tightened, as savings are re-allocated from residential investment into business investment, which is in turn more exposed to shocks hitting the entrepreneurial sector. A tightening of capital requirements makes the banking sector less prone to default and therefore better able to continue the provision of credit to the economy, even in adverse circumstances. This is reflected in the fact that tighter capital requirements are particularly effective in reducing the volatility of average bank defaults in response to corporate bank risk shocks (Chart B, panel b). It is important to note that the effect is highly asymmetric, as the increase in the sensitivity of average bank defaults when capital requirements are loosened is much higher than the decrease in volatility when capital requirements are tightened.

LTV limits and capital requirements complement each other in reducing the level of credit in the economy. When the policymaker's objective is to contain the level of credit in the economy, LTV limits play a dominant role. Chart C shows that LTV limits lead to a reduction of total credit in the long run, and the magnitude of the effect is similar for different calibrations of capital

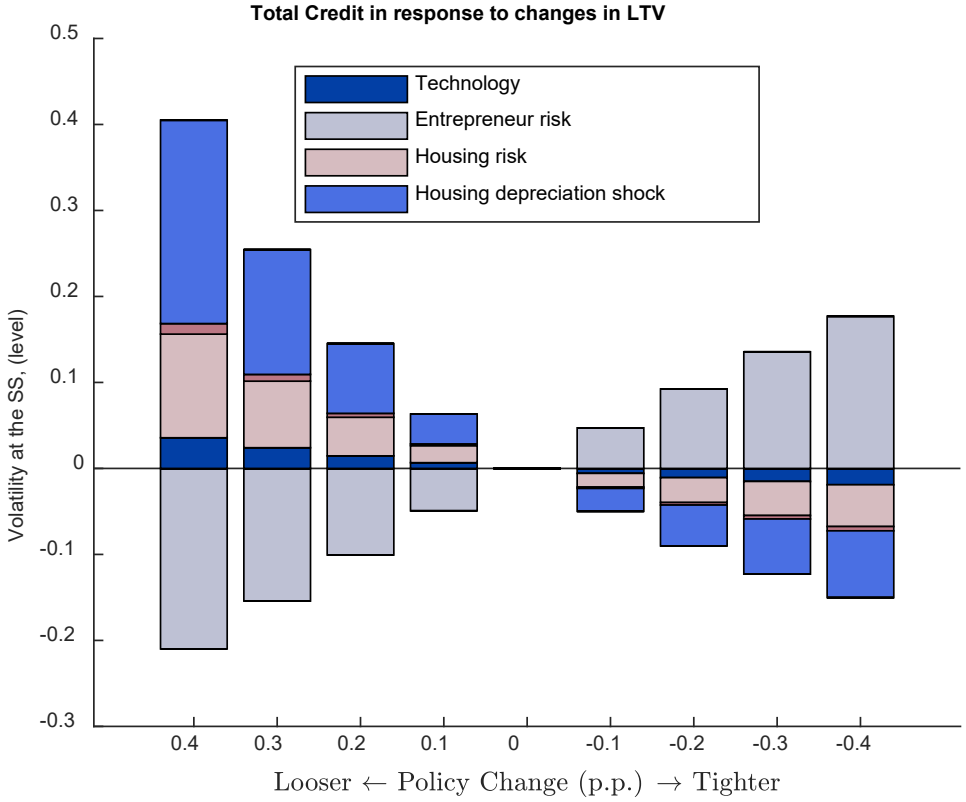
requirements. On the other hand, higher capital requirements have a negligible effect on total credit. However, negative synergies emerge in a loose LTV environment, where higher capital requirements increase total credit. This is because higher capital requirements lead to a shift from corporate loans to mortgage loans (carrying lower risk weights). As borrowers are less constrained by the LTV limit, they can easily satisfy their demand for new mortgages, leading to an increase in total credit.

Chart B

Volatility of macroeconomic aggregates in response to shocks for various instrument calibrations

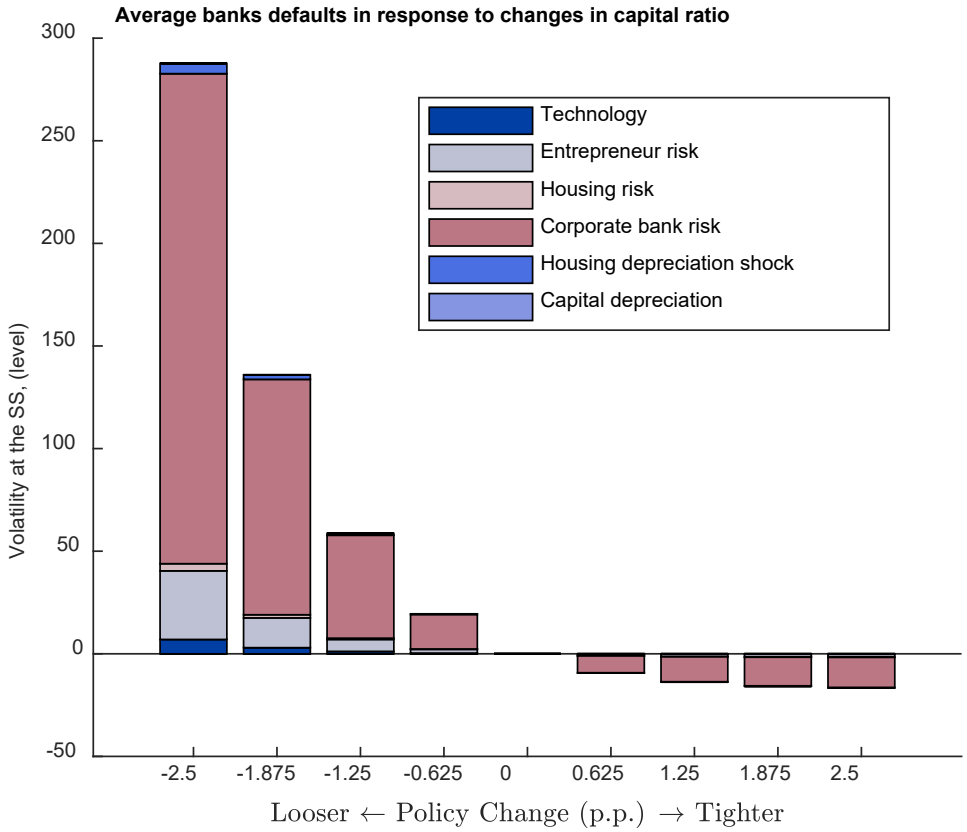
a) Volatility of total credit in response to shocks for different LTV calibrations

(x-axis: policy change (in percentage points. Negative values represent a tightening of the LTV ratio, positive values a loosening))



b) Volatility of average bank defaults in response to shocks for different calibrations of capital requirements

(y-axis: volatility at the steady state (variance); X-axis: policy change (in percentage points). Negative values represent a tightening of the capital requirements, positive values a loosening)

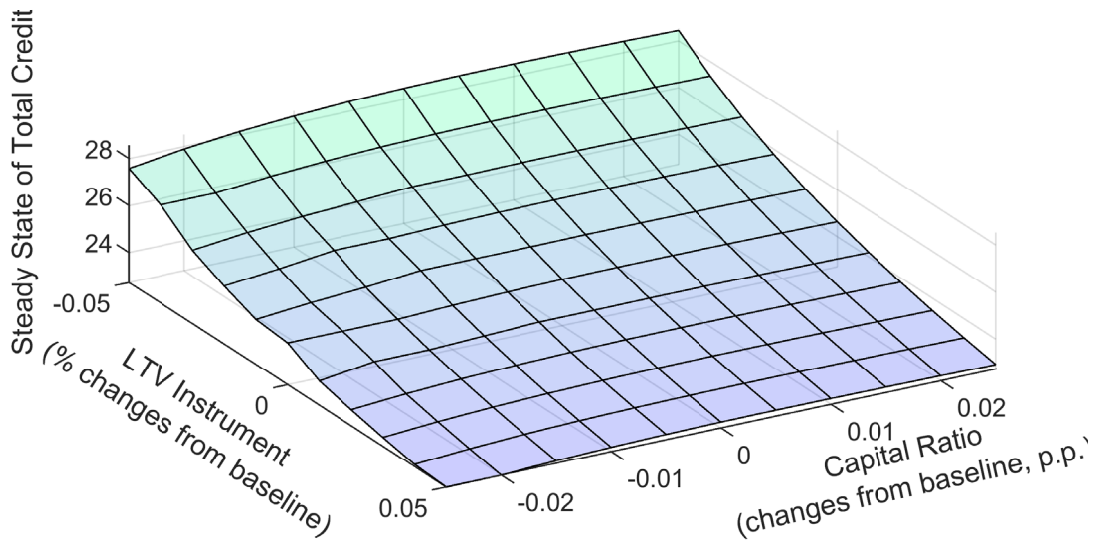


Notes: These results have been computed as follows. First, the steady state of the model is computed for each policy calibration. Then, using in turn each steady state, the model is subject to different shocks and the volatility of the variables around the steady state is computed.

Chart C

Steady-state impact on total credit of jointly changing bank capital requirements and LTV limits

(y-axis: steady state of variable; x-axis: calibration of LTV (change from the baseline, %). Positive values represent a tightening of the LTV ratio, negative values a loosening; z-axis: calibration of capital requirements (change from the baseline, percentage points); positive values represent a tightening, negative values a loosening)



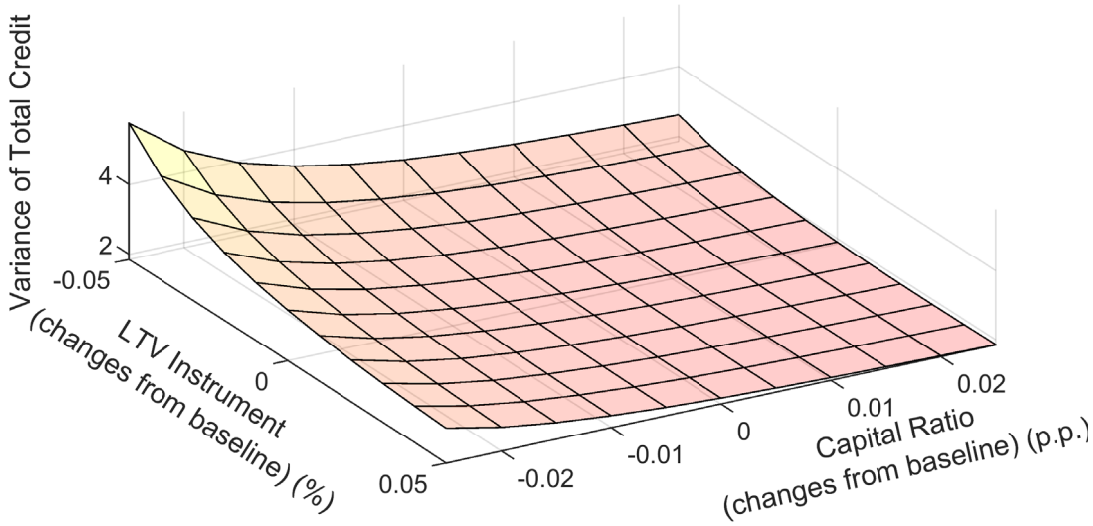
LTV limits and capital requirements reinforce each other in reducing the volatility of total credit in response to shocks. A joint tightening of the instruments indeed leads to a lower volatility of total credit (Chart D). While capital requirements unequivocally reduce the volatility of total credit in the event of negative shocks, LTV limits are effective against shocks in the housing sector. However, they expose the economy to increased volatility in response to shocks related to the entrepreneurial sector. By implementing both instruments simultaneously, the overall volatility of total credit is reduced, revealing a synergic effect of the two instruments. However, it is interesting to note the asymmetric effect of a joint tightening and a joint loosening. The volatility of total credit in the event of a joint loosening of both instruments increases by a greater amount than the decrease resulting from a joint tightening of the instruments.[30]

[30] This result refers to changes in the volatility around the steady state when several shocks in the model are active at the same time. Hence, it implies that economies with lower levels of capital requirements and/or higher levels of LTV in the steady state experience higher sensitivity to exogenous shocks. This does not imply that releasing capital buffers and/or loosening LTV requirements leads to increased macroeconomic volatility.

Chart D

Volatility of total credit in response to shocks for different calibrations of capital requirements and LTV limits

((y-axis: steady state of variable; x-axis: calibration of LTV (% change from the baseline). Positive values represent a tightening of the LTV ratio, negative values a loosening; z-axis: calibration of capital requirements (% change from the baseline); positive values represent a tightening, negative values a loosening)



Box 3

A micro-macro assessment of combinations of borrower-based measures[31]

This analysis uses a modular framework to quantify the change in the resilience of households (and banks) resulting from the tightening of borrower-based measures, under an adverse macroeconomic scenario. Specifically, the semi-structural micro-macro approach of Gross and Población (2017) is enhanced and adapted to the context of Slovakia. The framework integrates an ECM macro module (to generate adverse macroeconomic scenarios) with a micro module, which uses HFCS data to simulate the employment status of household members and the dynamic probability of default (PD) of households. In addition, the framework computes other household resilience measures such as LGDs and loss rates, as well as the impact on new lending flows. The policy exercise approximates the full phase-in of borrower-based measures as effective in July 2019 (LTV at 80% with a 20% exemption but up to a 90% level, DSTI of 80% and DTI at 8).

The results suggest that the combination of borrower-based measures can noticeably improve household (and bank) resilience to macroeconomic shocks (Chart A). In addition, the measures tend to complement each other, as the contribution of individual instruments takes place via different channels. In our simulations, the expected portfolio losses on new loans granted decline by almost 40% (a decline in the loss rate of 10 basis points) by the end of the adverse horizon, compared to a no-policy scenario. Looking at the relative impact of instruments, the results

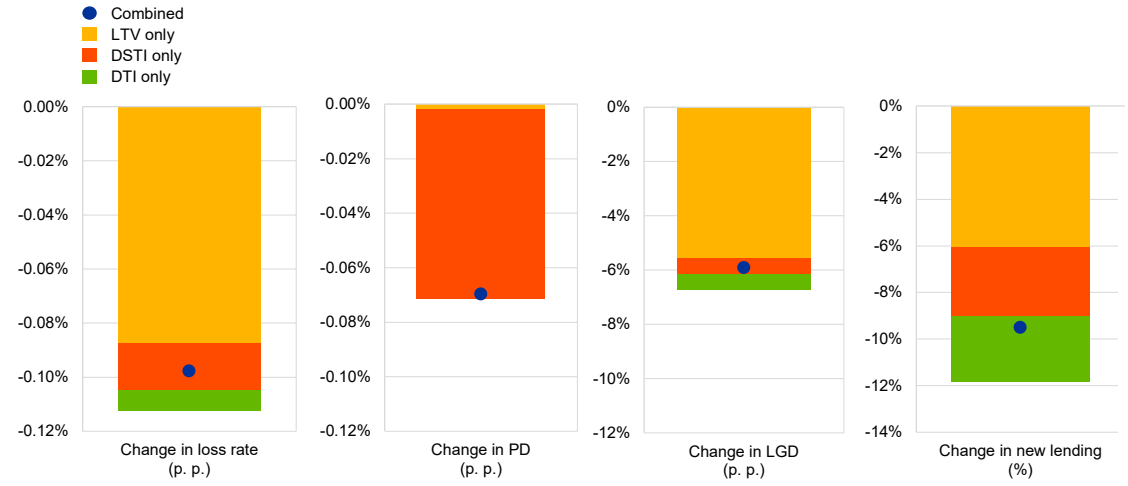
[31] Based on Jurca et al (2020), "The Effectiveness of Borrower-Based Macroprudential Measures: A Quantitative Analysis for Slovakia", IMF WP 20/134.

confirm that LTV impacts primarily via the LGD channel, while DSTI works via the PD channel. The joint policy package has a relatively greater impact via the LGD reduction channel compared to the PD reduction channel given that: (i) a larger proportion of borrowers in the Slovak data are constrained by the LTV limit and (ii) the LTV limit was tightened the most relative to the other borrower-based instruments.

The results also indicate a higher contribution of DTI in slowing the growth of household indebtedness (via new mortgage lending volumes) compared to its impact on portfolio riskiness. The impact of the package of measures on new mortgage lending is mild (some 10%), though this still translates to a slowdown in outstanding mortgage credit growth of 1 to 2%.

Chart A

Impact of borrower-based measures on new lending and household resilience



Sources: HFCS, National Bank of Slovakia and authors' calculations.

4.3 Country-specific factors and the influence of monetary, fiscal and microprudential policies

The structure of the economy and financial system, together with the mix of monetary, fiscal and microprudential policies, all influence the interaction and impact of macroprudential policies. This section reviews possible factors that affect the transmission of macroprudential policy instruments with implications on the design of combinations of macroprudential policy instruments.

