How might macroprudential capital policy affect credit conditions?

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- Macroprudential capital policy is designed to make the financial system more resilient and reduce the likelihood and severity of financial crises. In doing so, it can have an impact on credit conditions and economic growth more generally.
- This article considers the effects on credit conditions over the near term. The direction and magnitude of those effects are likely to depend crucially on the state of the financial system and the economy as well as the way in which banks, financial investors and borrowers respond to changes in macroprudential capital policy.

Overview

Macroprudential capital policy is one of the many actions the Financial Policy Committee (FPC) can take to tackle risks to financial stability. It is intended to encourage banks to act pre-emptively by raising capital in good times — when it is more easily accessible — to allow losses to be absorbed in bad times and so support the continued flow of credit to households and firms. In addition to the direct effect of making the financial system better able to withstand shocks, it can also affect resilience via its impact on credit conditions and economic growth more generally.

The near-term effects of any change in macroprudential capital policy on credit conditions are complex. This article sets out a simple framework for understanding them. But regardless of those near-term impacts, a well-capitalised financial system will be more resilient to future financial shocks and will, therefore, be better able to support a sustainable flow of credit in the longer term.

The effects of changes in macroprudential capital policy on credit conditions will depend crucially on the way in which banks adjust their balance sheets which, in turn, will reflect any guidance from the FPC on how banks should adjust their capital ratios. Aside from this, a key determinant of the impact of macroprudential capital policies on credit conditions will be the extent to which banks' cost of funding is affected. This, in turn, will likely depend on the severity of financial frictions and the extent to which a policy announcement influences things like investors' beliefs about the soundness of the financial system and their expectations of future policy. The overall impact on the price and quantity of lending will then depend on the extent to which banks pass through changes in funding costs to credit conditions and how much macroprudential capital policy influences borrower demand for credit. This article introduces a simple framework that can be used as a starting point for quantifying some of these channels. The framework adopts a 'general equilibrium' approach in order to try and take account of the decisions of savers and borrowers in the economy, as well as the banks themselves.

Of course, in practice, the direction and magnitude of these effects is likely to vary with the state of the financial system and the economy. For instance, during benign conditions, an increase in capital requirements could increase banks' overall funding costs by requiring them to finance more of their activities with equity, which is typically perceived to be more expensive than other sources of funding. Banks might then prefer to reduce lending by passing on these higher costs, for instance by charging higher interest rates on their loans. In contrast, when confidence in banks' capital adequacy is low and that pushes up on banks' funding costs, a requirement to increase capital ratios for all banks might improve systemic confidence to such an extent that overall funding costs might fall. This would help to support lending growth.

More generally, the framework introduced in the article is stylised and abstracts from a number of channels that are likely to be important. The transmission of macroprudential capital policy to credit conditions may not be linear, for instance, and might interact with monetary policy and with other regulatory requirements.

(1) The authors would like to thank Jonathan Stalmann for his help in producing this article.

A stable financial system is a prerequisite for a healthy economy. The recent financial crisis and its impact on economies across the world has generated a broad agreement among academics and policymakers that financial regulation needs to go beyond purely a concern for the safety and soundness of individual financial institutions, and needs to be macroprudential in nature. In the United Kingdom, the Bank of England has a statutory objective to protect and enhance the stability of the UK financial system. In support of this objective, the Prudential Regulation Authority(1) (PRA) is responsible for *microprudential* supervision of deposit-takers, insurers and major investment firms and the Financial Policy Committee (FPC) is responsible for the setting of *macroprudential* policy in the United Kingdom. It has legal powers to identify, monitor and take action to remove or reduce systemic risks, having operated on an interim basis since 2011.(2)

Banks and building societies(3) play an important role in the financial system by providing credit as well as a wide range of other financial services.(4) They can finance that lending from a variety of sources.(5) The ability of a bank to attract deposits from customers or funding from wholesale debt markets will reflect the confidence of depositors and investors in that bank. Equity capital (henceforth 'capital') is also a source of funds, but one that the bank has no obligation to repay. The more capital a bank has, therefore, the more it is able to absorb losses on its lending and other exposures. So when a bank has insufficient capital and prospective losses become so large as to threaten a bank's solvency, a bank will find it hard to attract funding. This was the situation facing a large number of banks during the financial crisis and resulted in a sharp contraction in the supply of credit to the real economy, with adverse consequences for the entire financial system.

The FPC's primary objective is to protect and enhance the resilience of the UK financial system. Macroprudential capital policy is one of the many policy actions the FPC can take in order to achieve this objective. It is intended to encourage banks to act pre-emptively by raising capital in good times — when it is more easily accessible — to allow losses to be absorbed in bad times and to ensure banks have sufficient capital to support the continued flow of credit to households and firms.

In addition to the direct effect of making the financial system better able to withstand shocks, there is also an indirect channel by which macroprudential capital policy can affect resilience via its impact on credit conditions and economic growth more generally. But the magnitude and direction of the relationship will depend on the conditions prevailing at the time. An increase in capital requirements during benign conditions could increase banks' overall funding costs by requiring them to finance more of their activities with equity, which is typically more expensive than other sources of funding. Banks might then pass on these higher funding costs by charging higher interest rates on their loans, reducing the amount of credit supplied to the economy and thereby helping to avoid the build-up of the vulnerabilities associated with an overextension of credit. When confidence in banks' capital positions is low, this indirect channel could work in reverse: an easing in macroprudential capital policy would allow previously accumulated buffers to be reduced, leading to looser credit conditions.

Since credit conditions play an important role in the outlook for economic growth and inflation, the Monetary Policy Committee (MPC) — whose primary objective is to deliver price stability, defined by the 2% inflation target — monitors closely any near-term(6) impact on credit conditions stemming from changes in macroprudential policies (including capital policies). Moreover, both Committees have a secondary objective to support the Government's broader economic policy, including its objectives for growth and employment. So for this reason, too, both the FPC and the MPC need to consider the likely impact of macroprudential capital policy on output and inflation when setting policy and a key part of this assessment is the impact via credit conditions.(7)

The focus of this article is on the impact on credit conditions over the near term, which has particular relevance for the MPC as it will interact with other considerations relevant to the setting of monetary policy. It is important to note, however, that over longer horizons, macroprudential capital policies should contribute to a more resilient financial system — this is the FPC's primary objective — that is better able to support the continued provision of credit and payment services to the economy.

