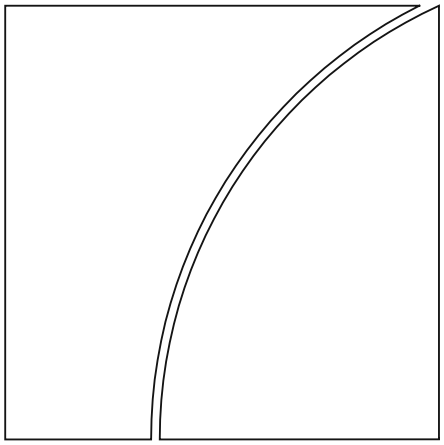
Basel Committee
on Banking Supervision

Working Paper 32

Towards a sectoral application of the countercyclical capital buffer: A literature review

March 2018



BANK FOR INTERNATIONAL SETTLEMENTS

The Working Papers of the Basel Committee on Banking Supervision contain analysis carried out by experts of the Basel Committee or its working groups. They may also reflect work carried out by one or more member institutions or by its Secretariat. The subjects of the Working Papers are of topical interest to supervisors and are technical in character. The views expressed in the Working Papers are those of their authors and do not represent the official views of the Basel Committee, its member institutions or the BIS.

This publication is available on the BIS website (www.bis.org/bcbs/).

Grey underlined text in this publication shows where hyperlinks are available in the electronic version.

ISBN 978-92-9259-146-5 (online)

Contents

List of members of the RTF work stream

Chairperson	Mr Stijn Ferrari	National Bank of Belgium
Belgium	Mr Pablo Rovira Kaltwasser	National Bank of Belgium
Brazil	Mr Marcos Castro	Central Bank of Brazil
Germany	Mr Marcus Pramor	Deutsche Bundesbank
Italy	Ms Roberta Fiori Ms Claudia Pacella	Bank of Italy
Mexico	Mr Calixto Lopez Castanon	Bank of Mexico
Norway	Mr Haakon Solheim Mr Kjell Bjørn Nordal	Central Bank of Norway
Switzerland	Ms Stefanie Behncke	Swiss National Bank
Secretariat	Mr Martin Birn Mr Davy Reinard	Bank for International Settlements

Towards a sectoral application of the countercyclical capital buffer: A literature review

The aim of this paper is to review the existing literature on the (sectoral) countercyclical capital buffer. Since the literature directly addressing this topic is relatively scarce, we also include relevant papers that are only indirectly related. We draw insights from the theoretical and empirical literature and use these to shed light on whether the countercyclical capital buffer (CCyB) setting in the Basel III framework could be extended towards a sectoral application of the CCyB. Rather than aiming at providing an exhaustive overview of the literature reviewed, the aim is to draw focused messages that could serve as sufficiently grounded arguments in the debate.

The main messages drawn from the literature review are the following:

(i) The literature reviewed suggests that sectoral risks, in sub-segments of both the household sector and the corporate sector, have the potential to adversely affect bank stability as well as the broader economy, and therefore, may give rise to systemic risk. While the impact of both the Basel III CCyB and the sectoral application of the CCyB to a large extent remains an empirical question, the literature reviewed provides reasons to believe that in the presence of sectoral risks to financial stability, especially in combination with low overall growth prospects, a sectoral application of the CCyB may have a more direct impact on the area of concern, stronger signalling power and smaller effects on the wider economy than the Basel III CCyB.

(ii) A sectoral CCyB could aim to increase resilience against risks in particular sectors in order to maintain credit provision to these and other sectors in a downturn, and to lean against the cycle in the targeted sectors. As a sectoral CCyB would change the relative capital charge for different credit segments, the instrument might be more successful in leaning against sectoral imbalances than the CCyB. The literature suggests that there is potential for a sectoral CCyB in raising banks' resilience to sectoral risk at low overall cost of foregone credit. However, the instruments' ability to support credit by releasing the buffer in downturns remains largely untested. The evidence also shows that sectoral capital requirements may limit loan growth in targeted sectors, but effective leaning requires adequate calibration and sufficiently early activation. Overall, the appropriate level of a sectoral CCyB and its timing of activation throughout the credit cycle would depend on the targeted objective.

(iii) Generally, macroprudential instruments that operate through different channels are likely to complement each other. The literature reviewed indicates that a sectoral CCyB could indeed be a useful complement to alternative sectoral macroprudential measures, including borrower-based measures such as LTV, LTI and D(S)TI limits. To the extent that a sectoral CCyB is more effective in increasing banks' resilience and borrower-based measures more successful in leaning against the sectoral credit cycle, both objectives could be attained more effectively and efficiently by combining the two types of instruments. Furthermore, there is some evidence that suggests that a sectoral CCyB could have important signalling effects and may therefore act as a substitute for borrower-based measures.

(iv) Spillover effects to untargeted sectors or other jurisdictions, either positive or negative, after the activation of a sectoral CCyB should be monitored and assessed against the state of the credit cycle in these sectors or jurisdictions. The literature reviewed provides scarce and somewhat mixed evidence on such potential spillovers to untargeted sectors. In this context, also the need for reciprocity arrangements when applying a sectoral CCyB is to be considered. Following the application of broad-based capital measures, leakages to foreign bank branches have been observed for both lending to non-financial firms and mortgage lending.

We also identified a number of gaps in the literature and areas for future research that need to be filled and pursued in order to gain a better understanding of the transmission of the macroprudential policy instruments under consideration:

(v) Macroprudential policymakers should take a system-wide perspective with a focus on those sectors that may entail risks to the stability of the broader financial system and the real economy. This requires further research on the implications of sectoral credit cycles for systemic risk. In addition, analyses on the intertemporal relationships between different credit cycles as well as the causality of these relationships would be important for the further development of the policy framework describing the interaction of the broad-based and a potentially more targeted application of the CCyB. This policy and 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.

(vi) To date, there is very little empirical analysis of the effects of the actual activation of the Basel III CCyB. More generally, 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 be carefully monitored in order to gain insights in the ability of countercyclical buffers to achieve this objective. In this context, interactions with other prudential instruments, such as the leverage ratio and liquidity requirements, should be considered as well.

Overall, the literature review shows that there is a justified need for sectoral macroprudential tools, and 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 empirical work is needed to assess their ability to achieve the different objectives that may be 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. It would also add an additional layer of complexity to the macroprudential capital buffer framework. While they are crucial for the further development of the policy framework on a sectoral CCyB, such operational issues are beyond the scope of this paper.

1. Introduction

The global financial crisis has been a painful reminder that microprudential regulation is necessary but not sufficient to maintain financial stability. The regulatory reforms after the crisis contained an intensified focus on macroprudential policy. In contrast to microprudential regulation, macroprudential policy takes a system-wide view and accounts for endogenous factors that give rise to systemic risk. This view can aid microprudential regulation in addressing a number of market failures that occur when agents do not internalise the negative externalities that their decisions can have on the rest of the financial system.[1] This may lead to collective behaviour resulting in increased risk-taking and excessive leverage in the financial system and in the real economy during boom periods and fire sale and credit crunch externalities in downturns.

By building up an additional capital buffer against total risk-weighted assets in periods of excessive credit developments, the countercyclical[2] capital buffer (CCyB) is one of the key macroprudential instruments in the Basel III reforms for dealing with such market failures and the associated externalities. However, because of its application to total risk-weighted assets, it has been argued that the CCyB may be a blunt tool. In the presence of sectoral risks to financial stability, especially in combination with low overall growth prospects, a sectoral application of the CCyB may have a more direct impact on the area of concern, stronger signalling power and smaller effects on the wider economy than the CCyB.

The aim of this paper is to draw relevant insights from the existing literature and use these to shed light on whether the CCyB setting in the Basel III framework could fruitfully be extended towards a sectoral application of the CCyB. Rather than aiming at providing an exhaustive overview of the relevant literature reviewed, the aim is to draw focused messages that could serve as sufficiently grounded arguments in the debate. Furthermore, we also attempt to identify gaps in the literature and areas for future research that need to be filled and pursued in order to gain a better understanding of the transmission of the macroprudential policy instruments under consideration.

While we aim at drawing focused messages, it should be kept in mind that each of the reviewed studies and their findings are subject to caveats and should be interpreted with caution. The BCBS (2016) highlights a number of issues with the literature that may all apply to a more or lesser extent to the studies discussed in this literature review as well. In brief, while theoretical studies rely on a range of simplifying assumptions and often face difficulties in the calibration to real world data, the outcome of empirical studies assessing the impact of policy measures crucially depends on a number of factors, such as the specific scope, design and calibration of the measure, the general macroeconomic and financial conditions at the time of the implementation of the measure, and the data and methodology used in the empirical assessment of the impact of the measure. Therefore, results on the impact of past macroprudential measures are not necessarily representative for the impact of future policy actions.

The remainder of this review is organised as follows. Section 2 provides a provisional assessment of the (potential) transmission of the CCyB that serves as a background for setting objectives and assessing the potential effectiveness of a sectoral CCyB. In Section 3, we show the importance of sectoral developments for systemic risks. Against this background, Section 4 assesses the potential scope for a sectoral CCyB in dealing with sectoral risks. In particular, we show that the literature provides reasons to believe that the Basel III CCyB may be an inefficient tool and can even be counterproductive in some economic circumstances. Furthermore, some preliminary lessons are drawn from the scarce literature

[1] See De Nicolo et al (2012) and Borchgrevinck et al (2014) for an in-depth discussion.

[2] It should be noted that the "countercyclical" capital requirement as such is procyclical, as capital buffers are built-up in the upswing. The term "countercyclical" refers to the fact that the capital requirement or buffer acts against the cycle.

focusing on the impact of sectoral capital requirements. Finally, we provide arguments for why a sectoral CCyB may be a useful complement to other already existing sectoral instruments.

2. Provisional assessment of the CCyB

2.1 Objectives of the CCyB

After the global financial crisis, the Basel III reforms strengthened the global capital framework by requiring banks to hold more and higher-quality capital (BCBS (2010a)). Indeed, better capitalised banks are less vulnerable to shocks. This reduces the probability and expected costs of future banking crises and therefore, contributes to the stability of the financial system. A comprehensive survey of the literature assessing these (net) benefits of higher capital requirements can be found in BCBS (2016).

In this context, the Basel III package also introduced the CCyB. The CCyB became part of the international macroprudential toolkit in 2016. The purpose of this buffer is to protect the banking sector from periods of excess aggregate credit growth, with the aim of ensuring that the banking sector in aggregate has the capital on hand to help maintain the flow of credit in the economy without its solvency being questioned, when the broader financial system experiences stress after a period of excess credit growth (BCBS (2010b)). The BCBS (2010b) also notes that in addressing the aim of protecting the banking sector from the credit cycle, the CCyB regime may also help to lean against the build-up phase of the cycle. It is emphasised, however, that this potential moderating effect on the build-up phase of the credit cycle should be viewed as a positive side benefit, rather than the primary aim of the CCyB regime. Furthermore, it is also explicitly stated that the CCyB is not meant to be used as an instrument to manage economic cycles or asset prices.

Several papers provide theoretical foundations for introducing countercyclical capital requirements. For instance, Repullo and Suarez (2013) use a dynamic equilibrium model of relationship lending calibrated on data for the United States prior to the global financial crisis to show that capital requirements should be higher than those under Basel II when the social cost of bank failure is high. At the same time, capital requirements should be less procyclical, in order to avoid increased credit rationing in recessions. The findings rely on the assumption that in downturns, some banks are unable to raise equity and some borrowers are unable to avoid credit rationing by switching to other sources of finance. Jokivuolle et al (2014) provide an alternative motivation for countercyclical capital requirements. Instead of assuming a constrained supply of bank capital in recessions, they develop a theoretical model in which asymmetric information between banks and firms leads to adverse selection and therefore a suboptimal allocation of bank loans between high- and low-risk projects. It is shown that risk-based capital requirements can eliminate the market failure and that when success probabilities of projects decline in times of recession, optimal capital requirements will have to be lower because market failure related to inefficient project allocation will be lower. Gersbach and Rochet (2017) develop a simple model with a complete market setting in which banks lend too much in high productivity states and too little in bad states. Imposing a stricter capital requirement in good states corrects capital misallocation, increases expected output and social welfare.

From an empirical perspective, the literature shows the destabilising effects of the build-up of leverage during periods of excessive credit growth (eg Jiménez and Saurina (2006), Schularik and Taylor (2012), Jordá et al (2013, 2014), Aikman et al (2015)), as well as the impact of procyclical risk-based capital regulation on bank lending (eg Behn et al (2016a), see also Athanasoglou et al (2014) and references therein for a broader discussion on bank procyclicality), providing an argument for (countercyclical) macroprudential policies.

2.2 Effectiveness of the CCyB

As only a handful of countries have activated the CCyB, evidence on its effectiveness is scarce. In fact, to date, there is very little empirical analysis of the effects of the actual activation of the Basel III CCyB. The academic and policy literature nevertheless provides both theoretical and empirical arguments and results that allow an indirect and provisional evaluation of the effectiveness of the CCyB.

From a theoretical perspective, the CCyB tends to be effective in reducing credit and output volatility, thereby increasing welfare. However, the transmission mechanism of higher capital requirements as well as the conditions under which the finding of positive effects of the CCyB hold are highly dependent on the model setup and its underlying assumptions. For instance, many models assume that banks can only increase capital adequacy by retaining earnings and/or reducing assets, which may overestimate the impact of capital requirements on credit.

A large literature using dynamic stochastic general equilibrium (DSGE) models calibrated on various countries shows the welfare improving effects of the CCyB (see Table 1). While often only approximately capturing the design of the CCyB, a number of these papers show that the gains of implementing a CCyB may be dependent on several factors, such as the type of shock hitting the economy. In particular, the CCyB tends to have stabilising effects after financial or housing demand shocks, but not after productivity or technology shocks and international macro shocks (eg Angelini et al (2014), Benes et al (2014), Arango and Valencia (2015), Benes and Kumhof (2015), Carvalho and Castro (2015b), Lozeij et al (2017)). Also other elements may affect the net benefits of the CCyB: Clerc et al (2015) find that the CCyB reduces output volatility and increases welfare only when minimum capital requirements are sufficiently high, whereas Angelini et al (2014) show that the impact of the CCyB may depend on whether there is cooperation between monetary and macroprudential policy.