The microeconomic transmission of borrower-based measures on default probabilities of borrowers and banks is conditioned by structural features of the economy and the financial system. On the one hand, a high share of variable rate loans increases the desirability of income-based limits designed to be sensitive to interest rates. On the other hand, the bankruptcy and foreclosure procedures, the recourse framework (i.e. the possibility to seize the borrower's assets in addition to the housing collateral in case of mortgage default), the presence of mortgage loan insurance or government guarantees affect the borrower's incentive to default and, therefore, the desirability of LTV limits as a deterrent of strategic defaults. From a lender perspective, the impact of all borrower-based instruments will be stronger in countries where the banking sector heavily relies on mortgage lending as its main line of business.

The macroeconomic transmission of both collateral and income-based instruments depends on the distribution of borrower income and wealth within a country, and other structural features of the economy. The contractionary effect of LTV and DSTI limits on credit demand and on the economy can be expected to be stronger in countries with a larger share of low-wealth, low-income borrowers. In fact, a large fraction of wealthy borrowers who can cover down payments with own funds may reduce the impact of LTV limits on credit and the economy. However, it should be noted that undifferentiated DSTI limits may be excessively restrictive for higher-income borrowers, who would be able to commit a larger fraction of their income to repayments.[32] In addition, the characteristics of housing supply and urban planning regulation, as well as the price elasticity of housing demand, determine the extent to which collateral and income-based instruments affect real estate prices: larger impacts on house prices can be expected in countries with less flexible housing supply and rigid urban planning regulation. Finally, factors such as the value added of the housing sector and the share of consumption in GDP also shape the transmission of borrower-based measures to output.

[32] While a 30% DSTI limit may be reasonable for a low/medium income borrower, it may be excessively restrictive for a high-income borrower, who could afford even a 70% DSTI and still have a flow of income more than sufficient for facing living expenses.

Both the micro and macro transmission of borrower-based measures are strongly influenced by factors affecting the pass-through of the improved risk characteristics of new loans to the stock of loans. These include the maturity of the outstanding stock of loans, the fraction of mortgage loans to total loans, amortisation and repayment practices.

The transmission and interaction of capital measures are influenced by bank specific features which condition the approach to higher capital buffers and portfolio rebalancing (Appendix B). Key bank specific features that influence the way banks meet the demand for higher capital buffers include: a) the size of management buffers, b) the bank business model, c) profitability and ability to retain profits, d) market power, e) ability to transfer costs to customers and f) market conditions (funding costs for banks, cost of equity, etc.). In addition, the potential for portfolio rebalancing from high to low capital intensive assets can also be influenced by: a) the bank business model, b) the composition of the lending portfolio, c) the use of internal models, d) the initial level of capital and e) the shareholder structure.

Monetary and fiscal policies are particularly relevant for the transmission and effectiveness of borrower–based measures (Appendix A). A low interest rate environment compresses D(L)STI ratios, which in turn may mask risks from rising underlying D(L)TI ratios (e.g. if loan maturities are also extended). Therefore, the addition of, for example, maturity limits can help address risks emerging in periods of monetary accommodation. In this environment, D(L)STI limits should be accompanied by affordability tests at loan origination using stressed interest rates. Ensuring household resilience to interest rate shocks can also facilitate a smooth transmission of monetary policy decisions and mitigate the risk of "financial dominance".[33] Similarly, a generous tax treatment of mortgage interest expenses de facto increases borrower income (depending on how income is calculated), thereby partially countering the effect of tightening income-based measures. Furthermore, high residential property taxes make LTV limits more stringent, all else being equal, as they require borrowers to have additional own funds to pay the required duties (which normally cannot be financed with a loan). The income tax rate also influences the impact of income-based limits in constraining borrowers with respect to their gross income (compared to those based on net income). The different relationship between gross and net income across jurisdictions and their use in designing income-based limits also makes it difficult to compare the effect of D(L)(S)TI measures across countries.

Monetary and fiscal policies also contribute to shaping the transmission of capital buffers (Appendix B). By impacting the macro-financial environment, monetary policy affects bank risk, the pricing of bank capital and the ability of banks to raise capital (Beyer et al, 2017). Microprudential policy can influence the effectiveness of macroprudential action, such as via the minimum requirement for own funds and eligible liabilities (MREL) or the leverage ratio (LR), as the same unit of capital can be counted towards MREL, LR and risk-based capital buffers. This may have implications for buffer usability (e.g. CCyB) in periods of stress, as MREL

[33] i.e. the risk that financial stability considerations (which have also implications for price stability) excessively condition monetary policy decisions.

and LR requirements must be adhered to at all times. Lastly, fiscal policy affects economic developments and country risk, while taxation might have an impact on the liability structure of banks and, in particular, the desirability of holding voluntary capital buffers, which ultimately affect the transmission of capital measures.

4.4 Considerations related to the circumvention, leakage, activation and communication of macroprudential policies

A number of additional considerations may influence the choice of whether and how to combine capital and borrower-based instruments. These considerations relate to possible circumvention and leakages, the timing in the cycle, communication and risk awareness (Table 1). The effectiveness of borrower-based instruments compared to capital measures varies across these dimensions. In many cases, there is a strong argument for combining both types of measures, but where one of the below dimensions is more relevant for the policymaker, a specific class of measure could be preferred.

Table 1

Other considerations influencing the choice of instrument combinations

	BBMs	Capital measures – general	Capital measures – specific
Circumvention (lending origination moving to entities outside the scope of regulation) (instrument / class specific)	**Lower** (if implemented as a proper policy mix and activity-based regulation)	**Higher** (via non-domestic lending – possibly mitigated by reciprocity arrangements – and non-bank lending)	**Targeted measures:** (may be watered down by lower credit in other sectors) **SyRB / RW:** (may have a lower impact if applied to retail (due to lower RWs))
Leakages (types of lending difficult to address with macroprudential measures)	Peer-to-peer lending	Bond financing	
Frontloading	**High risk** (applied to new lending flows)	**No risk** (applied to stock of credit)	
Revisions	**Infrequent** (given duration of consultative and legislative process, phase-in) and **more controversial** (if regular revision not originally envisaged)	**Easier** (mainly for CCyB where regular assessment is envisaged)	
Timing of activation (given credit and economic cycle)	**Easier** to activate at the initial stage of risk build-up; **less effective** if implemented late in the cycle	**Easier** for banks to raise equity in an expansion phase	**CCyB** can properly address sustainability of macroeconomic trends
Cyclical use	**Mainly structural**, with possible cyclical recalibration	**CCyB** – cyclical **SyRB** – both cyclical and structural **Other measures** – mainly structural	**SyRB** – both cyclical and structural **RW** – mainly structural
Communication	**Challenging** (many stakeholders, distributional effects)	**Easier** (no direct effect on specific borrowers, less public focus)	
Raising risk awareness	**High impact** Measures are widely discussed	**Lower impact** Very technical issue	Targeted measures and SRB More targeted -> Potentially higher signalling effect

Source: ECB.

Capital-based measures may be fully or partially circumvented by non-bank or foreign lending, warranting comprehensive reciprocation arrangements and the introduction of macroprudential instruments targeting lending in the non-bank sector. Capital-based measures could be fully or partially circumvented by non-bank or foreign lending, especially if comprehensive reciprocation arrangements are not implemented.[34] If applied as activity-based measures (e.g. all mortgages, irrespective of issuer) and used to achieve the same objectives, borrower-based instruments may complement capital-based measures by reducing leakages to unregulated sectors. Borrower-based measures might be less effective if foreign lending plays an important role in the domestic market. This is because they may be more difficult to reciprocate due to cross-country differences in legal basis, available toolbox and specificities of implementation.

At the same time, borrower-based measures are more prone to circumvention via frontloading of credit. Given the lengthy consultation processes and implementation issues involved (including phase-in considerations), there is often a long period between the announcement of new borrower-based measures and their entry into force. Since borrower-based instruments apply only to new lending, market participants might try to increase both demand and supply of credit before the tighter limits come into force.

The stage of the economic and financial cycle should also be carefully considered when combining borrower- and capital-based measures. On the one hand, it is often easier to implement at least a basic set of borrower-based instruments early in the cycle and provide a backstop to lending standards otherwise considered appropriate (Appendix A, Box A.3). As the expansion gains momentum, the introduction of borrower-based measures may be more forcefully opposed by the stakeholders concerned. On the other hand, capital-based measures can be easily introduced later in the cycle when the growth of both financial and economic variables is robust enough and banks have solid profits in order to generate the capital endogenously. This is also the case with structural capital measures, which, if implemented in a recession period or a period of initial economic recovery, need to be sensibly calibrated to avoid detrimental pro-cyclical effects.

The stage of the economic cycle also has significant implications on the calibration of measures to ensure their effectiveness. For example, LTV limits may become less binding during expansionary periods, as growth in the value of collateral (real estate) might exceed the growth of the economy and income (assuming sufficient savings to comply with LTV ratios at loan application). In addition, a positive and growing output gap or growing external imbalances suggest that even income growth, which enters into the denominator of DTI and DSTI, might not be sustainable in the longer term. As a result, the CCyB might serve as a useful complement to borrower-based instruments, which become less effective in periods of strong economic expansion (unless they are designed to account for interest rate and income shocks).

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[34] See also "Cross-border spillover effects of macroprudential policies: a conceptual framework", *ECB Occasional Paper* No 242/2020.

Discussions about different classes of macroprudential instruments differ in their ability to raise risk awareness among stakeholders and the general public. In general, policy action is accompanied by communicating and raising awareness of key financial stability risks and strengthening the understanding of the negative effects of over-indebtedness and loose lending standards. Since borrower-based measures directly affect individual borrowers and have broader social/welfare implications, they tend to be more widely explained and justified. Such discussions may also directly help to mitigate risks related to unsustainable lending. Capital-based measures, on the other hand, might attract less attention, especially when banks have sufficiently high management buffers or capital generation capacity to absorb the new requirements without significantly restricting lending. Nevertheless, more targeted types of capital-based measures can still elicit public discussion if they are focused on specific high-risk segments (e.g. LTV-related risk weights on retail loans).

5 Combining macroprudential instruments to effectively achieve policy objectives

The discussion so far has focused on the various elements that should be considered when implementing combinations of macroprudential instruments. This section builds on all these elements to illustrate the additional effectiveness of instrument combinations to achieve the intended policy objectives. This section outlines, first, how different instruments may interact to achieve macroprudential policy objectives and second, how specific combinations of instruments can be used to address financial stability risks. The focus is on how broader capital buffers and borrower-based measures interact, especially in relation to the household sector and real estate risks (as borrower-based measures for NFCs are not available, they are not discussed). This section summarises the main insights on combinations of borrower-based measures described in more detail in Appendix A.

5.1 Interaction of macroprudential instruments across policy objectives

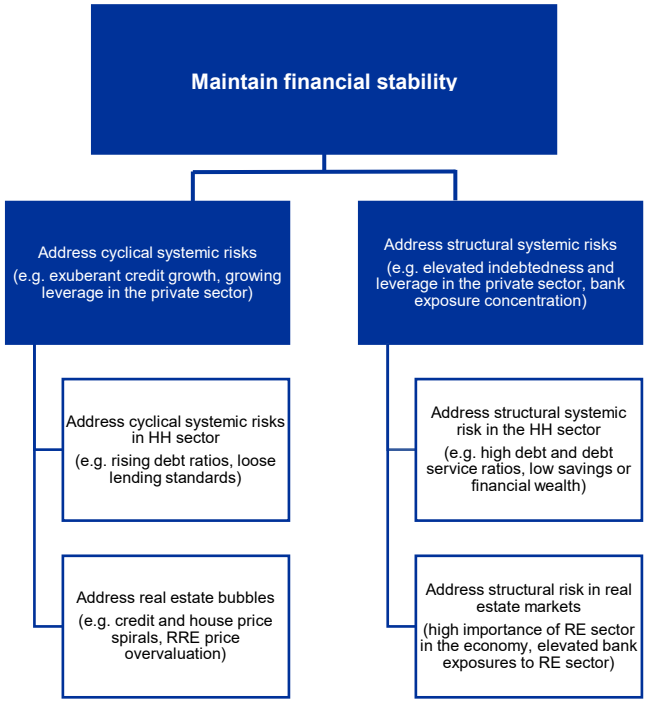
The previous discussion suggests that macroprudential instruments also interact across different policy objectives. This interaction emerges from the fact that macroprudential instruments affect the behaviour of micro and macroeconomic variables that are commonly used to measure the achievement (through benefits and costs) of different policy objectives (Section 4.2). For example, borrower-based measures are generally used to address real estate vulnerabilities. However, they also impact outcome variables (e.g. mortgage credit/household indebtedness) used to evaluate the attainment of objectives of cyclical and structural capital buffers such as the CCyB and, especially for real estate, the sectoral SyRB. The interaction of capital measures across policy objectives is complex, as one instrument (capital), with given transmission channels, is used in different "modalities" (e.g. broad vs. targeted sectoral measures) and with different policy goals (e.g. cyclical risks best addressed by CCyB vs. structural risks best addressed by SyRB/O-SII buffers).

Combinations of macroprudential instruments can address broader cyclical and structural risks as well as specific household sector and real estate sector risks (Figure 4). Broad cyclical risks that can be addressed by combinations of instruments may relate, for example, to exuberant credit developments or the build-up of leverage in the private sector. Structural risks may include high levels of private sector leverage and elevated exposures of the banking sector to specific types of assets or sectors. As borrower-based measures targeting the corporate sector are not yet available in the macroprudential toolkit, the focus here is on the interactions among capital and borrower-based measures aiming to curb vulnerabilities related to the household sector. Cyclical risks in the household sector may include increased household vulnerability, typically associated with rising debt ratios, and looser

lending standards affecting debt affordability and making borrowers and banks less resilient in the medium term. Structural risks in the household sector refer to structural weaknesses in household balance sheets (e.g. high debt and debt service ratios, low savings or financial wealth), which, in adverse scenarios, might lead households to either default or significantly reduce expenditure, thereby amplifying shocks and causing spillovers to other sectors. Housing bubbles (cyclical risk in the real estate sector) may emerge when exuberant growth in mortgage lending and house prices sustain each other, real estate assets (residential and commercial) are overvalued relative to fundamentals and business activity in the construction sector is overheating. Such cyclical imbalances in the real estate sector might result in capital misallocation and ultimately lead to financial instability.[35] Lastly, structural systemic risk in the real estate sector may arise when the real estate sector plays a crucial role in the domestic economy (e.g. in terms of employment and value added to GDP), the financial sector is largely exposed to it and its overall resilience to potential house price reversals is weak.

Figure 4

Financial stability objectives that can be achieved with instrument combinations



Source: ECB.

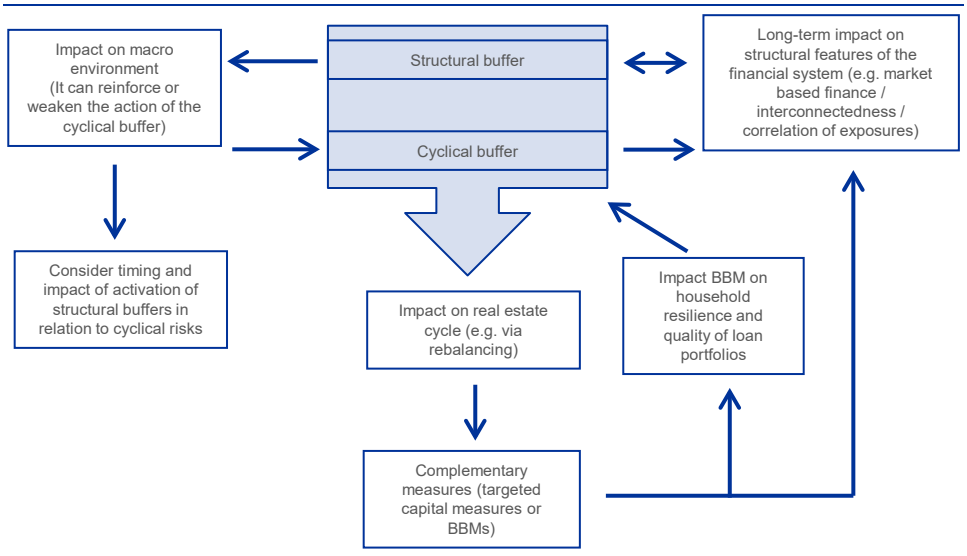
Borrower-based measures affect outcome variables relevant for capital measures. By influencing cyclical developments in housing markets (e.g. mortgage loan growth), borrower-based measures help to contain sources of cyclical systemic risk. As restrictions to risky new mortgage flows gradually feed into the stock of credit, borrower-based measures also contribute to household resilience, which benefits (reduces) both cyclical and structural systemic risk.

[35] See the special issue of the ECB Macroprudential Bulletin on real estate, October 2022 (forthcoming).