The first section of this article describes how macroprudential capital policy is set in the United Kingdom. The article then discusses a simple framework for thinking about the impact of a change in macroprudential capital policy on credit conditions in the near term. In particular, it describes how the impact on credit conditions depends on a range of factors, particularly on the way in which the policy is specified, the state of the economy and how banks, financial investors and borrowers respond to changes in macroprudential capital policy. The

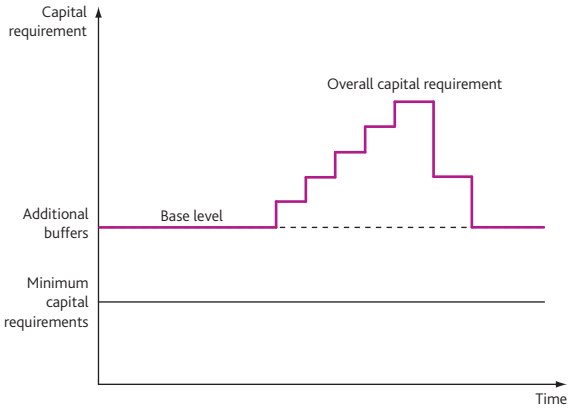
(1) For more detail on the role of the PRA, see Bailey, Breeden and Stevens (2012).
(2) For more detail on the role of the FPC, see Tucker, Hall and Pattani (2013) and Murphy and Senior (2013).
(3) In what follows, the term 'banks' is used to describe banks and building societies.
(4) For more detail on the role of banks, see Freixas and Rochet (2008).
(5) To some extent, the banking system is self-financing in that whenever banks make loans, they simultaneously create a matching deposit in the borrowers' bank accounts, thereby creating new funding. But what is true for the system as a whole does not necessarily hold for an individual bank. For more detail on money creation, see McLeay, Radia and Thomas (2014).
(6) 'Near term' in the context of macroprudential policy as used in this article refers to a period of up to two to three years from when a policy is announced. Note that this contrasts with 'near term' as used in discussions of monetary policy (such as in the *Inflation Report*), which typically refers to the coming few months.
(7) For more on the interaction between monetary policy and financial stability policy, see the June 2013 *Financial Stability Report*; www.bankofengland.co.uk/publications/Documents/fsr/2013/fsrfull1306.pdf.

following section introduces some theoretical models that can be used to quantify some of these channels. The final section briefly discusses some issues around the quantification of macroprudential policy that policymakers would be likely to consider in practice.

Setting the scene: macroprudential capital policy in the United Kingdom

In the United Kingdom, regulators can seek to ensure that banks have adequate capital in two steps. First, they apply **minimum capital requirements** for individual banks which all banks must adhere to; and second, they can apply **additional microprudential and macroprudential capital buffers** over and above these requirements.(1) Capital buffers are meant to encourage banks to build up reserves in 'good times' so that they can absorb losses in times of stress without breaching their minimum capital requirements. When the FPC does not judge there to be material risks to financial stability, it will set the macroprudential capital buffers to zero. In this case, microprudential capital requirements and additional buffers will form the base level for banks' overall capital requirements (as shown by the dashed line in **Figure 1**). But when threats to financial stability emerge, the FPC can increase macroprudential capital buffers above the microprudential base level. And as threats diminish, the FPC can reduce these buffers back to the microprudential base level. This scenario is illustrated by the solid magenta line in **Figure 1**.

Figure 1 Illustration of macroprudential capital policy(a)



(a) 'Additional buffers' refers to the capital conservation buffer, systemic risk buffers and any forward-looking guidance on capital levels by the microprudential regulators. For more details see Farag, Harland and Nixon (2013).

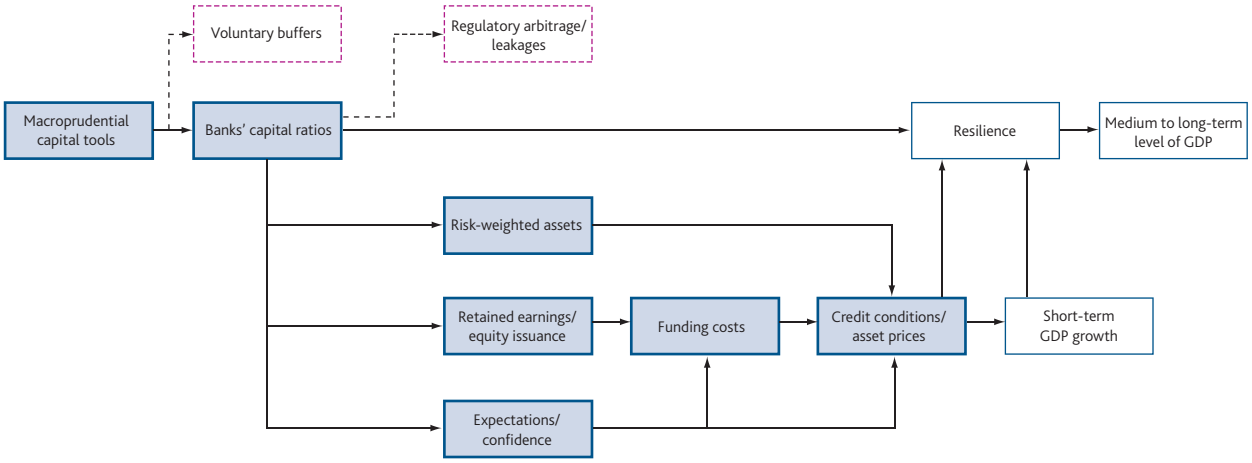
The FPC has two main sets of powers at its disposal. The first is a wide-ranging power to make *Recommendations* to mitigate systemic risks.(2) The second is a power to give *Directions* to regulators to adjust specific macroprudential tools. To date, the Government has given the FPC direction power over sectoral capital requirements (SCRs) and, in May 2014, it made the FPC responsible for policy decisions on the countercyclical capital buffer (CCB).(3) Both tools build on the existing microprudential regime and are designed to reduce the likelihood and severity of financial crises. The CCB tool allows the FPC to change bank capital requirements, over and above their microprudential level, in relation to all loans and exposures to UK borrowers. SCRs, meanwhile, allow the FPC to change capital requirements, over and above their microprudential level, on exposures to specific sectors of the economy that are judged to pose a risk to the system as a whole.(4) These sectors could include residential property, commercial property, or other parts of the financial sector. As required under statute, the FPC published a Policy Statement in January 2014 describing these tools, the circumstances in which they might be used and the likely impact of these tools on financial stability and growth.(5)

In June 2014, the FPC discussed the setting of a UK CCB following its introduction by legislation in May 2014.(6) As a starting point, it considered a 'buffer guide' — a simple metric identified in Basel III and EU legislation, which provides a guide for the CCB rate based on the gap between the ratio of credit to GDP and its long-term trend.(7) The Committee also looked beyond the guide at a wider set of core indicators, other relevant metrics, supervisory and market intelligence and information from stress tests. The FPC's core indicators, detailed in an annex in the June 2014 *Financial Stability Report*, include aspects of 'balance sheet stretch' in banks and other sectors as well as conditions in financial markets. Based on their assessment of these core indicators, the buffer guide and various other metrics, the FPC agreed to set the current CCB rate for UK exposures at 0%.