Welfare improving effects of the CCyB — Table 1

Paper	Country	Conditioning variable	Impact on output volatility	Impact on welfare	Unintended consequences
Caicedo Soler et al (2012)	Colombia	Credit to GDP gap	Lower volatility	N/A	N/A
Alpanda et al (2014)	Canada	Credit gap (no release, however)	Lower output in good times	N/A	Higher monitoring cost
Angelini et al (2014)	N/A	Deviation of loans to output ratio from ratio of steady state loans and output	Lower volatility after financial shock	N/A	After technology shock, lack of cooperation between policies leads to substantial volatility of the policy rate and capital requirements without macroeconomic stabilization
Benes et al (2014)	N/A	Credit growth	Lower volatility after financial shock	Shock dependent	Higher volatility after technology shock

Hollander (2014)	United States	Deviation of output from steady state	Lower volatility	N/A	N/A
Arango and Valencia (2015)	United States, European data	Output gap	Lower after monetary shock, higher otherwise	Shock dependent	Increased volatility in inflation and bank riskiness after productivity or financial shock
Benes and Kumhof (2015)	United States	Deviations of either output, the loan stock or the loans to output ratio from their trends	Lower volatility after financial shock and aggregate demand shocks associated with a demand for bank loans, higher otherwise	Significant increase in welfare	Procyclical effect after technology, monetary and aggregate demand (not associated with a demand for bank loans) shocks
Carvalho and Castro (2015b)	Brazil	Deviation of credit from steady state	Lower volatility after financial shock	N/A	N/A
Clerc et al (2015)	N/A	Deviation of credit from steady state	Lower volatility when minimum capital requirement is high	Positive welfare effect when minimum capital requirement is high	Higher volatility when minimum capital requirement is low
Ferreira and Nakane (2015)	Brazil	Range of anchor variables, credit growth performs best	Lower volatility	Modest welfare improvement	N/A
Mendicino et al (2015)	Euro area	Deviation of total credit from long-run mean	Lower volatility	Small welfare improvement	Increase in bank default risk in downturn
Clancy and Merola (2016)	Ireland	Deviation of credit to GDP from steady state	Real consumption and output less volatile	Substantial positive welfare effect	Aggressive release at cost of higher debt level
Karmakar (2016)	United States	Output growth	Lower volatility	Positive welfare effect	N/A
Lewis and Villa (2016)	N/A	Deviation of credit from steady state	Lower volatility	N/A	N/A
Mendicino et al (2016)	Euro area	Deviation of expected borrower default probability from steady state	Lower volatility	Small welfare improvement	N/A

Pool (2016)	Euro area	Deviation of credit to GDP from steady state, deviation of aggregate bank leverage from steady state	Lower volatility, strongest effect with aggregate bank leverage	Trade-off between cycle amplitude and cycle persistence	Makes recovery more sluggish
Rubio and Carrasco-Gallego (2016)	N/A	Deviation of credit from steady state	Lower volatility	Potentially positive welfare effect	Reduced monetary policy transmission
Bluwstein (2017)	Euro area	Credit to GDP ratio	Lower volatility. Small impact in upswing, potentially large impact in downturn	Considerable welfare improvement	N/A
Lozeij et al (2017)	Ireland	Credit to GDP gap, deviation of house price from long-run value	Lower volatility after housing demand shocks	N/A	Negative effect after export demand or supply shock

Some other theoretical papers evaluate the potential effects of the CCyB based on (calibrated) models. For instance, Galaasen and Johansen (2016) present a dynamic banking model with an optimising bank that lends to both households and the corporate sector. The assumption is that banks can increase their capital ratio by retaining net profits or selling loans. Based on a calibration of the model using balance sheet and income statement data from seven of the largest Norwegian banking groups, they show that a cyclical capital regulation reduces the volatility of lending over the cycle considerably compared to a fixed capital requirement. While focusing on microprudential capital requirements, De Nicolo et al (2014) show on the basis of a behavioural model of banking that the (voluntary) build-up of capital buffers in the upswing reduces the risk of costly loan liquidations and contributes to strengthening banks' liquidity positions in a downturn. Horváth and Wagner (2017) argue that the welfare implications of a CCyB are ambiguous and warn against a potential unintended side effect of the CCyB. They develop a model in which welfare maximising capital requirements are countercyclical. However, when the correlation of risks is endogenous, the welfare implications of a CCyB are ambiguous: while countercyclical capital requirements reduce the impact of shocks on the economy ex-post, they also provide banks with incentives to become more correlated ex-ante, thereby increasing systemic risk.

Like any other capital requirement or buffer, the CCyB aims at fostering resilience by increasing the amount of capital available for absorbing bank losses. What is specific to the aspect of resilience in the context of the CCyB is its objective of supporting credit by releasing the buffer in downturns. Effectiveness of the CCyB in increasing resilience should therefore be assessed against this objective. As mentioned, the theoretical studies reviewed often only approximately capture the design of the CCyB and only very few include the option of bank default (eg Clerc et al (2015), Mendicino et al (2015, 2016) and Lewis and Villa (2016), see also Benes and Kumhof (2015)). Yet, a number of papers do have an explicit role for the resilience aspect (in addition to the impact of leaning against the cycle in the upswing) of the CCyB. For instance, in Benes et al (2014) and Benes and Kumhof (2015) banks respond to losses by increasing spreads and cutting credit. More capital in good times will reduce the need to cut lending in bad times. A similar effect is present in the model by Clancy and Merola (2016). They also compare a quick

release and gradual release of the CCyB and find that the more aggressive policy stance during the release phase prevents the economy from entering a recessionary period. The results of Clerc et al (2015) suggest that introducing a countercyclical adjustment mitigates the reduction in the supply of credit to the economy, but does so at the cost of an increase in bank default and, thus, a higher overall cost of funds for banks (see also Mendicino et al (2015, 2016)). They conclude that relaxing capital standards only works well when the starting capital requirement position is strong (ie when bank default risk is already very low). Mendicino et al (2015) conclude in this context that the gains from an aggressive countercyclical adjustment in capital requirements are unwarranted. These findings suggest that macroprudential regulators need to account for the impact of buffer release on bank failure risk when pursuing the objective of supporting credit in a downturn.

From an empirical perspective, the literature provides some evidence pointing towards the potential of a buffer release for maintaining credit growth in downturns. Chen et al (2017) use the experience in Slovenia of the release in the fourth quarter of 2008 of a prudential filter that was in place since the third quarter of 2006. Based on bank panel data regressions they find that banks with a higher capital ratio prior to the release of the capital buffer had a higher probability of maintaining credit growth after the release of capital buffer. Jiménez et al (2017) find a substantial positive impact on bank lending from a release of the capital buffer in Spain. However, they note that the ability of banks to keep up lending in the wake of the financial crisis was highly dependent on how much capital they had put aside under the dynamic provisioning programme, implying that capital buffers should be sufficiently large in order to be able to support credit in downturns. Bahaj et al (2016) estimate for the United Kingdom that when credit growth is weak, a 25 basis point increase in the requirement can cause lending to fall by an extra 4%. Also using data for the United Kingdom, Bridges et al (2015) also find that the reaction of lending is stronger when the output gap is negative. To the extent that the impact of a reduction in capital requirements is symmetric to that of an increase, this would imply that the CCyB may be effective in supporting lending in downturns. However, Bridges et al (2015) find that when capital requirements are reduced, the increase in lending to the CRE sector and secured household lending is lower than the decrease following an increase in capital requirements. Finally, Kraft and Galac (2011) consider changes in Croatian macroprudential policy before 2008 to look at the effect of policy changes on bank variables based on empirical investigations and panel data regressions. They find that stricter regulation in the first part of the 2000's improved the capital and liquidity position of Croatian banks, but the impact on bank lending seems to have been small. Croatia handled the financial crisis in 2008–09 without any bank failures, but the real economy was still heavily affected. Yet, the authors argue that things would have been worse without tight regulation before the crisis.

Regarding the ability of the CCyB to lean against the cycle, the literature on the economic costs[3] of capital requirements, while representing a range of approaches and views, suggests that higher capital requirements may, in the short term, reduce lending and economic activity (BCBS (2016)). This suggests that the activation of the CCyB could indeed help to lean against the build-up phase of the cycle. However, there is very little evidence on the impact of actual countercyclical capital requirements on lending. From the literature reviewed, the results of empirical studies with a more specific focus on countercyclical capital requirements tend to be mixed regarding the ability to slow down credit growth (see Table 2).

In support of the CCyB's effectiveness in the upswing, Drehmann and Gambacorta (2012) simulate the effect of the CCyB on bank lending using Spanish data and conclude that the CCyB can reduce procyclicality in addition to the beneficial effects of higher resilience to shocks. Based on dynamic multi-equation macroeconometric model for Norway, Akram (2014) simulates that an increase in capital requirements in line with what is suggested in Basel III (consisting in a 2.5% CCyB on top of a 2.5% capital conservation buffer) should have a significant impact on credit and house prices through the effect on lending rates. Fraisse et al (2017) establish that an increase in capital requirement reduces bank lending

[3] In line with the objectives of the CCyB as set out by the BCBS (2010a), the short-term economic cost in terms of reduced lending may be considered to be a positive side benefit in the context of the CCyB.

through both the decision of granting a loan in the first place (extensive margin) and, to a lesser extent, through size of loans if a loan is granted (intensive margin). The assessment of the former, however, hinges on an assumption of which bank is a potential lender to a given firm and on the capital requirement that would apply to this loan. Noss and Toffano (2016) find that an increase in the (non-risk weighted) capital ratio by 15 basis points can give median reduction in bank lending of 1.4 % after 16 quarters. Finally, the cross-country evidence in Akinci and Olmstead-Rumsey (2015) suggests that countercyclical capital measures have a significant negative impact on total credit growth but no significant effect on housing prices.

Effectiveness of the CCyB in slowing down credit growth — Table 2

Paper	Methodology	Country	Time period	Simulated "CCyB"
Studies in support of the CCyB's effectiveness in the upswing				
Drehmann and Gambacorta (2012)	Counterfactual simulation based on estimated lending equation	Spain	1986–2009	2.5%
Akram (2014)	Simulation based on calibrated theoretical model	Norway	1992–2010	2.5% (on top of 2.5% capital conservation buffer)
Akinci and Omstead-Rumsey (2015)	Country-level panel data regressions	57 countries	2000–13	N/A
Fraisse et al (2015)	Loan-level panel data regressions	France	2008–11	1%
Noss and Toffano (2016)	VAR model with sign restrictions	United Kingdom	1986–2010	0.15%
Studies raising doubt on the CCyB's ability to slow down credit growth				
Francis and Osborne (2012)	Partial adjustment model and bank-level panel data regressions	United Kingdom	1996–2007	3%
Claessens et al (2014)	Bank-level panel data regressions	48 countries	2000–10	N/A
Havemann (2014)	Structural macro-economic model	South Africa	2003–07	1%
Bahaj et al (2016)	Local projections using bank-level data	United Kingdom	1989–2007	N/A
Jiménez et al (2017)	Difference-in-differences using loan-level data	Spain	2000–06	N/A
Meeks (2017)	Structural VAR model	United Kingdom	1990–2008	About 2%

Other empirical papers raise doubts on the CCyB's ability to slow down credit growth. For instance, Claessens et al (2014) analyse how changes in balance sheets of some 2,800 banks in 48 countries respond to specific macro-prudential policies and find that capital buffers may not be very effective through the cycle. Havemann (2014) analyses the effects of a variant of the CCyB used in South Africa in the 2003–07 period to manage a credit boom that the central bank judged to be potentially dangerous for financial stability. A 1 percentage point shock to the capital adequacy ratio is estimated to increase the bank lending rate by 0.4 percentage points, which is an effect similar to that of an interest-rate shock of between 0.3 and 0.4 percentage points. On the basis of this finding, the author concludes that capital adequacy increases may need to be quite large to have any meaningful impact on credit extension or on economic activity. Also the result of counterfactual simulations for the United Kingdom in Francis and Osborne (2012) and Meeks (2017) raises doubts about the ability of the CCyB to slow credit activity. Relying on the experience of the implementation of dynamic provisioning in Spain, Jiménez et al (2017) find that there is little effect on total lending of imposing stricter requirements: during a boom period, firms are

able to avoid credit rationing by switching to banks less affected by the policy. They also show that there is an important negative effect when the new requirements increased during crisis times. Similarly, Bahaj et al (2016) provide a theoretical model that predicts that lending is less sensitive to a change in capital requirements when lending prospects are good and legacy assets are healthy. They empirically show that in times of credit expansion (proxying good lending prospects and healthy legacy assets) an increase in capital requirements indeed has a minimal impact on lending. Using a simple derivation, Fraisse et al (2017) similarly show that risk weights only matter when equity is scarce: when equity is costless to raise, risk-weights do not play a role in determining a bank's portfolio.

The differences in results of the above papers may occur for many reasons, including the nature, timing and strength of the capital measures under investigation. Nevertheless, part of the potential lack of effectiveness of the CCyB in leaning against the cycle could stem from the possibility that credit provision may shift to intermediaries that are not subject to the CCyB requirement. In particular, credit substitution from non-banks may reduce the instrument's effectiveness in slowing down credit growth.[4] The empirical evidence of shifts from bank credit to non-bank credit after an increase in capital requirements is mixed. In a cross-country setting, Cizel et al (2016) find no evidence for credit substitution to non-bank credit after the introduction of price based measures (capital requirements): substitution effects to non-bank credit hold mainly for quantity based measures (including borrower-based measures such as caps on loan to value (LTV) ratios) and are stronger in advanced economies. Confirming the finding by Aiyar et al (2014a, b), De Marco and Wieladek (2015) and Uluc and Wieladek (2017) do not find evidence of substantial credit substitution by non-bank finance companies and capital markets in the United Kingdom. In contrast, Fraisse et al (2017) observe for French firms that the impact of capital requirements on firm investment is lower than the impact on bank lending, as firms partly replace bank debt by supplier debt. Similarly, based on a model for the banking system in the United Kingdom, de-Ramon et al (2012) estimate that the impact of increased capital requirements on corporate investment is lower than on bank loans to corporates. This suggests that firms can access alternative sources of finance.[5]

Finally, it should be noted that the effectiveness of the CCyB, both in the upswing and the downturn, may depend on the degree other prudential instruments constrain banks' actions. For instance, to the extent that a bank's assets on average attract a low risk weight, it may be that an unweighted leverage ratio requirement is in fact the more binding capital requirement. In such a case, the impact of the CCyB on credit growth is likely to be muted. Similarly, a release of the CCyB can only be effective in supporting credit in the downturn to the extent that no other prudential requirements, such as a leverage ratio requirement or liquidity requirements, put a binding constraint on banks' portfolio management. In this context, the Bank of England (2015) and the ESRB (2015) advocate a countercyclical leverage ratio buffer to be operated in tandem with the CCyB. The BCBS (2016) states that it would be natural to introduce in the leverage ratio constraint the same flexibility as is now present in the risk-based capital ratio in Basel III. In the context of interactions between capital and liquidity requirements, the BCBS (2016) discusses some evidence that suggests that adding liquidity requirements on top of capital requirements has a negative impact on credit. On the other hand, the contraction of bank credit would be less pronounced in the event that a shock materialises if liquidity requirements are in place.

