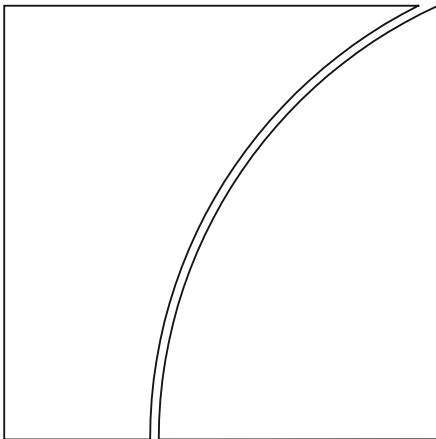


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Towards a sectoral application of the countercyclical capital buffer

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Towards a sectoral application of the countercyclical capital buffer

In May 2017, the Basel Committee's Research Task Force (RTF) initiated a new work stream on sectoral CCyBs (RTF-CCyB). It was tasked to produce two deliverables that would contribute to the understanding of the sectoral application of the CCyB: (i) a review of the existing literature; and (ii) a report summarising original research conducted within the RTF-CCyB. The work stream's mandate listed the following research topics as being particularly relevant: (i) the relevance of sectoral credit development for systemic risk; (ii) the transmission mechanism of sectoral CCyBs; and (iii) the interaction of sectoral CCyBs with the Basel III CCyB and other instruments.

The literature review was published in March 2018 (BCBS (2018)) and shows that there is a justified need for sectoral macroprudential tools. Moreover, it argues that a sectoral CCyB may be a useful complement to both the Basel III CCyB and existing targeted instruments in the macroprudential toolkit. Yet, countercyclical capital buffers, both broad-based and sectoral, remain largely untested and more work is needed to assess their ability to achieve the different objectives attributed to them. Furthermore, a sectoral application of the CCyB entails several challenges with respect to the design of the instrument and its interactions with the Basel III CCyB and other (targeted) instruments.

This research report summarises the RTF-CCyB work stream's findings regarding the open issues identified by the BCBS (2018). Two theoretical papers – Galaasen and Solheim (2018) in a partial equilibrium framework and Castro (2018) in a general equilibrium framework – analyse the transmission mechanism of a sectoral CCyB and compare its effectiveness and efficiency to that of the Basel III CCyB. The empirical work conducted by the work stream consists of three papers: two of them – Ferrari and Rovira Kaltwasser (2019) for the United States and Fiori and Pacella (2018) for Italy – focus on the link between sectoral credit cycles and systemic risk, and one – Behncke (2018) – analyses the transmission mechanism of the Swiss sectoral CCyB on banks' lending and risk taking.

In summary, the work stream's results suggest that a sectoral CCyB may be a useful addition to the countercyclical capital buffer framework. In particular, there is evidence that it increases resilience in the banking system at a lower cost than the Basel III CCyB. Moreover, it contributes to leaning against the wind by reducing excessive credit growth and credit risks in the targeted segments. However, the value added of a sectoral CCyB in these different dimensions depends on the structure of the banking sector and the broader financial system in a given country.

Furthermore, the research of the work stream discusses several challenges related to the design and use of a sectoral CCyB and offers some insights in this context. Broadly speaking, the challenges of adding a sectoral CCyB to the countercyclical buffer framework relate to finding the appropriate balance between flexibility and efficiency gains on the one hand, and the cost of increased complexity of the framework on the other hand. Designing a framework in which a limited number of carefully selected systemically relevant and easily definable credit segments are targeted would increase the effectiveness and efficiency of the countercyclical capital buffer framework in a way that does not excessively increase its overall complexity and safeguards the international reciprocity arrangements within the framework.

In addressing the stated topics, the RTF-CCyB work stream aimed at shedding light on some of the relevant mechanisms and likely implications for bank lending and the broader economy. The research findings presented here are hoped to be of value to policymakers when combined with other relevant sources of information, including economic considerations, policy and practical experience, and the broader academic literature. The report offers some direction regarding possible areas for future work by pointing at a number of open issues – including on the potential interactions of a sectoral CCyB with policy measures already available for addressing sectoral imbalances in various jurisdictions – that warrant further analysis and research.

1. Introduction

While the financial sector contributes to economic growth in good times, instabilities in the financial sector have caused substantial welfare costs in bad times. Increased risk-taking and credit provision in boom periods may lead to a build-up of leverage in the financial system and in the real economy. When the cycle turns, the contraction of credit supply, liquidity hoarding and fire sales of financial and real assets may exacerbate downturns. The consequences for the real economy are particularly manifest and prolonged if the unravelling of imbalances leads to a financial crisis.

The regulatory reforms in the aftermath of the global financial crisis recognised the need to target risks beyond those stemming from individual financial institutions. As a complement to microprudential regulation, the Basel III package introduced a set of macroprudential tools to address systemic risks in the banking system. Currently, the only tool in the Basel III framework directly aimed at mitigating the destabilising effects of credit and leverage cycles is the countercyclical capital buffer (CCyB). It requires banks to build up a capital buffer when credit developments are deemed excessive and leverage in the non-financial private sector is building up. Releasing this buffer in times of financial stress should allow banks to absorb credit losses and to continue extending credit to the real economy, thereby mitigating the economic downturn (BCBS (2010)). By increasing capital requirements in upswings, the CCyB may also help to lean against a further build-up of risks because extending (risky) credit becomes more costly.

The main objective of the Basel III CCyB is to protect the banking system from systemic risks arising from excessive credit developments. In particular, it aims to increase resilience of the banking sector in order to maintain credit provision to the real economy in downturns. The Basel III CCyB applies to banks' total risk-weighted assets. If the exuberance in credit developments is contained within individual credit segments, the Basel III CCyB can have unwanted distribution effects across sectors and can also increase the cost of lending in sectors with moderate or low credit growth.¹

In order to deal with this drawback of the Basel III CCyB, a sectoral application of the instrument could be envisaged. A sectoral CCyB would impose a buffer requirement only on a demarcated set of credit segments in which credit developments are deemed excessive.² A sectoral CCyB would therefore extend the existing CCyB framework in two dimensions: (i) it introduces an opportunity to affect the relative price between lending to different sectors over the cycle, thereby affecting credit distribution; and (ii) it can provide a more targeted signal to banks of what part of lending is seen as especially vulnerable.

The primary advantage of a sectoral CCyB would be to have a more targeted policy tool when credit growth is uneven across sectors. In such cases, it could achieve a stabilising effect at a lower cost than a broad-based capital requirement. This could reduce the inaction bias faced by macroprudential authorities, which arises from the fact that while the benefits of macroprudential policy may only accrue over time, the costs of policy action are immediately visible. As emphasised by the BCBS (2018), this may be particularly important when overall growth prospects are low and monetary policy is expansive. In

¹ An additional issue arising from the application of the CCyB to total risk-weighted assets is that, while the CCyB targets risks stemming from credit exposures to the non-financial private sector, the higher capital requirement also applies to exposures not included in the set of relevant credit risk exposures (notably exposures to sovereigns and institutions). Put differently, the increase in banks' capital requirements depends on their total risk-weighted assets, not only irrespective of whether the exuberance in credit developments is observed in all credit segments or contained within an individual credit segment, but also irrespective of the share of relevant credit risk exposures in the banks' balance sheets.

² While throughout the report we refer to a sectoral CCyB, sectoral credit cycles and sectoral risks, it should be noted that the interpretation of "sectoral" is not necessarily limited to economic sectors, such as households and non-financial corporations. In fact, a "sectoral" CCyB could be applied to particular credit segments, which may be defined by for instance the purpose of loans (eg house purchase, consumption), the geographical location of the counterparties or collateral, or on the basis of the currency in which the exposure is denominated. As discussed in Section 4, however, comparability of segment definitions across jurisdictions is important in the context of the international reciprocity arrangements within the countercyclical capital buffer framework.

addition to building resilience, there may be particular scope for a sectoral CCyB to lean against a build-up of vulnerabilities in case imbalances are contained within the targeted segment.

In May 2017, the Basel Committee's Research Task Force (RTF) initiated a new work stream on sectoral CCyBs (RTF-CCyB). It was tasked to produce two deliverables that would contribute to the understanding of the sectoral application of the CCyB: (i) a review of the existing literature, and (ii) a report summarising original research conducted within the RTF-CCyB. The work stream was mandated to in particular (i) further investigate the relevance of sectoral credit development for systemic risk; (ii) provide new evidence on the transmission mechanism of sectoral CCyBs; and (iii) explain how this relates to that of the Basel III CCyB.

The literature review conducted by the work stream was published in March 2018 (BCBS (2018)). It shows that there is a justified need for sectoral macroprudential tools. Moreover, it argues that a sectoral CCyB may be a useful complement to both the Basel III CCyB and existing targeted instruments in the macroprudential toolkit. Yet, countercyclical capital buffers, both broad-based and sectoral, remain largely untested and more work is needed to assess their ability to achieve the different objectives attributed to them. Furthermore, a sectoral application of the CCyB entails several operational challenges, such as defining modalities on when to activate a sectoral CCyB and on its interactions with the Basel III CCyB as well as with other (targeted) instruments.