Looking ahead, the FPC will also consider the CCB, SCRs and other capital policies in light of the first stress test of the UK banking system to be completed by the end of 2014. The exercise will examine the resilience of the eight major UK banks and building societies to a stress scenario incorporating a substantial fall in house prices and pressure on

(1) Additional buffers include a capital conservation buffer, a systemic risk buffer, and guidance reflecting a forward-looking assessment by the PRA or Financial Conduct Authority (FCA) of the capital required to ensure that banks' minimum level of regulatory capital can be met at all times. For more detail, see Bank of England (2014a).
(2) But it has a special power to make recommendations, potentially on a comply or explain basis, to the PRA and FCA to adjust the rules that banks and other regulated financial institutions must abide by. For a summary of various FPC recommendations on capital, see Section 5 of the June 2014 *Financial Stability Report* (www.bankofengland.co.uk/publications/Documents/fsr/2014/fsrfull1406.pdf) and Box 5 in the June 2013 *Financial Stability Report* (www.bankofengland.co.uk/publications/Documents/fsr/2013/fsrfull1306.pdf).
(3) The tool is implemented in the European Union via the Capital Requirements Directive and Regulation (CRD IV/CRR), which became effective on 1 January 2014 with CCB provisions applying, at the latest, from 1 January 2016. In 2013, the PRA launched a consultation on its approach to implementing the CRD IV — see www.bankofengland.co.uk/pra/Documents/publications/policy/2013/implementingcrdivcp513.pdf.
(4) In addition to capital buffers which apply over and above minimum capital requirements, SCRs could also be applied by amending banks' 'risk weights' which affect risk-weighted assets and minimum capital requirements.
(5) See Bank of England (2014a).
(6) See Section 5.3 of the June 2014 *Financial Stability Report*; www.bankofengland.co.uk/publications/Documents/fsr/2014/fsrfull1406.pdf.
(7) Basel III refers to the latest international banking standards, which became effective on 1 January 2014, set by the Basel Committee on Banking Supervision, of which the Bank of England is a member. Basel standards specify how much capital and, in the future, liquidity banks should be required to have.

Figure 2 Stylised impact of macroprudential capital policy on credit conditions, resilience and growth(a)



(a) This article focuses on the links in the transmission shown in blue.

borrowers' ability to service their debts if interest rates rise substantially.(1) The results of the stress test will be used to inform the FPC's assessment of the resilience of the financial system and, in doing so, aid formulation of macroprudential capital policy responses.

A framework for assessing the impact of macroprudential capital policy on credit

Macroprudential capital policy is designed to make the financial system more resilient. It does so, in part, directly by altering the amount of capital banks are required to hold. But, in doing so, it might have an impact on credit conditions which can have indirect consequences for financial resilience. This section outlines a simple framework for thinking about the near term effects on credit conditions (**Figure 2**). While this framework can be applied to thinking about the effects of both aggregate and sectoral macroprudential capital requirements, it is worth noting that sectoral capital requirements might have a very different effect on aggregate credit conditions if there is a shift in the distribution of lending to other sectors.

A commonly used measure of capital adequacy (both microprudential and macroprudential) is the capital ratio, or the amount of capital that a bank has relative to its assets, weighted for their risk:(2)

Capital ratio = Capital/(Risk-weighted assets)

A bank can change its capital ratio by either adjusting the numerator or the denominator. For instance, a bank can increase its capital ratio either by raising capital or by reducing its risk-weighted assets (RWAs). In turn, capital can be increased either through raising equity or retaining more earnings.(3) Or if a bank wishes to reduce its RWAs it can do so either by holding fewer assets (for instance by selling certain assets, or not rolling over loans as they fall due) or by altering the composition of assets such that it holds a greater share of low-risk assets. The box on pages 292–93 describes three stylised ways in which a bank's balance sheet can mechanically adjust to meet higher capital ratio requirements.

In the first instance, the decision a bank makes about whether to adjust its RWAs or its level of capital will need to reflect any guidance from the FPC on how banks should adjust their capital ratios.(4) For instance, in March 2013, the interim FPC recommended that the PRA should take steps to ensure that, by the end of 2013, major UK banks and building societies held capital resources equivalent to at least 7% of their risk-weighted assets (after accounting for various adjustments that reflected a more prudent assessment of expected future losses, future conduct costs and risk weights). In addition, it recommended that banks were to meet those requirements by issuing new capital or restructuring balance sheets in a way that did not hinder lending to the economy.(5) The box on pages 292–93 includes some evidence on how banks responded to the FPC's recommendation. It also discusses how banks have adjusted their balance sheets in response to other capital policies in the past.

Aside from any FPC guidance on how banks should adjust their balance sheets, a key determinant of the impact of

(1) For more detail on the stress test see Box 2 in the June 2014 *Financial Stability Report*; www.bankofengland.co.uk/publications/Documents/fsr/2014/fsrfull1406.pdf.
(2) As shown in **Figure A** in the box on pages 292–93, a bank's balance sheet consists of its 'sources of funds' on one side (liabilities and capital) and its 'use of funds' (that is, its assets) on the other side. A bank's assets include loans to households and businesses and other assets like liquid assets, physical infrastructure and intangible assets. But some assets tend to be riskier than others and each asset class can be assigned a risk weight according to how risky it is judged to be. These weights are then applied to the bank's assets, resulting in RWAs. This allows banks, investors and regulators to consider the risk-weighted capital ratio, which is a bank's capital as a share of its RWAs.
(3) While the main component of a bank's capital resources is equity, banks can also count other instruments in their regulatory capital requirements. For more detail, see Farag, Harland and Nixon (2013).
(4) In addition, the impact of a change in capital ratios will also depend on whether banks are holding any voluntary capital buffers and the extent to which the new requirements bind for banks.
(5) See Table 4.A in the June 2013 *Financial Stability Report*; www.bankofengland.co.uk/publications/Documents/fsr/2013/fsrfull1306.pdf.

macroprudential capital policies on credit conditions will be the extent to which banks' cost of funding is affected. This, in turn, will likely depend on the severity of financial frictions and the extent to which a policy announcement influences things like investors' beliefs about the soundness of the financial system and their expectations of future policy. The overall impact on the price and quantity of lending will then depend on the extent to which banks pass through changes in funding costs to credit conditions and how much macroprudential capital policy influences borrower demand for credit. This section outlines a simple framework that can be used to think about these different channels.

Impact on banks' cost of funding

The theoretical starting point for understanding the impact of capital on credit is the **Modigliani-Miller Theorem**.(1) The theorem states that if a firm and its investors were to have access to perfect capital markets and there were no other distortions in the economy, its value would be unaffected by the share of equity capital in total funds. If this were the case for a bank, for example, its overall cost of funding would be unaffected by its share of retail versus wholesale funding, or its overall mix of debt versus equity funding. In this case, banks could simply respond to changes in capital requirements by altering their level of capital since one would expect an increase in capital requirements to be met by a fall in debt or equity funding costs such that the weighted marginal cost of funding were unchanged. In other words, banks would be able to adjust frictionlessly to a higher capital requirement by retaining profits or by issuing new equity with no implications for their overall funding costs.

In practice, however, the assumptions underlying the Modigliani-Miller Theorem are unlikely to hold for banks due to the presence of various financial frictions. These frictions include the preferential treatment of debt in the tax system and the existence of deposit guarantees that lead to equity being more expensive than debt. More detail is provided in the box on page 294.(2) The severity of these financial frictions is likely to affect the extent to which capital regulation has an impact on banks' marginal funding costs and, therefore, on credit conditions.