The interaction of structural and cyclical capital buffers is bi-directional (Figure 5). While cyclical and structural buffers target different dimensions of systemic risk, the timing and impact of the activation of structural buffers cannot be considered in isolation from cyclical risks, considering that the two instruments operate though the same transmission channels. During upswing phases, activating a structural buffer may result in a macro impact (e.g. on credit) which reinforces the separate action of cyclical buffers to contain cyclical risks. In crisis times, the simultaneous release of releasable buffers may help loss absorption and sustain lending. However, the activation of a structural buffer (such as the SyRB or other institution-specific buffers) in a context of weak cyclical dynamics might entail unintended pro-cyclical effects. In the other direction, the activation of the CCyB to address broad cyclical risks might have an impact on structural risks in the medium term. For example, banks might take more correlated risk exposures (e.g. mortgage loans that have low risk weights), which might increase the structural component of systemic risk over time and warrant the introduction of structural capital buffers.

Figure 5

Capital-based measures: interactions across policy objectives



Source: ECB.

Closing the circle, broad capital measures may impact the real estate cycle. Specifically, broad capital measures might lead banks to rebalance their portfolios towards exposures carrying lower risk weights (e.g. mortgage loans), which could lead to an acceleration of mortgage lending. Therefore, the complementary introduction of other instruments may be considered to prevent unintended effects on house prices and the level of household indebtedness.

5.2 Combinations of macroprudential instruments to achieve financial stability objectives

5.2.1 Combinations of instruments to mitigate broad cyclical and structural systemic risks

Once a choice of a broad capital buffer such as the CCyB or (broad) SyRB has been made to address existing risks, complementary policies could be considered to strengthen the overall impact and achieve policy goals more effectively. First, risk weight floors or a leverage ratio requirement may be used as a backstop to ensure that the intended impact of broad capital buffers on bank resilience is not affected by changes in risk weights or portfolio rebalancing. Unwarranted declines in risk weights could undermine the effectiveness of these buffers, as they would result in an unintended decrease in the nominal amount of capital necessary to fulfil the requirements.[36] Second, borrower-based measures or targeted capital measures may complement broad capital buffers in order to limit the policy-induced incentive to originate additional mortgage loans which typically carry lower risk weights (see Section 4.2 and Box 2). Such a rebalancing might lead to the acceleration of mortgage lending and feed into the (possibly already accumulating) vulnerabilities within the residential real estate market. At the same time, borrower-based measures ensure that lending standards on mortgage loans remain sustainable. Furthermore, limiting rebalancing towards real estate assets would address a potential increase in the correlation of bank exposures, which could lead to the build-up of structural risk over time. The complementary role of borrower-based measures depends on the phase of the real estate cycle and country specificities (including, for example, the extent to which the banking system relies on estimating risk weights using the IRB approach). Targeted capital measures such as risk weight policies or sectoral buffers are imperfect substitutes for the complementary role of borrower-based measures when the goal is to contain rebalancing towards mortgages. In addition to their potential for leakages and circumvention, targeted capital measures have a milder impact on macroeconomic variables (e.g. credit), given their limited impact on mortgage loan pricing,[37] which might have only limited effects in preventing rebalancing towards real estate exposures. Nevertheless, targeted capital measures can be used to preserve

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36 Declines in risk weights might be the outcome of a number of factors, such as banks rebalancing towards low risk weight assets, changes in the share of bank assets and portfolios covered by IRB models, positive macroeconomic developments leading to improvements in default probabilities, or changes in bank internal models. Bank internal models may sometimes be too benevolent in the calculation of risk-weighted assets, thereby leading to unwarranted capital savings. The ECB Banking Supervision's Targeted Review of Internal Models (TRIM) was an important initiative to address non-risk-based variability of model outputs and to improve the comparability of outcomes of internal models used by euro area credit institutions (see ECB Banking Supervision, 2021, Project Report "Targeted Review of Internal Models"). The Basel Committee of Banking Supervision is also addressing these issues as it finalises the Basel III package.

37 Ferrari et al. (2016) estimate only a small effect of a 5 p.p. increase in the risk weight (RW) on mortgage loan exposures on loan pricing. As sectoral measures only affect specific segments of bank portfolios, a high calibration would be required to exert significant macroeconomic effects.

resilience to specific real estate risks that have already accumulated, thereby complementing broader measures.

Lastly, the activation of broad capital buffers may lead to unintended effects and structural changes in the financial system and require complementary policies not yet in the macroprudential toolkit. For example, broad capital buffers can lead to a migration of financial intermediation activity to non-banks. This, in turn, might lead to the emergence of certain financial structures with the potential to amplify shocks, over the medium term. They could also lead to increasing interconnectedness (among banks and between banks and non-banks) and to the emergence of asset commonalities (e.g. into low risk weight assets). While macroprudential action could help to increase bank resilience to risks emerging outside the banking sector (e.g. exposure limits or capital buffers), additional tools would be useful complements to existing policy instruments in tackling vulnerabilities directly.

5.2.2 Combinations of instruments to mitigate risks in the household sector

Combinations of income-based measures complemented by amortisation and maturity limits are best suited to containing cyclical and structural risks in the household sector. Income measures affect household overall indebtedness and debt servicing capacity, thereby dampening their default probability. Maturity limits and amortisation requirements prevent the circumvention of DSTI limits, reinforce the credit-constraining effect of income-based instruments and strengthen the gradual pass-through of their resilience-building effect on the stock of loans. Borrower-based measures have mostly been used in a structural way in euro area countries, to provide a backstop to those lending standards considered appropriate and to prevent their deterioration (see Box 4). In this case, measures were calibrated in a non-binding way at the level of prevailing lending standards and did not exert an impact on macroeconomic variables. However, borrower-based measures are also effective in addressing the cyclical dimension of systemic risk, as shown by the literature. In this case, a binding calibration of borrower-based measures (i.e. effectively limiting housing loan origination with weak lending standards) might be desirable to achieve a stronger impact on the credit cycle and, potentially, on debt ratios.

Box 4

Considerations for the design and calibration of borrower-based instruments

Borrower-based instruments are very versatile as the modalities of their implementation can be tailored to the specific circumstances and policy needs at hand. As the implementation of these instruments is governed by national, rather than European, law, national macroprudential authorities enjoy a degree of flexibility in their design and calibration. They may be introduced as legally binding requirements or simply adopted in the form of guidance from prudential authorities. Looking at the borrower-based instruments that have been enacted in euro area countries, it can be observed that no two countries implemented a tool in exactly the same way.

Depending on the prevailing level of lending standards and the specific policy objectives, borrower-based instruments may be calibrated in a binding or non-binding way. A binding calibration ensures a stronger effect of borrower-based instruments on credit demand, and it is therefore best suited when the policymaker is looking to tame cyclical risks. However, even in early stages of the real estate cycle, a non-binding calibration of borrower-based instruments may be used to prevent the build-up of vulnerabilities in the expansion phase. Such a pre-emptive activation can be beneficial on two grounds. First, limiting the build-up of vulnerabilities early on may reduce the need for additional measures in the future. Second, this approach might also limit the need to impose tighter, binding policies later in the cycle, with stronger repercussions on borrower access to the real estate market. A non-binding calibration is most suitable when the current lending standards are considered sufficiently prudent, and policymakers are aiming to curb structural vulnerabilities in lenders' and borrowers' balance sheets. Should the need arise to tighten lending standards to further increase resilience, the potential costs in terms of foregone credit and economic activity should be carefully considered.

Depending on the nature of the identified vulnerabilities and the policy objectives, the calibration of borrower-based instruments may be static or dynamic over the cycle. Borrower-based instruments can be introduced in a structural, permanent way in order to guarantee a minimum level of lending standards considered sufficiently prudent, and to avoid their future deterioration. However, should cyclical vulnerabilities arise, borrower-based instruments can be recalibrated over the cycle to counter the rise in household indebtedness or excessive credit and house price spirals.

In addition, speed limits and exceptions can be used to target specific segments of the borrower population or to limit the effect on others. Borrower-based instruments may have distributional consequences as they may restrict access to the credit market among young households with low wealth, but good income prospects. Also, banks' credit activity could be overly restricted if all borrowers are made equally subject to policy limits, as credit to the wealthiest (and less risky) borrowers would be unduly restricted by the policy measures. Speed limits consist in a different calibration of instruments for different categories of borrowers. For example, lower limits may be foreseen for first-time buyers, while higher limits may be imposed on second and subsequent borrowers, or to buy-to-let borrowers. Exceptions may be made to allow a given fraction of the flow of new lending to exceed the macroprudential limits, thus giving banks some flexibility to grant more favourable borrowing conditions to those borrowers considered less risky. Speed limits and exceptions can also be re-calibrated over the cycle to address the emergence of cyclical vulnerabilities.

The flexibility in the design and calibration of borrower-based instruments implies that a variety of policy designs is possible. For instance, policymakers may opt for tight borrower-based limits accompanied by generous exceptions, or softer limits accompanied by tight exceptions. These choices are strongly dependent on the identified risks and on the specific objectives of the policymaker.

Lastly, the calibration of borrower-based instruments may be affected by country specificities and other policies. For example, the presence of fiscal incentives on home ownership (e.g. tax rebates, fiscal deductibility of mortgage loan interest rates) might require a tighter calibration of income-based limits when the objective is to counter the rise in household indebtedness or tame cyclical vulnerabilities in property markets. A looser calibration of LTV limits might be justified when state guarantees on mortgage loans are present, as they lower the inherent

LGD of the loan. The monetary policy stance at a given phase of the cycle might influence the calibration of D(L)STI limits in countries with a prevalence of variable rate loans.

The choice to implement (combinations of) income-based limits to address structural vulnerabilities in the household sector can be influenced by prevailing practices regarding interest rate fixation and the phase of the cycle. With variable rate mortgages, D(L)TI limits complement D(L)STI limits. For example, while D(L)STI limits can be more easily met when interest rates are low, DTI limits stay constant and provide a backstop to safeguard borrower solvency. A further instance when the two income-based limits are complementary arises when the cycle is at its peak. In this case, D(L)TI limits may become less binding due to very strong income growth, while D(L)STI limits may become binding in the event of an increase in interest rates.

Low interest rates and a generous tax treatment of mortgage interest expenses affect the calibration of borrower-based measures to address cyclical vulnerabilities in the household sector. When cyclical vulnerabilities emerge in a low interest rate environment, D(L)STI limits may not be binding even if the underlying D(L)TI ratios are rising, thus increasing the desirability of combining them. In addition, accommodative monetary policy and expectations of future interest rate increases justify a tighter calibration of DSTI limits and reinforce the need for affordability tests at loan origination (e.g. via debt service stressed for interest rate increases). Ultimately, safer borrowers that are resilient to higher interest rates could facilitate the conduct of monetary policy in a tightening cycle. By possibly encouraging households to leverage up, tax incentives for credit financed home ownership reinforce the need for income-based macroprudential measures to balance financial stability objectives against broader housing policies.

The degree of substitutability/complementarity of capital and borrower-based instruments to address risks in the household sector also depends on the horizon at which effectiveness is evaluated and on the availability of borrower-based instruments in the legal framework. From a cyclical risk perspective, targeted capital measures are not as effective as borrower-based measures in addressing cyclical risks in the household sector. While borrower-based measures address such risks directly by affecting the quantity and quality of new lending, capital measures increase the banking system's resilience to potential shocks in the household sector and may help to tame cyclical developments, depending on calibration. In the short term, instruments such as sectoral risk weights and the sectoral SyRB complement borrower-based measures: while the former increase resilience to already accumulated risks, the latter ensure the quality of new lending flows. In the medium term, both measures help to increase resilience, as the impact of borrower-based measures starts to feed into the stock of loans.[38] Therefore, targeted capital measures might be used more strongly in transition phases as a backstop until the effect of borrower-based measures gradually transmits to the stock of lending to households. Targeted capital measures can also act as imperfect

[38] See ECB Macroprudential Bulletin, October 2022.

substitutes of borrower-based measures if the macroprudential use of the latter is legally constrained. Lastly, when losses might spill over beyond the real estate sector (e.g. if household expenditure drops in response to a shock), there might be a complementary role also for broad capital measures.

5.2.3 Combinations of instruments to mitigate risks from the household component of bubbles and structural risk in the real estate sector

Combinations of income-based measures, LTV limits, amortisation and maturity limits appear to be the most appropriate instrument mix to address the household component of housing bubbles and of structural risk in housing markets. While income measures and maturity limits increase household resilience by limiting household probability of default, LTV limits reduce the potential losses given default for banks, which is particularly relevant when house prices deviate from fundamentals and bolster the impact of income measures on PDs. Overall, beyond making households more resilient, this combination reduces expected losses for banks in adverse scenarios, while also helping to improve bank resilience. When addressing the cyclical dimension of systemic risk (e.g. housing bubble) a "more-binding" calibration of the combination of borrower-based measures might be desirable. A binding calibration would have a faster impact on the evolution of credit and debt ratios, thereby bringing beneficial effects when taming the cycle is a policy objective.

Targeted and broad capital measures are important complements to borrower-based measures in addressing real estate risks. As noted in the previous section, borrower-based measures can effectively address risks in the household sector. However, they cannot address the whole range of vulnerabilities that characterise a housing bubble more broadly or those that drive structural risk in the real estate sector. During housing bubbles, vulnerabilities may extend beyond the household sector, perhaps spilling over into the construction and the commercial real estate sectors and affecting also the related banking sector exposures. Capital measures may therefore be useful in complementing borrower-based measures by ensuring the banking system's resilience to spill-overs across sectors in case real estate risks materialise.

If risks related to rapidly rising house prices emerge in an environment of low interest rates, a combined implementation of collateral and income-based instruments is desirable. Rapidly rising or overvalued house prices lead LTV limits to become less binding, thus warranting the combined use of income-based instruments to counteract the emergence of credit and house price spirals. In addition, DSTI limits may become not binding with low interest rates, even if the underlying DTI ratios are rising, thereby increasing the desirability of combinations of income-based instruments.

6 Conclusions

This paper reviews the evidence and literature on the use of combinations of macroprudential instruments to draw lessons and offer conceptual considerations to inform their implementation. While macroprudential policy instruments have been increasingly used in the aftermath of the Great Financial Crisis, their interactions and the benefits from their combined use have received less attention. Specifically, only a few euro area countries activated combinations of instruments with the explicit intention to exploit complementarities and synergies. To guide policymakers in the implementation of combinations of instruments in the upward phase of the financial cycle, this paper outlines a framework to structure and inform the discussion on macroprudential instrument combinations. It also presents the results of selected applications of quantitative models to better understand interactions, quantify the impact of instrument combinations on outcome variables and assess their effectiveness. The analysis indicates that notable benefits can be obtained through the combined implementation of macroprudential instruments, both within and across instrument classes.

Using combinations of borrower-based instruments ensures that multiple aspects of systemic risk related to households are addressed, reduces the scope for circumvention and enhances their effectiveness. While collateral-based and income-based instruments exhibit strong complementarities by tackling different sources of systemic risk, they may also occasionally act as substitutes given the commonality of their transmission channels. Income-based instruments can effectively support the resilience of the household sector while at the same time increase the ability of banks to absorb adverse shocks. Not only are income-based instruments not influenced by changes in house prices (unlike LTV limits), they become even more effective when complemented by other instruments such as maturity limits and amortisation requirements to limit potential circumvention.

Targeted capital measures complement broad capital requirements by strengthening the overall impact and achieve policy goals more effectively. Targeted capital measures can be used to preserve resilience to risks related to specific bank exposures that have already accumulated, thus complementing broader measures. In addition, sectoral capital requirements or leverage ratio requirements can limit the incentives for bank actions in changing risk weights or rebalancing portfolios, which may undermine the intended impact of broad capital buffers on bank resilience. Furthermore, structural capital requirements such as the SyRB or institution-specific requirements may address potential increases in interconnectedness (among banks and between banks and non-banks) and address the emergence of asset commonalities (e.g. into low risk weight assets) resulting from the introduction of broad cyclical requirements.

Combining borrower and capital-based measures ensures further coverage of different systemic risks and entails important synergies. The complementarity of capital and borrower-based measures arises in the short run: while capital requirements increase bank resilience to already accumulated risks, borrower-based measures act on the quantity and quality of new mortgage lending. In the medium term, both measures contribute to increasing resilience, as the impact of borrower-based measures starts to feed through to the stock of loans. Furthermore, capital measures may also usefully complement borrower-based measures by ensuring the banking system's resilience to spill-overs across sectors in the event that real estate risks materialise.