This report summarises the RTF-CCyB work stream's findings regarding the open issues identified by the BCBS (2018). The five research projects are based on the experience in economies with different structures: Brazil, Italy, Norway, Switzerland and the United States. In particular, these economies differ with respect to the role of bank credit as a financing means, the specialisation of banks and the importance of certain credit sectors for systemic risks. Two research projects are theoretical and three are empirical. The two theoretical projects analyse the transmission mechanism of a sectoral CCyB and compare its effectiveness and efficiency to that of the Basel III CCyB: Galaasen and Solheim (2018) calibrate a partial equilibrium framework for Norway and Castro (2018) applies a general equilibrium framework for Brazil. There is one empirical paper assessing the transmission mechanism of a sectoral CCyB: Behncke (2018) estimates the effect of the Swiss sectoral CCyB on banks' lending and risk taking. Finally, two empirical projects focus on the link between sectoral credit cycles and systemic risk: Ferrari and Rovira Kaltwasser (2019) for the United States and Fiori and Pacella (2018) for Italy.

Section 2 discusses the work stream's findings on how a sectoral CCyB would affect financial stability. Section 3 focuses on the work stream's insights on some of the operational issues in relation to the sectoral application of the CCyB. Finally, Section 4 brings together the research projects' findings in the different areas. Based on the five research projects, it aims to draw a number of policy insights. It is important to note that most of this research discussed in this report has not been published yet and that many members will continue to work on their analyses and conclusions. A brief summary of work stream members' research projects can be found in the Appendix.

In summary, the work stream's results described in this report suggest that a sectoral CCyB may be a useful addition to the countercyclical capital buffer framework. In particular, there is evidence that it increases resilience in the banking system at a lower cost than the Basel III CCyB. Moreover, it contributes to leaning against the wind by reducing excessive credit growth and credit risks in the targeted segments. However, the value added of a sectoral CCyB in these different dimensions depends on the structure of the banking sector and the broader financial system in a given country. The research of the work stream also discusses a number of challenges in the design and use of a sectoral CCyB and offers some insights in this context.

2. How does a sectoral CCyB affect financial stability?

A sectoral CCyB would require banks to build up a capital buffer on exposures to credit segments in which credit developments are deemed excessive. Thus, its activation may have a more direct impact on the area of concern while at the same time having a lower effect on the wider economy than the Basel III CCyB.

The literature reviewed by the BCBS (2018) shows that sectoral capital requirements have already been applied to a range of sectors and credit segments, but only a small number of papers perform explicit impact assessments of sectoral capital requirements in general and sectoral CCyB specifically. Therefore, the potential effectiveness and efficiency of a sectoral CCyB remain largely untested.

The following sub-sections present the insights on the potential transmission mechanism of a sectoral CCyB from research conducted within the work stream. The discussion is structured along the aforementioned objectives of a sectoral CCyB, namely to increase resilience and to lean against a build-up of risks. It aims at assessing the value added of a sectoral CCyB relative to alternative instruments, notably the Basel III CCyB and other targeted instruments. The outlined research agenda boils down to answering three questions: (i) Does a sectoral CCyB affect credit growth and credit risk in upswings?; (ii) Does a sectoral CCyB raise resilience and support credit in downturns?; and (iii) Does a sectoral CCyB add value compared to the Basel III CCyB and other targeted instruments?

2.1 Does a sectoral CCyB affect credit growth and credit risk in upswings?

According to the BCBS (2010), the objectives of the Basel III CCyB are to protect the banking sector from the costs associated with excessive credit cycles and to help to lean against the upward phase of the cycle. This potential moderating effect on the credit cycle in the upswing is considered as a positive side benefit, rather than the primary aim of the CCyB regime. Eight years later the empirical evidence on the alleviating effect of the Basel III CCyB on credit growth is still very scarce, and results on the impact of capital requirements in general on the supply of credit remain mixed.

As a sectoral CCyB would change the relative capital charge for different credit segments, the instrument might provide banks with stronger incentives to reduce credit to the targeted segments than the Basel III CCyB. In particular, banks might reduce their lending to the targeted segment since the costs of providing credit to this segment relative to other credit segments increases. In addition, banks might reduce their risk-weighted assets in the targeted segment by reducing risks associated with lending in the segment. For instance, if the sectoral CCyB is applied to mortgages, banks might reduce risk indicators such as loan-to-value (LTV) and loan-to-income (LTI) ratios, as they are determinants of regulatory risk weights.

The literature reviewed by the BCBS (2018) suggests that a sectoral CCyB could indeed contribute to lean against the build-up of risks in the targeted segment. However, it also warns against potential spillover effects to untargeted sectors after the activation of a sectoral CCyB. In particular, targeted capital requirements may drive lending activity out of the targeted sector and into another. Such spillovers can be either positive or negative, depending on the state of credit cycle in the segments to which credit is leaking. The BCBS (2018) also discusses the possibility that a sectoral CCyB is not able to lean against sectoral imbalances: if banks have weak capital adequacy and inadequate access to new capital, higher capital requirements for a low-weighted asset class may induce banks to reduce lending to segments that attract higher risk weights.

The research of the work stream has resulted in two theoretical papers and one empirical study that all explicitly analyse the transmission mechanism of a sectoral CCyB. Galaasen and Solheim (2018) and Castro (2018) contribute to the scarce theoretical research that to date only provides few insights on the ability of sectoral capital requirements to contribute to financial stability. Behncke (2018) contributes to the existing studies on the transmission mechanism of the sectoral CCyB in Switzerland.

Galaasen and Solheim (2018) describe the dynamic optimisation problem of a bank, inspired by the banking industry model in Corbae and D’Erasmus (2014). However, a key difference is that Galaasen and Solheim (2018) consider two loan sectors, which enables them to analyse the transmission channel of a sectoral CCyB. In the model, any increase in capital requirements will lead to a rise in average financing costs. Banks will shift their supply curve, demanding a higher interest margin. This will reduce demand. For a reasonable change in capital requirements (up to 2.5%) the effects on actual credit supply tends to be moderate in a given period. However, in the model the effect is permanent, leading to a potentially high aggregate effect if an excess capital requirement is imposed for a long period of time. Therefore, while the impact on interest rates is moderate, a sectoral CCyB turns out to be effective in leaning against the credit cycle in the targeted segment.

Regarding spillovers to untargeted credit segments, Galaasen and Solheim (2018) show that the amount of leakage depends on the structure of the banking sector. In a banking structure where different banks’ business tends to be concentrated in different credit segments, the sectoral buffer will only affect the sector in which it is introduced. In a universal banking system, in which a bank’s business is diversified across multiple credit segments, a sectoral buffer will change the relative returns between the two sectors. In response, the bank adjusts its lending portfolio towards sectors with no sectoral CCyB.

Castro (2018) introduces sectoral countercyclical buffers in an estimated DSGE model with a representative bank and three credit sectors – consumer, commercial and housing loans. In the model, loan interest rates depend on capital requirements and on the amount of bank capital in excess of the total requirements. As a result, an increase of capital requirement in one sector produces two effects: a direct impact on the targeted sector leading to higher interest rates, as a result of increased funding costs, and a secondary smaller impact on all credit sectors, as bank capital becomes scarcer for all sectors. This secondary impact is of a smaller magnitude than the direct impact, but it still leads to additional increases of all sectoral lending rates. The overall impact of an increase of a sectoral CCyB on the economy is contractionary. In the general equilibrium setup, the monetary authority reduces the base interest rate, lowering somewhat the initial impact on loan interest rates in the targeted sector, but more than offsetting the secondary impact on non-targeted sectors. The overall result is an increase in interest rates in the targeted sector and a decrease of interest rates in other credit sectors. Credit volume falls in the targeted sector and grows in the other sectors.

In the model by Castro (2018), the transmission of a sectoral CCyB is different in each sector and also depends on whether the shock is anticipated or not. In the case of consumer and commercial loans, the sectoral CCyB is found to be effective in leaning against the credit cycle in the targeted segment. A sudden permanent increase of 2.5 percentage points of the commercial sectoral CCyB can reduce sectoral credit by as much as 12% over 20 quarters, with limited impact on other sectors. Analogously, a 2.5 percentage points increase of a consumer sectoral CCyB may reduce sectoral credit by 5% over 20 quarters, with smaller effects on other sectors. Only in the housing sector is the impact of a sectoral CCyB subdued, as the model was tailored for Brazil, where housing loans are regulated by the government and were under limited influence of capital requirements during the sample period.