To conclude, while the literature reviewed provides support regarding the potential benefits of the CCyB, the effectiveness of the CCyB remains an empirical question. Capital requirements might have

[4] Such credit substitution should not be detrimental in all circumstances. For instance, Cizel et al (2016) argue that there is a trade-off between market-based finance offering a "spare tire" in the supply of credit in times of systemic banking crises and market-based finance itself entailing (new) systemic risks by further fuelling non-financial private sector leverage and interconnections to the traditional banking sector.

[5] Credit substitution may also occur by competing banks not affected by the capital requirement. However, reciprocity arrangements in the context of the CCyB imply that the countercyclical buffer requirement applies to all banks. See also Section 4.3.2.

substantial and intended effects, but this depends on how banks choose to adjust their capital ratios[6] and on the extent to which borrowers are able to obtain funding from other sources. The latter should be accounted for when evaluating the effectiveness of the CCyB, as the impact on bank credit provision may overestimate the true effect on total lending. To date, there is very little empirical analysis of the effects of the actual activation of the Basel III CCyB.[7] More generally, there is a particular scarcity of papers focusing on the impact of a release of capital requirements, which are crucial to assessing the CCyB's effectiveness in achieving its primary objective, namely supporting credit in downturns.

3. Sectoral risks to financial stability

3.1 Sector-specific credit developments

As discussed in Section 2.1, the CCyB is specifically designed to protect the banking sector from risks stemming from the credit cycle. In this context, the BCBS (2010b) has proposed the credit to GDP gap as common reference guide for the activation of the CCyB. The usefulness of this indicator has received broad empirical support in BIS research (eg Borio and Lowe (2002), Borio and Drehmann (2009) and Drehmann et al (2010, 2011)) and other papers in the early warning literature (eg Detken et al (2014) and references therein). While the focus of the reference guide is on broad credit to capture all sources of debt funds for the private sector, vulnerabilities leading to potential systemic risk may not always be broad-based but instead build up at the sectoral level.

Indeed, several strands of literature suggest that it would be useful to analyse different components of total credit in a disaggregated manner. First, the literature on credit cycle synchronisation suggests that while credit market integration and business cycle co-movements lead to stronger credit cycle synchronisation, there is evidence that in many European countries non-financial corporations credit cycles and household mortgage credit cycles are not always very well synchronised. For instance, De Backer et al (2016) conclude that the lack of synchronicity between credit developments to households and non-financial corporations calls for capital-based macroprudential policy instruments that can be applied at the sectoral level. Samarina et al (2017) find that within countries, credit cycles for mortgages and business credit diverge more with more trade openness, higher GDP growth and lower interest rates. They conclude that there is a need for designing macroprudential policies that would address national specifics of credit cycles and systemic risk in the financial system. In an analysis of macro-financial linkages for the United States, Gerba (2016) shows that correlations between different credit segments with output vary over time as well as across credit segments. For instance, whereas consumer credit on average is slightly more correlated with output than household mortgage credit over the period 1953–2011, the latter's correlation with the business cycle was much larger over the period 2000–11. In contrast, the co-movement of total loans to firms and output is lower on average but far more stable over time. It should be noted that these papers only look at contemporaneous synchronisation. As discussed below, the choice of the relevant policy instrument (broad-based or targeted) requires knowledge on whether sectoral cycles are

[6] In response to an increase in capital requirements, banks can choose to reduce their voluntary management buffer above the minimum requirement, increase the level of capital (by reducing dividends or issuing new equity) and/or reduce the size of risk-weighted assets (by reducing lending or shifting lending to assets with lower risk weights). With respect to the last two cases, Behn et al (2016b) refer to expansionary deleveraging and contractionary deleveraging.

[7] Assessment of the effectiveness of the Basel III CCyB could also shed light on the importance for the transmission channel of the one-year period that banks are given to build up the buffer. To the extent that announcement effects dominate implementation effects, one would expect the implementation lag not to matter. The BCBS (2016) makes reference to the issue of "excessive market discipline", according to which, as sometimes claimed by banks, "markets do not care about transitional paths towards new capital standards and immediately request fully-loaded capital levels". In the context of the Swiss CCyB, Auer and Ongena (2016) find that the announcement effects are actually stronger than the implementation effects.

synchronised at short time lags. If this is the case, this would imply that sectoral imbalances tend to result in the build-up of broad-based vulnerabilities within a reasonable time span. In addition, in many of the above papers, 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 (eg mortgage credit vs. consumer credit) and credit to different corporate sectors could provide further useful insights on the required level of granularity in cyclical systemic risk assessment as well as the relevant credit segments to be targeted.

Also the literature on early warning models for banking crises corroborates the suggestion of considering sectoral credit cycles in isolation. For instance, Büyükkarabacak and Valev (2010) find for a sample of annual data for 37 developed and developing countries over the period 1990–2006 that household credit is statistically significant and economically important in affecting the likelihood of a banking crisis. Business credit is also found to matter, but the effect is weaker and less robust. The authors conclude that a differential policy of targeting household credit may reduce the likelihood of crises without limiting the growth enhancing effects of enterprise credit. Based on a sample of 17 advanced OECD countries going back to 1870, Jordà et al (2014) find that over the long run, both mortgage and non-mortgage credit help predict financial crises in an independent manner, especially in the post-WWII era. They conclude that financial fragility seems to have a variety of sources. Using data over the period 1975–2014, Anundsen et al (2016) estimate multivariate logit models to predict 33 banking crises in 20 OECD countries. They find that both the credit-to-GDP gap for credit to households and the one for credit to NFCs have a significantly positive and economically relevant effect on the likelihood of a financial crisis. Pseudo-R^2 and AUROC increase relative to a model where credit is not split up, leading the authors to conclude that there are gains from studying the different components of total credit in a disaggregated manner. They further find that while the impact of household credit to GDP gap is amplified when there is a house price bubble, this is not the case for business credit.

Finally, there is a strand of literature calling for a sectoral dimension in systemic risk assessment and management systems with the aim at capturing the impact of interactions across sectors. One of the findings of this literature is that credit risk developments can differ across economic sectors. For instance, Jiménez and Mencía (2007) and Fiori et al (2009) model historical default rates grouped by sectors of economic activities. In these models, macroeconomic variables represent the systematic risk component while sector-specific variables represent the idiosyncratic risk component. Both studies identify agriculture, manufacturing, construction, and trade as "cyclical" sectors, while mining and quarrying and utilities are "idiosyncratic" ones. Saldías (2013) addresses the importance of heterogeneity across corporate sectors in the euro area in terms of risk determinants and transmission, by taking into account both the cross-section dimension and the time series dimension of risk. On the basis of a contingent claims analysis for 12 sectors in the euro area over the period 2001–09, the paper shows that neglecting this heterogeneity by focusing only on the macro-financial determinants of risk would be misleading in terms of overall credit risk management, financial stability analysis and policy decisions. Accornero et al (2017) show significant dispersion across stock market return correlations for Italian corporate sector indices.

3.2 Systemic relevance of credit segments

As macroprudential policy takes a system-wide perspective, the focus of cyclical systemic risk assessments should be on those sectors that may entail risks to the stability of the broader financial system that are not covered by microprudential regulations. 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 shows that evolutions in sub-segments of both the household sector and the corporate sector have the potential to adversely affect bank stability as well as the broader economy, and therefore, may give rise to systemic risk.

Regarding the household sector, an area of particular concern is mortgage credit and the housing market. As documented by Jordà et al (2014) for a sample of 17 advanced OECD countries, the share of mortgage loans (including both residential and commercial real estate) in banks' lending portfolios has roughly doubled over the course of the past century and virtually the entire increase of bank lending to GDP ratios has been driven by the rapid rise in mortgage lending relative to output since the 1970s. Furthermore, they show that mortgage credit has important implications for financial fragility in advanced economies and has increasingly left its mark on business cycle dynamics. Forlati and Lambertini (2011) introduce endogenous default on mortgages in a DSGE model with housing and show that an unanticipated increase in mortgage risk produces a credit crunch where delinquencies and mortgage interest rates increase, lending is curtailed, and aggregate demand for non-durable goods falls. Using a DSGE model of the US economy that explicitly models the price and the quantity side of the housing market, Iacoviello and Neri (2010) find that collateral effects on household borrowing amplify the response of non-housing consumption to given changes in fundamentals and show that average spillovers from the housing market to the rest of the economy have become more important over time. Gelain et al (2013) introduce excess volatility in a DSGE model by allowing a fraction of households to employ simple moving-average forecast rules (ie adaptive expectations). This results in excess volatility and persistence of house prices and household debt, making the economy more vulnerable to negative shocks. Finally, a number of studies show the empirical relationship between real estate developments and bank instability or bank stock returns. For instance, Koetter and Poghosyan (2010) test two competing views of the relation between real estate markets and bank stability: the collateral value and the deviation hypotheses. The former suggests that higher prices increase the value of collateral and net wealth of borrowers and thus reduce the likelihood of credit defaults. In contrast, the latter theory argues persistent deviations from fundamentals may foster the adverse selection of increasingly risky creditors by banks seeking to expand their loan portfolios, which increases bank distress probabilities. Testing the hypotheses for 78 regional real estate markets in Germany over the period 1995–2004, they find that house price deviations from fundamentals contribute to bank instability, providing support for the deviation hypothesis. Nominal house price developments do not affect bank instability, implying that the collateral value hypothesis does not hold in the sample used by Koetter and Poghosyan (2010). Using a threshold model for the United States over the period 1990–2010, Pan and Wang (2013) find support for both the collateral value hypothesis and the deviation hypothesis: house price growth negatively affects bank instability, especially in recessions where income growth is below a particular threshold, whereas house price deviations from fundamentals contribute to bank instability, but only in recessions where income growth is below a particular threshold. It is also noteworthy that both Koetter and Poghosyan (2010) and Pan and Wang (2013) emphasise regional heterogeneity in housing markets in Germany and the United States, respectively. Finally, taking a cross-country perspective, Martins and Serra (2012) assess if bank stock returns are systematically affected by the real estate market conditions. By looking at the sensitivities of banking industry indices of 15 EU countries, the empirical results show the existence of a positive and statistically significant relationship between bank stock returns and real estate market returns. The results further show an increasing influence of real estate market movements in bank stock returns after the subprime crisis in Ireland, Spain and the United Kingdom.

Also idiosyncratic and sectoral developments in the corporate sector may give rise to systemic risk, for instance due to co-movements and spillovers within and across sectors. These sectoral aspects are not accounted for in microprudential capital requirements, which assume that a single risk factor is driving correlations across borrowers (Gordy (2003)). Using both theory and empirical evidence for the United States, Gabaix (2011) shows that idiosyncratic firm-level shocks can explain an important part of aggregate business cycle fluctuations and provide a microfoundation for aggregate shocks. More specifically, idiosyncratic shocks to large firms or, more generally, to large subunits such as sectors in the economy, affect aggregate outcomes. Lucas (1995) shows that sectoral or geographical factors may influence the default risk of otherwise unrelated firms. Acemoglu et al (2012) argue that, in the presence of sectoral input-output interlinkages, microeconomic idiosyncratic shocks might lead to aggregate fluctuations. The

rate at which idiosyncratic shocks propagate depends on the structure of the sectoral network: if there is a high degree of asymmetry in terms of the roles that different sectors play as direct or indirect suppliers to others, the interplay of sectoral shocks and network effects leads to sizable aggregate fluctuations. Interconnections might therefore give rise to cascade effects, whereby productivity shocks to a sector propagate not only to its direct customers, but also to the rest of the economy. The importance of cross-dynamics of risks across sectors in addition to the systemic impact generated by macroeconomic variables is also highlighted by a number of other papers, including Alves (2005), Jiménez and Mencía (2007), Fiori at al (2009), and Castren and Kavonius (2009). Finally, Accornero et al (2017) outline a framework for measuring credit risk in banks' exposures to non-financial firms which accounts for the role played by sectoral risk factors. Their measure can help to identify the economic sectors which might play a relevant role for the stability of the banking system in economic downturns, contributing more than others to potential losses.

To conclude, the literature reviewed suggests that sectoral risks may be important drivers of bank stability and real economic developments. Evidence shows that this may particularly be the case for mortgage credit, but also sub-segments of banks' business portfolios may be the source of system-wide risk. However, more work is needed to identify the required level of granularity in cyclical systemic risk assessment as well as the relevant credit segments to be targeted by macroprudential policymakers. In particular, a system-wide perspective with a focus on those sectors that may entail risks to the stability of the broader financial system and the real economy should be taken. This requires further research on the implications of sectoral credit cycles for systemic risk. In addition, analyses on the intertemporal relationships between different credit cycles as well as the causality of these relationships would be important for the further development of the policy framework describing the interaction of the broad-based and a potentially more targeted application of the CCyB (see Section 4.2). This policy and 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.