If the Modigliani-Miller Theorem did not hold, then an increase in capital requirements would change overall funding costs and so the value of the firm. Equity investors typically demand higher returns than debt investors. So, without a corresponding fall in the rates of return that debt investors require in response to the increase in capital requirements, the overall weighted cost of funding for the bank would increase. In this case, given the increase in funding costs that would result from raising capital, banks would be likely to respond to a higher capital requirement by adjusting their loan book — either by raising the interest rates they charge on new loans to decrease demand or via tightening non-price terms.(3) The higher the rate a bank charges on its loans, the greater is the reduction in the overall supply of (and, hence, demand for) loans.

Another factor influencing whether the Modigliani-Miller Theorem holds or not and the impact of a change in macroprudential capital requirements on overall funding costs is labelled 'expectations/confidence' in **Figure 2**. **Expectations** matter for any economic decisions that are intertemporal in nature, including lending and borrowing decisions. This feature of intertemporal decision-making is well understood in the context of monetary policy, where the forward-looking behaviour of households and businesses puts particular emphasis on using monetary policy to anchor inflation expectations.(4) In a similar way, the FPC can influence the behaviour and actions of financial market participants through signalling. For instance, if banks and financial market investors came to expect that a policy change will be reinforced by further policy changes in the future were risk-taking to continue, then the initial impact of macroprudential capital policy on funding costs and credit conditions might be larger than in the case where market participants expected a change in capital requirements to be temporary.

The **confidence** channel captures the idea that investor confidence in the soundness of the banking system as a whole is a crucial determinant of the funding conditions faced by individual banks seeking to raise debt or equity finance from investors. For example, in a situation in which investors are highly concerned about banks' likelihood of default, banks' funding costs are likely to be highly sensitive to capital adequacy: banks that are perceived by investors not to have enough capital to absorb potential future losses would need to pay a higher rate on any wholesale debt that they issue. So a direction to increase capital ratios for all banks might improve systemic confidence to such an extent that overall funding costs might fall. By ensuring that banks are well-capitalised, and by leaning against upswings and downturns in credit market risk appetite, macroprudential policy should boost investor confidence in the stability of the financial system.(5)

In practice, the size and direction of the effect of a move towards more equity finance on overall funding costs is likely to vary over time. Miles, Yang and Marcheggiano (2011) estimate that in the United Kingdom on average around

(1) See Modigliani and Miller (1958) for a discussion of how a value of a firm is affected by the way it is financed.
(2) Some of the frictions discussed in the box on pages 293–93 may be more important for time-varying macroprudential capital policy than for a permanent change in capital requirements. For instance, bank management may fear that raising capital quickly on the market would be seen as a signal of distress but be happy to raise capital more slowly through retained earnings. This could take several years, by which time cyclical macroprudential conditions could have changed.
(3) For instance, banks can reduce lending growth by ceasing to offer loan products or by tightening credit standards.
(4) See, for example, Woodford (2003).
(5) The strength of this channel would rely on the directive being applied to all banks. This is because individual banks may be unable to raise capital unilaterally since investors may be unwilling to inject equity into banks associated with a high probability of default. But in some circumstances, a system-wide increase in capital solves this problem by making the system safer, thereby reducing the probability of default and improving profitability prospects for all banks.

Mechanics of balance sheet adjustment

There are several adjustments a bank can make to change its capital ratio in response to a change in capital requirements. This box shows three stylised ways, explained in more detail below, in which a bank's balance sheet can mechanically adjust to meet higher capital ratio requirements (**Figure A**). These options are purely illustrative and not exhaustive: for example, a bank may adjust in more than one way and may make other changes to its business model in response to changes in capital requirements that have other effects on its balance sheet. Importantly, an increase in capital requirements does not necessarily require a fall in the amount of lending. Under Options 1 and 2, an individual bank can support the same amount of domestic lending as was supported by the original balance sheet, even at a higher capital ratio. It is only under Option 3 that a bank reduces loans to UK households and firms on its own balance sheet.

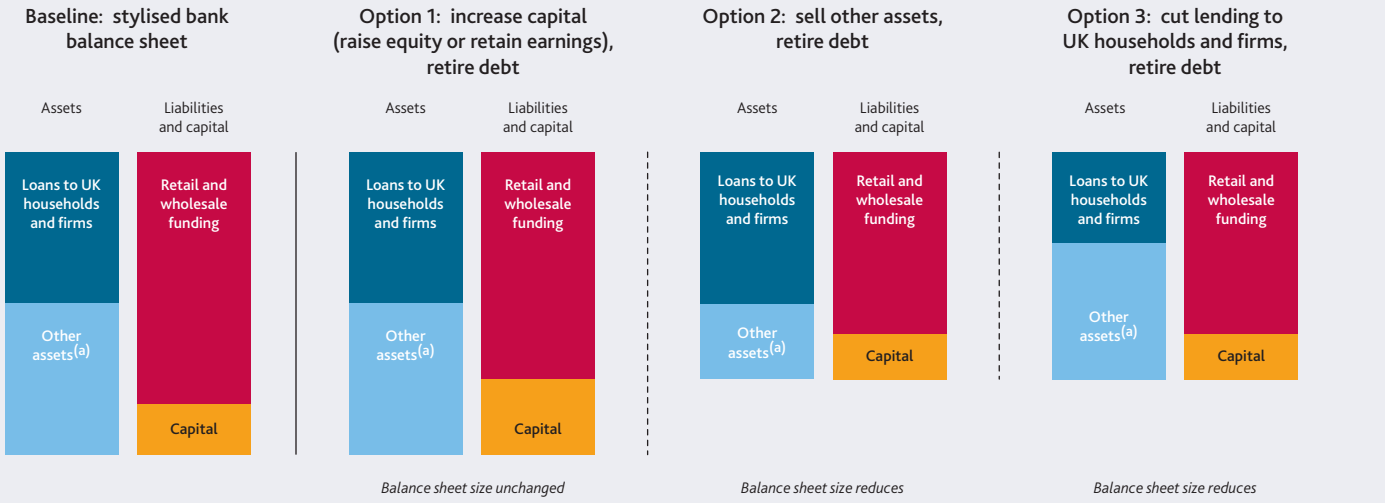
Under **Option 1**, the bank achieves a higher capital ratio by increasing the level of its capital. One way a bank can increase its capital is by issuing new equity shares, either through 'direct placements' or 'rights issues'.(1) Another way a bank can increase the level of capital is to retain earnings. If the bank retires debt at the same time then this option would be consistent with no change in the overall size of the bank's balance sheet and no change in its domestic lending. Under **Option 2**, the bank achieves a higher capital ratio by reducing the level of its risk-weighted assets (RWAs) but it does not reduce its level of UK household and corporate lending. As shown in **Figure A**, this could be because the bank reduces its holdings of other assets such as non-UK loans or trading book assets, decreasing the overall size of the balance sheet. Alternatively, the bank could reduce the level of its RWAs without affecting the size of its balance sheet by switching into assets that have lower risk weights. Under **Option 3**, the bank achieves a higher capital ratio by reducing its UK lending. But this does not necessarily imply a reduction in aggregate whole-economy lending, for instance if a bank reduces its loans by selling them to other financial market participants. Moreover, in the longer term, higher capital ratios should make the bank more resilient and support the stability of credit supply in the face of macroeconomic shocks.