It should be noted that both Galaasen and Solheim (2018) and Castro (2018), like many of the theoretical papers on capital requirements, assume that banks can only increase capital adequacy by retaining earnings and/or reducing assets. Furthermore, the models do not allow for the shifting of credit activities to the non-banking sector after the tighter regulation of the banking sector. These assumptions are conducive to the finding that (cyclical) capital requirements are effective in reducing credit.

From the empirical side, the evidence discussed in BCBS (2018) is relatively scarce and shows mixed evidence regarding the effectiveness of sectoral capital requirements in leaning against credit in the targeted segments. The impact likely depends on inter alia country- and segment-specificities as well as on the specific design and timing of the measure. The BCBS (2018) concludes that sectoral capital requirements may indeed limit loan growth in targeted sectors, but effective leaning requires adequate

calibration and sufficiently early activation of the measure. The literature reviewed further provides scarce and somewhat mixed evidence on sectoral capital requirements' potential spillovers to untargeted sectors.

Behncke (2018) analyses the impact of the activation of a sectoral CCyB targeting the residential mortgage loan segment in Switzerland. A sectoral CCyB of 1% was introduced in February 2013 to protect the banking sector from the consequences of excessive credit growth by increasing its resilience. Furthermore, as a secondary objective the instrument should lean against the build-up of excesses. The buffer's level was further increased to 2% as of January 2014.

She finds that the sectoral CCyB in Switzerland helped lean against the build-up of imbalances through both the quantity and composition of credit in the targeted segment. First, the findings indicate that the sectoral CCyB led to a reduction of LTV risks. Banks more likely to be affected by the sectoral CCyB reduced new mortgages with an LTV of more than 80%, which receive a higher risk weight according to the standardised approach of capital regulation. As such, affected banks were able to shift new mortgage loans to exposures with lower risk-weighted assets. Second, most of the banks affected by the sectoral CCyB reduced mortgage lending more than control banks after the activation. Finally, with respect to potential unintended consequences and leakages, Behncke (2018) finds neither an increase in risk taking regarding LTI risks nor any significant impact on credit growth in segments other than the targeted mortgage loans.

While Behncke (2018)'s result that banks that were affected more by the Swiss sectoral CCyB reduced mortgage lending more than other banks after the activation is in line with the conclusion by Basten and Koch (2017), a number of her findings contrast those of earlier papers that examine the impact of the activation of the Swiss sectoral CCyB.

First, regarding the transmission on LTV risks, Basten and Koch (2017) do not find evidence that banks affected by the sectoral CCyB charge higher risk premiums for high LTV mortgages after the activation. There are several possible explanations for these contrasting results, including measurement differences in the outcome and treatment variable. Regarding the outcome variable, Basten and Koch (2017) observe mortgage rates offered within an online platform. Behncke (2018) observes the actual LTV distribution of newly issued mortgages once the contract was signed. Moreover, Behncke (2018) defines the sectoral CCyB treatment group more narrowly. She combines the information of each bank's capital required by the sectoral CCyB relative to its specific excess capital. According to this definition, only a few banks were affected by the sectoral CCyB activation as many Swiss banks are either well capitalised or have a low share of residential mortgages in their portfolio. Basten and Koch (2017) do not combine the information but instead use two separate indicators on banks' capital cushions and their mortgage share. Finally, she disentangles the effects of the sectoral CCyB from the effects of the LTV cap that has been implemented seven months before the CCyB activation with a five months' transition phase. Given that both measures were implemented almost contemporaneously with similar intended effects, it is important to rule out that results for the CCyB activation are not confounded by the LTV cap implemented before.

Second, her results on other (than mortgage) credit growth rates are in contrast to those of Auer and Ongena (2016), who conclude that banks that have a higher share of residential mortgage risk-weighted assets (and therefore are more affected by the sectoral CCyB) increase lending to corporates more than other banks. Possible explanations for these differences are the data and identification strategy used to infer the impact of the sectoral CCyB. While Behncke (2018) uses bank balance sheet data, Auer and Ongena (2016) use data from a survey on lending conditions without observing true lending volumes. In this survey it is not distinguished whether a loan is newly issued or whether lending conditions changed for an existing loan. Moreover, they define the treatment group by focusing on the specialisation of the banks. Behncke (2018) considers not only the specialisation (in terms of residential mortgage risks), but also the banks' capital situation. She argues that it is crucial to set the additional capital requirement due to the sectoral CCyB in perspective to the bank's existing excess capital. Out of two banks with the same share of (risk-weighted) residential mortgages in their total balance sheet, the more capital constrained bank is more affected by the sectoral CCyB.

2.2 Does a sectoral CCyB raise resilience and support credit in downturns?

Like any other capital requirement or buffer, the Basel III CCyB aims at fostering resilience by increasing the amount of capital available for absorbing bank losses. The BCBS (2018) argues that the aspect of resilience that is specific to *countercyclical* buffers is their objective of supporting credit by releasing the buffer in downturns. Therefore, a sectoral CCyB could aim to increase resilience against risks in particular credit segments in order to maintain credit provision to these and other segments in a downturn.

In this sub-section, we present the insights from the research conducted within the work stream on both dimensions of resilience. That is, we discuss both findings relating to the degree to which a sectoral CCyB would reduce bank risk, for instance by improving their capital position or reducing the riskiness of borrowers, as well as those relating to the extent to which a release of a sectoral CCyB would be effective in supporting credit in downturns.

From a theoretical perspective, the BCBS (2018) discusses a large body of theoretical (mainly DSGE) studies. Many of these assess the welfare effects of the Basel III CCyB, whereas only a few papers focus on a sectoral CCyB. A common feature of these studies is that, from the perspective of resilience, only very few include the option of bank default and often they only approximately capture the design of countercyclical buffers. In particular, the impact of a release of the buffer is generally not assessed.

In contrast to many of the earlier studies, the theoretical research of the work stream explicitly analyses the time-varying nature of a sectoral CCyB and its impact on the credit cycle in the downturn.

Galaasen and Solheim (2018) investigate the effect of a policy response to sector-specific boom and bust cycles in the retail segment and in the commercial and industrial sector. They consider coordinated boom and bust cycles across both sectors as well as cycles with a boom in one sector and a bust in both sectors.

In the framework of Galaasen and Solheim (2018) banks will only very rarely fail due to lack of equity. In the calibration banks start out with a 14% capital ratio. This would have been more than sufficient to sustain the losses during for instance the Norwegian banking crisis in the early 1990s. However, banks do have to meet a capital requirement, also during times of stress. If the bank holds no prior capital buffer, it must adjust credit (sell existing loans at a haircut) in order not to breach the capital requirement. If losses are large, capital buffers are low and the cost of adjusting credit is high, it might be better for the bank to close its business than to retain its charter value.

In general, the probability for a bank to fail is seen as minor, unless a bad outcome occurs when both the bank and the policymaker simultaneously assume the probability of a bad outcome to be zero, so that precautionary capital buffers are too low. The main purpose of capital regulation, both broad-based and sectoral, in the framework of Galaasen and Solheim (2018) is to alleviate the negative effects on credit supply in a downturn, not to avoid bank failure. In most cases, an increase in capital prior to a downturn will alleviate the need to adjust capital during a downturn. Even a moderate build up in capital prior to the crisis can have a substantial effect on credit supply during a crisis.

In the model by Castro (2018) banks don't fail, but one can gauge resilience by the amount of capital banks amass before crisis events. In a series of simulations, a simple CCyB policy was compared to alternative sectoral CCyB policies. In the CCyB policy simulation, the buffer is announced to move up and down with discrete 0.5 percentage point steps for every discrete 2 percentage point movement of the total credit gap, ranging from zero when the credit gap was zero to 2.5% when the credit gap reached 10 percentage points. Effective buffer activation only takes place four quarters after announcement. Additionally, a complete release of the buffer in the next quarter is announced if the GDP growth rate in the current period falls more than two standard deviations below its mean level. Alternative sectoral CCyB policies have been simulated with the same trigger as the CCyB for buffer release but different triggers for sectoral CCyB activation. Castro (2018) shows that, with proper calibration, the sectoral CCyB can help

support credit in downturns. As the model is linear, a sectoral CCyB release is as effective in supporting credit in downturns as a buffer increase is to lean against the wind in upturns. Therefore, sectoral CCyB releases mirror sectoral CCyB activations.

Concerning empirical evidence, very few studies focus on the resilience aspects of (countercyclical) capital buffers. The BCBS (2018) emphasises that there is a particular scarcity of papers focusing on the impact of a release of capital requirements, which are crucial to assessing countercyclical buffers' ability to support credit in downturns. To date, no assessments have been performed on the ability of a sectoral CCyB to support credit in downturns.