4. Potential scope for a sectoral CCyB

4.1 Sectoral risks and the CCyB

The use of a broad-based non-targeted CCyB has both advantages and disadvantages. For instance, Elliott (2011) argues that the CCyB is suited for targeting a general problem and is harder for the industry to work around. However, in cases where, as discussed above, systemic risks are building up in specific credit segments, a non-targeted approach may be inefficient or even counterproductive. In a policy document that summarises the main lessons from the IMF's 2011 Article IV consultations with European countries, the IMF (2011) states that the CCyB is a blunt tool and that the set of instruments emerging from the international consensus (ie Basel III capital requirements and borrower-based measures) appears too focused on taming broad-based credit booms and real estate bubbles, and not sufficiently aware of other specific channels and sources of risks. In particular, it is argued that when the build-up of imbalances is concentrated in particular sectors this could lead to a crisis well before the CCyB is triggered by aggregate developments. Finally, Tarullo (2014) argues that the CCyB is quite blunt and that it could in some circumstances have the unintended effect of encouraging banks to do more lending in the booming areas of concern, at the expense of lending in more stable areas.

Indeed, when facing a change in capital requirements, banks will make trade-offs between different assets and between different options of how to move to a higher capital ratio. There is evidence in both theoretical and empirical studies that capital requirements 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. Calibrated theoretical models that generate such findings are found in, for instance, Akram (2014), Carvalho et al (2014), Galaasen and Johansen (2016) and Mendicino et al (2015, 2016). Empirically, a number of studies confirm such portfolio composition adjustments in response to

higher capital requirements using data for the United Kingdom. Francis and Osborne (2012) find that rather than adjusting the volume of loans or assets, United Kingdom banks focus on increasing capital and adjusting the composition of the portfolios towards lower risk-weighted assets. de-Ramon et al (2012) simulate that a one percentage point increase in target capital ratios reduces risk-weighted assets to a greater extent than it does total assets and loans. They argue that one might expect banks to shrink their portfolios of corporate loans, which generally attract a higher risk weight, more than their portfolios of domestic mortgages. Their results show that banks tend to increase lending margins to corporate borrowers more than to households (19 basis points vs 6.7 basis points). De-Ramon et al (2012) further state that the greater demand elasticity on the part of corporate borrowers helps banks reduce their risk-weighted assets most efficiently (see also Carvalho and Castro (2015a)). Similarly, while not being the focus of the discussion of their paper, the results of Bahaj et al (2016) show that the impact of regulatory capital requirements on cumulative flow of new lending is stronger for corporate lending than for lending to households. Bridges et al (2015) show that the impact on lending is heterogeneous across sectors: loan growth falls most to the CRE sector, followed by other corporate lending and household secured lending. Finally, the international evidence in Akinci and Olmstead-Rumsey (2015) shows that capital requirements that are not specifically targeted on the housing market can lead to higher housing related credit growth even if total credit growth falls.

4.2 Potential scope for and objectives of a sectoral CCyB

The above discussion suggests that in the presence of sectoral risks to financial stability, targeted instruments, such as a sectoral application of the CCyB, may both be more effective and efficient than the Basel III CCyB. According to Elliott (2011), the arguments for changes in capital requirements at the sectoral level are their direct impact on the area of concern, stronger signalling power and smaller effects on the wider economy. The latter may be particularly important when overall growth prospects are low and monetary policy is expansive. Increasing capital requirements in a downturn may work against the positive effect of monetary policy on bank lending. For instance, Beyer et al (2017) discuss the interactions between monetary and macroprudential policies, and use models developed by Clerc et al (2015) and Darracq Pariès et al (2015, 2016) to simulate the magnitudes of such interactions and examine the different channels through which these arise. They show that, while having substantial benefits for output in the longer term, an increase in capital-based prudential instruments dampens the transmission of expansionary monetary policy. The authors also suggest that more targeted tools likely have a lower impact on monetary policy transmission as they only affect a specific proportion of borrowers.[8]

The IMF (2011) urges EU countries to extend their macroprudential toolkit beyond the existing set and consider including additional instruments targeting, among others, time varying exposures to specific sectors. It is argued that time and sectoral contingent risk weights would usefully complement the CCyB as they would allow targeting more specifically the sectors where systemic risk is developing, thus allowing a cross-sectional differentiation of risks. For similar reasons, the ESRB (2016) states that a more targeted application of the CCyB could be considered.

The main arguments of some of the theoretical models that provide a motivation for countercyclical capital requirements may also be extended to motivate the use of a sectoral CCyB. For

[8] Aiyar et al (2016) discuss the theoretical literature on interactions between monetary and macroprudential policies in affecting credit supply and conclude that several channels through which they could interact have different implications in terms of sign and magnitude of the interaction between the two instruments. Empirically, Aiyar et al (2016) do not find interaction effects between changes in monetary policy and bank capital requirements on credit supply in the United Kingdom (see also De Marco and Wieladek (2015)). In contrast, using data on Pillar 2 capital requirements for Belgian banks, De Jonghe et al (2016) find that there may be a trade-off between prudential policy and monetary policy: monetary policy has a weaker impact on credit supply for banks with higher capital requirements, or alternatively, that increasing capital requirements during expansionary monetary policy periods is more detrimental for credit supply compared to a similar increase during monetary tightening.

instance, on the basis of the argument in Jokivuolle et al (2014) one could argue that optimal risk-based capital requirements will have to be higher for sectors in which asymmetric information between banks and firms on the potential risk of projects is larger. Similarly, the reasoning of the theoretical model by Horváth and Wagner (2017) may extend to the usefulness of a sectoral CCyB, as it incentivises banks to become less correlated by charging higher capital requirements for correlated banks. In doing so, it also makes the system less procyclical as more heterogeneous institutions will respond less strongly to aggregate shocks.

Given that the (expected) transmission mechanisms of the Basel III CCyB and the sectoral CCyB overlap in important dimensions (eg CGFS (2012) and ESRB (2014)), the objectives of a sectoral CCyB could be similar to those of the CCyB. In particular, a sectoral CCyB could aim to increase resilience against risks in particular sectors in order to maintain credit provision to these and other sectors in downturns, and to lean against the cycle in the targeted sectors. Which of these objectives should prevail and when a sectoral application of the CCyB should be chosen over a broad-based activation depends on a number of factors, such as on how risks build up and materialise. In particular, to the extent that the materialisation of sectoral risks is (initially) limited to losses on exposures to these specific sectors, a sectoral CCyB could build resilience to these sectoral losses and avoid a spillover of losses to other credit segments. In case of (immediate) broad-based losses, the Basel III CCyB would be more appropriate. In the context of leaning, the Basel III CCyB would also be more appropriate in case sectoral credit cycles tend to exhibit positive intertemporal relationships without any causal link. If, in contrast, excessive credit developments in one segment cause a risk build-up in other segments, there may be scope for a sectoral CCyB to lean against excessive developments in the first segment in order to avoid sectoral imbalances becoming widespread.

In fact, as a sectoral CCyB would change the relative capital charge for different credit segments, the instrument might be more effective in leaning against sectoral imbalances than the CCyB. For instance, Crowe et al (2013) argue in the context of real estate booms that capital requirements or risk weights linked to real estate price dynamics could help limit the consequences of boom-bust cycles. In particular, by forcing banks to hold more capital against real estate loans during booms, these measures could build a buffer against the losses during busts. Furthermore, they state that, by increasing the cost of credit, such measures might reduce demand and contain real estate prices themselves. However, the focus should not be on fine-tuning idiosyncratic industry- or segment-specific credit and price developments. As mentioned above, a systemic perspective should be taken, with the aim of macroprudential policy instruments being to reduce systemic risk.

4.3 Potential effectiveness of a sectoral CCyB

4.3.1 Intended effects

The literature reviewed shows that sectoral capital requirements have been applied so far to a range of sectors, including exposures to residential and commercial real estate (see eg ESRB (2017) for an overview of residential real estate instruments active in Europe), consumer loans and foreign currency loans. They have also been targeted in a more granular way at specific sub-segments of sectoral loan portfolios, such as high loan to value exposures or loans with maturities exceeding a certain threshold. The purpose of such measures was either to enhance bank resilience or to restrain lending growth within a given sector. Like for the CCyB, however, only a small number of papers perform explicit impact assessments of sectoral capital requirements in general and sectoral CCyB specifically. Therefore, the effectiveness and efficiency of sectoral capital requirements remain largely untested. Yet, theoretical (DSGE) research provides some, albeit partial, insights on the transmission of sectoral capital requirements and suggests that there may be a role for this instrument in macroprudential policy. For instance, Crowe et al (2011) use a DSGE model for quantitative evaluation of different policy options for dealing with real estate booms. Their results suggest that tools that are narrower in scope (eg macroprudential tools) perform better. However, the representation of financial intermediaries in their model is overly simplified, with no room for important bank variables such as bank capital or capital adequacy ratios. As a consequence, the representation of

the macroprudential instrument is generic and can be anything that impacts interest rate spreads. Using a DSGE model for Brazil Carvalho et al (2014) and Carvalho and Castro (2015a) show that increases in sectoral risk weights primarily affect lending rates of the targeted segments. Carvalho and Castro (2015b) find that there is a role for sectoral risk weights that are allowed to respond to the sectoral credit gap in the optimal policy combination. Finally, Chen and Columba (2016) calibrate an open economy DSGE model for Sweden and show that welfare improves when mortgage risk weights increase, as stronger capital buffers have greater ability to preserve funding intermediation function during periods of stress, thereby reducing macroeconomic volatility. They make no attempt to assess the effect of time-varying mortgage risk weights, however.

The empirical literature on the impact of sectoral capital requirements is equally scarce (see Table 3). In fact, only the case of Switzerland considers the activation of an actual sectoral CCyB. The sectoral CCyB of 1% targeting the residential mortgage market in Switzerland 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. Basten and Koch (2017) examine the impact of the activation in February 2013 of this sectoral CCyB in Switzerland. They find that while the sectoral CCyB did not affect banks' rejection rates, both capital-constrained and mortgage-specialised banks exhibited higher offered mortgage rates after the introduction of the measure. Furthermore, mortgage-specialised banks reduced year on year mortgage loan growth by 0.19 percentage points after the activation. They do not find evidence that the sectoral CCyB induced banks to raise lending rates more for high LTV mortgages or to substitute low- for high-LTV customers. Basten and Koch (2017) conclude that the overall size of the identified effects is relatively small.

Impact of sectoral capital requirements on lending Table 3

Paper	Country (Time period)	Type of requirement	Successful in leaning
Mohan and Kapur (2009), Sinha (2011)	India (2005–07)	Sectoral risk weights and provisioning requirements across a range of sectors (eg risk weight for commercial real estate exposures from 100% to 150%)	Activation: yes for commercial real estate (but together with other measures) Release: no (but no counterfactual)
Central Bank of Ireland (2010)	Ireland (2006, 2008)	Risk weight from 50% to 60% on high LTV mortgages, risk weight increase to 150% on speculative commercial real estate	Activation: no
Andersen et al (2012)	Croatia (2005)	Risk weight increase on foreign currency loans	Activation: no
Pereira da Silva and Harris (2012)	Brazil (2010–11)	Risk weight policies on segments of the consumer loans market other than auto loans (eg stepwise increase of risk weights on payroll-guaranteed consumer loans with maturities above 60 months from 75% to 300%, while risk weights of shorter-term consumer loans in the segment were decreased from 100% to 75%)	Activation: yes (after sufficiently strong calibration)
Crowe et al (2013)	Bulgaria, Croatia, Estonia, Poland and Ukraine	Increased capital requirements and/or risk weights on particular groups of real estate loans	Activation: mixed

Bank of England (2014)	Australia (2004)	Risk weights from 50% to 100% on mortgage loans with less than the required documentation and checking of income and serviceability, absence of mortgage insurance and LTV above 60%	Activation: yes
IMF (2014)	Israel (2010–13)	Increase in mortgage loan risk weights as a function of inter alia LTV	Activation: no
Martins and Schechtman (2014), Afanasieff et al (2015)	Brazil (2010–11)	Increase in risk weights from 75% to 150% for auto loans with high LTVs and long maturities	Activation: yes Release: yes (but smaller effect than for activation)
Ferrari et al (2017)	Belgium (2012–15)	5 percentage point risk weight add-on on IRB mortgage loans	Activation: no
Kara (2016), IMF (2017)	Turkey (2011, 2013)	Increase in risk weights for consumer loans (from 100% to 150 or 200%) and on credit cards	Activation: yes
Anguren et al (2017)	Spain (2013)	SME supporting factor	Release: yes
Basten and Koch (2017)	Switzerland (2012–13)	1% sectoral CCyB on mortgage loans	Activation: yes/no (small effect)
Gómez et al (2017)	Colombia (2006–09)	Dynamic provisioning on commercial loans	Activation: yes

A few papers also provide an evaluation of the increase in sectoral capital requirements other than a sectoral CCyB as such. Ferrari et al (2017) estimate the effect of the introduction in December 2013 of a 5 percentage point add-on to IRB risk weights for mortgage loans in Belgium on IRB banks' mortgage lending. The primary aim of the measure was to increase IRB banks' resilience against potential losses stemming from less buoyant conditions on the residential real estate market. At the sectoral level, the add-on resulted in a total additional capital requirement for all IRB banks in the sample of €820 million, representing in aggregate about 1.8% of these banks' outstanding Tier 1 capital. Ferrari et al (2017) find that the sectoral capital requirement on average did not affect IRB banks' mortgage rates and mortgage loan growth. Banks may have reacted heterogeneously to the introduction of the risk weight add-on, however, with IRB banks having a larger share of affected mortgage loans in their balance sheet and facing a relatively larger additional capital requirement due to the risk weight add-on reducing mortgage lending growth relatively more. In addition, banks with a larger voluntary management capital buffer exhibit stronger mortgage loan growth after the introduction of the measure. Also, a temporary stronger increase in mortgage rates is estimated for banks with a larger share of mortgage loans to Belgian households in their balance sheet. Ferrari et al (2017) conclude that the overall effect on the mortgage rates and mortgage loan growth of individual banks in the sample remains limited in terms of both statistical and economic significance.