The impact of a change in capital ratios on an individual bank's balance sheet in Options 2 and 3 should be judged against the size of its loans or other RWAs in the absence of policy — 'the counterfactual'. For example, a bank that is expanding its balance sheet might simply grow its riskier assets at a lower rate and maintain the same composition of capital relative to debt. So the size of the balance sheet may not shrink in absolute terms. In summary, a bank can mechanically adjust to a change in its required capital ratio in a number of ways, but all result in adjusting the amount of capital and/or adjusting the level of RWAs. And a bank might use a combination of various options to achieve the required change. Moreover, the decision a bank makes about how to adjust its balance sheet is likely to depend on the implications of macroprudential capital policy on banks' overall cost of funding. This is discussed on pages 291 and 295.

How have banks adjusted their balance sheets in the past?

One way of estimating how banks might respond to changes in capital requirements is to use data on how banks have responded to changes in *microprudential* standards, on average, in the past. Evidence for this is limited for the United Kingdom. A panel data study by Francis and Osborne (2009) based on 1996–2007 data for the United Kingdom suggests roughly half of the adjustment to

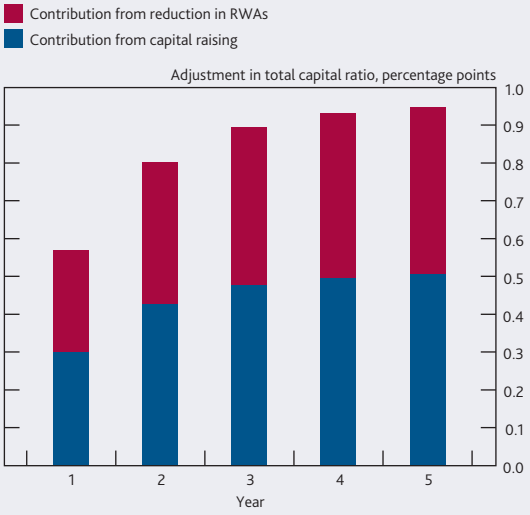
Figure A Options for how a bank might achieve a higher capital ratio



(a) Other assets include non-UK loans, trading book assets, loans to financial companies and cash.

higher capital ratios came through capital raising (**Chart A**). That study also found that the reduction in RWAs was driven by banks reducing their riskiest assets by more than their less risky assets. In contrast, a Federal Reserve study using data on UK banks in the 1990s finds that none of the response to changes in capital requirements came through adjustments to RWAs. But this study was based on changes in Pillar 2 capital requirements and so caution is needed when assessing the impact.(2)

Chart A Banks' adjustments through time to achieve a 1 percentage point increase in capital ratios(a)(b)



Sources: Financial Services Authority regulatory returns data and Bank calculations.

(a) The estimates are derived from the model used in Francis and Osborne (2009) as referenced in Andrews *et al* (2012). The model describes how banks adjust their balance sheets in response to shocks to their actual capital ratios and is based on 1996–2007 data.
(b) The estimates in **Chart A** are based on a starting regulatory capital to RWAs ratio of 10%.

These historical relationships between changes in *microprudential* capital requirements and changes in banks' balance sheets may be, however, a poor guide to forecasting banks' responses to future changes in *macroprudential* capital requirements as these estimates are based on previous microprudential regimes and circumstances at the time.(3) While the evidence is limited, there are a few examples of changes in system-wide capital requirements that can shed light on how banks might adjust their balance sheets in response to changes in macroprudential capital policy. For instance, the adjustment to higher capital ratio requirements for European banks following the 2011 European Banking Authority stress tests came mainly via an increase in the level of capital and to a lesser extent, by reducing RWAs.(4) And in the case of the US Supervisory Capital Assessment Program in 2009, the majority of the increase in capital requirements was met by increasing common equity.(5)

In the United Kingdom, an example of a change in macroprudential capital requirements is the Financial Policy Committee's (FPC's) capital shortfall exercise in 2013. In response to the FPC's recommendation, major UK banks and building societies improved their capital ratios both through reductions in RWAs and increases in capital resources. And in line with the FPC's recommendation, the shortfalls were addressed without a reduction in lending to the domestic economy by selling non-core assets and scaling back investment banking operations.(6)

(1) Under a direct placement, banks raise equity from new investors, which, all else equal, reduces existing shareholders' claims on future earnings. Rights issues, on the other hand, give existing shareholders the option to subscribe to newly issued shares. So this gives existing shareholders the option to invest more money without their ownership share being diluted.
(2) See Ediz, Michael and Perraudin (1998).
(3) This is in the spirit of the Lucas critique. See Lucas (1976).
(4) See European Banking Authority (2013).
(5) See Board of Governors of the Federal Reserve System (2009).
(6) See Section 4 of the June 2014 *Financial Stability Report*, available at www.bankofengland.co.uk/publications/Documents/fsr/2014/fsrfull1406.pdf.

The Modigliani-Miller propositions and banks

Modigliani and Miller (1958) established conditions under which the value of a firm is invariant to its capital structure — the mix of debt and equity used to finance the firm's assets. The so-called 'MM' propositions showed that, in the absence of financial frictions, a firm's average funding cost does not vary with its leverage (defined as the share of debt in total funding). For example, as leverage falls, a firm's equity becomes safer as losses are spread over a larger capital base, which in turn should lower the required return on equity and debt.

The MM proposition applies to firms that have access to capital markets. An implication of the theorem for banks is that changes in leverage would have no effect on funding costs. But the presence of various financial frictions means that the theorem is unlikely to hold in practice. Moreover, the severity of some of the frictions are likely to vary over time.(1) This box explains the nature of some of those financial frictions in more detail.

First, interest payments on debt are **tax-deductible**, meaning that banks' interest payments to bondholders can be set against their corporation tax payments. All else equal, this creates a 'tax wedge' that lowers the cost of debt finance relative to the cost of equity finance. Raising capital requirements would, therefore, mean that banks forgo some of this tax advantage, thereby increasing their overall funding costs.

Second, some components of banks' funding are subject to **guarantees**. These include (explicit) deposit insurance, which ensure up to some limit that banks' depositors do not lose their money in the event of bank default, and (implicit) government guarantees stemming from the perception that some banks are too big for the government to allow to default. Deposit insurance — unless it is charged at a rate that reflects accurately the probability of default of the bank — may give banks an incentive to take on more risks and substitute equity funding with other types of funding. In addition, if deposit insurance is underpriced, then deposit funding would be cheaper from a bank's perspective, all else equal. This is because deposit insurance lowers the rate of return banks must pay to attract deposits. As a result, a rise in capital requirements might cause banks to forgo these subsidies, raising their overall funding costs.

Third, some bank debt liabilities, including bank deposit accounts, have a special role in providing **liquidity services** to customers. By 'storing' households' savings and providing access to these resources at short notice, bank deposit accounts help households to smooth consumption or meet emergency expenditures without having to hold their savings in the form of notes and coins. Because of this liquidity benefit to households, they may be willing to hold their savings in the form of deposits for a lower interest rate than would otherwise be the case. This again would lower the cost of debt finance relative to equity.