Behncke (2018) notes that the sectoral CCyB raised capital requirements in the Swiss banking system somewhat. For the 25 largest mortgage banks in her sample, the additional capital requirement due to the sectoral CCyB activation was 3% of their total minimum capital requirements. Moreover, there was a considerable heterogeneity among banks: the amount of additional capital required by the sectoral CCyB varied between 1 and 8% of total minimum required capital. The additional capital requirement was higher for banks more exposed to the residential mortgage market. In this respect, Basten and Koch (2017) show that banks specialising in mortgages reacted to the introduction of the sectoral CCyB by strengthening their capital base through drawing on retained earnings. Since the Swiss sectoral CCyB has not been released yet, its effectiveness in supporting credit in downturns remains untested.

As discussed in the previous sub-section, with respect to the riskiness of borrowers, Behncke (2018) finds that the sectoral CCyB led to a reduction of LTV risks. Banks reduced their share of new mortgages with an LTV between 80 and 90% at the expense of an increase in the respective share with LTVs between 70 and 80%. A reduction in high LTV mortgages increases the resilience of banks in two respects. First, the higher down-payment implies more available collateral in case of a real estate price bust. Second, a lower LTV correlates with lower unobservable risks in other dimensions as mortgage takers signal their ability to save.

2.3 Does a sectoral CCyB add value compared to other instruments?

Macroprudential policymakers have alternative instruments available to mitigate risks stemming from sectoral credit cycles. These include the Basel III CCyB as well as other targeted measures such as borrower-based measures and sectoral risk weights. While the BCBS (2018) concluded that the literature reviewed indicates that a sectoral CCyB could indeed be a valuable complement to the Basel III CCyB and to alternative sectoral macroprudential measures, there is hardly any literature that explicitly compares the transmission mechanism of a sectoral CCyB to that of alternative macroprudential instruments.

The research conducted in the work stream extends the literature by comparing the transmission mechanism of a sectoral CCyB to that of the Basel III CCyB and to limits on LTV ratios, respectively. The theoretical studies produced by the work stream also allow a comparison of the transmission mechanism of a sectoral CCyB compared to that of sectoral risk weights.

2.3.1 The Basel III CCyB

While a potential moderating effect on the build-up phase of the credit cycle can be considered as a positive side benefit of the Basel III CCyB, this is only the case if banks reduce lending in those credit segments in which credit developments are indeed excessive. That is, while a potential curtailing of credit to sectors in which credit developments are exuberant may be intended, slowing down the supply of credit in segments in which credit provision is already subdued is not desirable.

The literature reviewed by the BCBS (2018) indicates that broad-based capital requirements, such as the Basel III CCyB, may change the composition of banks' lending portfolios, with an increase in capital requirements often having a stronger negative impact on high risk weight portfolios. As a result, the activation of a broad-based CCyB could potentially result in an acceleration of credit growth in exuberant

segments at the expense of a reduction in credit to segments that do not contribute to cyclical systemic risk.

As mentioned above, the primary advantage of a sectoral CCyB is that it can achieve a stabilising effect at a lower cost by targeting those segments in which imbalances are building up. That is, a sectoral CCyB is expected to have a more direct impact on the area of concern and smaller effects on the wider economy than the Basel III CCyB.

In the setting of Galaasen and Solheim (2018), the difference between a sectoral buffer and the Basel III CCyB is that if there is a sectoral specific boom, the sectoral buffer will only cover the booming sector, while the CCyB will cover both sectors. If there is a boom in both sectors, the sectoral and broad buffer would be equivalent. The gain from a sectoral buffer is that if the boom is contained to one sector, there may be less disturbance to credit in good times. However, the impact of a sectoral CCyB on total credit may, in addition to the level of calibration of the sectoral and broad-based buffer and the segment to which the sectoral CCyB is applied, depend on the banking sector structure. In fact, as mentioned above, in a universal banking system, there will be a leakage between sectors, even when the buffer is only imposed on one sector, as banks will shift capital to assure the same marginal expected income in both sectors.

If the bust only affects the booming sector, the alleviating effects in a downturn would match the effects from a broad buffer. Hence, in their analysis, the sectoral CCyB would work as a substitute to the Basel III CCyB. The biggest benefit of a sectoral CCyB is a more targeted regulation if booms and bust are sector specific.

According to Galaasen and Solheim (2018), the cost of a sectoral buffer is the probability of a policy mistake, ie a case in which the bust occurs in sectors that did not experience a boom. The impact of such policy mistakes depends on the banking system structure as well as on how sectoral buffers are implemented. Galaasen and Solheim (2018) show that in a sectoral banking system, there is a large potential loss in a crisis if the buffer has not been applied in sectors that experience a severe downturn. In such cases, the Basel III CCyB would be more effective in ensuring resilience. In contrast, a universal banking structure has self-stabilising features that reduce the cost of policy mistakes, as universal banks make internal adjustments between sectors. Furthermore, in a universal banking system, the sectoral CCyB could serve as a substitute for the Basel III CCyB from a resilience perspective. In particular, Galaasen and Solheim (2018) show that if sectoral and broad buffers are calibrated such that the total capital level is the same under both options, the difference in outcome between a broad and sector-specific crisis is minimal for a universal banking system.

Taken together, the results of Galaasen and Solheim (2018) suggest that both the benefits and the potential costs of a sectoral CCyB relative to the application of the Basel III CCyB, are likely to be larger in a sectoral banking system than in a universal banking system.

In Castro (2018) the sectoral CCyB and Basel III CCyB as macroprudential policy instruments are quite equivalent, as they act through the same transmission channels. As a matter of fact, the sectoral CCyB can be regarded as a generalisation of the CCyB in the model, as one can reproduce any CCyB policy using the sectoral CCyBs.

In policy simulations, the sectoral CCyB was introduced as a substitute to the Basel III CCyB, and its performance was compared to the latter. On the basis of these simulations, Castro (2018) shows that macroprudential policies using a sectoral CCyB with adequate calibration may yield lower volatilities of total and sectoral credit gaps than a simple CCyB policy. This result was expected since more policy instruments allow for better stabilisation, at least in theory.

However, these additional degrees of freedom were accompanied by more frequent macroprudential intervention. While the simple CCyB policy called for changes in the level of the buffer in 12% of the periods, alternative sectoral CCyB policies might require modifications to buffers up to 23% of

the periods. As a consequence, while the emphasis on risks in the credit segments the policymaker is concerned about may facilitate communication on policy activation, the implementation and coordination of sectoral CCyB policies may in practice prove more complex than the use of the Basel III CCyB.

Finally, as discussed above, Behncke (2018) empirically confirms that the Swiss sectoral CCyB did not have any impact on credit segments other than the targeted one. While there is no counterfactual of what would have been the effect of the Basel III CCyB on affected banks' loan portfolios, her evidence suggests that the Swiss sectoral CCyB had a positive effect on financial stability without unintended effects on untargeted credit segments.

2.3.2 Other targeted tools

A sectoral CCyB would not be the only targeted tool available to macroprudential policymakers for dealing with risks stemming from sectoral credit cycles. Both borrower-based measures, like caps on LTVs, LTIs or D(S)TIs, which are often applied to mitigate risks stemming from the housing market, and sectoral risk weight measures have been actively used for financial stability purposes. However, based on the literature reviewed, BCBS (2018) concludes that a sectoral CCyB could be a useful complement to borrower-based measures.

Indeed, Behncke (2018) provides evidence that the sectoral CCyB and the LTV cap in Switzerland complemented each other by affecting different parts of the upper LTV distribution. In addition to the sectoral CCyB, Swiss authorities implemented an LTV cap where banks were restricted from providing new mortgage loans with LTV ratios over 90%. This cap became effective in July 2012 with a five months transition phase, while the sectoral CCyB activation was announced in February 2013. Since the macroprudential measures were implemented at almost the same time, and had similar intended effects, disentangling their effects is not straightforward.

Behncke (2018) exploits differences in timing of the activation of the measures as well as the extent to which different banks were affected by the two measures to disentangle the effects of the sectoral CCyB activation from the LTV cap. She finds that both the LTV cap and the sectoral CCyB did affect LTV risks. However, the sectoral CCyB and the LTV cap shifted different parts of the upper LTV distribution: the LTV cap of 90% led to a reduction of new mortgages with LTVs of more than 90%; the sectoral CCyB led to a reduction of new mortgages with LTVs between 80 and 90%. Thus, these measures complemented each other. Their complementarity was further strengthened through the difference in their coverage: the LTV cap was targeted at new mortgage loans, while the sectoral CCyB applies to the stock of residential mortgage loans. Therefore, it will take some time before any impact of the LTV cap is observable in the mortgage stock.

Regarding time-varying risk weights, it could be argued that, from a theoretical point of view, increasing sectoral capital requirements through risk weights or through a sectoral buffer could be considered equivalent, as both measures narrow the gap between a bank's actual and required capital ratio. Yet, the BCBS (2018) discusses important differences in the design and transmission mechanism of both instruments and concludes that a sectoral CCyB would be a simpler, more transparent and less distorting alternative to time-varying sectoral risk weights.