Using data from the Brazilian Public Credit Register and the accounting database of Brazilian financial institutions, Martins and Schechtman (2014) analyse the effectiveness of a within-sector bank regulation that was implemented in Brazil in December 2010 in response to increasing risk in the auto loan market in the context of rapid household credit growth. Representing 13% (25%) of outstanding (household) loans at the time of introducing the measure, auto loans represent a significant share of assets of the Brazilian banking system. Regulatory risk weights were raised for targeted auto loans (high LTVs and long maturities) from 75% to 150%, whereas other auto loans were not affected by the measure. They find that lending spreads charged on targeted loans increased by at least 2.19 percentage points more than on untargeted loans. This amounts to 15% of lending spreads, leading the authors to conclude that the effect was material. Martins and Schechtman (2014) also observe a (temporary) decline in lending volumes of targeted loans relative to a moderate increase pattern in untargeted loans. Afanasieff et al (2015) further document that the origination of targeted loans with high LTVs and long maturities fell from 74% of all auto loans in November 2010 to 60% in December 2011. Their estimates confirm the decrease

in loan volumes in the risky segment after the introduction of the measure. They also show a decrease in non-performing loans for new auto loans after the introduction of the measure. Overall, both Martins and Schechtman (2014) and Afanasieff et al (2015) conclude that the measure was effective in reducing credit in the targeted segment.

The above discussion reveals mixed conclusions regarding the impact of increased sectoral capital requirements on lending, both in quantity and price effects. This result is further corroborated by a number of other papers providing more anecdotal evidence related to sectoral capital requirements. Crowe et al (2013) state that the empirical evidence on the impact of increased capital requirements and/or risk weights on particular groups of real estate loans is mixed: while some attempts (such as the cases of Bulgaria, Croatia, Estonia, and Ukraine) failed to stop the boom, others (such as the case of Poland) were at least a partial success. Mohan and Kapur (2009) and Sinha (2011) document changes in sectoral risk weights and provisioning requirements across a range of sectors in India between 2005 and 2007 to protect banks' balance sheets against risks from high asset price and credit growth. They show that a stepwise increase in risk weights on commercial real estate exposures from 100% to 150% was followed by a sustained reduction in the growth of credit to the targeted sector. However, Sinha (2011) conjectures that the provisioning measures might have been more effective than the changes in risk weights, as Indian banks operated at capital levels well above minimum requirements. The Central Bank of Ireland (2010) provides an assessment of a risk weight increase from 50% to 60% on high LTV mortgages in Ireland in 2006 and an increase in risk weights on speculative commercial real estate lending to 150% in 2007. Both measures had only a small impact in terms of Tier 1 capital requirements (0.4% and 2%, respectively) and were deemed to have been rather modest in their likely impact. Andersen et al (2012) state that a risk weight increase on loans with exchange rate risk in Croatia in 2005 was not effective in curbing growth in foreign currency loans. Pereira da Silva and Harris (2012) discuss the Brazilian central bank's risk weight policies on segments of the consumer loan market other than auto loans. For instance, risk weights on payroll-guaranteed consumer loans with maturities above 60 months were increased from 75% to 150% in December 2010. As the effects on lending in the targeted segments were modest, risk weights were increased again in November 2011, from 150% to 300%, while at the same time risk weights on shorter-term consumer loans in the segment were decreased from 100% to 75%. Furthermore, in order to prevent leakages to other types of longer maturity consumer loans, risk weights on long-term non-guaranteed consumer loans were raised to 300% as well. These changes were followed by a sharp reduction of the share of new long-term payroll guaranteed loans relative to short-term payroll guaranteed loans. The Bank of England (2014) reports that a rise in risk weights from 50% to 100% on mortgage loans with less than the required documentation and checking of income and serviceability, absence of mortgage insurance and LTV above 60% in 2004 in Australia appears to have reduced the growth of the targeted loan segment. The IMF (2014) estimates that the capital measures targeting mortgage loans in Israel over the period 2010–13 have contributed to foster resilience of the financial system, they have been less successful in leaning against mortgage and housing market activity. Kara (2016) and the IMF (2017) state that the measures taken to contain the cyclical build-up of consumer credit risks in 2011 (an increase in risk weights for consumer loans) and 2013 (higher risk weights on credit cards) contributed, together with a package of other macroprudential measures targeting consumer loans and tighter monetary policy, to the subsequent slowdown of consumer loan growth. Gómez et al (2017) identify the effect of macroprudential regulations in Colombia over the period 2006–09. The tools applied include reserve requirements and dynamic provisioning on commercial loans. The latter has similarities to a sectoral capital buffer and is shown to have had a negative impact on credit growth and contributed to stabilise the credit cycle in Colombia before the financial crisis in 2008–09.

This evidence shows that the effectiveness of sectoral capital requirements likely depends on inter alia country- and segment-specificities. For instance, Andersen et al (2012) discuss how the impact of changes in banks' risk weights may differ depending on loan segment characteristics, such as product homogeneity and competition. Another important explanation for the differences in effectiveness is

undoubtedly the level of calibration. A clear relationship between impact and calibration can be observed. In particular, in Brazil, where the sectoral measure on auto loans had an economically significant impact on loan pricing, the risk weight increase from 75% to 150% translated to an additional capital charge of 8.25%, which would be equivalent to a sectoral buffer of 11%. Effective leaning was also observed in Turkey, where the increase in risk weights for consumer loans in 2011 was substantial (from 100% to 150 or 200%, depending on loan maturity (IMF (2012)), and in Australia (risk weights from 50% to 100%). In contrast, the Swiss sectoral CCyB was calibrated to 1%, whereas the Belgian risk weight add-on of 5 percentage points would be equivalent to a 5% sectoral buffer on average. Also the Irish measure was assessed as too little, and the Brazilian measure targeting payroll guaranteed consumer loans was only effective in reducing credit to the targeted segment after an increase in the calibration of the initial measure. Hence, the experience gained so far suggests that sectoral capital requirements can limit loan growth of targeted sectors, at least if calibration is sufficiently stringent.[9] This point is also put forward by the Bank of England (2014), which, based on the experiences in Ireland and Australia, also highlights the importance of early intervention. As will be discussed in more detail in Section 4.4.2, Fahr and Fell (2017) also emphasise the need to activate instruments aimed at leaning sufficiently early in the cycle (see also Andersen et al (2012)).

From the perspective of resilience, the lack of impact in terms leaning implies, according to Ferrari et al (2017), that banks' resilience to sectoral risk could be raised at low overall cost of foregone credit. Basten and Koch (2017) indeed show that banks specialising in mortgages reacted to the introduction of the sectoral CCyB by strengthening their capital base through drawing on retained earnings. The objective of resilience is also investigated by Smith et al (2014), who perform a counterfactual simulation on the basis of historical data for the United States. They use a dynamic stress test of mortgage assets, resulting in capital requirements for mortgage loans being linked to swings in housing prices. Their results show that if the rule had been followed, Fannie Mae would in 2008 have held capital sufficient to cover losses during the following housing crisis.

However, as mentioned, the effectiveness of countercyclical instruments in increasing resilience should be evaluated against the objective of supporting credit by releasing the buffer in downturns. Like for the Basel III CCyB, it would be important to also consider interactions with other prudential instruments, such as the leverage ratio and liquidity requirements, in this assessment. To date, no assessments have been performed on the ability of a sectoral CCyB to support credit in downturns: the effects of the future release of activated buffers, for instance in Switzerland, should be carefully monitored in order to gain insights in the ability of a sectoral CCyB to achieve this objective. The evidence presented in Anguren et al (2017) suggests, however, that there may be the potential for a release in sectoral capital requirements in fostering credit growth. Using Spanish data, they investigate the impact of the introduction of an SME supporting factor at the end of 2013, which resulted in a capital reduction that was established to ensure an adequate flow of credit to SMEs. They find that the capital release that took place after the application of the SME supporting factor led to an increase in bank lending to SMEs. In contrast, Sinha (2011) discusses the relaxation of prudential standards to targeted sectors in India during the period 2008–09 and concludes from the deceleration of credit growth during the crisis that the leaning against the wind has been more effective in dampening the lending exuberance in the boom phase than in ensuring a stable credit supply in the downturn. No counterfactual is available, however, on what credit growth would have been during the crisis in the absence of the relaxation of sectoral capital requirements. Finally, the Brazilian case may provide some useful insights regarding the potential signalling function of a sectoral CCyB, as approximately one year after the introduction, the higher capital charges were abolished for most of the auto loans. Martins and Schechtman (2014) find that the credit spread narrowed again, but by less than the increase in spreads after of the introduction of the original regulation. Furthermore, they document that there was no visible rebound of credit volumes. The latter is confirmed by Afanasieff et al (2015). This

[9] It should be noted that a relatively high level of a sectoral CCyB rate does not necessarily imply a stringent calibration in terms of an "equivalent" Basel III CCyB rate, as the overall additional capital demand depends on the share of the banks' balance sheets targeted by the sectoral CCyB.

leads the authors to suggest that macroprudential tools that target the quality of credit origination can have a powerful signalling effect: after the capital measure targeting auto loans with high LTVs and long maturities was enacted, banks revised their lending practices and corrected the lending excesses that had been taking place and they continued to do so even after the measure was relaxed.

4.3.2 Potential drawbacks

There may also be potential drawbacks of a sectoral CCyB. In addition to those that also hold for the CCyB (ie potential leakages to non-bank credit), Meeks (2017) argues that the CCyB is not prone to leakages that the sectoral CCyB would suffer from, namely the fact that targeted requirements may drive lending activity out of one sector and into another. Indeed, Andersen et al (2012) argue that if risk weights for one asset class are increased sharply, investments in other markets may be relatively more profitable, inducing banks to increase investment in or lending to these markets. On the other hand, they also raise the possibility that if banks have weak capital adequacy and inadequate access to new capital, higher risk weights for a low-weighted asset class may induce banks to engage in the type of portfolio composition adjustments discussed in Section 4.1 and reduce lending to segments that attract higher risk weights. The ESRB (2014) refers to this as "unintended crowding-out effects". The extent to which sectoral capital requirements generate undesirable spillovers to non-targeted sectors, (either positive or negative) and therefore should be considered as a drawback, depends on the state of credit cycles in different segments.

The literature reviewed provides scarce and somewhat mixed evidence on sectoral capital requirements' potential spillovers to untargeted sectors. In particular, Auer and Ongena (2016) explore whether the activation of the sectoral CCyB in Switzerland affected lending to corporates, where most of corporate loans are not residential mortgages and hence not subject to the higher capital requirement. They use panel data on reported corporate loans from 20 banks seven months before to eleven months after the activation of the measure in February 2013. Banks report loans either if they extend new loans or if they change conditions of existing loans (eg maturity, interest rates or ratings). They assume that banks with a higher share of residential mortgage risk weighted assets to total assets are affected by the sectoral CCyB, irrespective of their capital level. They find that these banks report corporate loans more often and increase interest rates and commissions for them. They interpret this finding as evidence of a targeted macroprudential policy to squeeze lending in one sector leading to an expansion of lending in another sector. In contrast, the results by Martins and Schechtman (2014) on the Brazilian risk weight increase for auto loans show that while the increased capital charges significantly increased the spread of the targeted loans, the effect on untargeted loans becomes insignificant after introducing controls. This suggests that the spillover effects from the higher costs of targeted loans on untargeted loans are limited. Sonoda and Sudo (2016), in the context of direct limits on sectoral credit rather than sectoral capital requirements, warn against negative spillovers of targeted instruments on lending volumes to other sectors and also on the real economy. They find that, by damaging the balance sheets of banks and non-financial firms, the application of limits on lending to the Japanese real estate industry and related activities ("Quantitative Restriction") from the 1970s to the 1990s had, in addition to its impact on the real estate sector and land prices, aggregate impacts even though its regulatory scope was limited.

Finally, spillovers may not only occur across sectors within the same jurisdiction: like changes in general capital requirements[10], changes in sectoral capital requirements could also lead to a reallocation

[10] See for instance Ongena et al (2013) and Buch and Goldberg (2017) for evidence on spillovers of higher home-country minimum capital requirements on lending abroad. Further evidence suggests that the need for reciprocity may be country- and instrument-specific. In a study of 64 countries over the period 2000–15, Kang et al (2017) find no evidence of credit leakage after applying capital-based instruments, and the evidence reported in Buch and Goldberg (2017) and references therein is rather weak. In contrast, Reinhardt and Sowerbutts (2016) find for an international sample of 37 countries over the period 2005–14 that a tightening in capital regulation is associated with an increase in lending growth of foreign banks to domestic non-banks. The authors suggest that this mainly is leakage through foreign branches. This finding is supported for Spain by Jiménez et al (2017) and for the United Kingdom by Aiyar et al (2014a,b), De Marco and Wieladek (2015) and Uluc and Wieladek (2017).

of lending across different jurisdictions. Indeed, Buch and Goldberg (2017), and country-specific references therein, report evidence of both inward and outward international policy spillovers after the application of sectoral capital buffers. This suggests that the potential for cross-border spillovers needs to be accounted for when assessing policy impact. In this context, it should be considered whether reciprocity arrangement applying to the Basel III CCyB should also be in place when applying a sectoral CCyB. The need for reciprocity may be both country- and sector-specific, as the amount of cross-border lending and lending through foreign branches may differ across jurisdictions and sectors. The literature on the impact of broad-based capital requirements and dynamic provisioning suggests that leakages to foreign bank branches are observed for both lending to non-financial firms (eg Aiyar et al (2014a,b), De Marco and Wieladek (2015) and Jiménez et al (2017)) and mortgage lending (eg Uluc and Wieladek (2017)). Hills et al (2017) emphasise the importance of using sectorally disaggregated data for analysing cross-border spillovers of macroprudential policies.

To conclude, the experience gained so far shows that sectoral capital requirements may limit loan growth in targeted sectors, but effective leaning requires adequate calibration and sufficiently early activation. Spillover effects to untargeted sectors or other jurisdictions, either positive or negative, should be monitored and assessed against the state of the credit cycle in these sectors or jurisdictions. The need for reciprocity arrangements when applying a sectoral CCyB is to be considered.