While this paper marks an important step forward in guiding the use of combinations of macroprudential instruments, further work is warranted going forward. Firstly, the modelling toolkit to support the calibration and assessment of combinations of instruments remains under-developed. While approaches used to guide the calibration and assess the effectiveness of individual instruments range from structural models to empirical analysis, the complexities in analysing instrument combinations call for sufficiently flexible modular frameworks that integrate multiple methods. Secondly, the quantitative analysis of instrument interactions could be expanded in order to include other relevant aspects, such as interactions with other policies, state dependencies, the assessment of welfare effects and distributional implications.

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Appendix

A Combinations of borrower-based instruments

Despite there being scant academic literature on the subject, borrower-based instruments are often used in combination (Table A.1). Before the COVID-19 pandemic in 2020, LTV limits were the most popular instrument within the EU (17 cases), and they were frequently accompanied or followed by DSTI limits (11 cases) or amortisation/maturity requirements (8 cases). Also, amortisation requirements and maturity limits were often used in combination with DSTI limits (6 cases each). In late 2019, LTI/DTI limits were active in five countries, in four of which they were used in conjunction with LTV limits. Overall, the evidence on the combined use of borrower-based instruments in the EU suggests a degree of complementarity among different instruments, and that these measures may be more effective when used in combination.

Table A.1

Combined use of borrower-based instruments in the EU before the pandemic

(number of countries having activated the specific combination of instruments simultaneously)

	Loan-to-value	Amortisation / maturity of housing loans	Debt service to income	Loan (debt) to income
Loan-to-value	17	8	11	4
Amortisation/maturity limits	-	8	6	1
Debt service to income	-	-	11	2
Loan (debt) to income	-	-	-	5

Sources: ESRB "Overview of national macroprudential measures" (December 2018) and ECB calculations.

This appendix complements the paper with additional details regarding the interaction of borrower-based measures. Section 8.1.1 provides an overview of the definitions of borrower-based instruments and highlights interdependencies stemming from the construction of indicators. Section 8.1.2 supplements the main text of the occasional paper with additional details on the transmission of borrower-based measures, the role of country-specific factors and the influence of monetary, fiscal and microprudential policies, as well as other considerations related to the circumvention, leakage, activation and communication of borrower-based instruments.

The definition and design of borrower-based instruments

The definitions of borrower-based instruments have been recently harmonised at the EU level by the ESRB Recommendation on closing real estate data gaps[39]. In addition to providing general definitions of indicators used to set

[39] Recommendation of the European Systemic Risk Board on closing real estate data gaps (ESRB/2016/14).

corresponding borrower-based macroprudential instruments, the Recommendation provides precise guidance on the computation of the indicators.[40] This section outlines the definition of each instrument, highlighting, where possible, interactions arising from the construction of the indicators.[41]

LTV limits restrict the value of the loan relative to the value of the underlying (real estate) collateral at loan origination. By requiring borrowers to finance a determined fraction of real estate purchases with own funds, *LTV limits reduce borrowers' and lenders' vulnerability to property price reversals*. Formally, LTV limits require that the maximum size of the secured housing loan be such that LTV(i) ≤ $\overline{LTV}$, where LTV(i) denotes the loan-to-value ratio of borrower i at loan origination and $\overline{LTV}$ denotes the loan-to-value regulatory cap. LTV(i) = L(i)/V(i) where L(i) denotes the value of all loans or loan tranches secured by the borrower on the immovable property and V(i) is the fair value of the property used as the collateral for the loan at loan origination.

LTI limits constrain the amount of a mortgage loan relative to the borrower's disposable (annual) income at loan origination. DTI limits are broader, as they constrain the total value of the borrower's debt in relation to their income. *LTI and DTI limits focus on debt repayment capacity and increase the probability that borrowers are able to service their loans from their regular income.* LTI limits require that the maximum size of the secured housing loan be such that LTI(i) ≤ $\overline{LTI}$, where LTI(i) denotes the loan-to-income ratio of a borrower i at loan origination and $\overline{LTI}$ is the loan-to-income regulatory cap. LTI(i) = L(i)/I(i) where L(i) has the same meaning as in the LTV ratio and I(i) is the borrower's total annual disposable income as registered by the credit provider at the time of loan origination. When the information is available at borrower level, L(i) should ideally be replaced with D(i), which denotes the total gross or net household debt of borrower i at the time of loan origination.

LSTI (DSTI) limits in turn require that a household's loan (debt) service (interest and principal) does not exceed a certain percentage of its disposable income (on a monthly or annual basis). In some countries, lenders are required to use stressed (higher) interest rates when assessing the borrower's ability to service their loans at the time of loan origination.

Amortisation requirements mandate that borrowers make periodical repayments of (at least a part of) the loan principal over the life of the loan, while maturity limits impose a maximum time limit for the full repayment of the loan. Full amortisation implies that the loan principal is periodically repaid so that it is fully repaid at maturity. Amortisation requirements are only relevant in countries where interest-only mortgage loans are common and are not relevant in those countries where full amortisation is the market norm (e.g. Ireland, the United Kingdom). Similarly, excessively long maturities should be discouraged to reduce the probability of adverse developments hampering the borrower's ability to repay the

40 See Chapter 2 and Annex IV of the Recommendation.

41 A discussion of borrower-based instruments is also outlined in chapter 3 of ESRB (2014), although abstracting from interdependencies between different instruments.

loan. Long maturities at origination also reduce the ability to restructure the loan by extending the maturity if a borrower gets into difficulty over the life of the loan.

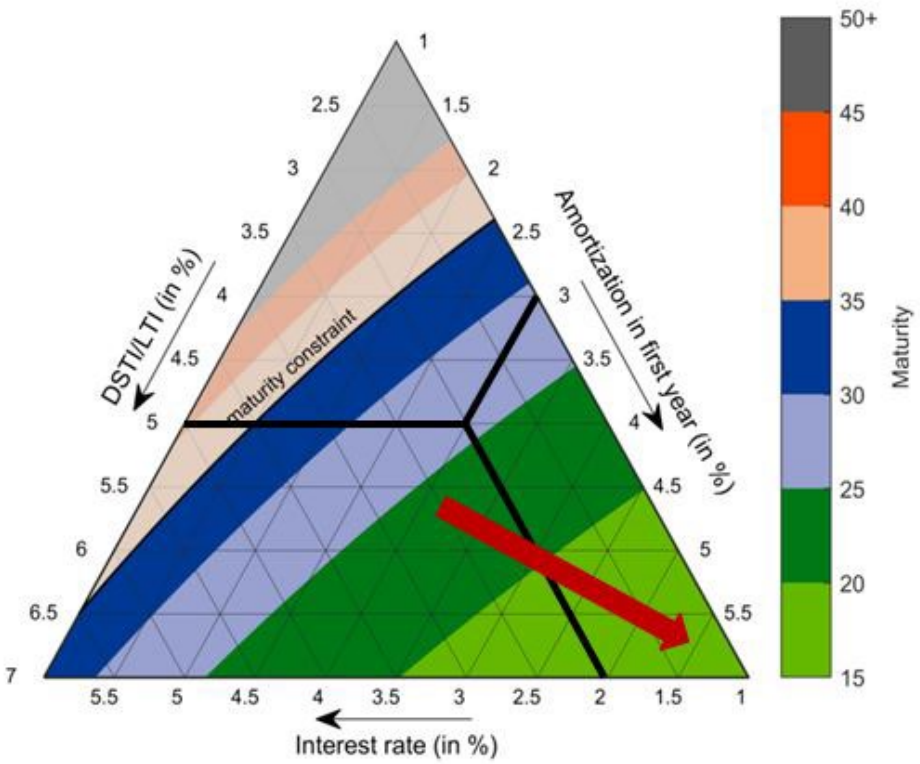
By construction, borrower-based instruments may be strongly interdependent. For example, the DSTI ratio can be written as a function of the DTI ratio, the loan's maturity (T) and the loan's interest rate (i), as follows:

$$DSTI = f(DTI, i, T) = \frac{i}{(1-(1+i)^{-T})} \cdot DTI$$

The formula clarifies that, for a given maturity requirement and interest rate, a DSTI limit yields an implicit DTI requirement. Also, where loan refinancing is not allowed, a maturity requirement automatically results in an amortisation requirement, for given interest rate. In these cases, any principal remaining at loan maturity should be repaid in full as it cannot be financed with another mortgage loan. This is not the case in countries where loan refinancing of residual loan amounts is permitted (e.g. in Germany).

More generally, in a standard fixed repayment mortgage loan, the monthly payments (debt service) are related to the principal (loan amount) and to the interest rate over a predetermined maturity (Figure A.1). This implies that the ratio of the debt service to the loan size is equal to the sum of interest rate and amortisation rate. The plot shows that, as debt repayments relative to the loan size (left axis) and amortisation rates (right axis) increase, the implied loan maturity decreases (red arrow). In the example depicted, the loan has 3% amortisation in the first year and carries a 2% interest rate. In addition, the loan is characterised by a DSTI ratio of 25%, an LTI ratio of 5. These conditions result in a loan maturity of 26 years.

Figure A.1
Interdependence between LTI, DSTI, maturity and amortisation



Source: Fell, J., "Trade-offs in macroprudential policy", presentation at the Conference on Financial Stability, Banco de Portugal, 17 October 2017.

Interactions among borrower-based instruments

The assessment of interactions among borrower-based instruments requires a thorough understanding of the mechanism underlying the transmission of individual instruments, in order to identify overlaps and complementarities. In addition, interactions with other policies as well as other factors affecting the transmission and effectiveness of borrower-based instruments are very important as they may influence the choice of (and combinations of) instruments.

Micro and macroeconomic transmission of combinations of borrower-based instruments

A visual benefit-cost representation of the details of transmission channels helps to understand the potential for interaction among borrower-based measures (Table A.2).[42] Green cells refer to benefits, with bold fonts highlighting the strength of the instrument's transmission. While red-coloured cells represent outright costs of a policy instrument, orange-coloured cells refer to potential costs. In fact, there are cases for which the assessment of an effect as positive or negative strongly depends on the policymaker's objective. For example, a reduction in mortgage credit growth may be desirable for a policymaker whose objective is to counter an excessive expansion of the property market, but may be considered as a cost by a policymaker whose objective is to introduce borrower-based instruments early in the cycle to increase resilience (without hampering, for example, the stimulus from accommodative monetary policy).

[42] The information reported in the table is a qualitative representation of the main insights from the literature on the transmission of borrower-based instruments and from the experience gained by experts in the implementation of such instruments.

Table A.2

Transmission channels of borrower-based instruments

		LTV	LTI/DTI	LSTI/DSTI	Maturity Limits	Amortisation Requirements
Micro Impact	Borrower PD	Lowers incentives to strategic default in case of house price declines (PD↓)	Fosters sustainable level of debt/loan in relation to income (solvency) (PD↓)	Fosters borrowers' ability to meet regular payments (liquidity) (PD↓)	Mixed effect: i) shorter life of the loan (PD↓); ii) allows for loan renegotiation in case of distress (PD↓); iii) increases DSTI or residual payments (PD↑)	Mixed effect: i) shorter life of the loan (PD↓) ii) increases DSTI (PD↑)
	Lender PD	Improves quality of mtg loan portfolio	Improves quality of mtg loan portfolio		Mixed effect (it reflects the PD of the pool of borrowers)	Mixed effect (same as maturity limits)
	Lender LGD	Long-run effect on the stock of lending (LGD↓)	Indirect effect, depending on whether DTI/LTI limits ↓L and if this results in lower LTV (if LTV↓, then LGD↓)		Mixed effect: Effect on the residual LTV (LGD↓), but it depends on possibility of residual payments	Effect on the residual LTV of the loan (LGD↓)
Macro Impact	Mortgage credit growth	Constrains credit demand (flow effect). Weak effect in RRE upturns when V is growing	Constrains credit demand	Constrains credit demand	May affect the pace of loan repayments and may constrain credit demand (smaller loans)	May affect the pace of loan repayments and may constrain credit demand (smaller loans)
	RRE price growth	Could reduce or delay demand for housing			Potential effect through lower credit demand	
	Household indebtedness	Long-run effect on aggregate indebtedness (stock)	Long-run effect on aggregate indebtedness (stock)		Long-run effect (affects pace of loan repayments)	
	GDP	Short-run: reduction in residential investment due to decline in housing expenditure Short-run: consumption decline due to switch to saving for house pruchase and potential spillover to other sectors			Potential effect through lower credit demand	
		Long-run: i) lower leverage smoothens wealth effect on consumption in case of negative RRE price shocks; ii) as LTV absorbs savings, lower buffers lead to stronger consumption declines in case of adverse shock.	Long-run: lower debt or interest payments lead to smaller effect on consumption in case of adverse shocks			

Notes: The effect of borrower-based instruments on lenders (i.e. mortgage loan PD and LGD) arises in the medium term, when the effect of the instruments on flows has transmitted to the stock of outstanding mortgages.
Dark green = benefit of measure (stronger transmission)
Light green = benefit
Orange = potential cost
Red = cost

While income-based instruments (LTI/DTI and LSTI/DSTI) primarily foster household resilience, collateral-based instruments (LTV) predominantly improve lender resilience during real estate market downturns. LTI/DTI and LSTI/DSTI have a primary effect on borrower probability of default by promoting debt sustainability, also in the event of adverse shocks to income and interest rates. Meanwhile, LTV limits affect the loss given default of banks by limiting the amount of

the loan in relation to the value of the collateral. In the event of default, banks are more likely to suffer losses on high LTV lending given the lower level of borrower down payment that is used to protect the bank against low sale prices. LTV limits may also have a secondary effect on borrower default probability, by lowering their incentives to default in the event of negative house price shocks. In fact, by requiring a larger down payment, LTV limits reduce incentives for strategic defaults. However, this effect arises only in countries where strategic default is possible.

By acting on different risk parameters, income and collateral-based instruments are complementary in enhancing the quality of bank mortgage loan portfolios. By reducing the probability of borrower default and limiting losses in the event of default, the combined use of LTV and income-based limits contains lenders' expected losses in adverse circumstances, thereby promoting resilience.

The similarity of transmission channels and expected effects also suggests a certain degree of substitutability between LTI/DTI limits and LSTI/DSTI limits. However, the two instruments tackle different aspects of borrower resilience. While LTI/DTI instruments focus on enhancing borrower solvency by limiting the total amount of the loan/debt to income, LSTI/DSTI limits improve the ability of borrowers to service the regular repayments of their loan/debt (liquidity perspective). In addition, specific circumstances may warrant the joint implementation of the two instruments. For example, in the event of low interest rates, DSTI limits may become not binding even if the underlying DTI ratios are increasing. In these cases, combinations of DSTI and DTI limits may be desirable. Furthermore, in countries with a prevalence of variable rate loans, DSTI limits can be calibrated to account for potential increases in interest rates, with the aim of ensuring that borrower repayments continue even in the event of future increases in the repayment burden.

At the macro level, collateral and income-based measures may affect macroeconomic variables through their effect on credit demand (Box A.1). By imposing limits on the loan amount relative to the value of collateral (LTV) or to income (DTI/LTI), or limits on the loan repayment capacity (DSTI/LSTI), these instruments, all else being equal, could reduce or delay demand for housing, thereby dampening mortgage credit growth and the real estate cycle.[43] However, the effect of LTV limits on credit growth might be weaker in upturns of the real estate cycle when real estate prices are growing, thus allowing credit to rise.[44] This effect is stronger for existing homeowners who can avail of the increase in equity in their

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43 Evidence for Israel shows that the introduction of LTV limits (75% for first-time buyers, 70% for upgraders and 50% for investors with two or more homes) affected their purchasing choices. Investors (most affected by the policy change) purchased houses that were 22% less expensive, 14% smaller, 24% further form the centre and 18% in lower quality neighbourhoods (Tzur-Ilan, 2017). The IMF (2013) estimated that a 1 p.p. reduction in maximum LTV delivered a 0.4 p.p. reduction in credit growth in Canada.

44 There is mixed evidence on the effect of LTV, LTI/DTI and LSTI/DSTI limits on credit growth, house prices and GDP. Relying on a large panel of 56 countries, Richter et al. (2018) find that a 10 percentage point reduction in the maximum LTV ratio lowers output by about 1.1% after four years. Using a cross-regional global VAR model for South Korea, Kim et al. (2015) find that a 10 p.p. decrease in the LTV limit lowered the level of mortgage credit by about 2%, house prices by about 3%, and real GDP by 0.8% in the long run. Empirical evidence for Hong Kong finds no significant effect of LTV limits on the growth of mortgage credit and house prices (Ahuja and Nabar, 2011). Jácome and Mitra (2015) find that, in a panel of six countries, tighter LTV limits yield small effects on mortgage credit levels and non-significant effects on house prices.

existing property. On the other hand, income-based limits may have a stronger impact in terms of containing credit demand in relation to repayment capacity, by linking increases in mortgage credit to increases in borrower income or to borrower servicing capacity of the outstanding debt. The effect of both collateral and income-based limits on aggregate borrower indebtedness will only materialise in the long run: the magnitude of this effect will depend on the impact on lending flows over the years and on the maturity of the outstanding stock (the faster the stock matures, the faster the pass-through of the policy to the stock of loans).