A comparison of a sectoral CCyB to time-varying sectoral risk weights is not the focus of the theoretical studies conducted within the work stream. At the relatively aggregated level in these models, adjustment of risk weights should be able to achieve the same end result as an adjustment of capital ratios. As a matter of fact, the introduction of time-varying risk weights in Castro (2018)'s model is algebraically equivalent to sectoral buffers up to a scale factor. However, in practice risk weights are finer grained than capital ratios, and this might have implications for policy application. This will not be captured in these models.

3. How to operationalise a sectoral CCyB?

The introduction of a new instrument to the macroprudential toolkit entails the development of an operational framework describing the scope and design of the instrument. While there was no specific focus on operational issues, the following sub-sections present the work stream's insights on key operational issues relating to the sectoral application of the CCyB, including the credit segments that could be targeted by a sectoral CCyB, and issues regarding the activation and the calibration of a sectoral CCyB.

3.1 Identifying segments to be targeted by a sectoral CCyB

As the focus of macroprudential policy is on reducing systemic risk, a sectoral CCyB would target cyclical risks that, while being contained within particular credit segments, could have adverse effects on the broader financial system and the real economy. In this context, the BCBS (2018) concludes that more work is needed to identify the relevant credit segments to be targeted by macroprudential policymakers. In particular, the BCBS (2018) argues that further research on the implications of sectoral credit cycles for systemic risk as well as on the intertemporal relationships between sectoral credit cycles would be important for the further development of the policy framework describing the interaction of a broad-based and potentially more targeted application of the CCyB.

The outlined research agenda in this area essentially boils down to answering two questions: (i) Does sectoral credit exhibit sector-specific boom/bust cycle behaviour?, and (ii) Are sector-specific boom/bust cycles systemically relevant? The next two sub-sections provide insights on these respective questions from the research conducted within the work stream.

3.1.1 Does sectoral credit exhibit sector-specific boom/bust cycles?

Several strands of literature reviewed by the BCBS (2018) suggest that there may be sector-specific components to credit cycles and therefore it would be useful to analyse different components of total credit in a disaggregated manner. The choice between a broad or a sectoral CCyB depends on the degree of synchronisation of sectoral credit cycles. If sectoral credit cycles are well synchronised, policymakers are more likely to choose the broad-based variant. If, in contrast, sectoral credit cycles often exhibit sector-specific behaviour, using the Basel III CCyB would harm the sectors experiencing downturns.

Indeed, a number of recent studies discussed by the BCBS (2018) indicate that (sub-segments of) credit to households and credit to the corporate sector are not always in the same phase of the credit cycle. However, the BCBS (2018) identified a number of shortcomings with respect to these papers. First, they only look at contemporaneous synchronisation. However, the choice of the relevant policy instrument (broad-based or sectoral) depends on whether sectoral cycles are synchronised, not only contemporaneously but also with short time lags. More specifically, a sectoral application of the CCyB would be particularly relevant if imbalances tend to remain sector-specific and do not become broad-based for a reasonable time span.

Second, in many of the reviewed papers on the synchronicity of credit cycles, the synchronisation of sectoral credit cycles is assessed at a relatively aggregate level: further disaggregation of sectoral credit cycles into different types of credit to households and business credit might be helpful. This could shed light on the required level of granularity in cyclical systemic risk assessment as well as the relevant credit segments to be targeted.

The papers produced by the work stream extend this literature by providing empirical evidence on the cyclicity of sectoral credit in three different countries.

Fiori and Pacella (2018) study the sectoral decomposition of the credit-to-GDP gap for Italy over the period 1990Q1-2017Q2. Their analysis spans from a two-sector to a six-sector decomposition of the

credit cycle, which is the maximum level of granularity achievable given data constraints. The two-sector decomposition distinguishes the non-financial corporate sector from the household sector. The corporate sector includes also producer households, while the household sector comprises loans to consumer households (ie mortgages, consumer credit, other). The four-sector decomposition takes into account the purpose of loans, by further splitting the corporate sector into two credit segments: real estate-related non-financial corporations, as represented by construction firms and real estate agencies, and non-real estate-related non-financial corporations. In addition, the loans to households are further split into loans for house purchase and consumer credit. Finally, in the six-sector decomposition the corporate sector is further broken down by firms' size into medium and large real estate-related enterprises, medium and large non-real estate-related enterprises, small real estate-related enterprises and small non-real estate-related enterprises. In this classification, small enterprises include producer households and small firms with up to 20 employees, whereas medium and large enterprises represent the rest of the corporate sector.

Regarding the existence of sector-specific boom/bust cycles, Fiori and Pacella (2018) show that, while sectoral credit cycles in Italy display broadly similar patterns, their synchronicity over time decreases as the monitoring shifts from a two-sector to a six-sector decomposition. This implies that the timing for policy decisions could be different when accounting for credit exuberance at such granularity level. To investigate the causality of the intertemporal relationships across cycles, they run a set of in-sample Granger causality tests based on trivariate regressions of the total credit gap on its own lags, sectoral credit gaps at different lags and a measure of the business cycle. Results show that sectoral cycles do not Granger cause the credit cycle when the test is run on higher degrees of sector granularity.

Ferrari and Rovira Kaltwasser (2019) study the sectoral composition of the credit-to-GDP gap for the United States over the period 1952Q2-2017Q3. Acknowledging the fact that there may be common factors driving sectoral credit cycles, they decompose sectoral credit-to-GDP gaps into a common credit cycle and sector-specific credit cycles using a constrained principal components approach. Sector-specific components are obtained for credit-to-GDP gaps for four sectors: residential real estate (RRE) mortgages, commercial real estate (CRE) mortgages, consumer credit and commercial and industry (C&I) credit.

Their analysis shows that the credit cycle in the United States was indeed characterised by systemically relevant sector-specific boom/bust cycles during the sample period. Estimates of the duration of the different credit cycle variables using the frequency domain representation of the data indicate that the cyclical properties of the estimated common component closely resemble those of the total credit-to-GDP gap series that is used to guide decisions on the Basel III CCyB. Ferrari and Rovira Kaltwasser (2019) further show that there are important idiosyncrasies in the different credit segments that remain hidden when looking at the aggregated data only. In particular, their results indicate there are large differences in the duration of the sector-specific cyclical components, which can range from 13 to 65 years. Ferrari and Rovira Kaltwasser (2019) use Granger causality tests to show that sectoral credit exuberance, with the exception of consumer credit, generally does not lead to broader credit exuberance within a period of one year. They interpret these results as an indication that it may be useful to act upon sectoral credit cycles rather than on broad-based credit developments.

Finally, the sectoral credit cycles in the model by Galaasen and Solheim (2018) were calibrated on Norwegian data over the period 1980-2015. While not explicitly focusing on the degree of synchronisation or co-movement of sectoral credit cycles, they find that C&I credit has a stronger cyclical component, implying that credit varies more over the cycle and that non-performing loans (NPLs) in bad times are considerably higher than in the retail sector. To assess this effect, they estimate the sensitivity of loan demand and NPLs to GDP and interest rates. C&I is more sensitive to GDP fluctuations. Moreover, in the calibrated theoretical model, banks' loan supply responds more in the C&I sector in response to GDP fluctuations. The main reason is that as the return to C&I loans falls more in a crisis and that C&I loans have shorter maturity, it is less costly for banks to cut lending in the C&I segment compared to household loans.

3.1.2 Are sector-specific boom/bust cycles systemically relevant?

Macroprudential policy takes a system-wide perspective, implying that the focus of cyclical systemic risk assessments should be on those sectors that may entail risks to the stability of the broader financial system. Therefore, in addition to the presence of sector-specific components in credit developments, also the systemic relevance of credit segments matters for determining the appropriate level of granularity at which to analyse sectoral credit cycles.

The theoretical and empirical literature reviewed by the BCBS (2018) shows that evolutions in sub-segments of both the household sector and the corporate sector may have the potential to adversely affect bank stability as well as the broader economy and, therefore, may give rise to systemic risk. Particular attention is given to evidence on (residential) real estate mortgage credit and house prices affecting business cycle dynamics.

By explicitly assessing the systemic relevance of the sectoral credit cycles under consideration, the work stream's contributions provide a useful addition to evidence on the systemic relevance of sector-specific boom/bust cycles.

Fiori and Pacella (2018) observe that the contribution of sectoral cycles to cyclical systemic stress, as proxied by the system-wide new bad debt rate, differs quite significantly. They run a set of in-sample Granger causality tests based on bivariate and trivariate regressions to investigate the causality of the relationships between the imbalances at a sectoral level and the new bad debt rate, which is measured by the ratio between the flow of new bad loans over the year and the average stock of outstanding loans in the same year. They find that the non-real estate-related segment of corporate lending is the most systemic credit segment in Italy: credit exuberance in this sector is followed by a surge in systemic stress within a year. In contrast, the increases in new bad debt following exuberance in the real estate-related segment of business lending does not spill over to other sectors.