Fourth, a bank's liability structure might reflect deeper **informational frictions** that exist between bank 'insiders' — such as bank managers paid in equity — and bank outsiders — such as investors in bank debt or equity. Some theories of capital structure suggest that bank equity may be costly relative to debt because its issuance contains information about the quality of a bank's asset portfolio that is otherwise unobservable to the market.(2) For example, a bank might wish to issue equity if asset quality deteriorated in order to share the downside losses with others. But if asset quality were expected to be high, a bank might issue debt in order to enjoy the profitable upside. Understanding this, investors would take desired equity issuance as a signal of bad asset quality, and would require a premium as compensation.

Finally, banks may perceive equity to be costly because of the problem of **debt overhang**: when a bank has excessive amounts of debt, investors may be reluctant to provide additional equity financing if a bank's assets were perceived to be of low quality. In this case, with mounting prospective losses, an injection of equity would represent a transfer from equity holders to holders of risky debt whose claims on the bank would otherwise incur reductions in value ('write-downs'). The reticence of new equity holders to make this transfer to existing bondholders would introduce another friction in the equity issuance decision.

(1) The severity of financial frictions are not likely to be constant over time, meaning that a given change in macroprudential policy would have effects that vary over time (see Tucker (2013)).
(2) See Myers and Majluf (1984).

45%–75% of any mechanical increase in overall bank funding costs from holding extra capital would be offset by a fall in debt funding costs. In such a scenario, banks are likely to adjust to a higher capital ratio requirement through a combination of increasing capital and reducing RWAs.

Impact on the amount of credit extended

The impact of macroprudential capital policy on bank lending is, therefore, likely to be influenced by two factors: first, the extent to which a change in policy affects credit supply via a change in banks' overall cost of funding and second, the extent to which a change in policy influences borrower demand for credit.

The pass-through of any change in banks' funding costs to the interest rates they charge on new lending will be influenced to some extent by the frictions banks face in repricing their existing loans. Due to the length of credit contracts, banks may not be able to renegotiate all their lending terms immediately in response to a change in policy.(1) This tends to dampen the pass-through of changes in capital requirements to existing borrowers, as banks are unable to reprice the entirety of their existing lending stocks immediately. So banks may attempt to adjust the interest rates for *new* borrowers by more than they otherwise would to compensate for the reduction in profitability. In addition to interest rates, banks can also choose to adjust the amount of credit supplied to the economy by adjusting the non-price terms on credit.

But the extent to which banks can and desire to alter their interest rates (or other non-price terms) will be affected both by how sensitive to interest rates the demand for loans is, and by the competitive nature of the banking system and the wider financial system. For instance, banks may be constrained by their competitors' behaviour, which could reduce their ability to raise loan rates immediately following a rise in capital requirements without jeopardising market share. In this case, these banks may absorb more of the costs of adjustment by reducing their profit margins on new lending.

The strength of these channels and the impact on credit conditions is also likely to vary with the state of the economy and the financial system. For instance, when confidence in banks' capital adequacy is high, an increase in capital requirements might have little impact on banks' cost of debt finance but increase banks' overall funding costs due to a higher proportion of more expensive equity on their balance sheets. Banks might then pass on these higher funding costs by charging higher interest rates on their loans, reducing the amount of credit supplied to the economy. In contrast, when confidence in banks' capital adequacy is low and banks' funding costs are high, a requirement to increase capital for all banks might improve systemic confidence to such an extent that overall funding costs fall. This would, in turn, help to support credit conditions.

In addition, the impact of macroprudential capital policy on the amount of credit extended may also be influenced by the extent to which a change in policy influences borrowers' demand for credit. So the impact on the volume of lending could be even more powerful if households and businesses come to anticipate that a policy change will be reinforced by further policy changes. For instance, if households and companies came to expect that the FPC would tighten macroprudential capital requirements in a sequence of steps when exuberant lending threatens financial stability, then that might dampen the expected outlook for aggregate demand and reduce households' and businesses' demand for borrowing.

In summary, the decision a bank makes about whether to adjust its RWAs or its level of capital will reflect any guidance from the FPC on how banks should adjust their capital ratios. But the impact on RWAs (and credit conditions) is also likely to depend on the size and the direction of the effect of the policy on banks' overall cost of funding. More generally, the impact on credit conditions will also depend on the state of the economy and the extent to which any change in policy influences borrower demand for credit.

The equilibrium impact on credit: a theoretical approach

The previous section described the key channels through which macroprudential capital policy might be expected to affect credit conditions. These effects are complex and quantifying them is challenging, not least because there is limited historical experience of how some of these channels operate. This section introduces two highly stylised economic models that contribute to the growing literature on this topic and can be used as a starting point for quantifying some of the channels articulated in the previous section.(2) The first model outlines the lending decision of a bank subject to capital regulation in a 'partial equilibrium' setting, referring to the fact that the bank's loan pricing problem is studied in isolation from the rest of the economy. And the second model extends the framework to include a role for the decisions of depositors and borrowers in the economy in response to policy changes — a 'general equilibrium' approach.

The simple models introduced in this section are necessarily stylised and abstract from a number of channels that are likely to be important and that policymakers would consider in practice when assessing the likely impact of macroprudential actions. For instance, the models considered here do not explicitly consider the impact of expectations of future policy on credit supply and demand, or capture the non-linear behaviour that are likely to characterise borrowers, banks and

(1) As a result, there are likely to be lags involved and adjustments in the aggregate stock of lending would therefore be likely to take several quarters.
(2) For lessons from the literature on some of these channels, see Giese *et al* (2013).

investors in the real world. Some of these channels are covered in the final section. Moreover, the models take the long-term benefits of macroprudential capital policy on resilience and credit availability as given and focus on credit market dynamics over the near term.

Partial equilibrium model

To understand the impact of a change in capital requirements on lending in a partial equilibrium framework, one might consider a highly stylised model in which loans make up the asset side of a bank's balance sheet and a bank finances those loans with equity and insured deposits or wholesale funding. The lower the rate the bank charges on these loans, the more loans are demanded. So any lending decision by the bank boils down to whether a new loan generates sufficient return to merit making that loan: a profit-maximising bank will set interest rates on new lending such that it covers its cost of funds, any expected credit losses, a capital charge to account for the cost associated with having capital, and other costs such as administrative costs. Banks are also likely to charge a 'mark-up' over their marginal costs to generate an expected return.(1)

The extent to which a change in capital requirements affects new lending rates will depend, in part, on the impact on overall funding costs. As described in the previous section, that impact on funding costs will, in turn, depend on whether the Modigliani-Miller Theorem holds and the extent to which confidence and expectations affect funding costs.

The impact on lending volumes would then depend on how sensitive demand for loans is to the interest rate charged — the slope of the demand curve. **Figure 3** shows stylised demand and supply curves for the loan market: the lower the interest rate, the more loans are demanded (D_0) but the fewer loans banks will supply (S_0). **Figure 3a** illustrates the impact on the loan market of a rise in capital requirements in the partial equilibrium model: credit supply shifts from S_0 to S_1, the loan rate rises and the amount of lending falls as banks move along the demand curve from point A to point B.