Depending on the policymaker's objective, the short-run negative effect of collateral and income-based limits on macroeconomic variables such as credit, house prices and GDP may be perceived as a benefit or as a cost. In general, the strength of these effects depends on the calibration of the measures in relation to lending standards prior to the introduction of the measures. All else being equal, the reduction in residential investment due to the decline in housing expenditure can negatively affect output in the short term. In addition, the expenditure switch from consumption into savings for house purchase may entail spillovers to other sectors, thereby affecting economic activity. However, the short-term dampening impact of borrower-based tools on GDP and other macro variables may not always be perceived as a cost: under certain circumstances, borrower-based tools may be used to reduce risks stemming from excessive real estate market developments. In these cases, countering the real estate market's overheating may be an explicit policy objective of the macroprudential policymakers.

It is important to note that the strength of the effects in Table A.2 on macroeconomic variables depends on the instruments' design and calibration (Box 4 in the main text). In some cases, borrower-based measures are introduced in a non-binding manner and calibrated at the prevailing level of lending standards, resulting in a negligible impact on credit demand and macro variables. In other cases, measures are introduced with the aim of tightening lending standards and are calibrated to be binding. In such cases, their effect on economic variables is expected to be stronger. Lastly, the pace of introduction of the measures (phasing-in) and the specific design of the instruments (e.g. proportionate versus hard limits) also affect the strength of their transmission.

In the long run, when aiming to increase the resilience of the economy to adverse shocks, income-based measures seem better placed than collateral-based instruments to achieve this objective. As house prices decline during a downturn, LTV limits might further constrain credit growth for new borrowers.[45] In addition, by requiring higher down payments and therefore reducing borrower savings in the upturn, collateral-based instruments could reduce household buffers to absorb income shocks at aggregate level. Lastly, contrary to income-based measures, LTV limits are less effective at improving the sustainability of borrower debt as they do not link debt to repayment capacity, which could still lead to house price/debt spirals in the making of housing bubbles.

[45] For example, an 80% LTV limit with an initial property value of 100 implies a maximum loan amount equal to 80. If house prices decline to 90, with an unchanged 80% LTV limit, the maximum loan amount declines to 72.

However, due to their different effect on lender and borrower resilience, collateral and income-based instruments may also complement each other in improving overall resilience to different shocks. Loan-to-value ratios and amortisation requirements make lenders more resilient to house price adjustments. Conversely, LTI/DTI and LSTI/DSTI limits protect borrowers against income and interest rate shocks.[46]

Maturity and amortisation requirements are strongly interdependent and primarily contribute to increasing the resilience of borrowers and lenders. By lowering maturities or imposing full loan amortisation, both instruments reduce the probability that negative shocks will lead to borrower default, thereby indirectly fostering the resilience of lenders' mortgage loan portfolios. However, their effect on borrower and lender resilience can be mixed in the short term as the instruments require new borrowers to increase debt servicing above their desired level, which, all else being equal, increases their debt-service-to-income ratios and lowers their PDs. While these instruments are generally not introduced with the objective of containing credit growth and house prices, an effect on macroeconomic outcomes may be observed.

Maturity and amortisation requirements usefully complement DSTI and LSTI limits. Maturity and amortisation requirements are often used to accompany collateral and income-based measures, to reinforce their effects and prevent circumvention. For example, tighter maturity limits and faster amortisation schedules accelerate the transmission of collateral and income-based instruments (which act on the flow of new lending) to the outstanding stock of loans, as the latter will be repaid more quickly.

Country-specific factors and the influence of monetary, fiscal and microprudential policies

Country-specific features and other policies, including fiscal or monetary, may affect the transmission of borrower-based instruments and should be carefully acknowledged when choosing the best combination of instruments to address real estate-related vulnerabilities. In particular, some country specificities (legal framework, banking sector structure, etc.) might have a stronger effect on the transmission of one instrument compared to others, and this may have implications for the desirability of a specific combination of instruments. In addition, other policies (monetary, fiscal, urban planning, etc.) may interact with borrower-based instruments, reinforcing or dampening their effectiveness. Table A3 presents an overview of the country specificities and policies that may affect the transmission and effectiveness of borrower-based instruments on the key objective variables.

[46] See O'Brien and Ryan (2017).

Table A.3

Country characteristics and policies affecting the transmission of borrower-based instruments

		LTV	LTI/DTI	LSTI/DSTI	Maturity Limits	Amortisation Requirements
Micro Impact	Borrower PD	i) Legal framework (bankruptcy and foreclosure, non- vs full recourse loans); ii) fiscal policy (government support by state guarantees)	Definition of income	i) Interest rate fixation; ii) loan maturity; iii) legal framework (consumer credit); iv) definition of income	Amortisation practices	i) Maturity practices; ii) possibility of refinancing
		Availability of savings			DSTI/LSTI practices	
	Lender PD	Banks' business model (relative share of mtg loans in total assets)			Banks' business model (relative share of mtg loans in total assets)	
	Lender LGD	(i) Maturity of outstanding stock; (ii) pace of amortisation; (iii) legal framework (non- vs. full recourse loans, possibility of loan refinancing)	NA	NA	Amortisation practices	Maturity practices
Macro Impact	Mortgage credit growth	i) Distribution of borrowers' wealth; ii) accepted collateral (LTV vs. LTC); ii) Fiscal policy (property taxes)	i) Labor market (wages, contract types); ii) Fiscal policy (deductibility of mtg interest expenses and property taxes)	i) Monetary policy (becomes more binding with higher rates); ii) share of variable rate loans; iii) fiscal policy (deductibility of mtg interest expenses and property taxes)	NA	Initial amortisation practices and average loan maturities
		Share of cash buyers				
	RRE price growth	i) Distribution of borrowers' wealth; ii) fiscal policy (property taxes)	i) Distribution of borrower income; ii) fiscal policy (property taxes and deductibility of mtg interest expenses)		NA	
		i) Housing supply; ii) house price elasticity of demand; iii) urban planning regulation; iii) share of cash buyers				
	Household indebtedness	(i) Maturity of outstanding stock; (ii) proportion of mtg. loans to total household loans; iii) share of home ownership			Share of home ownership	
	GDP	i) Value added construction to GDP; ii) share of consumption; iii) monetary and fiscal space in downturns			NA	

Note: The table reports relevant country-specific features and policies affecting the transmission and the impact of borrower-based instruments on relevant objective variables. Rows: key indicators representing the potential policymaker's objectives. Columns: BB instruments.

The effect of certain country specificities on transmission channels and impact is common across instruments and has little influence on the choice of instrument combinations. On the micro side, a higher availability of savings by borrowers lowers their incentives to default, thereby reinforcing the effect of both collateral and income-based instruments on borrower probability of default. A greater availability of savings may also weaken the effect of both collateral and income-based instruments on macroeconomic variables, as borrowers may use their savings

to cover additional down payments. Furthermore, the impact of all borrower-based instruments on lender resilience can be expected to be stronger in countries where the banking sector relies heavily on mortgage lending as the main line of business. On the macroeconomic side, the impact of borrower-based instruments on mortgage credit growth and on house prices will be lower the greater the share of cash home buyers. In addition, the characteristics of housing supply, the price elasticity of demand and urban planning regulation determine the extent to which collateral and income-based instruments affect real estate prices: larger impacts on house prices can be expected in countries with slowly adapting housing supply and rigid urban planning regulation. The transmission of a tightening of borrower-based instruments to household indebtedness is strongly influenced by factors affecting the pass-through of borrower-based instruments to the stock of existing loans (e.g. the maturity of the outstanding stock of loans, the fraction of mortgage loans in total loans) and can be expected to be stronger in countries with a high share of home ownership. Lastly, factors such as the value added of the housing sector in GDP and the share of consumption in GDP affect the transmission of collateral and income-based instruments to output.

Other country-specific characteristics, such as specific features of a country's legal system, labour market, banking sector practices and characteristics of mortgage loan contracts, may affect the transmission channels and impact of individual instruments, and therefore may influence the desirability of combination of instruments. The characteristics of a country's bankruptcy and foreclosure procedures and the recourse characteristics of mortgage loans influence the ability of LTV policies to improve borrower resilience, thus calling for complementary income-based instruments. As explained earlier, LTV limits may help reduce borrower incentives to strategically default. Borrower incentives to default are lower (higher) in countries where foreclosure procedures are efficient (long and costly) and in countries where loans are full recourse[47]. In these cases, LTV limits might not help to lower borrower probability of default as incentives are already low.

The presence of government guarantees on mortgage loans or a strong mortgage insurance scheme may weaken the need for LTV limits. By shielding banks against heavy losses on mortgage loans, government guarantees de facto act as a backstop to the loss given default of banks, therefore reducing the inherent riskiness of the loan. If a country also has a well-structured and funded mortgage insurance scheme, this may also reduce losses to the banks in the event of widespread defaults.

Prevailing maturity and amortisation practices influence the effect of LTV limits on lender loss given default, by affecting the current LTV of the stock of loans. LTV limits are particularly needed in countries where loan maturities are long and loans are amortised slowly. In these cases, the average remaining loan amounts are high and the LTV on the outstanding stock of loans decreases slowly. In addition,

47 In this case, the lender has rights to additional assets beyond just the specified collateral to cover full repayment of a borrower's loan obligations.

the possibility of loan refinancing in some countries makes LTV limits less effective at reducing lender LGD.

Maturity limits and amortisation requirements are strongly interdependent as their respective calibration impacts their effectiveness. The effectiveness of maturity limits on borrower PD and lender LGD depends on prevailing loan amortisation practices (and the possibility of refinancing at maturity). Maturity limits are less effective in reducing borrower PD and lender LGD if accompanied by slow amortisation schedules, as the latter imply a slower decrease in the remaining loan amount and a higher probability that borrowers may be affected by shocks hampering their ability to repay the principal in full at loan maturity. In turn, the effect of amortisation requirements on borrower PD and lender LGD is reduced with long loan maturities, as these also imply slower loan repayments and a higher probability of adverse shocks affecting borrowers.

The transmission of both collateral and income-based instruments to mortgage credit growth and other macro variables is affected by the distribution of borrower income and wealth within a country. The impact of LTV limits on mortgage and real estate price dynamics is lower in countries with a significant share of high-wealth borrowers, as they can comfortably cover the additional down payment with own equity. On the other hand, income-based measures have a stronger contractionary effect on credit demand for high-income borrowers. While a 30% DSTI limit may be reasonable for a low/medium-income borrower, it may be excessively restrictive for a high-income borrower, who could afford even a 70% DSTI ratio and still have a flow of income more than sufficient to cover their living expenses.

Monetary policy strongly interacts with both the objectives and the transmission mechanism of borrower-based instruments. In most circumstances, monetary and macroprudential policies act in the same direction and complement each other. For example, economic upturns are usually associated with increasing inflationary pressures and increasing macroprudential risks related to the growth of lending and rising asset prices. In such an environment, monetary policy tightening fosters both price stability and financial stability by increasing the cost of lending. Tighter macroprudential policies, in turn, dampen lending growth and restrain inflationary pressures. However, in some circumstances, the objectives of monetary and macroprudential policies may conflict. For example, before the Global Financial Crisis, low inflation was accompanied by a build-up of imbalances within the financial system. After the crisis, a highly accommodative monetary policy was needed to contain deflationary pressures and bring inflation closer to its target level. Such policies, while necessary to achieve price stability, may have inflated asset prices and created incentives for search-for-yield.

The effectiveness of different borrower-based tools may depend on the prevailing inflationary environment and monetary policies. For example, in the current low interest rate environment, some borrowers may have become unaware of the interest rate risks related to their housing and other long-term loans . If widespread, such complacency may pose a macroprudential concern and call for macroprudential measures. DSTI limits, if calibrated using stressed interest rates,

could be an appropriate tool to help households service loan repayments and avoid contractions in consumption if interest rates were to rise substantially. Overall, therefore, macroprudential policy could facilitate monetary policy normalisation.

In turn, borrower-based instruments such as LTV and LTI/DTI limits may help in containing risks related to accommodative monetary policies. Income-based tools are more effective in curbing excessive lending whereas LTV limits are needed to protect borrowers and the financial system from potential house price reversals.

The interplay between borrower-based measures and fiscal policies is also important, but at the same time, less researched. Beneficial tax treatment of debt – such as the tax-deductibility of interest payments – may encourage leverage and contribute to systemic risk. Therefore, the need for macroprudential measures targeted at housing lending may be stronger in countries with generous tax incentives for borrowing and home ownership.

Monetary and fiscal policy stances particularly affect the transmission and effectiveness of income-based measures, as well as the need for their combined implementation. As the loan repayment burden increases with interest rates, LSTI and DSTI limits are particularly warranted in countries with a high share of variable rate loans and are more effective for improving borrower resilience when calibrated in order to account for potential increases in interest rates. D(L)TI limits might be more appropriate than D(L)STI limits in countries with high proportions of variable rate loans: while D(L)STI ratios change in the event of interest rate developments, D(L)TI limits remain constant. However, there may be cases warranting the use of combinations of D(L)TI and D(L)STI limits. For example, D(L)STI limits used in isolation may not be sufficient in an environment of low interest rates, if the underlying D(L)TI ratios are rising. Lastly, it is important to note that, in the presence of active maturity limits, a D(L)TI limit implies a D(L)STI limit, and vice-versa. Regarding fiscal policy, a generous fiscal treatment of mortgage interest expenses de facto increases borrower income, thereby partially countering the effect of income-based measures. Furthermore, high residential property taxes make LTV limits more binding, as they require borrowers to have additional own funds to pay the required duties (which normally cannot be financed with a loan). The fiscal regime also has an effect on the calibration of income-based measures that are based on gross income. As the relationship between gross and net income differs across jurisdictions, it is difficult to compare the effect of an LTI/DTI measure based on gross income across countries.

Considerations related to the circumvention, leakage, activation and communication of borrower-based instruments

The choice to implement specific combinations of borrower-based instruments also depends on a variety of additional considerations, such as the possibility of circumvention, the characteristics of the instruments in terms of cyclicality, the availability of relevant data and political considerations (Table A.4). Combinations of borrower-based instruments might be particularly desirable in cases where individual instruments may be easily circumvented. Also, the extent to which some instruments are binding differs according to the phases of the real estate cycle, thus posing issues of effectiveness and suggesting the need for additional, complementary measures. Moreover, while some instruments may be preferred to others based on their definitions and characteristics, their implementation might be hampered by the absence of relevant statistical information needed for their calibration and enforcement. Political considerations may play an important role in influencing the policymaker's choice of a specific combination of borrower-based instruments and its calibration, due to the effect that these instrument have on borrower access to the housing market. Lastly, the preferences of the policymaker may also affect the choices made around instrument selection and calibration.

All borrower-based instruments with the exception of DTI and DSTI limits are prone to circumvention through unsecured credit, when used in isolation. The recourse to additional, unsecured funding may severely hinder the strength of LTV, LTI, LSTI, maturity and amortisation requirements, which may not apply to loans not secured by real estate property.[48] In most jurisdictions, borrower-based tools apply only to a subset of financial institutions and loan products, which makes them vulnerable to regulatory arbitrage. On the other hand, DTI and DSTI limits constrain the total amount of a borrower's debt, thus also encompassing unsecured loans. For this reason, debt-based instruments (DTI/DSTI) should generally be preferred to their loan-based counterparts (LTI/LSTI). In addition, they may be useful complements to LTV limits if risks of circumvention or regulatory arbitrage exist.

[48] This crucially depends on the scope of applicability of borrower-based instruments. In countries where borrower-based instruments also apply to consumer loans, this problem is less relevant.

Table A.4

Other considerations influencing the choice of combinations of BB instruments

		LTV	LTI/DTI	LSTI/DSTI	Maturity Limits	Amortisation Requirements
Other considerations	Circumvention	Possible via: i) unsecured credit; ii) loans provided by other lenders; iii) lower standards for collateral valuation	Possible via: i) broad income definition; ii) unsecured credit (LTI only)	Possible via: i) unsecured credit (LSTI only); ii) lengthening of maturity; iii) interest-only loan	Possible via: i) unsecured credit; ii) by rolling over the loan	Possible via unsecured credit
	Cyclicality	Partially anti-cyclical: as V increases, the LTV (and LGD) on the stock of existing lending decreases, while it does not neutralise the financial acceleration mechanism for new lending	Is binding over the RRE cycle. Effective especially when house prices are rising faster than income		Is binding over the RRE cycle	
	Data		Availability of data on total debt may lead to choice of LTI/LSTI			
	Additional considerations	Does not ensure borrowers' resilience to income and interest rate shocks	i) Does not ensure resilience to shocks to interest rate; ii) leaves banks exposed to house price adjustments	Leaves banks exposed to house price adjustments	i) ceteris paribus, it increases the DSTI; ii) in case of repayment difficulties, maturity limits can be lengthened to prevent the default of borrowers; iii) ceteris paribus, it increases amortisation	i) ceteris paribus, it increases the DSTI
		Political sensitivity as it restricts access to credit to borrowers with low wealth/income; may be too lenient for low-income applicants and too strict for high-income borrowers			Ceteris paribus, it increases the DSTI	

However, data considerations might hamper the applicability of debt-based instruments (DTI and/or DSTI). These indicators actually require information on the entire stock of a borrower's debt exposure, which may involve several lenders. This information is available in countries with a comprehensive credit register. Otherwise, it might be difficult to retrieve.