Ferrari and Rovira Kaltwasser (2019) use a local projections approach to assess the impact of the common and sector-specific components of the credit-to-GDP gap on two types of systemic risk variables: the Chicago Fed National Financial Conditions Index (starting from 1971Q1) and borrower delinquency rates (starting from 1985Q1). The analysis shows that RRE mortgages and CRE mortgages are the most systemic credit segments: exuberance in the sector-specific component of the RRE and CRE mortgage credit-to-GDP gap tends to be followed by a surge in financial stress and borrower delinquencies. Exuberance in C&I credit may also be followed by a moderate rise in borrower delinquency rates, but it generally does not trigger financial stress.

When focusing on the sectoral decomposition of borrower delinquency rates (starting from 1987Q1 for consumer and business credit and from 1991Q1 for residential and CRE mortgage credit), Ferrari and Rovira Kaltwasser (2019) find that losses following broader credit exuberance are typically isolated in the real estate credit segments. In contrast, exuberance in CRE mortgage credit tends to raise delinquency rates in all credit segments, but it rises most strongly in the real estate-related ones. This also holds for RRE mortgages; exuberance in this segment is followed by increased delinquency rates not only in the RRE mortgage segment, but also in CRE mortgage credit and consumer credit. Finally, losses following (moderate signs of) exuberance in C&I credit are concentrated in the business segment itself. However, for sufficiently large shocks to C&I credit, losses also materialise in the real estate credit segments. These findings are broadly confirmed when using data on charge-offs and non-performing loans.

Galaasen and Solheim (2018) illustrate in a two-sector model how a sectoral shock can spill over to other sectors through a bank lending channel if there is a universal banking sector, where banks lend to several different sectors. Losses in one sector will affect bank lending in other sectors and can lead to a general fall in the supply of credit.

3.2 Activation, release and calibration

An important element in the operationalisation of macroprudential instruments is the specification of when they would be used and how they will be calibrated. The design of a sectoral CCyB could build on that of the Basel III CCyB, both regarding the choice of relevant indicators and the methodology for calibrating the instrument. Both the activation and the calibration of the Basel III CCyB are closely linked to the state of the credit cycle. In particular, as a common reference guide, the BCBS (2010) proposed a linear mapping of the credit-to-GDP gap into a buffer guide for the CCyB, where the CCyB is activated when the credit-to-GDP gap exceeds 2% and reaches a maximum level of 2.5% when the credit-to-GDP gap is at or above 10%. Regarding the release, BCBS (2010) states that the buffer can be released gradually in situations where credit growth slows and system-wide risks recede in a benign fashion. A prompt release may be triggered by the materialisation of bank losses or based on relevant market indicators of financial stress.

3.2.1 Activation and release

While a number of caveats have been identified regarding the credit-to-GDP gap (eg Edge and Meisenzahl (2011), Lang and Welz (2017)), a sectoral version of the credit-to-GDP gap could nevertheless be a useful starting point for the activation of a sectoral CCyB. Ferrari and Rovira Kaltwasser (2019) use such a sectoral composition of the standard credit-to-GDP gap in their analysis of sectoral credit cycles for the United States, in which the credit trend is measured by the one-sided HP filter with smoothing parameter of 400,000. Fiori and Pacella (2018) use a sectoral decomposition of the credit-to-GDP gap as well, but they adapt the trend calculation to account for country-specificities in Italy. In particular, they measure the credit trend by a two-sided HP filter (also with a smoothing parameter of 400,000), rather than a one-sided HP filter.

As discussed above, Fiori and Pacella (2018) and Ferrari and Rovira Kaltwasser (2019) find that sectoral credit-to-GDP gaps contain forward-looking information regarding systemic stress in Italy and the United States, respectively. In this regard, Ferrari and Rovira Kaltwasser (2019) propose to decompose sectoral credit variables into a common component of the credit cycle and sector-specific developments. Both Fiori and Pacella (2018) and Ferrari and Rovira Kaltwasser (2019) performed robustness checks of their results using alternative trend calculations.

Also in the theoretical contributions of the work stream, the activation of a sectoral CCyB is linked to the credit cycle. Galaasen and Solheim (2018) do not endogenise the policymaker's decision but perform policy simulations in a context of sector-specific boom and bust cycles. While they use GDP as a measure for the different states of the business cycle, credit growth tends to be high in booms and low in busts. For activation of the buffer, authorities would focus on sectoral credit growth, whereas the development in sectoral non-performing loans would be the determining factor for the release of a sectoral CCyB. It should be noted that also in Fiori and Pacella (2018) and Ferrari and Rovira Kaltwasser (2019) there is a large emphasis on default rates or non-performing loans in banks' sectoral loan exposures when it comes to assessing systemic risk.

In the simulations in Castro (2018), credit-to-GDP gaps – both total and sectoral – are considered as indicators for activation in combination with two alternative activation triggers. A sectoral buffer would be activated as a function of (i) the respective sectoral credit gap only, or (ii) both total credit gap and sectoral credit gaps. The results show that combining information from total and sectoral credit gaps in the decision to trigger sectoral CCyBs permits the reduction of both total and sectoral credit volatility and generates less credit volatility than targeting each sectoral gap independently. For sudden release in crisis periods, Castro (2018) used only GDP growth as an indicator. As the related literature presents no consensus on the proper indicators in the case of downturns, he did not perform any experiments with respect to the release indicator.

Regarding the exact timing of activation, Galaasen and Solheim (2018) argue that, in their activation decision, macroprudential authorities should balance the potential cost of foregone credit of

early implementation against the benefits from being able to give banks more flexibility in downturns. For achieving the policy objective of mitigating the destabilising effect of excessive credit growth and supporting credit supply in a crisis, one should seek early implementation of the buffer. However, if more weight is put on avoiding negative effects on credit supply during normal times, one should aim to only introduce a buffer when there are clear signals of the build-up of systemic risk and the probability of a crisis is high. Regarding the release in a downturn, Galaasen and Solheim (2018) argue that the buffer should be released as soon as losses materialise and banks start to constrain credit to meet capital requirements.

3.2.2 Calibration

The calibration of a sectoral CCyB would need to be in line with the targeted objectives. As discussed in Section 2, the objectives of a sectoral CCyB could be twofold: to lean against the build-up of imbalances in particular credit segments, and to increase resilience to the materialisation of credit losses if such imbalances unravelled. While the focus of the Basel III countercyclical capital buffer framework is mainly on the resilience aspect, policymakers' preferences regarding the relative weight attached to these two objectives may differ across jurisdictions.

As a sectoral CCyB would change the relative capital charge for different credit segments, the instrument might provide banks with stronger incentives to reduce credit to the targeted segments than the Basel III CCyB. Galaasen and Solheim (2018) find that, while the period-by-period effect of an increase in the capital requirement of 2.5% on credit supply is seen as small, a buffer of 2.5% (even if only imposed on a sectoral basis) would potentially have considerable dampening effects on the credit cycle. Also, in Castro (2018), a sudden permanent increase of 2.5 percentage points of the sectoral CCyB on commercial and consumer credit, respectively, had a substantial negative impact on credit in the targeted segments.

As mentioned, the assumption that banks can only increase capital adequacy by retaining earnings and/or reducing assets and the fact that the models do not allow for the shifting of credit activity to non-bank institutions are conducive to the finding of a sectoral CCyB being effective in reducing credit in the targeted segment. Indeed, Behncke (2018) finds the impact on mortgage credit growth of the Swiss sectoral CCyB, which was calibrated at 1% and later on increased to 2%, to be much weaker than the theoretical effects simulated in Galaasen and Solheim (2018) and Castro (2018). Her findings are in line with the conclusion by the BCBS (2018) that a sectoral CCyB may limit loan growth in targeted sectors, but effective leaning requires adequate calibration of the measure.

Regarding resilience, the fact that a sectoral CCyB applies only to a subset of credit exposures implies that, for the same buffer rate, a sectoral CCyB would result in a lower capital buffer than the Basel III CCyB. The exercises in Castro (2018) suggest that if a sectoral CCyB is to be introduced in substitution for a broad CCyB in the Brazilian three-sector case, the calibration of the sectoral buffer rate should be roughly twice as high in order to achieve the same resilience and stabilisation impact on macroeconomic variables. The same applies in the two-sector model for Norway by Galaasen and Solheim (2018). Of course, as noted by Castro (2018), the more granular the implementation of the sectoral CCyB, the lower the contribution of each individual sectoral buffer to total capital requirement and to bank resilience.

The amount of capital needed to guarantee a sufficient resilience of the banking sector eventually depends on whether credit losses are contained within the credit segment in which credit was deemed excessive in the boom, or instead also materialise in other credit segments. Galaasen and Solheim (2018) illustrate how a sectoral shock can spill over to other sectors through a bank lending channel if banks lend to several different sectors. That is, losses in one sector could affect bank lending in other sectors and lead to a general fall in the supply of credit. Ferrari and Rovira Kaltwasser (2019) find for the United States that losses in downturns may not be limited to those credit segments in which credit developments were exuberant in the upswing.