4.4 A sectoral CCyB relative to alternative sectoral macroprudential measures

4.4.1 Time-varying sectoral risk weights

In the previous sub-paragraph, we discussed evidence based on the implementation of macroprudential sectoral capital requirements, including both a sectoral CCyB and sectoral risk weights. From a theoretical point of view, these two ways of increasing sectoral capital requirements could be considered equivalent, as both a capital buffer and a risk weight increase narrow the gap between a bank's actual and required capital ratio (eg Andersen et al (2012)). To the extent that banks maintain targeted buffers above regulatory thresholds (eg Francis and Osborne (2010)), the impact of both types of capital instruments on banks' behaviour may be expected to be similar. Indeed, in, for instance, the DSGE model of Mendicino et al (2015), the impact of a higher risk weight on mortgages is qualitatively similar to that of higher capital requirements.

Yet, there are important differences in the design and transmission mechanism of both instruments. While the literature reviewed does not allow a direct comparison of the effectiveness of a sectoral CCyB and time-varying risk weights, it provides grounds for a number of theoretical arguments regarding the differences in these instruments' transmission mechanisms. In particular, Andersen et al (2012) discuss the effects of changes in banks' risk weights and raise a number of issues that may be important in this context: while higher risk weights may push up equity ratios, higher risk weights will not necessarily affect banks' measured capital adequacy; banks' incentives to improve risk management may be impaired if internal risk models are overridden; and effects will depend on how the authorities increase risk weights or the underlying risk parameters.

The first issue stems from the fact that a temporary increase in risk weights will lead to a deterioration of the banks' disclosed capital situation. While banks' efforts to restore their capital ratios following a risk weight increase will also increase the capital buffer in the system, this buffer will not be visible in banks' disclosed capital ratios. This implies that the transparency between both instruments differs: a sectoral CCyB can be argued to be more transparent, as it sets requirements in terms of risk-weighted assets that come on top of all other capital requirements. If banks react to an activation of the sectoral CCyB with a build-up of capital, this will lead to an improvement of banks' disclosed capital ratios, reflecting the additional capital buffers available in the banking system. Therefore, the market could perceive both instruments in a different manner, as they affect disclosed capital figures in a different manner. In particular, an increase in the risk weight might be perceived as an immediate deterioration in the capital position of an individual bank, while a sectoral CCyB might be interpreted as a signal of

increased sectoral risk. In the medium term, both instruments will lead to an increase of capital if banks aim at maintaining a fixed voluntary buffer above the minimum requirement. However, the market might perceive the disclosed capital figures as "restored" capital ratios under the temporary risk weight scheme vs "increased" capital ratios under the sectoral CCyB scheme.

It should be noted, though, that both policies entail equivalent dynamics in terms of the unweighted leverage ratio. Therefore, whether this difference between both instruments matters, depends on how well markets are able to read disclosed capital figures and the extent to which they focus on risk-based capital rather than on unweighted leverage ratios. The literature suggests that markets (also) internalise unweighted leverage ratios, and therefore, the above-mentioned difference in transmission channels may not be that important. For instance, Blundell-Wignall and Roulet (2013) find for a sample of 94 global banks over the period 2004–11 that the unweighted leverage ratio is a predictor for their estimated distance-to-default, while this was not the case for the Basel Tier 1 ratio. Demirguc-Kunt et al (2013) show that bank capitalisation for 381 banks in 12 economies during the period 2005–09 did not matter for banks' stock return before the financial crisis, but a stronger capital position was associated with better stock market performance during the crisis. This relationship was stronger for the leverage ratio than for risk-based capital ratios.

Despite this finding, the transparency argument does seem to necessitate more elaborate communication by macroprudential authorities on the temporary nature and purpose of a sectoral risk weight increase compared to a sectoral CCyB. The build-up of temporary capital buffers that are to be released to support credit in a downturn is intrinsically embedded in the design and name of (sectoral) countercyclical buffers (BCBS (2010a, b)). As this is not the case for time-varying risk weights, macroprudential authorities will need to explain their actions and policy strategy even more, in order to manage banks' and markets' expectations as well as to ensure that freed-up capital is actually used to support credit when the sectoral risk weight is released. As pointed out by Born et al (2012), the ESRB (2014) and the CGFS (2016), communication on macroprudential policy is both important and challenging. Macroprudential policy communication, including on what macroprudential policies can and cannot achieve, should be guided by clarity, transparency and predictability in order to increase its effectiveness and ensure accountability. Using data on releases of central banks' financial stability reports and speeches, Born et al (2012, 2014) further show that communication on financial stability may at times raise market volatility and uncertainty, in particular during crises. This underlines the importance of choosing carefully a communication strategy on macroprudential policy which is suited for a given market environment.

The second issue raised by Andersen et al (2012) relates to the potential of sectoral risk weight changes in affecting banks' incentives in risk measurement and management. While the risk-sensitivity of IRB risk weights is being questioned (eg Turk-Ariss (2017) and references therein) and banks have an incentive to understate their risk (eg Blum (2008), Mariathasan and Merrouche (2014), Begley et al (2017)), one motivation for the increased risk-sensitivity and greater reliance on banks' internal systems as inputs to capital calculations of Basel II is to promote the adoption of stronger risk management practices by the banking industry (BCBS (2006)). Andersen et al (2012) argue that banks' incentives to improve risk management may be (further) impaired if internal risk models are overridden. This effect is likely to be stronger when the macroprudential authority imposes a (temporary) minimum floor or fixed level of sectoral risk weights, as banks would no longer be able to achieve lower capital requirements by reducing risk. In such cases, banks may actually increase the level of riskiness of targeted exposures if their internal risk weights are below the (minimum) level imposed by the macroprudential authority. Hence, time-varying sectoral risk weights may have stronger unintended effects on banks' risk measurement and management incentives than a sectoral CCyB.

The final issue relates to the inherent complexity of implementing countercyclical policies through (sectoral) risk weights rather than through (sectoral) buffers. First, the effects of a sectoral risk weight increase will depend on how the authorities increase risk weights or the underlying risk parameters. Andersen et al (2012) raise three options for increasing sectoral risk weights: a minimum floor, a fixed add-

on to banks' estimated risk weights, and a multiplier to banks' estimated risk weights. Under the three options, different banks will be affected to a different extent. In particular, while a risk weight floor would affect banks with the lowest risk weights the most, banks with higher risk weights are more affected by an add-on or a multiplier. As one determinant of the choice of the appropriate choice among these options, Andersen et al (2012) put forward the extent to which the macroprudential authority believes heterogeneity in risk weights reflects heterogeneity in risk of the underlying exposures. While allowing for a more granular approach than a sectoral CCyB, these considerations complicate the macroprudential policymaker's choice and calibration of the most appropriate instrument.[11] In addition, the treatment of IRB banks and banks applying the standardised approach is likely to differ in this context. However, it may be challenging to explain why a system-wide risk to which the entire banking sector is exposed requires action for only a sub-set of the banking sector. Especially when macroprudential policy targets IRB banks to a larger extent than banks that use the standardised approach, doubts may be raised on the reliability of IRB banks' internal models. The above-mentioned considerations, which are absent or at least less explicit in the application of a sectoral CCyB, would blur the communication on identified sectoral macroprudential risks. Finally, a further complicating factor in calibrating sectoral risk weights is that changes in risk weights, by changing a bank's risk-weighted assets, also affects the impact of other micro- and macroprudential capital add-ons, including macroprudential capital buffers. That is, compared to the calibration of a sectoral CCyB, there is a larger degree of interaction between the calibration of the sectoral risk weight and that of other macroprudential buffers. For instance, the release of a macroprudential "buffer" that was built up by means of an increase in sectoral risk weights would, through its effects on risk-weighted assets, also imply a partial release of other macroprudential buffers.

To conclude, while time-varying sectoral risk weights may be used as a substitute for a sectoral CCyB and allow for a more granular approach, the literature provides a number of arguments for why a sectoral CCyB may be favoured. In particular, acting through risk weights is inherently more complex, less transparent and has a potentially larger adverse impact on banks' incentives to conduct appropriate risk measurement and management. Moreover, compared to macroprudential measures affecting sectoral risk weights or risk parameters, a sectoral CCyB would interfere less with other micro- and macroprudential requirements.

4.4.2 Borrower-based measures

The above discussions consider the potential impact of (countercyclical) capital requirements on resilience and credit supply. However, macroprudential instruments can also target other parts of the credit process. The most important group of such instruments will be tools that target lending practices, such as limits to LTV ratios, loan to income (LTI) or debt (service) to income (D(S)TI) ratios. There exists a broad literature that reviews the effects of such borrower-based measures. Differences in the (expected) transmission mechanisms of capital requirements and borrower-based measures suggest that both types of instruments are likely to complement each other (eg CGFS (2012)). More generally, the model by Goodhart et al (2013) predicts that the more successful policy packages combine regulations that operate via fairly different channels.

When assessing to what extent a sectoral CCyB is a valuable complement to existing borrower-based measures, it is useful to take the main objectives of the instrument as the starting point. One objective of a sectoral CCyB could be to smooth the downturn of the credit cycle by increasing banks' resilience to credit losses in downturns: the release of the buffer in bad times aims at freeing up capital in order to allow banks to absorb losses without their solvency being questioned and to maintaining the flow of credit in the economy. Borrower-based measures may contribute to this fostering of banks' resilience by making borrowers more resilient and consequently reducing banks' credit losses in downturns. For instance, Crowe et al (2013) argue that, in addition to raising recovery rates for lenders, LTV limits help

[11] Trade-offs are likely to become even more complex when, instead of through risk weights, macroprudential policy should act through the input parameters to risk weights, for instance by imposing LGD floors or add-ons to LGDs.

contain the build-up of leverage on the borrower side, thereby reducing the risks associated with declines in house prices. Similarly, D(S)TI limits increase borrowers' resilience to a decline in their income or temporary unemployment. Empirical evidence indeed supports the relationship between credit standards and borrower default (eg Dietsch and Welter-Nicol (2014) and references therein and De Backer et al (2015)).

However, if losses nevertheless did materialise in times of financial stress, a relaxation of borrower-based limits would not necessarily help supporting supply of credit. While there is some evidence on the relaxation of borrower-based measures smoothing the downturn (eg cross-country evidence in Claessens et al (2014) and Bierut et al (2015) on the relaxation of DTI caps in Poland), Jácome and Mitra (2015) state that there is little knowledge on when, by how much, and based on what information, countries should ease LTV/D(S)TI limits. They conclude that this might reduce the feasibility of their use in case of an actual credit downturn. Wong et al (2016) find that the effectiveness of LTV and LTI standards depends on whether demand or supply factors drive credit growth. They argue that if a reversal of the credit cycle mainly reflects a sharp drop in the demand for properties, relaxing LTV caps is expected to produce only a limited stabilising effect on credit growth. Additionally, one could argue that if capital requirements become increasingly binding and put a drag on credit provision in the downturn, the relaxation of borrower-based measures would not be sufficient in supporting the supply of credit. Also in such a case, a sectoral CCyB that could be released in the downturn would be a necessary complement in order to achieve the objective of smoothing the downturn of the credit cycle. Indeed, Chen and Columba (2016) calibrate an open economy DSGE for Sweden (1996Q1–2014Q4) that compares different macroprudential instruments for reducing household indebtedness. Their results suggest that welfare improvements from stricter LTV requirements come from reductions in household indebtedness, thereby reducing the deleveraging process in response to adverse shocks, whereas an increase in mortgage risk weights improves welfare because stronger capital buffers have greater ability to preserve funding intermediation function during periods of stress, thereby reducing macroeconomic volatility. Thus, relying on a single tool to bolster the effect of a downturn on credit supply might be insufficient, as the effectiveness of different tools depends on the characteristics of the downturn, such as whether it is demand or supply driven.

Regarding the objective of leaning against credit growth in the upswing of the cycle, there is a consensus among empirical studies that borrower-based measures like limits on LTV and LTI ratios can effectively dampen credit growth in the mortgage market, whereas evidence concerning the build-up of property prices is more ambiguous. Cerutti et al (2017), for instance, find that these measures significantly affect credit, but not house price growth, while Akinci et al (2015) find significant effects on housing credit growth and house price inflation. In fact, in a number of studies, borrower-based measures are found to be more effective in dampening credit growth than capital requirements. For example, in its country assessment for Israel, the IMF (2014) finds that direct measures such as LTV and D(S)TI limits have been more effective than indirect measures such as capital surcharges for mortgages. Claessens et al (2014) study a large panel data set of individual bank balance sheets and find that borrower-based tools are particularly useful in reducing asset growth, whereas buffer-based policies seem to have little impact.

However, CGFS (2012) argues that the impact of LTV or D(S)TI limits on the credit cycle may be moderated by the fact that (in contrast to capital requirements) these instruments do not directly affect the cost of borrowing but instead only affect marginal lending. The ultimate impact could be further limited if house prices continue to increase after the introduction of the LTV cap. Indeed, the evidence in the literature is not unambiguous, as other studies suggest that capital requirements are actually more effective than borrower-based measures. For example, while showing that LTV and D(S)TI caps reduce the growth in housing credit most effectively, Akinci and Olmstead-Rumsey (2015) find that capital requirements are actually the most effective tool in leaning against the wind when looking at bank credit growth in general. Thus, it may be sensible to have a broader toolbox available and use the instrument most suitable depending on the characteristics of the credit boom, rather than relying on a single

instrument. Furthermore, similar to other instruments, the level of effectiveness of borrower-based measures seems to vary across countries, especially between advanced economies and emerging market economies (eg Claessens et al (2014), Akinci and Olmstead-Rumsey (2015), Cizel et al (2016), Cerutti et al (2017)). Therefore, in those instances where the tightening of borrower-based measures would fail to slow down credit growth, a sectoral CCyB would be a useful complement to other policies aimed at leaning against the cycle.

Finally, especially when macroprudential policymakers aim at targeting both a particular level of resilience to sectoral risk as well as a certain amount of leaning against the build-up of such risks, there may be merit in combining a sectoral CCyB and borrower-based measures. On the basis of a simplified New-Keynesian model, Fahr and Fell (2017) provide a framework for assigning policy instruments to objectives. To the extent that a sectoral CCyB is more effective in increasing banks' resilience and borrower-based measures more successful in leaning against the sectoral credit cycle, their framework would imply that both objectives could be attained more effectively and efficiently by combining the two types of instruments. Their analysis furthermore shows that emphasis on the two types of instruments should vary over the financial cycle, with borrower-based instruments being tightened earlier in the cycle and a sectoral CCyB being tightened later on in the cycle when the probability of a crisis is high.