Other risks of circumvention may stem from the definitions of income and collateral used by banks to compute the relevant ratios. LTV limits may be circumvented by inflating the collateral value of the property, as this would lower the actual LTV ratio.[49] Also, broader definitions of collateral (encompassing not only the financed property but also other assets such as financial collateral) may result in an underestimation of the LTV ratio, thereby allowing borrowers to receive larger loan

[49] See Montalvo and Raya (2018) for evidence of over-appraisals of housing collateral in Spain.

amounts than they would otherwise be allowed to. The strength of LTI/DTI limits, in turn, may be weakened by a broad definition of income.[50]

Due to their mutual possibility of circumvention, LSTI/DSTI limits, maturity and amortisation requirements are strongly interdependent and complement each other. On one hand, LSTI/DSTI limits may be ineffective in constraining credit demand if borrowers are allowed to compensate by obtaining longer loan maturities. In addition, the effect of limits to periodic loan/debt repayment may be weakened if borrowers can opt for slower amortisation schedules. On the other hand, the introduction of maturity and amortisation requirements may lead to excessive increases in DSTI/LSTI ratios in the absence of specific requirements limiting them.

Income-based instruments such as LTI/DTI and LSTI/DSTI usefully complement collateral-based instruments due to the potential procyclicality of the latter. A well-known shortcoming of the LTV limit is its potential pro-cyclicality: LTV limits may not sufficiently constrain the lending supply in expansionary phases of the real estate cycle, when house prices are rising.[51] On the other hand, income-based macroprudential instruments are less affected by this issue, as they limit borrowing in relation to income, which typically rises at a slower pace than house prices during housing market upturns. Therefore, they act as automatic stabilisers in expansionary phases of the real estate cycle. While maturity limits and amortisation requirements are also non-cyclical, their role in limiting the procyclicality of LTVs on credit growth is limited due to their weaker potential to constrain new lending.

Political considerations may influence the design of instrument combinations, as instrument affect low-income and high-income households differently. LTV limits are typically more binding for young and low-income households who have not yet accumulated much own financing or housing equity.[52] On the other hand, income-based limits may be unnecessarily stringent for high-income households, who could potentially service loans with very high DTI and DSTI ratios without incurring financial difficulties. How progressive the national tax regime is will also affect these measures. A DSTI measure in a country with a very progressive tax system could also be perceived as overly-constraining on low-income borrowers. DTI/DSTI measures may also constrain individuals with low annual income but high net worth. While the activation of both collateral and income-based instruments may be justified by the policymakers' objectives to preserve or improve the quality of bank mortgage loan portfolios or to increase borrower resilience, their design should also take into account potential unintended effects on specific segments of the borrowing population. For example, different calibrations of combinations of instruments may be considered, whereby LTV limits are less stringent for first-time buyers and DSTI limits are calibrated to become less tight for higher income borrowers. Also, the use of exemptions could alleviate this "one-size-does-not-fit-all" problem of borrower-based instruments.

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50 This may happen if a gross income concept is used (i.e. gross of taxes) or if minimum living expenses are not deducted from the income calculation.

51 This effect is different for first-time buyers compared to buyers who have already benefitted from increasing their equity in an existing property.

52 See Shaar (2018) for evidence for New Zealand.

B Combinations of capital instruments

Different capital measures often coexist as they have different goals and modalities of application. Therefore, understanding the interactions among capital measures is important to achieve a consistent approach to macroprudential policy by exploiting interactions between the different types of capital add-ons, thereby limiting the unintended effects.

This appendix discusses interactions among different macroprudential capital instruments (e.g. broad and specific macroprudential capital buffers) and from the use of capital requirements with different financial stability purposes (e.g. to address cyclical versus structural risks). Similarly to Appendix A, the analysis provides a comparative assessment of the transmission channels of different capital instruments and their impact on relevant micro and macro variables underlying the key policy objectives. It also points to country-specific features and the effect of other policies which could influence the transmission and effectiveness of the instruments. As different capital measures are often used with different policy objectives (i.e. cyclical risk versus structural risk), the analysis also covers the interactions stemming from the adoption of capital measures with different financial stability goals. This section draws on evidence stemming from the literature on the impact of bank capital requirements (e.g. BCBS, 2010; Noss and Toffano, 2014; Gross et al., 2016) and from the literature on interactions stemming from the regulatory environment and the design of instruments (ESRB, 2017).

Capital measures in the EU

While different capital-based measures coexist among EU countries, their simultaneous activation has been less common than for borrower-based measures (Table B.1). Here, the focus is on the situation preceding the coronavirus pandemic, where several capital-based measures were in place.[53]

Table B.1

Combined use of capital-based instruments in the EU

If one of these instruments is activated…		…one of these instruments is also activated in x% of cases			
		RW / LGD*	CCyB**	G-SII / O-SII***	SyRB****
RW / LGD	(5)	-	1	5	1
CCyB	(0)	0	-	0	0
G-SII / O-SII	(8)	0	1	-	1
SyRB	(6)	1	3	6	-

Source: ESRB and ECB calculations as of December 2018.
Note: In brackets: number of countries to have activated the instrument.
*Risk-weight / Loss given default.
**Countercyclical Capital Buffer (including countries where the CCyB has been announced but has not entered yet into force).
***Global Systemically Important Institution Buffer / Other Systemically Important Institution Buffer.
****Systemic Risk Buffer.

53 Several countries released macroprudential capital buffers during the coronavirus pandemic to support lending to the real economy; see ECB Financial Stability Review, May 2020.

Macroprudential capital measures available in the European Union under CRD V and CRR II[54] include a set of instruments with different modalities of application and goals. While broad capital measures such as the countercyclical capital buffer (CCyB) apply to all bank exposures, other capital measures such as risk weights (RWs), LGD floors or the systemic risk buffer (SyRB) are targeted to specific exposures. Furthermore, capital measures may address system-wide risks or institution-specific risks (O-SII and G-SII buffers).Capital-based measures may address cyclical risks (CCyB and SyRB) or structural risks (OSII and GSII buffers and SyRB[55]) (Table B.2).[56] Lastly, macroprudential capital measures differ in terms of the possibility to release them during downturns: while the CCyB and the SyRB may be released or lowered in periods of distress to facilitate the use of the underlying capital, other capital measures (OSII and GSII buffers) cannot be released.[57] Interactions among capital measures may emerge for several reasons related to the commonality of transmission channels, the different financial stability goals pursued and constraints related to regulation, which might affect the choice of specific instruments.

Table B.2

Capital measures in the EU

Measure	Legal basis	Goal: cyclical risks vs. structural risks	Applicability: System wide vs. institution-specific	Scope: broad (all exposures) vs. targeted (specific exposures)	Relevant amendments to CRD IV/CRR
CCyB	CRD 130, 135-140	Cyclical risk	System wide	Broad	-
O-SII / GSII buffer	CRD 131	Structural risk	Institution-specific	Broad	Cap is raised from 2% to 3% of total risk exposure amount GSII/OSII and SyRB buffers become additive (max. 5%)
SyRB	CRD 133 and 134	Cyclical and structural risk	System wide	Broad or targeted (to a subset of institution exposures)	GSII/OSII and SyRB buffers become additive (max. 5%)
Risk weight / LGD floors	CRR 458, 124, 164	Cyclical and structural risk	System wide or institution-specific	Targeted (can also be applied to geographic exposures within one jurisdiction)	

Source: ECB.

54 "CRD V" refers to Directive 2019/878 (EU) of the European Parliament and of the Council of 20 May 2019 amending the CRD IV (Directive 2013/36/EU of the European Parliament and of the Council of 26 June 2013 on access to the activity of credit institutions and the prudential supervision of credit institutions and investment firms), while "CRR II" refers to Regulation (EU) 2019/876 of the European Parliament and of the Council of 20 May 2019 amending the CRR (Regulation (EU) No 575/2013 of the European Parliament and of the Council of 26 June 2013 on prudential requirements for credit institutions and investment firms and amending Regulation (EU) No 648/2012).

55 Under the CRD V, the SyRB could be used to address structural as well as cyclical systemic risk not covered by the CCyB. Under the earlier CRD IV, the SyRB could only be used to address structural risks.

56 See ESRB (2014) for a discussion on the macroprudential framework in Europe.

57 See Couaillier et al. (2021).

First, the commonality of transmission channels among capital-based measures implies that different instruments interact with one another in relation to the impact on outcome variables and financial stability objectives. Different modalities of application of capital surcharges might operate more strongly via some transmission channels and produce different outcomes at the micro and macro level. Capital instruments include broad buffers on all exposures, buffers on specific exposures (e.g. sectoral buffers, geographic buffers) and risk weight policies. As such, capital requirements can be designed to shield the financial sector from specific pockets of risk within banks' portfolios. The ability to target specific risks by differentiating types of transactions makes the instruments more precise and potentially more effective while at the same time having a milder effect on the broader economy (Box B.1). Targeted or sectoral instruments can have positive side effects if banks reduce credit to those segments / activities / geographic areas in which credit developments are indeed excessive (intended effect), without affecting credit provision to other, less risky, segments (desirable effect). Moreover, targeted capital instruments can indirectly help curb existing vulnerabilities, such as high household indebtedness, when targeting mortgage exposures (see the next subsection).

Second, the EU framework comprises macroprudential capital measures with overlapping transmission channels to different policy objectives. Although all capital requirements imply higher loss absorption capacity, countercyclical capital buffers vary through the credit cycle: they should be built up in periods of increasing systemic risk from excessive credit growth and released upon a negative shock that may disrupt the flow of credit to the real economy, thereby limiting the impact of downturns on the financial system and on the broader economy. Meanwhile, structural buffers are of a more permanent nature and are intended to mitigate risks arising from excessive exposure concentration towards specific sectors, geographic areas or entities. Therefore, the use of capital measures benefits from the analysis of unintended spillovers from the adoption of measures that pursue different goals.

Lastly, a number of interactions among capital buffers emerge in the context of the EU regulatory framework. A commonly observed interaction between structural buffers in the EU involves the SyRB (when used to address the structural component of systemic risk) and the OSII buffer. In several member states where the overall OSII buffer cap and the cap on subsidiaries are considered too low, the SyRB has been activated to circumvent the OSII buffer cap at 2%. The revision of CRDIV/CRR considered this and raised the OSII buffer from 2% to 3% while additionally the sum of GSII/OSII buffers and SyRB buffer to 5%.

The remainder of this appendix focuses on interactions emerging from the transmission channels of different capital instruments and from the use of capital with different financial stability purposes.

Interactions among capital measures

Transmission channels

This section presents a comparative assessment of the transmission of three types of capital measures, namely broad capital buffers, sectoral buffers and risk weight surcharges, highlighting the interactions among these instruments.[58] The framework distinguishes between the impact on individual banks and borrowers, and the impact on macro variables such as mortgage credit growth, house price growth, household indebtedness and, more broadly, GDP. Similar to Appendix A, the transmission of instruments to borrowers and lenders is assessed through the effect on their probability of default (for individual households and for portfolios of bank loans) and loss-given-default on bank mortgage loan portfolios. While other effects on borrowers (e.g. expenditure-shifting effects) and lenders (changes in loan pricing and quantities, changes in risk pricing) are not explicitly mentioned in the micro-block of the framework, they are reflected in the transmission of the instruments to macro indicators.

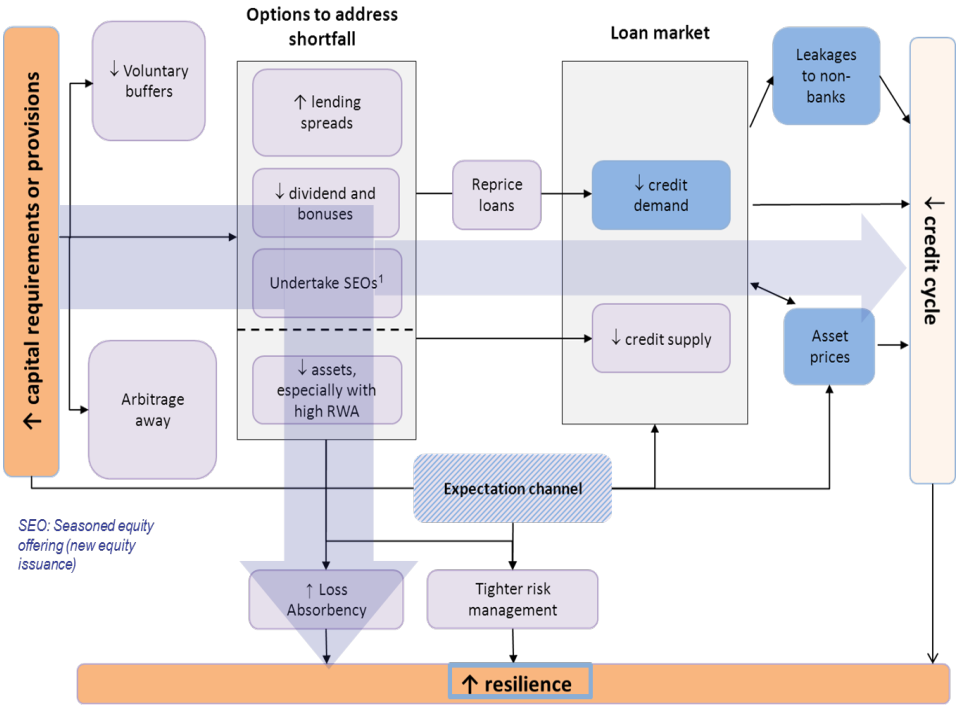
Capital measures require banks to hold additional capital, thereby increasing the resilience of the affected institutions. Depending on how banks meet their capital requirements (through voluntary capital buffers, equity issuance, de-leveraging, etc.), capital measures may also affect the credit cycle (Figure B.1).[59] While borrower-based measures act as quantity constraints on credit volume, capital-based instruments can be seen as price-based measures affecting the average cost of lending.

[58] We focus on these modalities of capital-based measures since their transmission channels are slightly different, influencing the micro and macro impact of each type of capital instrument.

[59] See CGFS (2012) for a discussion on the transmission channels of capital measures and ESRB (2018) for a discussion on the macroeconomic effect of capital buffers.

Figure B.1

Transmission channels of higher capital requirements



Source: CGFS (2012).

The instrument design, calibration and several other factors (for instance, the initial capital position of banks) may affect the strength of the transmission to micro and macro variables (Tables B.3 and B.4). In addition to the instrument's calibration, the strength of the transmission of capital-based measures also depends on whether a measure is phased in or becomes effective immediately and on whether other capital-based measures are already in place or being phased in, given implicit and explicit interactions between structural, cyclical and targeted capital measures. The strength of the transmission of higher capital requirements also depends on the extent of the voluntary buffers held by banks above minimum requirements and whether banks decide to maintain these voluntary buffers in the event of a capital increase. Capital measures have a limited micro and macro impact when banks already hold excess capital and do not need to take any further action in order to meet additional buffers.[60] However, in these cases, capital measures might still have important signalling effects (e.g. increasing risk awareness).[61] Conversely, when banks do not hold large voluntary buffers, they need to either raise equity, optimise risk weights or deleverage in order to meet the capital requirements, with different implications from a micro and macro perspective. Furthermore, other non-capital measures in place, such as borrower-based measures, may also interact with

60 Banks may, however, decide to preserve their voluntary buffers above requirements.

61 Nevertheless, against the backdrop of the uncertain determinants of voluntary buffers, capital measures might still increase bank resilience in adverse scenarios by ensuring that capital remains in banks as long as it is needed.

capital buffers and in doing so have implications on the way they transmit to the macroeconomy.

Table B.3
Transmission channels of capital-based instruments

Micro impact

Variables	Broad capital measures	Targeted measures (RW/LGD)	Sectoral buffers (SyRB)*
Borrower PD	No effect on individual borrower PD	No effect on individual borrower PD	No effect on individual borrower PD
Lender PD	Improvement	Improvement	Improvement
Lender LGD	No effect	No effect	No effect

Source: ECB.
Note: *Sectoral buffer on real estate exposures (cyclical or structural).