4. Policy implications and conclusions

This report summarises the RTF-CCyB work stream's theoretical and empirical results that are relevant in the context of a sectoral application of the CCyB. While most of this research has not been published yet and many members will continue to work on their analyses and conclusions, it allows drawing some tentative policy insights.

Overall, the research conducted by the work stream confirms the conclusion by the BCBS (2018): there is a justified need for sectoral macroprudential tools and a sectoral CCyB may be a useful addition to the countercyclical capital buffer framework. Empirical evidence in Fiori and Pacella (2018) and Ferrari and Rovira Kaltwasser (2019) stresses the importance of monitoring sectoral credit cycles. For the cases of Italy and the United States, they find that aggregate credit cycles mask cross-sectoral variation. Therefore, they recommend to monitor individual credit segments in addition to the broad credit aggregates used as a reference guide for policy decisions in the Basel III CCyB. Furthermore, their results indicate that credit booms in some credit segments may lead to an increase in bank losses and financial stress, thereby contributing to systemic risk. Therefore, both studies argue for careful monitoring of sectoral credit cycles and a more targeted approach for dealing with cyclical systemic risk. Galaasen and Solheim (2018) and Castro (2018) illustrate the benefits of a sectoral application of the CCyB in models calibrated to Norway and Brazil, respectively. Castro (2018) shows that a sectoral CCyB may be at least as effective as the Basel III CCyB in increasing resilience and reducing credit and GDP volatility. According to Galaasen and Solheim (2018), the main advantage of a sectoral buffer is that it is more cost effective by only restricting credit growth in the upturn to the booming sector. Behncke (2018)'s results show that the sectoral CCyB in Switzerland helped lean against a build-up of risks, as it led to a reduction of mortgage loan growth and LTV risks. In addition, there were no unintended consequences on LTI risks or on other credit segments. From a financial stability perspective, the activation of the sectoral CCyB in Switzerland was positive. Moreover, the instrument acted as a complement to the LTV cap implemented a few months before the sectoral CCyB activation.

However, the effectiveness of a sectoral CCyB in these different dimensions depends on the structure of the banking sector and the broader financial system in a given country. Behncke (2018) argues that the ability of a sectoral CCyB to influence credit is lower if the banking sector is better capitalised and holds large buffers above the minimum requirements. The effectiveness of a sectoral CCyB in leaning against the cycle also depends on the extent to which sectoral credit cycles are bank-driven. For instance, while Ferrari and Rovira Kaltwasser (2019) find evidence of sector-specific credit cycles in the United States, non-bank credit plays an important role in sectoral credit developments. While in such circumstances the instrument could still be effective in shielding banks from losses stemming from excessive credit developments at the sectoral level, the ability to lean against sectoral credit growth may be limited. Of course, the above caveats on effectiveness in leaning against the build-up of risks apply to the Basel III CCyB as well. When comparing the value added of a sectoral CCyB to the Basel III CCyB, Galaasen and Solheim (2018) show that a sectoral buffer would be particularly efficient in a banking system in which individual banks focus their lending on specific sectors. If the banking sector consists of universal banks that can make an internal trade-off between sectors, they find that the possible gains from a sectoral buffer would be more limited.

The research of the work stream also discusses a number of challenges in the design and use of a sectoral CCyB and offers some insights in this context. Broadly speaking, the challenges of adding a sectoral CCyB to the countercyclical buffer framework relate to finding the appropriate balance between flexibility and efficiency gains on the one hand, and the cost of increased complexity of the framework on the other hand. In this regard, Castro (2018) shows that, while a sectoral approach proves to be more flexible than the broad-based approach in the Basel III countercyclical capital buffer framework, it may come at a cost of more frequent policy interventions if credit cycles do not evolve synchronously across credit segments. In addition, the work by Ferrari and Rovira Kaltwasser (2019) and Fiori and Pacella (2018) shows that monitoring and analysing risks in different credit segments may be particularly challenging, as

it requires sufficiently granular data on sectoral credit segments for sufficiently long time periods. The operational complexity increases with the degree of granularity at which a sectoral CCyB would be applied.

The trade-off between effectiveness and efficiency on the one hand and data requirements and complexity of the framework on the other, puts a limit on the number of segments that policymakers can reasonably target with a sectoral CCyB. The models by Galaasen and Solheim (2018) and Castro (2018) focused on two and three subsectors, respectively. Fiori and Pacella (2018) argue that in presence of data constraints for Italy the six-sector decomposition could strike the right balance between the maximum level of sectoral granularity achievable and relevance for policymaking, since it controls for type of activity and firm size, exposure to cyclical fluctuations and prudential capital requirements. For the United States, Ferrari and Rovira Kaltwasser (2019) find that RRE and CRE mortgages, and to a lesser extent credit to C&I, are the most systemically relevant credit segments. Overall, the findings for these two countries suggest that it is important to distinguish between credit to households and corporates and, within those segments, between credit for real estate purposes and other purposes. The Swiss sectoral CCyB analysed in Behncke (2018) targets residential mortgage loans.

While the cross-border dimension is beyond the scope of the work stream's analyses, the number and nature of segments that would be targeted is also relevant in the context of international reciprocation in the countercyclical buffer framework. In particular, the application and monitoring of too many sectoral CCyB rates on top of the current Basel III CCyB rates in many different countries would substantially increase the burden of the countercyclical capital buffer framework. Furthermore, targeted segments should be easily defined and comparable across jurisdictions to facilitate replicability of the measure by other jurisdictions. A limited number of carefully selected systemically relevant credit segments would allow increasing the effectiveness and efficiency of the countercyclical capital buffer framework, while at the same time fostering cross-border coherence in segment definitions and facilitating the monitoring of risks in targeted segments across jurisdictions.

More generally, the number of credit segments that can be targeted by a sectoral CCyB also affects its interaction with the Basel III CCyB. In principle, a sectoral CCyB should address the exuberance in the targeted credit segment by raising banks' resilience to losses in the targeted credit segment and/or leaning against the further build-up of risks in the segment. In such cases, a sectoral CCyB would be a more efficient and potentially more effective alternative to the Basel III CCyB. However, according to Galaasen and Solheim (2018), a crisis might affect not only the credit segments that were exuberant in the upturn, but also other, non-targeted segments. Ferrari and Rovira Kaltwasser (2019) indeed find that losses in downturns may not be limited to those credit segments in which credit developments were exuberant in the upswing. In this context, the work stream's results indirectly plead in favour of having both a sectoral CCyB and Basel III CCyB in one framework that permits the use of the two buffers in a flexible way depending on the situation in the credit market. Limiting the application of a sectoral CCyB to a few systemically relevant and easily definable segments would capture gains from potential complementarities between a sectoral CCyB and the Basel III CCyB in a way that does not excessively increase the overall complexity of the framework.

Finally, while the research conducted by the work stream provides insights on sectoral credit cycles as well as on the transmission mechanism and operationalisation of a sectoral CCyB, there are still a number of open issues that warrant further analysis and research.

First, the findings are based on models, policy experience and data availability specific to the different countries under consideration. For instance, both in Fiori and Pacella (2018) and Ferrari and Rovira Kaltwasser (2019) some of the main findings can be driven by the global financial crisis. Furthermore, their findings may also depend on the definition of the credit segments in their analysis, which is in part driven by the sectoral breakdown of credit data available in the respective countries. Similarly, the empirical evidence in Behncke (2018) relies on the activation of a sectoral CCyB in a single country at a given point in time and at a given level of calibration. For instance, in Switzerland, most of the banks are well capitalised

and the sectoral CCyB increased capital requirements only somewhat. A tighter calibration or a similar calibration in a more capital-constrained banking system may generate stronger effects. Also the models of Galaasen and Solheim (2018) and Castro (2018) are calibrated to reflect the financial and/or real economic conditions in specific countries. For Norway, the results depend very much on the assumption that retail lending takes lower losses during financial crises than C&I lending, as has been the experience in Norway. The model in Castro (2018) is tailored to the Brazilian bank credit market and presents some peculiar features when compared to advanced economies, such as relatively low credit-to-GDP ratio (roughly 50%) and no shadow banking system. But the most striking country specificity is situated in the real estate loan market: it is relatively small (15% of total credit) and is regulated by the government, such that the influence of macroprudential instruments on this sector is quite small. There would therefore be merit in extending the analyses performed by the work stream to a larger set of countries and time periods. As also noted by the BCBS (2018), such a research agenda may entail filling data gaps, as sufficiently granular data on sectoral credit segments may not be available for sufficiently long time periods in all countries.