5. Conclusions

The aim of this paper is to shed light on whether the CCyB setting in the Basel III framework could be fruitfully extended towards a sectoral application of the CCyB. The insights drawn from the literature result in number of focused messages that could serve as sufficiently grounded arguments in the debate:

(i) The literature reviewed suggests that sectoral risks, in sub-segments of both the household sector and the corporate sector, have the potential to adversely affect bank stability as well as the broader economy, and therefore, may give rise to systemic risk. While the impact of both the Basel III CCyB and the sectoral application of the CCyB to a large extent remains an empirical question, the literature reviewed provides reasons to believe that in the presence of sectoral risks to financial stability, especially in combination with low overall growth prospects, a sectoral application of the CCyB may have a more direct impact on the area of concern, stronger signalling power and smaller effects on the wider economy than the Basel III CCyB.

(ii) A sectoral CCyB could aim to increase resilience against risks in particular sectors in order to maintain credit provision to these and other sectors in a downturn, and to lean against the cycle in the targeted sectors. As a sectoral CCyB would change the relative capital charge for different credit segments, the instrument might be more successful in leaning against sectoral imbalances than the CCyB. The literature suggests that there is potential for a sectoral CCyB in raising banks' resilience to sectoral risk at low overall cost of foregone credit. However, the instruments' ability to support credit by releasing the buffer in downturns remains largely untested. The evidence also shows that sectoral capital requirements may limit loan growth in targeted sectors, but effective leaning requires adequate calibration and sufficiently early activation. Overall, the appropriate level of a sectoral CCyB and its timing of activation throughout the credit cycle would depend on the targeted objective.

(iii) Generally, macroprudential instruments that operate through different channels are likely to complement each other. The literature reviewed indicates that a sectoral CCyB could indeed be a useful complement to alternative sectoral macroprudential measures, including borrower-based measures such as LTV, LTI and D(S)TI limits. To the extent that a sectoral CCyB is more effective in increasing banks' resilience and borrower-based measures are more successful in leaning against the sectoral credit cycle, both objectives could be attained more effectively and efficiently by combining the two types of instruments. Furthermore, there is some evidence that

suggests that a sectoral CCyB could have important signalling effects and may therefore act as a substitute for borrower-based measures.

(iv) Spillover effects to untargeted sectors or other jurisdictions, either positive or negative, after the activation of a sectoral CCyB should be monitored and assessed against the state of the credit cycle in these sectors or jurisdictions. The literature reviewed provides scarce and somewhat mixed evidence on such potential spillovers to untargeted sectors. In this context, also the need for reciprocity arrangements when applying a sectoral CCyB is to be considered. Following the application of broad-based capital measures, leakages to foreign bank branches have been observed for both lending to non-financial firms and mortgage lending.

We also identified a number of gaps in the literature and areas for future research that need to be filled and pursued in order to gain a better understanding of the transmission of the macroprudential policy instruments under consideration:

(v) Macroprudential policymakers should take a system-wide perspective with a focus on those sectors that may entail risks to the stability of the broader financial system and the real economy. This requires further research on the implications of sectoral credit cycles for systemic risk. In addition, analyses on the intertemporal relationships between different credit cycles as well as the causality of these relationships would be important for the further development of the policy framework describing the interaction of the broad-based and a potentially more targeted application of the CCyB. This policy and 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.

(vi) To date, there is very little empirical analysis of the effects of the actual activation of the Basel III CCyB. More generally, 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 be carefully monitored in order to gain insights in the ability of countercyclical buffers to achieve this objective. In this context, interactions with other prudential instruments, such as the leverage ratio and liquidity requirements, should be considered as well.

Overall, the literature review shows that there is a justified need for sectoral macroprudential tools, and 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 empirical work is needed to assess their ability to achieve the different objectives that may be 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. It would also add an additional layer of complexity to the macroprudential capital buffer framework. While they are crucial for the further development of the policy framework on a sectoral CCyB, such operational issues are beyond the scope of this paper.

References

Accornero, M, G Cascarino, R Felici, F Parlapiano and AM Sorrentino (2017): "Credit risk in banks' exposures to non-financial firms", *European Financial Management*, September, pp 1–17.

Acemoglu, D, VM Carvalho, A Ozdaglar and A Tahbaz-Salehi (2012): "The network origins of aggregate fluctuations", *Econometrica*, vol 80, no 5, pp 1977–2016.

Afanasieff, TS, FLCA Carvalho, EC de Castro, RLP Coelho and J Gregório (2015): "Implementing loan-to-value ratios: The case of auto loans in Brazil (2010–11)", *Banco Central do Brasil Working Papers*, no 380.

Aikman, D, AG Haldane and BD Nelson (2015): "Curbing the credit cycle", *The Economic Journal*, vol 125, June, pp 1072–1109.

Aiyar, S, CW Calomiris and T Wieladek (2014a): "Does macro-prudential regulation leak? Evidence from a UK policy experiment", *Journal of Money, Credit and Banking*, supplement to vol 46, no 1, pp 181–214.

——— (2014b): "Identifying channels of credit substitution when bank capital requirements are varied", *Bank of England Working Paper*, no 485.

——— (2016): "How does credit supply respond to monetary policy and bank minimum capital requirements?", *European Economic Review*, vol 82, pp 142–165.

Akinci, O and J Olmstead-Rumsey (2015): "How effective are macroprudential policies? An empirical investigation", *Board of Governors of the Federal Reserve System International Finance Discussion Papers*, no 1136.

Akram, QF (2014): "Macro effects of capital requirements and macroprudential policy", *Economic Modelling*, vol 42, pp 77–93.

Alpanda, S, G Cateau and C Meh (2014): "A policy model to analyze macroprudential regulations and monetary policy", *BIS Working Papers*, no 461.

Alves, I (2005): "Sectoral fragility: factors and dynamics", *BIS Papers*, no 22.

Andersen, H, R Johansen and K Kolvig (2012): "Effects of changing banks' risk weights", *Norges Bank Staff Memo*, no 15/2012.

Angelini, P, S Neri and F Panetta (2014): "The interaction between capital requirements and monetary policy", *Journal of Money, Credit and Banking*, vol 46, no 6, pp 1073–1112.

Anguren, R, G Jiménez and J Peydró (2017): "Bank risk-taking and capital requirements", mimeo.

Anundsen, AK, K Gerdrup, F Hansen and K Kragh-Sørensen (2016): "Bubbles and crises: The role of house prices and credit", *Journal of Applied Econometrics*, vol 31, no 7, pp 1291–1311.

Arango, CA and OM Valencia (2015): "Macro-prudential policies, moral hazard and financial fragility", *Banco de la República Colombia Working Paper*, no 878.

Athanasoglou, PP, I Daniilidis and MD Delis (2014) : "Bank procyclicality and output: Issues and policies", *Journal of Economics and Business*, vol 72, pp 58–83.

Auer, R and S Ongena (2016): "The countercyclical capital buffer and the composition of bank lending", *BIS Working Papers*, no 593.

Bahaj, S, J Bridges, F Malherbe and C O'Neill (2016): "What determines how banks respond to changes in capital requirements?", *Bank of England Staff Working Paper*, no 593.

Bank of England (2014): "The Financial Policy Committee's powers to supplement capital requirements: A policy statement", January 2014 (updated April 2016).

——— (2015): "The Financial Policy Committee's powers over leverage ratio tools: Policy statement", July 2015 (updated October 2017).

Basel Committee on Banking Supervision (BCBS) (2006): "International convergence of capital measurement and capital standards: A revised framework", June 2006.

——— (2010a): "Basel III: A global regulatory framework for more resilient banks and banking systems", December 2010 (revised June 2011).

——— (2010b): "Guidance for national authorities operating the countercyclical capital buffer", December 2010.

——— (2016): "Literature review on integration of regulatory capital and liquidity instruments", *Basel Committee on Banking Supervision Working Paper*, no 30.

Basten, C and C Koch (2017): "The countercyclical capital buffer", mimeo.

Begley, TA, A Purnanandam and K Zheng (2017): "The strategic underreporting of bank risk", *The Review of Financial Studies*, vol 30, no 10, pp 3376–3415.

Behn, M, R Haselmann and P Wachtel (2016a): "Pro-cyclical capital regulation and lending", *The Journal of Finance*, vol 71, no 2, pp 919–956.

Behn, M, M Gross and T Peltonen (2016b): "Assessing the costs and benefits of capital-based macroprudential policy", *European Systemic Risk Board Working Paper Series*, no 17.

Benes, J, M Kumhof and D Laxton (2014): "Financial crises in DSGE models: Selected applications of MAPMOD", *IMF Working Paper*, no 14/56.

Benes, J and M Kumhof (2015): "Risky bank lending and countercyclical capital buffers", *Journal of Economic Dynamics & Control*, vol 58, pp 58–80

Beyer, A, G Nicoletti, N. Papadopoulou, P. Papsdorf, G. Rünstler, C. Schwarz, J. Sousa and O. Vergote (2017): "The transmission channels of monetary, macro- and microprudential policies and their interrelations", *European Central Bank Occasional Paper Series*, no 191.

Bierut, B, T Chmielewski, A Głogowski, A Stopczyński and S Zajączkowski (2015): "Implementing loan-to-value and debt-to-income ratios: Learning from country experiences. The case of Poland", *Narodowy Bank Polski Working Paper*, no 212.

Blum, JM (2008): "Why 'Basel II' may need a leverage ratio restriction", *Journal of Banking & Finance*, vol 32, no 8, pp 1699–1707.

Blundell-Wignall, A and C Roulet (2013): "Business models of banks, leverage and the distance-to-default", *OECD Journal: Financial Market Trends*, vol 2012/2.

Bluwstein, K (2017): "Asymmetric macro-financial spillovers", *Sveriges Riksbank Working Paper Series*, no 337.

Borchgrevinck, H, S Ellingsrud and F Hansen (2014): "Macroprudential regulation: What, why and how?", *Norges Bank Staff Memo*, no 13/2014.

Borio, C and P Lowe (2002): "Asset prices, financial and monetary stability: exploring the nexus", *BIS Working Papers*, no 114.

Borio, C and M Drehmann (2009): "Assessing the risk of banking crises – revisited", *BIS Quarterly Review*, March.

Born, B, M Ehrmann and M Fratzscher (2012): "Communicating about macro-prudential supervision – A new challenge for central banks", *International Finance*, vol 15, no 2, pp 179–203.

Born, B, M Ehrmann and M Fratzscher (2014): "Central bank communication on financial stability", *The Economic Journal*, vol 124, June, pp 701–734.

Bridges, J, D Gregory, M Nielsen, S Pezzini, A Radia and M Spaltro (2015): "The impact of capital requirements on bank lending", mimeo.

Buch, CM and L Goldberg (2017): "Cross-border prudential policy spillovers: How much? How important? Evidence from the International Banking Research Network", *International Journal of Central Banking*, March, pp 505–558.

Büyükkarabacak, B and NT Valev (2010): "The role of household and business credit in banking crises", *Journal of Banking & Finance*, vol 34, no 6, pp 1247–1256.

Caicedo Soler, SC, D Estrada and ML Quintero (2012): "Countercyclical banking capital buffers in a DSGE model", *Banco de la República Colombia Temas de Estabilidad Financiera*, no 71.

Carvalho, FA de, MR Castro and SMA Costa (2014): "Traditional and matter-of-fact financial frictions in a DSGE model for Brazil: The role of macroprudential instruments and monetary policy", *BIS Working Papers*, no 460.

Carvalho, FA de and MR Castro (2015a): "Foreign capital flows, credit growth and macroprudential policy in a DSGE model with traditional and matter-of-fact financial frictions", *Banco Central do Brasil Working Papers*, no 387.

Carvalho, FA de and MR Castro (2015b): "Macroprudential and monetary policy interaction: A Brazilian perspective", *Banco Central do Brasil Working Papers*, no 405.

Castren, O and IK Kavonius (2009): "Balance sheet interlinkages and macro-financial risk analysis in the euro area", *European Central Bank Working Paper Series*, no 1124.

Central Bank of Ireland (2010): "The Irish banking crisis: Regulatory and financial stability policy 2003–2008", A report to the Minister for Finance by the Governor of the Central Bank.

Cerutti, E, S Claessens and L Laeven (2017): "The use and effectiveness of macroprudential policies: New evidence", *Journal of Financial Stability*, vol 28, pp 203–224.

Chen, J and F Columba (2016): "Macroprudential and monetary policy interactions in a DSGE model for Sweden", *IMF Working Paper*, no 16/74.

Chen, Y, V Sivec and M Volk (2017): "Empirical evidence on the effects of capital buffer release", mimeo.

Cizel, J, J Frost, A Houben and P Wierts (2016): "Effective macroprudential policy: Cross-sector substitution from price and quantity measures", *IMF Working Paper*, no 16/94.

Claessens, S, SR Gosh and R Mihet (2014): "Macro-prudential policies to mitigate financial system vulnerabilities", *IMF Working Paper*, no 14/155.

Clancy, D and R Merola (2016): "Countercyclical capital rules for small open economies", *European Stability Mechanism Working Paper Series*, no 10.

Clerc, L, A Derviz, C Mendicino, S Moyen, K Nikolov, L Stracca, J Suarez and AP Vardoulakis (2015): "Capital regulation in a macroeconomic model with three layers of default", *International Journal of Central Banking*, June.

Committee on the Global Financial System (CGFS) (2012): "Operationalising the selection and application of macroprudential instruments", *CGFS Papers*, no 48.

——— (2016): "Objective-setting and communication of macroprudential policies", *CGFS Papers*, no 57.

Crowe, C, G Dell'Ariccia, D Igan and P Rabanal (2011): "Policies for macrofinancial stability : Options to deal with real estate booms", *IMF Staff Discussion Note*, no 11/02.

——— (2013) : "How to deal with real estate booms : Lessons from country experiences", *Journal of Financial Stability*, vol 9, no 3, pp 300–319.

Darracq Pariès, M, E Rancoita and C Kok (2015): "Quantifying the policy mix in a monetary union with national macroprudential policies", *European Central Bank Financial Stability Review November 2015*, pp 159–171.