From a micro perspective (Table B.3), all capital-based measures increase the loss-absorbing capacity of banks, which reduces the probability of bank default. Each of the different capital-based instruments can lead to increased resilience in the banking sector but the magnitude of the increase in resilience will vary according to the instrument used and the level of calibration and also banks' strategies to operate with voluntary capital buffers.

At the micro and macro level, the main difference across capital-based measures lies in the potential for portfolio rebalancing and related effects. An increase in risk weights for specific exposures could lead a bank to shift activity to assets with lower risk weights such as mortgages (see, for example, Bridges et al., 2014, Noss and Toffano, 2014 and Meeks, 2014).[62] However, the magnitude of this effect will vary according to many factors, including a bank's business model and overall strategy, and it is difficult to determine the overall effect a priori. When considering capital measures to directly address risks from mortgage lending (i.e. risk weights of sectoral buffers), the incentive to rebalance may be more limited. This is because risk weights on mortgages tend to be lower than for other categories of loans.[63]

At the macro level (Table B.4), the transmission of capital instruments primarily depends on the channels through which banks decide to comply with higher capital requirements. If banks decide to raise equity by retaining profits, the channel operates through higher lending spreads that reduce overall credit demand. Banks may also decide to deleverage and to reduce lending, with stronger repercussions on credit supply. Banks might opt to reduce assets carrying higher risk weights, such as lending to non-financial corporations, in order to decrease risk-weighted assets, which may result in a lower provision of financing to the productive

62 For example, Bridges et al. (2014) show that, based on an empirical study, after one year secured household lending decreases by -0.94 p.p. (+0.18 after three years) in response to a 1 p.p. increase in the capital ratio, while lending to private non-financial corporations (PNFCs) decreases by -3.86 p.p. (-0.67 after three years). These results are for the United Kingdom and the authors use panel data regressions. Noss and Toffano (2014) find that in the long run secured household lending growth falls by -0.18 p.p. after a 0.5 p.p. increase in the capital ratio, whereas lending to PNFCs falls by -0.5 p.p. The study by Meeks (2014) concludes that a 1 p.p. increase in the capital ratio is associated with a decline of -0.19 p.p. in secured household lending growth, which compares with a fall of -4 p.p. in lending to PNFCs three years later.

63 A sectoral capital buffer on mortgage loans or certain risk weight policies could lead to portfolio rebalancing within the mortgage portfolio, with potential effects on the PD and LGD of the portfolio.

sector.[64] Lastly, portfolio rebalancing could ultimately lead to changes in the risk profile of the bank and affect its overall PD, if it rebalances towards assets with low risk weights, as long as these truly reflect the inherent asset riskiness.

Table B.4

Transmission channels of capital-based instruments

Macro impact

Variables	Broad capital measures	Targeted measures (RW/LGD)	Sectoral buffers (SyRB)
Mortgage credit growth*	Potential positive effect: it might lead to higher mortgage lending as it normally has relatively low risk weights (although the impact may depend on the effects of other measures in place, such as BB measures)	Negative effect if higher RWs target RRE exposures	Negative effect if mortgage exposures are targeted
NFC credit growth*	Negative effect: it might lead to lower NFC lending as it normally has relatively high risk weights	Negative effect if higher RWs target CRE exposures	Negative effect on credit to the NFC credit segments targeted by the measure
Overall credit growth*	Negative effect: the magnitude of the impact depends on the effect on mortgage and NFC lending, although the literature finds a negative reduction in total credit	Mixed effects Depends on the portfolio adjustment effect	Mixed effect Depends on the portfolio adjustment effect
RE price growth	Potential positive effect if broad capital measures lead to higher mortgage lending	Potential negative effect if higher RWs target RRE exposures	Potential negative effect if sectoral buffers target RRE exposures
Household indebtedness	Uncertain, potentially positive effect (given the potential positive impact on mortgage lending)	Potential negative effect (depending on impact on mortgage lending)	Potential negative effect (depending on impact on mortgage lending)
GDP growth	Negative effect in the transition phase via credit channel In steady state, the impact on GDP may be positive (via risk reduction channel)	Potential negative effect (depending on impact on mortgage lending and RE prices) in the transition phase	Potential negative effect in the transition phase (magnitude of the impact might depend on the exposures that are being targeted by the sectoral buffers)
GDP volatility	Reduces volatility: higher capital requirements smooth the impact of shocks	Reduces volatility: higher capital requirements smooth the impact of shocks	Reduces volatility: higher capital requirements smooth the impact of shocks

Source: ECB.
Note: *Adjustment occurs through price channel.

Empirical evidence shows that overall credit growth may decrease following an increase in broad capital buffers, although the magnitude of the reduction will depend on the balance sheet composition of banks and on the defined level of the capital buffer. The literature finds that an increase in capital requirements usually leads to higher lending spreads in the short term, which limits growth in credit to households and non-financial corporations.[65] These findings are common across the literature, regardless of the modelling techniques, which may also vary considerably with respect to the hypothesis upon which the models are built (ESRB, 2017). Meanwhile, overall credit growth is found to be negative or stable

64 The findings of Clerc et al. (2015) provide support for the portfolio adjustment effect towards assets with lower risk weights. In their modelling framework, an increase in capital requirements of 1 p.p. does not restrain demand for mortgage loans through the price channel. Given the lower risk weight for mortgage loans compared to loans for NFCs, the cost of equity is less important for the increase in mortgage rates. For NFC lending, the impact is the opposite, as it is associated with higher risk weights, implying that the costs of higher capital ratios feed through to NFC loan rates and dampen demand for NFC credit.

65 See Tarsila S. Afanasieff, Fabiana L. C. A. Carvalho, Eduardo C. de Castro, Rodrigo L. P. Coelho and Jaime Gregório (2015), "Implementing Loan-to-Value Ratios: The Case of Auto Loans in Brazil (2010-11)", Banco Central do Brasil, *Working Paper* 380, March.

in response to sectoral buffers, depending also on the balance sheet composition of banks.

Role of bank- and country-specific features and interaction with other policies

Bank- and country-specific features as well as other policies affect the transmission of instruments and represent important considerations when selecting combinations of capital-based instruments. Bank-specific features include the type of adjustment to new capital requirements in accordance with the policies and structural characteristics of individual banks. Examples of country-specific features include the structure and degree of competition in different lending markets. Lastly, other policies such as monetary, as well as microprudential and resolution condition, affect the calibration of capital-based macroprudential instruments and their transmission to the economy.

Alternative options for meeting the regulatory demand for higher buffers have different implications for the micro and macro transmission of capital-based measures and may be influenced by bank-specific characteristics. As discussed earlier, banks can meet the demand for higher buffers either by (i) generating capital internally; (ii) raising capital by issuing equity; (iii) asset de-leveraging; (iv) portfolio rebalancing towards less risky assets (Beyer et al., 2017). Alternatively, banks can circumvent the measure by optimising risk weights. The possibility to raise additional equity is conditioned by bank-specific factors such as the level of voluntary capital buffers, the bank's business model, overall profitability and ability to retain profits, market power and ability to transfer costs to customers, and overall market conditions. The asset composition affects the potential for rebalancing given that a bank which is primarily a mortgage lender has less scope to rebalance compared to a diversified lender. The choice of rebalancing also depends on whether the capital measure targets only a subset of exposures, in which case the measure will have a stronger effect on banks that are more exposed to the specific exposures targeted by the measure. The shareholder structure (and the ability to raise additional capital) further influences whether a bank decides to rebalance. If an individual bank has enough voluntary capital buffers to meet the new capital requirement, it may not see it as necessary to rebalance unless it chooses to maintain the same level of voluntary buffer. More broadly, rebalancing incentives may be affected by the presence of other (sector-specific) macroprudential instruments such as borrower-based measures or risk weight limits for mortgage exposures.

The transmission of higher capital requirements and the response among banks are also influenced by country-specific characteristics such as the structure and degree of competition in different lending markets and the degree to which firms rely on bank funding. In competitive markets, the pass-through of higher capital costs to customers (via increased credit spreads) may be weaker, which may impair the ability of the banking sector to generate additional capital internally. Competitive pressures might also limit the de-leveraging options for

banks, implying they would simply operate under thinner margins and lower profitability. The choice of portfolio rebalancing may also be affected by the degree of reliance of the non-financial private sector on bank funding (e.g. a stronger rebalancing in European countries compared to the United States or the United Kingdom given the higher proportion of bank-based financing) as well as sector-specific characteristics (e.g. functioning rental markets and reliance on bank financing for residential real estate).

The transmission of capital measures may also be influenced by monetary policy. On the one hand, the compression of risk premia, positive effects on asset valuations and the positive impact on the business cycle resulting from monetary policy accommodation should make it easier for banks to raise capital from markets or generate it internally. On the other hand, tighter margins and the compression of net interest income make it more difficult for banks to generate capital internally and meet new requirements. Furthermore, lower margins might induce bank risk-taking, thereby making banks riskier overall. The broad impact of monetary policy on the transmission of capital measures also depends on bank-specific and country-specific conditions that determine the relative strength of the different effects at play. For example, in less competitive markets, monetary policy accommodation might have a limited impact on the compression of margins and risk-taking. Therefore, all else being equal, monetary policy accommodation might facilitate the accumulation of buffers in less competitive banking systems.

Microprudential policies can reinforce or offset macroprudential capital requirements depending on the phase in the credit cycle. During upturns, the potential system-wide tightening of capital requirements by macroprudential authorities works in tandem with the microprudential requirements to support bank resilience. During downturns however, when systemic risks materialise, the macroprudential release of capital buffers may be perceived as a reduction of bank resilience from a microprudential perspective. Thus, a coordinated approach between macroprudential authorities and microprudential authorities is necessary, and also to avoid both double-counting and an underestimation of specific risks.

Overlapping requirements, such as the leverage ratio requirement on top of the requirements set out in the European recovery and resolution framework (BRRD, SRM), can influence the implementation of macroprudential capital requirements. Specifically, the same unit of capital can be counted towards MREL, leverage ratio requirements and also capital buffers. As the former requirement is continuous, the potential release of capital buffers when systemic risks materialise may not be feasible if the institution is in a binding capital context.[66]

Lastly, the effect of fiscal policies should be considered as they could impact the structure of bank balance sheets. For example, mortgage interest rate deductibility may boost mortgage credit demand, which could warrant macroprudential intervention on bank capital.

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[66] See ESRB, 2021, “Report of the Analytical Task Force on the overlap between capital buffers and minimum requirements”, December.

Instrument circumvention and leakages

Instrument circumvention and leakages are important additional considerations when implementing combinations of capital-based measures. Some of these are common across instruments, while others are specific to the different types of measures.

Stricter regulatory capital requirements could lead to a shift from domestic banks to either non-bank or foreign bank/direct cross-border bank financing. Non-banks that are not subject to these requirements may enjoy a comparative advantage as the non-financial private sector could substitute bank funding with market debt financing (CGFS, 2012). The lending of foreign bank branches not subject to requirements (or direct cross-border lending in the absence of reciprocation) can also increase on similar grounds (this is particularly the case for broad capital measures set on domestic exposures, such as the CCyB and the SyRB). This is supported by empirical evidence pointing to the existence of regulatory leakages from foreign branches and affiliated subsidiaries (Ayar et al., 2012; Ayar et al., 2014).

Sectoral risk weight policies and capital buffers, while more effective in addressing risks in specific portfolios and/or geographic areas, can also be subject to leakages and circumvention. In general, a targeted measure is effective only when defaults are expected to remain contained in specific sectors/portfolios.[67] In the case of sectoral policies, the potential for circumvention via direct cross-border and foreign branch lending implies a need for reciprocation, as was the case for broader capital measures.[68] They may also have distortionary effects by shifting lending towards riskier sectors which also offer more profitable opportunities.

Lastly, banks can also choose to re-optimise their internal models in response to stricter capital requirements.[69] Broad capital buffers could lead to an incentive to generate lower risk-weighted assets across all portfolios. While monitoring re-optimisation is difficult, a complementary leverage ratio could be introduced, as the empirical evidence suggests it could improve on risk weight policies in supporting bank resilience (Aikman et al., 2014).

Use of capital buffers with different financial stability goals

This section discusses the implications of using capital buffers with different financial stability goals. It focuses on (i) interactions between broad capital instruments to address either cyclical or structural risks and (ii) interactions between broad and targeted (sectoral) capital instruments.

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67 This might not be the case for real estate markets, which in adverse scenarios can have significant spillovers across sectors within one economy.

68 C. Lim, F. Columba, A. Costa, P. Kongsamut, A. Otani, M. Saiyid, T. Wezel, and X. Wu (2011), "Macroprudential policy: what instruments and how to use them – Lessons from Country Experiences", International Monetary Fund, WP/11/238.

69 See also see ECB Banking Supervision, 2021, Project Report "Targeted Review of Internal Models".

Interactions between broad capital instruments to address either cyclical or structural risks

The current regulatory framework distinguishes between broad measures to address cyclical versus structural systemic risks. In the current European macroprudential framework, the CCyB is the main instrument foreseen to target broad cyclical systemic risks. The SyRB may be used to address both broad and sectoral cyclical and structural risks. Lastly, risks specific to systemic banks can be addressed by buffers for significant institutions (e.g. OSII and GSII buffers).

Irrespective of the above distinction, overlapping transmission channels imply that the various types of broad capital instruments can reinforce or counteract each other. An important determinant of this type of interaction is the phase in the credit cycle when activated. Specifically, during the expansionary phase of the credit cycle, cyclical and structural buffers should be regarded as strategic complements as they reinforce each other by simultaneously building the resilience of the financial system and attempting to tame the cycle (ESRB, 2017).

Another dimension of interaction is the reciprocal impact of one instrument on the risks targeted by the other. Introducing a structural buffer during an expansionary phase of the cycle may help tame the build-up of cyclical systemic risks. Therefore, while the calibration of structural buffers would remain linked to structural risks, the timing of activation could impact the developments in cyclical risks. Conversely, an increase in structural buffers during the contractionary phase (when risks manifest) should be carefully considered so as not to reinforce a potential credit crunch. Moreover, the activation of the CCyB can lead to gradual changes in the structure of the financial system. For example, the subsequent potential migration of credit provision to non-banks could result in financial structures capable of amplifying shocks in the medium term. Consequently, a potential policy response is the adoption of structural buffers to increase the resilience of banks (e.g. Luxembourg enhanced OSII methodology to address risks from interconnectedness between banks and non-banks). More broadly, the research indicates that, while countercyclical instruments can insulate banks from sector-wide fluctuations and mitigate the impact of aggregate shocks on investment, their unintended effect is that banks take more correlated risk exposures, which in turn increases the structural component of systemic risk (Horvath and Wagner, 2017).[70]

[70] In the model of Horvath and Wagner (2017), a CCyB reduces a bank's expected costs from exposures to aggregate risk relative to bank-specific exposures. A bank that invests in bank-specific activities faces the risk of receiving a negative bank-specific shock. When the CCyB is high, costs of the exposure to risks related to bank-specific activities increase. This boosts bank incentives to invest in common exposures. This, in turn, increases correlations of risks and exacerbates the problem of excessive interconnectedness in the financial system (i.e. the structural dimension of systemic risk). Taken together, procyclicality cannot be separated from the structural (cross-sectional) dimension of systemic risk and due to their interactions it is not possible to address the two dimensions of systemic risk in isolation.

Interactions between broad and targeted (sectoral) capital instruments

The preference for a targeted (sectoral) capital instrument over a broad-based one depends, among other factors, on how risks build up and materialise across credit portfolios. While broad measures could be used to increase resilience to system-wide vulnerabilities that have the potential to generate losses across different bank exposures in adverse scenarios, a targeted instrument is appropriate if losses resulting from the materialisation of risks remain contained to the targeted sectors (Box B.1). Specifically, sectoral RW policies can also be an adequate instrument to deal with risk-taking incentives stemming from a specific sector (NFC or HH).[71] Consequently, a sequencing of first activating targeted measures and possibly following up with broader measures could be appropriate. This would ensure that sectoral risks are addressed first and if vulnerabilities expand beyond the specific sector, broader instruments can complement them.[72]

Box 5

Impact of broad-based vs. sectoral capital buffers on macroeconomic variables – evidence from the 3D DSGE model

In light of the provisions introduced by the CRD V, according to which the SyRB can be used to address sectoral imbalances, this box presents the key findings of an exercise exploring the relative features of broad-based permanent (BCR) and broad-based cyclical (CCyB) capital buffers versus their sectoral application in enhancing the resilience of banks and taming the procyclicality of credit. The analysis is based on an extended version of the "3D" Dynamic Stochastic General Equilibrium (DSGE) model outlined in Boxes A.1 and B.1. This box presents two exercises: first, a steady state analysis illustrating the long-term effects of increasing the BCR versus the sector-specific minimum capital requirement. Second, an analysis of the responses of key macroeconomic variables to a shock when either the CCyB or a sectoral version, which we name SCCyB, is activated.