Second, while the work conducted in the work stream provides insights on the interaction of a sectoral CCyB with the Basel III CCyB and with LTV caps, empirical evidence on such interactions remains scarce. Regarding the interaction between a sectoral CCyB and the Basel III CCyB, the models by Castro (2018) and Galaasen and Solheim (2018) compare the effectiveness and efficiency of the two instruments when they are implemented as substitutes of one another. As for the interaction with other instruments, Behncke (2018) finds that in Switzerland the sectoral CCyB acted as a complement to the LTV cap implemented a few months before the sectoral CCyB activation. As both instruments have a different scope of application (new loans vs the stock of outstanding loans) and may affect different banks in a different manner, implementing a set of macroprudential instruments might be useful to increase the coverage in the banking system. However, further work is needed to improve our understanding of the potential complementarities between a sectoral CCyB and the Basel III CCyB, and of the interaction of (sectoral) capital requirements with other macroprudential instruments, such as borrower-based measures.

Third, the specific objective of (sectoral) countercyclical capital buffers in terms of resilience is to support credit in the downturn by making the accumulated buffers available to banks in downturns. Their effectiveness should therefore be assessed against achieving this ultimate objective. As already concluded by the BCBS (2018), there is a particular scarcity of papers focusing on the impact of a release of capital requirements, which are crucial to assessing countercyclical buffers' ability to support credit in downturns. The effects of the future release of activated buffers should therefore be carefully evaluated in order to gain insights into the ability of (sectoral) countercyclical buffers to achieve this objective. It will also be important in this respect to assess the extent to which other regulatory constraints, such as the leverage ratio and liquidity requirements, affect the usability of capital buffers in times of crisis.

References

- Auer, R and S Ongena (2016): "The countercyclical capital buffer and the composition of bank lending", *BIS Working Papers*, no 593.
- Basel Committee on Banking Supervision (2010): "Guidance for national authorities operating the countercyclical capital buffer", December 2010.
- (2018): "Towards a sectoral application of the countercyclical capital buffer: A literature review", *Basel Committee on Banking Supervision Working Paper*, no 32.
- Basten, C and C Koch (2017): "The countercyclical capital buffer", mimeo.
- Behncke, S (2018): "The effects of macroprudential policies on bank lending and credit risks", mimeo.
- Castro, M (2018): "Sectoral countercyclical buffers in a DSGE model with a banking sector", mimeo.
- Corbae, D and P D'Erasmus (2014): "Capital requirements in a quantitative model of banking industry dynamics", *Federal Reserve Bank of Philadelphia Working Paper*, no 14-13.
- Edge, R and R Meisenzahl (2011): "The unreliability of credit-to-GDP ratio gaps in real time: Implications for countercyclical capital buffers", *International Journal of Central Banking*, December, pp 261–298.
- Ferrari, S and P Rovira Kaltwasser (2019): "Sectoral credit cycles and systemic risk in the United States", mimeo, https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3332378.
- Fiori, R and C Pacella (2018): "Should the CCyB be enhanced with a sectoral dimension? The case of Italy", mimeo.
- Galaasen, S and H Solheim (2018): "Targeted countercyclical capital buffers", Norges Bank Staff Memo, no 13-2018.
- Lang, J and P Welz (2017): "Semi-structural credit gap estimation", mimeo.

Appendix: Abstracts of the research projects

Behncke (2018): The effects of macroprudential policies on bank lending and credit risks

This paper analyses the effects of two macroprudential policy measures on bank lending and credit risks: the activation of a sectoral CCyB and a cap on LTV ratios. Both measures have been implemented in Switzerland to limit systemic risks in the mortgage market. Some banks were more affected than others by the different measures. We use a conditional Difference-in-Differences method to estimate their effects. Our analysis is made possible by a rich bank panel data set. For the 25 largest mortgage banks covering almost 90% of the Swiss mortgage market, we combine data on quantitative risk indicators such as their LTV and loan-to-income (LTI) ratios and mortgage growth rates with supervisory information. We find that both the LTV cap and the sectoral CCyB led to a reduction of high LTV mortgages. Some of the banks affected by the sectoral CCyB also reduced their mortgage growth rates. We do not find any evidence that these measures had unintended consequences on LTI risks or on other credit growth rates.

Castro (2018): Sectoral countercyclical buffers in a DSGE model with a banking sector

This paper develops and estimates a closed economy DSGE model with a banking sector to assess the impact of introducing sectoral CCyBs as a macroprudential tool. The model was developed to suit Brazilian bank credit markets. It features three types of bank credit (housing, consumer and commercial) as well as loans provided by a development bank. Loans are long term, and the government regulates housing loans, influencing both interest rates and loan supply. Banks are subject to bank capital requirement, and both a broad CCyB and sectoral CCyBs can be introduced by macroprudential authorities. We simulated alternative policies using sectoral CCyBs and a CCyB with implementable nonlinear rules using broad and sectoral credit gaps as indicators, and compare the resulting performances. We conclude that, compared to the CCyB, sectoral CCyBs provide a more flexible set of instruments that allows achieving better macroeconomic stabilisation in terms of variances of credit, total capital requirement and CAR. However, the marginal benefit of those sectoral CCyB policies relative to the CCyB-only policy is lower than the improvements obtained by this latter policy compared to the reference scenario with no buffer. Also, sectoral CCyB policies called for more frequent intervention, suggesting that in practice introducing these additional instruments may require more complex implementation procedures.

Ferrari and Rovira Kaltwasser (2019): Sectoral credit cycles and systemic risk in the United States

This paper studies the properties and systemic risk implications of sectoral credit cycles for the United States over the period 1960Q1–2017Q3. The analysis shows that the credit cycle in the United States was indeed characterised by systemically relevant sector-specific boom/bust cycles during our sample period. Sectoral credit exuberance, with the exception of consumer credit, generally does not lead to broader credit exuberance within a period of one year. Taken together, these findings indicate that it may be useful to act upon sectoral credit cycles rather than on broad-based credit developments. Regarding the systemic relevance of sector-specific boom/bust cycles, the results indicate that CRE is the most systemic credit segment: exuberance in the sector-specific component of the CRE credit-to-GDP gap tends to be followed by a surge in financial stress and borrower delinquencies. Exuberance in the residential mortgage sector may also lead to financial stress and tends to be followed by a moderate rise in borrower delinquency rates. For sufficiently large shocks to C&I credit, there has been an increase in the aggregate credit risk at commercial banks in the United States, albeit not as strong as following sector-specific shocks to RRE and CRE mortgages. Finally, losses following a period of exuberance in sectoral credit developments are not necessarily limited to the exuberant credit segments. In particular, exuberance in CRE and RRE mortgage credit tends to raise delinquency rates in credit segments beyond real estate.

Fiori and Pacella (2018): Should the CCyB be enhanced with a sectoral dimension? The case of Italy

The aim of the paper is to investigate whether in Italy there is sufficient empirical support for the introduction of a sectoral countercyclical capital buffer (CCyB) in the macroprudential framework. We study the sectoral decomposition (considering up to six sectors, which is the maximum level of granularity achievable given data availability) of the credit-to-GDP gap over the period 1990Q1-2017Q2. Overall, our results suggest that a sectoral CCyB could be a useful addition to the macroprudential framework, as both the timing for activation and the size of the capital buffer could differ when accounting for the sectoral dimension of the credit-to-GDP gap. We find that the synchronicity of sectoral credit cycles over time decreases as we move from a two-sector to a six-sector decomposition. Moreover, the contribution of sectoral cycles to systemic stress, as measured by the system-wide new bad debt rate, as well as the prudential requirements associated to their risk exposure differs quite significantly. While exuberance in the non-real estate-related segment of corporate lending is usually followed by a surge in systemic stress, exuberance in the real estate-related segment of business lending as well as the following increase in the new bad debt rates does not spill over into other sectors. We conclude that a policy framework in which both broad-based credit and sectoral credit are strictly monitored, along with their implications for financial stability, would provide policymakers with sufficient information to select the most appropriate policy tool.

Galaasen and Solheim (2018): Targeted countercyclical capital buffers

This paper investigates the effect of broad-based versus sectoral capital requirements using a dynamic model of bank behaviour. We study the problem facing banks when determining their dividend policy and portfolio of long-term loans to the retail and corporate sector. The return on lending is uncertain, and capital requirements may be reduced when loan losses are high, in order to stabilise lending. We find that when shifting capital between sectors is difficult or very costly, targeted regulation, such as a sectoral countercyclical capital buffer (CCyB), can lead to more stable lending during a crisis than a broad-based CCyB, at a lower cost. This depends on the ability of the policymaker to foresee the type of crisis. A targeted requirement is ex-post an inefficient policy if crises occur in sectors where the buffer requirement is inactive, as the targeted policy cannot effectively stabilise credit. However, the consequences of policy "mistakes" depend on the degree of sectoral segmentation in the banking market. Banks that provide credit to both the retail and the corporate sector will endogenously reallocate capital to the constrained sector in a crisis, irrespective of the kind of regulatory buffer that is implemented, thereby dampening the consequences of such inefficient policy.