General equilibrium model

The partial equilibrium approach might be adequate for thinking about idiosyncratic changes in a particular bank's capital requirements — such as those implemented by a microprudential regulator with a remit to ensure the resilience of individual institutions. In the case of a macroprudential regime, however, the objectives underpinning policy actions relate directly to the stability of the financial system as a whole. This means that the reaction of borrowers and savers to policy changes is an important part of modelling the overall impact. In order to capture the general equilibrium impact of policy changes, this section employs a simplified version of a model presented by Gerali *et al* (2010). A stylised description of the model is shown in **Figure 4**, with details of the equations and the calibration used to estimate the parameters of the model provided in the annex. A key assumption in the general equilibrium model relative to the partial equilibrium model is that borrowers and savers react to changes in macroprudential capital policy.

Figure 3 Stylised response of the market for loans following a tightening of capital requirements in the presence of financial frictions

Figure 3a Partial equilibrium effect

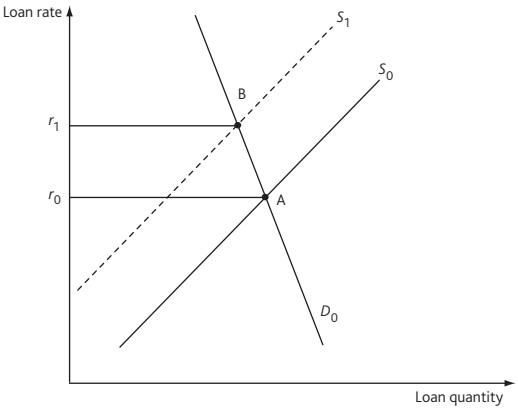


Figure 3b General equilibrium effect

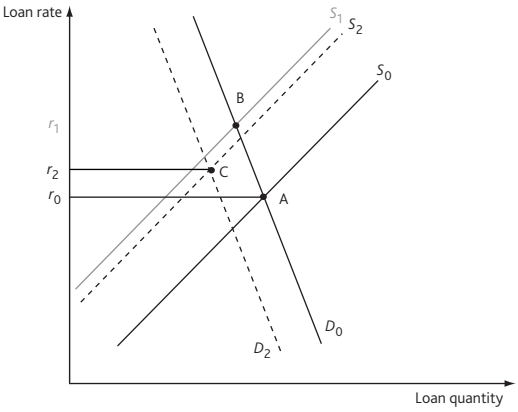
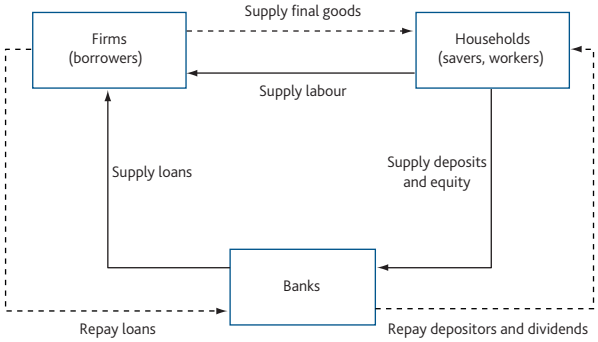


Figure 4 A stylised depiction of the general equilibrium model



(1) See Button, Pezzini and Rossiter (2010) and Butt and Pugh (2014) for a detailed overview of how banks price loans.

Figure 3b illustrates what happens to the loan market in response to a policy change in a general equilibrium setting. Rather than ending up at point B as in **Figure 3a**, the loan market equilibrium resides at point C: both loan volumes and loan rates are lower in the general equilibrium model. This reflects two features in **Figure 3b** that differ from **Figure 3a**. First, the demand curve for loans also shifts inwards in response to the tightening in capital requirements (D_0 to D_2). This effect reflects a reduction in firms' ability to borrow due to collateral constraints.(1) And second, the upward shift in the loan supply schedule is mitigated somewhat (moving S_0 to S_2 following the increase in capital requirements, compared with S_1 for the partial equilibrium model), further dampening the upward pressure on the loan rate. This effect reflects the dynamics in the market for banks' debt funding (which is taken to be households' deposits): since banks meet higher capital requirements by reducing loan quantities, this in turn reduces their demand for debt financing. That puts downward pressure on banks' funding costs which, in turn, ameliorates the scale of the upwards shift in the loan supply curve.

The combined effects of these additional features in the general equilibrium model can be seen by considering a temporary tightening cycle in which macroprudential capital requirements are increased when threats to financial stability emerge and subsequently reduced once these threats diminish. Specifically, we consider a hypothetical scenario in which the increase in macroprudential capital requirements is assumed to be 1 percentage point at the start of the shock, building to 2.5 percentage points, before gradually unwinding. **Chart 1** shows the impact of this temporary tightening in macroprudential capital policy on loan volumes and loan rates under a purely illustrative calibration of the model. Consistent with the dynamics set out in **Figure 3**, the impact on loan volumes is amplified in the general equilibrium model, while the impact on loan rates is dampened, reflecting the reduction in the demand for credit in response to the tightening in capital requirements.

The impact on loan volumes in **Chart 1** is similar in magnitude to other recent studies, including those summarised in the FPC's Policy Statement (**Table A4**, annex). Comparisons should be made with care, though, since the models and shocks used to obtain the results differ across each approach.(2) More fundamentally, the estimates in **Table A4** are based on the relationship between microprudential capital requirements and credit conditions over the past. So these studies may be a poor guide to assessing the impact of macroprudential capital policy since banks, financial investors and borrowers are likely to change their behaviour in response to a regime change. But despite the uncertainty around using these different estimates, some general statements are possible. Most of the studies in **Table A4** as well as the model presented in this section find that an increase in regulatory capital requirements generates only a modest tightening in credit conditions in the near term. That impact is also likely to vary with the severity of various financial frictions faced by banks and investors over time. **Chart A2** in the annex shows that as the severity of financial frictions falls, so does the impact of macroprudential capital policy on loan quantities, in the near term. Moreover, regardless of these effects, there is

Chart 1 Illustrative impact of a temporary tightening in macroprudential capital requirements in partial and general equilibrium settings in the presence of financial frictions(a)

Chart 1a Volume of loans

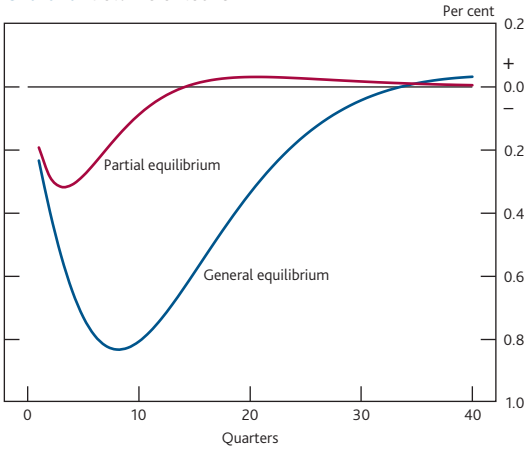
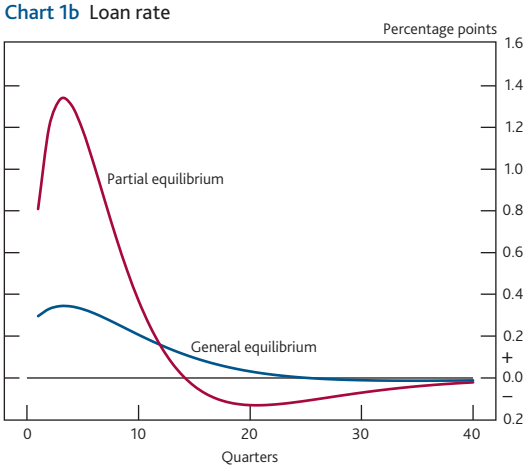


Chart 1b Loan rate



Note: The panels show deviations from trend lending and from the steady-state annualised loan rate.