In this extension of the model, capital requirements are imposed by a macroprudential authority according to a policy rule that includes broad fixed capital requirements (BCR), a broad-based countercyclical capital requirement (CCyB) as well as fixed sectoral capital requirements (SCR) and a sectoral countercyclical capital buffer (SCCyB). The BCR applies to all banks in the model, while the SCR applies only to banks lending to a specific sector. The broad-based CCyB rule implies that capital requirements (the amount of equity required per unit of loans) are increased (decreased) for all banks depending on positive (negative) deviations of total credit from the steady state. The SCCyB rule instead implies that capital requirements for bank lending to households (firms) increase when credit to households (firms) deviates positively from the steady state, and decrease for negative deviations of sectoral credit from the steady state.[73]

71 ESRB (2019), "Report on Macroprudential approaches to non-performing loans", January.

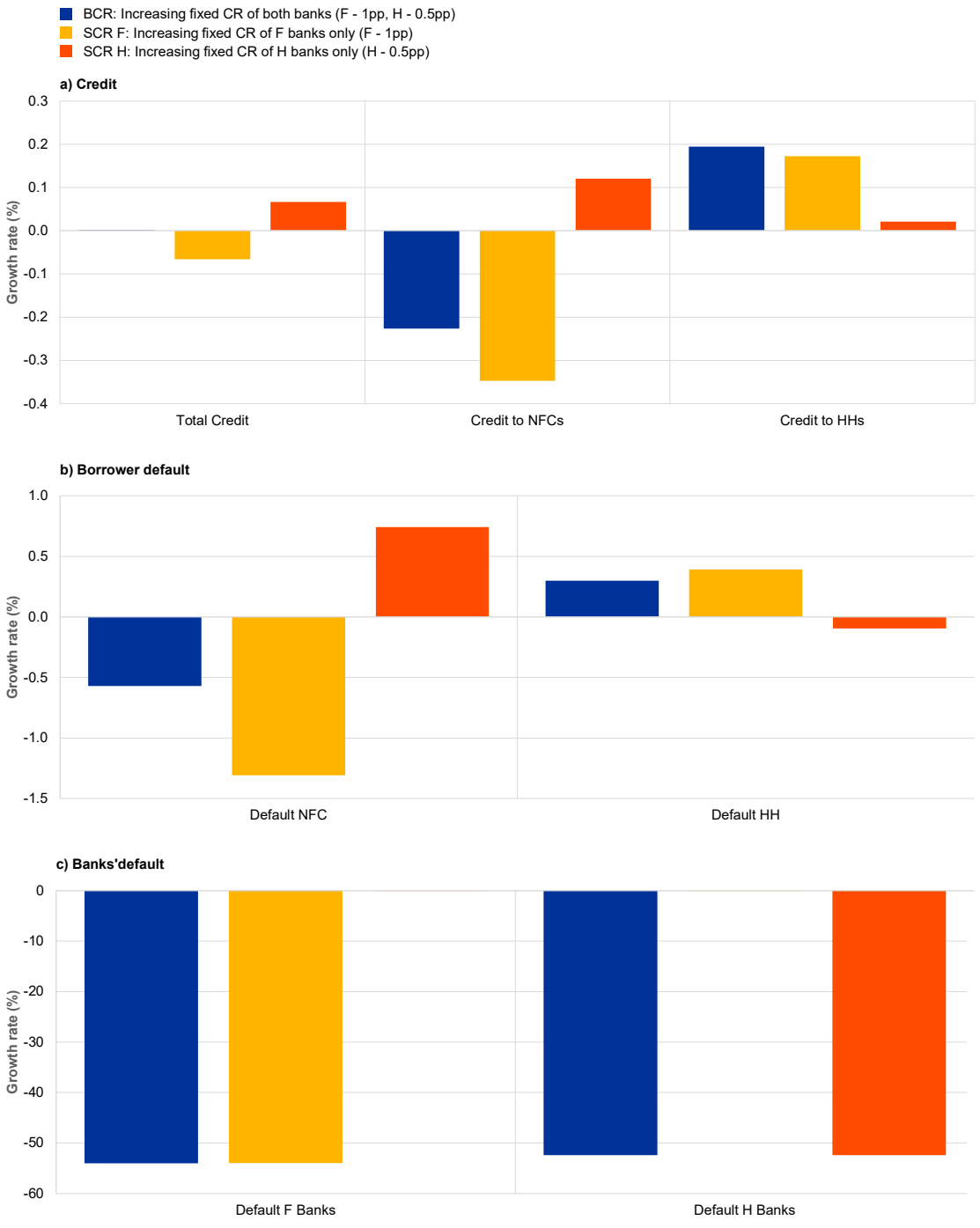
72 "The sectoral countercyclical capital buffer as a potential macroprudential instrument", Financial Stability Review 2018, Nationale Bank van België/Banque Nationale de Belgique.

73 The analysis has been conducted on the assumption that the capital ratios are binding, i.e. that the voluntary buffers held are maintained throughout the policy exercises.

A broad-based permanent buffer decreases the defaults of both types of bank, while a SCR only decreases the default rate of the bank addressed by the policy (Chart A). The introduction of a BCR leaves total credit almost unchanged. This results from the fact that the balance sheet channel is stronger for banks lending to firms so the overall effect on NFC credit is negative. Conversely, the risk reduction channel is stronger for banks lending to households, thus implying that the overall effect on credit to households is positive. When comparing the growth rates of credit to firms and to households (BCR, red bars) with the case when only the capital requirements of banks lending to firms are increased (dark blue bars), the balance sheet channel dominates for such banks so that credit to corporates decreases. Meanwhile, credit to households increases because banks specialising in mortgage credit benefit from the risk reduction channel following the decrease in defaults in the targeted banking sector, without having to increase equity. This, in turn, allows them to increase the supply of credit. This provides some evidence for potential spillovers and leakages to untargeted sectors, which are found to increase sectoral credit in the untargeted sector and shift the financial risk towards higher borrower default in that sector.

Chart A

Steady state effect of increasing broad capital requirements (BCS) and sectoral capital requirements (SCR)



Note: Such steady state impacts should be interpreted as the long-term impacts of the policy, rather than short-term effects. Therefore, this analysis does not allow us to examine the short-term costs of activating different macroprudential instruments.

To assess the relative features of the CCyB versus the SCCyB, we assess the responses of key macroeconomic variables to a shock resulting in an increase in mortgage credit to the household sector when either the CCyB or the SCCyB is activated. The considered housing preference shock increases household demand for loans for housing purposes, leading to an increase in credit to households (Chart B). As households substitute expenditure in consumption goods with expenditure in housing (given the shock), the demand for consumption goods declines. The resulting drop in demand for firms' products leads them to cut capital investment and curtail the demand for corporate credit. Overall, the rise in credit to households dominates and total credit surges.

The impulse responses of a CCyB versus SCCyB reflect a diverse impact of the two macroprudential rules on banks' capital requirements. Since the deviation of total credit from steady state is always positive, the Basel III CCyB implies an additional positive capital requirement for both types of bank. This reduces the default rates of both banks lending to households and banks lending to corporates, and the banking sector's average default rate. Compared to the broad-based rule, the SCCyB has a heterogeneous impact on the resilience of the two types of banks, as measured by their default rate. Given that the deviation of mortgage credit following the housing preference shock is positive and larger than that of total credit, the SCCyB imposes higher capital requirements on banks lending to households compared to the Basel III CCyB. As a consequence, the decline in these banks' default rate is also relatively stronger. Conversely, as the demand for corporate credit declines as a consequence of the shock, the SCCyB leads to a decrease in the capital requirement for corporate exposures. This causes banks lending to corporates to become de facto riskier because they are less capitalised and explains their initial higher default rate. Overall, the enhanced resilience of banks lending to households dominates and the average bank defaults declines by more than under the broad-based CCyB rule.

These results show that, in the policy exercise considered, a SCCyB appears to be more effective than a CCyB in curbing sectoral credit cycles. Due to the increase in total credit compared to the steady state, the broad-based CCyB rule implies a positive additional capital requirement for all banks in the model. Conversely, the SCCyB rule reacts to the increase in credit to households, resulting in an increase in capital requirements affecting only banks specialising in lending to households. Because of its targeted nature, the credit-specific increase (decrease) in the household (corporate) sector is lower compared to the broad-based policy rule and, in this regard, the SCCyB has a smoothing effect across sectors.

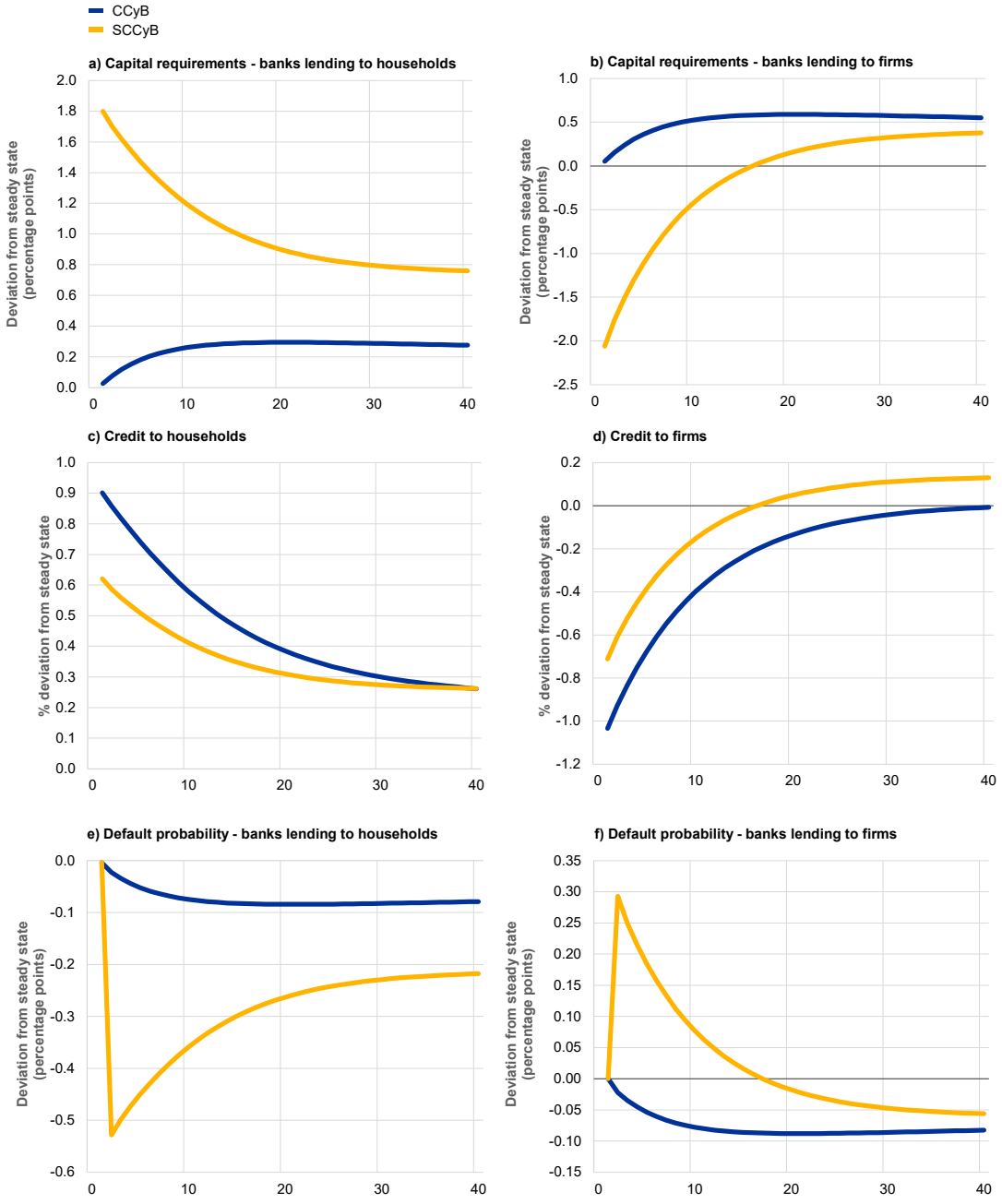
In order to increase the resilience of the banking sector as a whole during periods of excess aggregate credit growth, the model confirms that the broad-based CCyB should remain the first line of defence. However, in situations where imbalances are confined to specific credit segments only or associated systemic risks arise amid low overall nominal growth, sectoral capital buffers could allow macroprudential authorities to address the identified risks in a more effective and efficient manner, without bearing the risk of a generalised reduction in economic activity. The model-based policy exercise indicates that, in case of confined imbalances, a sectoral capital buffer could prove to be more effective than its broad-based equivalent in strengthening bank resilience towards the target sector and in mitigating sectoral credit imbalances.

Chart B

Impulse responses of model variables to a housing preference shock

Comparison of CCyB and SCCyB policy rules

(X-axis: quarters after the shock; Y-axis: % deviation from steady state (for capital requirements and bank defaults p.p. deviation; for average default banks annualised p.p. deviation)



Note: Impulse responses following a positive shock in household housing preferences calibrated to generate a 1 percentage point increase in house prices.

Important interactions arise between broad capital measures and measures targeting risks in the real estate sector. First, if real estate risks have the potential to spill over to the broader economy despite targeted measures, broader buffers may be an appropriate complementary choice. Second, the possible rebalancing towards (generally lower risk-weighted) real estate assets resulting from the application of a broad buffer may require a complementary targeted measure.

In the first case, the likelihood of spillovers of real estate vulnerabilities would be an important determinant of the need for complementary broad-based measures. In several countries default rates on mortgage loans were relatively low when real estate downturns materialised, while credit risk emerged on other bank exposures. As households maintain debt service by reducing consumption and real estate companies by reducing investment, real estate vulnerabilities are likely to spill over to the broader economy. In such a situation, a broad capital buffer might be an appropriate policy response to increase resilience of banks to the spillovers of real estate downturn.

In the second case, the introduction of a broad capital buffer may exacerbate certain vulnerabilities in real estate portfolios via the portfolio rebalancing effect. As discussed in the previous section, portfolio rebalancing towards low risk-weight mortgages could lead to the acceleration of mortgage lending, which could further feed into house prices and the level of household indebtedness. Based on the assessment of its effectiveness throughout an entire financial cycle, Benes et al. (2016) show that the application of a broad CCyB is effective in reducing credit growth over an expansion phase of the credit cycle, but it is not enough to counteract the relationship between the credit and the real estate cycles. In addition, their study concludes that a broad CCyB is not efficient in reducing credit growth when it occurs over a period of growth in real house prices, and it has a very mild macroeconomic impact, since consumption and credit growth are hardly affected. As such, systemic risk associated with real estate sector dynamics continues to expand even in the presence of a broad CCyB. While there is uncertainty on the size of these effects (see Bridges et al., 2014; Meeks, 2014; and Noss and Toffano, 2014, among others), this suggests that broad capital buffers should be complemented by targeted measures addressing real estate vulnerabilities when these are a concern.

One way of counteracting the rebalancing effect would be to introduce complementary higher risk weights on mortgage exposure or to apply a sectoral SyRB/CCyB.[74] Despite there being some conceptual equivalence among these alternatives (since they all help to improve bank capital ratios), there are important differences with respect to their transmission mechanisms that should be accounted for when considering interactions. While risk weight-based capital

[74] The combination of measures can be calibrated such that they result in the same increase in capital and thus resilience of the banking sector. If a policymaker is concerned about risks in the real estate sector more specifically, they could implement a sectoral capital buffer to increase resilience to these risks or they could increase risk weights instead. Depending on the calibration of both measures, the increase in capital could be equivalent. As such, although cyclical and structural buffers should not interact explicitly (i.e. policymakers should assess the implementation and effects of each buffer in relation to its specific objectives in an independent manner), implicitly the instruments may interact given that they are ultimately targeting risks stemming from the financial sector through capital requirements.

requirements could be circumvented by optimising internal models, a number of caveats apply also to RW floor policies. First, compared to broad or sectoral applications of either CCyB or SyRB, RW floor policies are less transparent since they do not imply an additional capital requirement that is publicly disclosed by banks (i.e. lower transparency and lower signalling effects).[75] Second, an increase in risk weights on mortgage exposures can lead to a deterioration of the capital ratios of a bank in the short run. Lastly, interactions depend on whether the introduction of the complementary sectoral instrument is aimed to be time-varying or permanent. If a more permanent intervention is needed, then an increase in risk weights may be an adequate option, since they are primarily a microprudential (permanent) instrument. Otherwise, a sectoral SyRB (or CCyB) applied to mortgage exposures could be a preferred option.

[75] BCBS (2018), "Towards a sectoral application of the countercyclical capital buffer: a literature review", Bank for International Settlements, *Working Paper* 32, March.

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