Darracq Pariès, M, P Jacquinot and N Papadopoulou (2016): "Parsing financial fragmentation in the euro area: A multi-country DSGE perspective", *European Central Bank Working Paper Series*, no 1891.

De Backer, B, P Du Caju, M Emiris and C Van Nieuwenhuyze (2015): "Macroeconomic determinants of non-performing loans", *National Bank of Belgium Economic Review*, December.

De Backer, B, H Dewachter, S Ferrari, M Pirovano and C Van Nieuwenhuyze (2016): "Credit gaps in Belgium: identification, characteristics and lessons for macroprudential policy", *National Bank of Belgium Financial Stability Report 2016*, pp 135–157.

De Jonghe, O, H Dewachter and S Ongena (2016): "Bank capital (requirements) and credit supply: Evidence from pillar 2 decisions", *National Bank of Belgium Working Paper Research*, no 303.

De Marco, F and T Wieladek (2015): "The real effects of capital requirements and monetary policy: Evidence from the United Kingdom", *Bank of England Staff Working Paper*, no 573.

De Nicolo, G, G Favara and L Ratnovski (2012): "Externalities and macroprudential policy", *IMF Staff Discussion Note*, no 12/05.

De Nicolo, G, A Gamba and M Lucchetta (2014): "Microprudential regulation in a dynamic model of banking", *The Review of Financial Studies*, vol 27, no 7, pp 2097–2138.

Demirguc-Kunt, A, E Detragiache and O Merrouche (2013): "Bank capital: Lessons from the financial crisis", *IMF Working Paper*, no 10/286.

de-Ramon, S, Z Iscenko, M Osborne, M Straughan and P Andrews (2012): "Measuring the impact of prudential policy on the macroeconomy: A practical application to Basel III and other responses to the financial crisis", *Financial Services Authority Occasional Paper Series*, no 42.

Detken, C, O Weeken, L Alessi, D Bonfim, MM Boucinha, C Castro, S Frontczak, G Giordana, J Giese, N Jahn, J Kakes, B Klaus, JH Lang, N Puzanova and P Welz (2014): "Operationalising the countercyclical capital buffer: indicator selection, threshold identification and calibration options", *European Systemic Risk Board Occasional Paper Series*, no 5.

Dietsch, M and C Welter-Nicol (2014): "Do LTV and DSTI caps make banks more resilient?", *Autorité de Contrôle Prudentiel et de Résolution Débats Économiques et Financiers*, no 13.

Drehmann, M, C Borio, L Gambacorta, G Jiménez and C Trucharte (2010): "Countercyclical capital buffers: exploring options", *BIS Working Papers*, no 317.

Drehmann, M, C Borio and K Tsatsaronis (2011): "Anchoring countercyclical capital buffers: the role of credit aggregates", *BIS Working Papers*, no 355.

Drehmann, M and L Gambacorta (2012): "The effects of countercyclical capital buffers on bank lending", *Applied Economics Letters*, vol 19, no 7, pp 1–6.

Elliot, DJ (2011): "An overview of macroprudential policy and countercyclical capital requirements", *The Brookings Institution*, March 2011.

European Systemic Risk Board (ESRB) (2014): "The ESRB Handbook on Operationalising macroprudential policy in the banking sector", March 2014.

——— (2015): "The ESRB Handbook on Operationalising macroprudential policy in the banking sector, Addendum: Macroprudential leverage ratios", June 2015.

——— (2016): "ESRB response to the European Commission's Consultation Document on the "Review of the EU macro-prudential policy framework"", October 2016.

——— (2017): "A review of macroprudential policy in the EU in 2016", April 2017.

Fahr, S and J Fell (2017): "Macroprudential policy – Closing the financial stability gap", *Journal of Financial Regulation and Compliance*, vol 25, no 4, pp 334–359.

Ferrari, S, M Pirovano and P Rovira Kaltwasser (2017): "The impact of sectoral macroprudential capital requirements on mortgage lending: Evidence from the Belgian risk weight add-on", mimeo.

Ferreira, LN and MI Nakane (2015): "Macroprudential policy in a DSGE model: Anchoring the countercyclical capital buffer", *Banco Central do Brasil Working Papers*, no 407.

Fiori, R, A Foglia and S Iannotti (2009): "Beyond macroeconomic risk: The role of contagion in the Italian corporate default correlation", *Bocconi Carefin Working Paper*, no 12/09.

Forlati, C and L Lambertini (2011): "Risky mortgages in a DSGE model", *International Journal of Central Banking*, March, pp 285–335.

Fraisse, H, M Lé and D Thesmar (2017): "The real effects of bank capital requirements", *European Systemic Risk Board Working Paper Series*, no 47.

Francis, WB and M Osborne (2010): "On the behavior and determinants of risk-based capital ratios: revisiting the evidence from UK banking institutions", *International Review of Finance*, vol 10, no 4, pp 485–518

——— (2012): "Capital requirements and bank behavior in the UK: Are there lessons for international capital standards?", *Journal of Banking & Finance*, vol 36, no 3, pp 803–816.

Gabaix, X (2011): "The granular origins of aggregate fluctuations", *Econometrica*, vol 79, no 3, pp 733–772.

Galaasen, SM and RM Johansen (2016): "Cyclical capital regulation and dynamic bank behaviour", *Norges Bank Staff Memo*, no 22/2016.

Gelain, P, KJ Lansing and C Mendicino (2013): "House prices, credit growth, and excess volatility: Implications for monetary and macroprudential policy", *International Journal of Central Banking*, June, pp 219–276.

Gerba, E (2016): "Have the US macro-financial linkages changed? The balance sheet dimension", mimeo.

Gersbach, H and J Rochet (2017): "Capital regulation and credit fluctuations", *Journal of Monetary Economics*, vol 90, pp 113–124.

Gómez, E, A Lizarazo, JC Mendoza and A Murcia (2017): "Evaluating the impact of macroprudential policies on credit growth in Colombia", *BIS Working Papers*, no 634.

Goodhart, C, AK Kashyap, DP Tsomocos and AP Vardoulakis (2013): "An integrated framework for analyzing multiple financial regulations", *International Journal of Central Banking*, January, pp 109–143.

Gordy, MB (2003): "A risk-factor model foundation for ratings-based bank capital rules", *Journal of Financial Intermediation*, vol 12, no 3, pp 199-232.

Havemann, R (2014): "Counter-cyclical capital buffers and interest-rate policy as complements: The experience of South Africa", *Economic Research Southern Africa working paper*, no 476.

Hills, R, D Reinhardt, R Sowerbutts and T Wieladek (2017): "International banking and cross-border effects of regulation: Lessons from the United Kingdom", *International Journal of Central Banking*, March, pp 405–433.

Hollander, H (2014): "The effectiveness of countercyclical capital requirements and contingent convertible capital: A dual approach to macroeconomic stability", *Stellenbosch Economic Working Papers*, no 19/14.

Horváth, BL and W Wagner (2017): "The disturbing interaction between countercyclical capital requirements and systemic risk", *Review of Finance*, vol 21, no 4, pp 1485–1511.

Iacoviello, M and S Neri (2010): "Housing market spillovers: Evidence from an estimated DSGE model", *American Economic Journal: Macroeconomics*, vol 2, no 2, pp 125–164.

International Monetary Fund (IMF) (2011): "Euro area policies: 2011 Article IV Consultation – Lessons from the European Financial Stability Framework Exercise; and Selected Issues Paper", *IMF Country Report*, no 11/186.

——— (2012): "The interaction of monetary and macroprudential policies – Background paper", December 2012.

——— (2014): "Israel: Selected issues", *IMF Country Report*, no 14/48.

——— (2017): "Turkey: Financial Sector Assessment Program: Financial System Stability Assessment", *IMF Country Report*, no 17/35.

Jácome, LI and S Mitra (2015): "LTV and DTI limits – Going granular", *IMF Working Paper*, no 15/154.

Jiménez, G and Mencía (2007): "Modelling the distribution of credit losses with observable and latent factors", *Banco de España Documentos de Trabajo*, no 0709.

Jiménez, G and J Saurina (2006): "Credit cycles, credit risk, and prudential regulation", *International Journal of Central Banking*, June, pp 65–98.

Jiménez, G, S Ongena, J Peydró and J Saurina (2017): "Macroprudential policy, countercyclical bank capital buffers and credit supply: Evidence from the Spanish dynamic provisioning experiments", *Journal of Political Economy*, vol 125, no 6, pp 2126–2177.

Jokivuolle, E, I Kiema and T Vesala (2014): "Why do we need countercyclical capital requirements?", *Journal of Financial Services Research*, vol 46, no 1, pp 55–76.

Jordá, Ò, M Schularick and AM Taylor (2013): "When credit bites back", *Journal of Money, Credit and Banking*, supplement to vol 45, no 2, pp 3–28.

——— (2014): "The great mortgaging: Housing finance, crises, and business cycles", *National Bureau of Economic Research Working Paper*, no 20501.

Kang, H, F Vitek, R Bhattacharya, P Jeasakul, S Muñoz, N Wang and R Zandvakil (2017): "Macroprudential policy spillovers: A quantitative analysis", IMF Working Paper, no 17/170.

Kara, H (2016): "Turkey's experience with macroprudential policy", *BIS Papers*, no 86.

Karmakar, S (2016): "Macroprudential regulation and macroeconomic activity", *Journal of Financial Stability*, vol 25, pp 166–178.

Koetter, M and T Poghosyan (2010): "Real estate prices and bank stability", *Journal of Banking & Finance*, vol 34, no 6, pp 1129–1138.

Kraft, E and T Galac (2011): "Macroprudential regulation of credit booms and busts: The case of Croatia", *The World Bank Policy Research Working Paper*, no 5772.

Lewis, V and S Villa (2016): "The interdependence of monetary and macroprudential policy under the zero lower bound", *National Bank of Belgium Working Paper Research*, no 310.

Lozeij, M, L Onorante and A Rannenberg (2017): "Countercyclical capital regulation in a small open economy DSGE model", *Central Bank of Ireland Research Technical Paper*, no 03/RT/2017.

Lucas, DJ (1995): "Default correlation and credit analysis", *The Journal of fixed income*, vol 4, no 4, pp 76–87.

Mariathasan, M and O Merrouche (2014): "The manipulation of basel risk-weights", *Journal of Financial Intermediation*, vol 23, no 3, pp 300–321.

Martins, B and R Schechtman (2014): "Bank capital requirements and loan pricing: Loan-level evidence from a macro prudential within-sector policy", mimeo.

Martins, AM and AP Serra (2012): "Real estate market risk in bank stock returns: Evidence for 15 European countries", *Centro de Economia e Finanças da UPorto Working Paper*, no 2012-03.

Meeks, R (2017): "Capital regulation and the macroeconomy: Empirical evidence and macroprudential policy", *European Economic Review*, vol 95, pp 125–141.

Mendicino, C, K Nikolov, J Suarez and D Supera (2015): "Welfare analysis of implementable macroprudential policy rules: Heterogeneity and trade-offs", mimeo.

——— (2016): "Optimal dynamic capital requirements", mimeo.

Mohan R and M Kapur (2009): "Managing the impossible trinity: Volatile capital flows and Indian monetary policy", *Stanford Center for International Development Working Paper*, no 401.

Noss, J and P Toffano (2016): "Estimating the impact of changes in aggregate bank capital requirements on lending and growth during an upswing", *Journal of Banking & Finance*, vol 62, pp 15–27.

Ongena, S, A Popov and G Udell (2013): "When the cat's away the mice will play: Does regulation at home affect bank risk-taking abroad?", *Journal of Financial Economics*, vol 108, no 3, pp 727-720.

Pan, H and C Wang (2013): "House prices, bank instability, and economic growth: Evidence from the threshold model", *Journal of Banking & Finance*, vol 37, no 5, pp 1720–1732.

Pereira da Silva, LA and RE Harris (2012): "Sailing through the global financial storm: Brazil's recent experience with monetary and macroprudential policies to lean against the financial cycle and deal with systemic risks", *Banco Central do Brasil Working Paper Series*, no 290.

Pool, S (2016): "Credit defaults, bank lending and the real economy", mimeo.

Reinhardt, D and R Sowerbutts (2016): "Regulatory arbitrage in action: evidence from banking flows and macroprudential policy", mimeo.

Repullo, R and J Suarez (2013): "The procyclical effects of bank capital regulation", *The Review of Financial Studies*, vol 26, no 2, pp 452–490.

Rubio, M and JA Carrasco-Gallego (2016): "The new financial regulation in Basel III and monetary policy: A macroprudential approach", *Journal of Financial Stability*, vol 26, pp 294–305.

Saldías, M (2013): "A market-based approach to sector risk determinants and transmission in the euro area", *European Central Bank Working Paper Series*, no 1574.

Samarina, A, L Zhang and D Bezemer (2017): "Credit cycle coherence in the Eurozone: Was there a euro effect?", *Journal of International Money and Finance*, vol 77, pp 77–98.

Schularik, M and AM Taylor (2012): "Credit booms gone bust: Monetary policy, leverage cycles, and financial crises, 1870–2008", *American Economic Review*, vol 102, no 2, pp 1029–1061.

Sinha, A (2011): "Macroprudential policies: Indian experience", address at Eleventh Annual Seminar on Policy Challenges for the Financial Sector.

Smith, S, D Fuller, A Bogin, N Polkovnichenko and J Weiher (2014): "Countercyclical capital regime revisited: Tests of robustness", *Federal Housing Finance Agency Working Papers*, no 14-1.

Sonoda, K and N Sudo (2016): "Is macroprudential policy instrument blunt?", *BIS Working Papers*, no 536.

Tarullo, DK (2014): "Macroprudential regulation", *Yale Journal on Regulation*, vol 31, no 3, pp 505–521.

Turk-Ariss, R (2017): "Heterogeneity of bank risk weights in the EU: Evidence by asset class and country of counterparty exposure", *IMF Working Paper*, no 17/137.

Uluc, A and T Wieladek (2017): "Capital requirements, risk shifting and the mortgage market", *European Central Bank Working Paper Series*, no 2061.

Wong, E, A Tsang and S Kong (2016): "How does loan-to-value policy strengthen resilience of banks to property price shocks – Evidence from Hong Kong", *International Real Estate Review*, vol 19, no 1, pp 120–149.