(a) The charts show the impact of a temporary tightening in macroprudential capital requirements on loan volumes and the loan rate under the assumption that financial frictions are present. Specifically, the simulations assume that there is a 1 percentage point shock to macroprudential capital ratio requirements in period 1 which then builds to 2.5 percentage points before unwinding. In addition, the severity of financial frictions is captured by a non-zero value for the baseline financial friction parameter in the model (**Table A1**, annex).

(1) When the loan rate increases, it becomes expensive to borrow to finance capital goods, so investment falls. This reduces the future value of borrowers' collateral, and because the borrowing constraint continues to bind this reduces the demand for loans. So borrowers' constraints generate an additional reduction in loan quantities through a collateral channel.

(2) And while the impact on loan rates is similar in order of magnitude to other simple approaches, the peak effect in the partial equilibrium (PE) model is at the higher end of other estimates. That is because the shock builds over the simulation, and because the approach neglects general equilibrium effects. Moreover, the PE model used here contains a set of second-round effects that arise in this (dynamic) model that are not typically captured in other simpler PE models.

evidence that once banks have transitioned to higher capital ratios, a better-capitalised banking system is more resilient and, therefore, better able to support a sustainable flow of credit in the longer term.(1)

Issues around the quantification of macroprudential policy

The simple framework introduced so far provides a stylised representation of the transmission mechanism of macroprudential capital policy but largely abstracts from a number of important issues that policymakers would be likely to consider in practice when assessing the impact of macroprudential capital policy. Some of these are mentioned earlier, such as how the impact on credit is likely to vary with the state of the economy. This section describes some other considerations in more detail.

Non-linearities in the transmission mechanism

The transmission mechanism in the models considered in the previous section — from capital requirements, through to banks' cost of funding and then on to credit conditions in the economy — was assumed to be linear. And the results above were obtained using a linear approximation to a fundamentally non-linear model. This approach may not, therefore, fully capture certain types of non-linear behaviour that are likely to characterise borrowers and lenders in the real world. For example, firms' borrowing constraints were assumed always to bind — so allowing for the possibility that this is not always the case (depending on other factors at play in the economy) would provide a richer description of the macroprudential transmission mechanism.

Disintermediation and regulatory arbitrage

The discussion in this article so far generally assumes that all intermediaries involved in credit intermediation fall under the auspices of the FPC. It is possible, however, that macroprudential capital policy could cause some lending to migrate to institutions that are not subject to the macroprudential authority's regulation. To the extent that any such 'regulatory arbitrage' reduces its ability to mitigate systemic risks, the FPC could, if necessary, make recommendations to HM Treasury to expand the set of institutions to which its tools apply. With regards to cross-border leakages of macroprudential capital policies, reciprocity arrangements already in place with overseas regulators should help minimise these leakages. For instance, the FPC will set the CCB rate to be applied to all lending by banks in the United Kingdom, irrespective of the country of origin of the lender. In the same way, other countries will set national CCB rates that will apply to lending by UK banks overseas.(2)

Interactions with other regulatory requirements

Other regulatory requirements, such as liquidity or leverage(3) requirements, might influence the way that banks adjust their balance sheets in response to a change in macroprudential capital requirements. Such considerations are absent from the simple framework introduced in this article, but may be important when thinking through the impact of a change in macroprudential capital policy on credit conditions. For instance, changes in liquidity metrics such as the Basel III Liquidity Coverage Ratio may effect a bank's capital position, and *vice versa*.(4) The FPC therefore needs to be cognisant of the interaction of various regulatory requirements to strike an appropriate balance between resilience and the supply of credit to the economy. For instance, in June 2013 the FPC recommended a relaxation in liquidity requirements for the banks meeting the 7% capital threshold. They judged that the reduction in the level of required liquid asset holdings would help to underpin the supply of credit, since every pound held in liquid assets could be a pound that could be lent to the real economy.(5)

Interactions with monetary policy

The simple model considered in the previous section abstracted from monetary policy and its response to the impact of macroprudential capital policy.(6) To the extent that macroprudential policy influences the outlook for output and inflation via the impact on credit conditions, the MPC will need to take account of the FPC's policy actions when setting monetary policy. And the FPC will need to take account of the MPC's actions when calibrating the likely impact of their macroprudential capital policies.(7)

(1) There is evidence that the long-run benefits of higher capital requirements exceed the short-run costs. For instance, the Macroeconomic Assessment Group study (MAG (2010)) showed that the impact of the transition to Basel III capital requirements was net positive in the long run. In addition, Kapan and Minoiu (2013) show that banks that are well-capitalised going into a crisis can support the real economy by maintaining lending.

(2) Specifically, the FPC will set the CCB rate applied to UK lending by banks incorporated in the United Kingdom. But under the reciprocity arrangements set out in Basel III and the CRD IV/CRR, overseas regulators will be bound to apply a CCB rate to their banks' UK exposures which is no less than the rate chosen by the FPC for CCB rates up to 2.5% of RWAs.

(3) For more on the role of a leverage ratio within the capital framework of the United Kingdom, see Bank of England (2014b).

(4) See, for example, the box 'The relationship between a bank's capital and liquidity positions' in Farag, Harland and Nixon (2013).

(5) For more information on this recommendation, see www.bankofengland.co.uk/publications/Pages/news/2013/099.aspx.

(6) One way to interpret the results is to imagine that monetary policy were working in the background to keep demand in line with supply, such that inflation were perfectly stabilised in response to the macroprudential and credit boom shocks considered. Within this framework, there arises a neat separation between monetary stability and stability in the credit market: monetary policy aims at offsetting the implications of nominal frictions, like sticky prices, while macroprudential policy aims at offsetting the effects of financial frictions. In this world, the addition of macroprudential instruments helps to ameliorate the effects of financial shocks that monetary policy may otherwise be required to consider, and so the two tools are complementary.

(7) For more on the interaction between monetary policy and financial stability policy, see the June 2013 *Financial Stability Report*; www.bankofengland.co.uk/publications/Documents/fsr/2013/fsrfull1306.pdf.

Conclusion

Both the FPC and the MPC assess the impact of macroprudential policy on the credit market in discharging their policy remits. This article has set out a simple framework to help to understand the possible impact of macroprudential capital policy on credit conditions over the near term. Aside from any FPC guidance on how banks should adjust their balance sheets, the direction and magnitude of the impact is likely to depend crucially on the state of the financial system and the economy as well as the way in which banks, financial investors and borrowers respond to changes in macroprudential capital policy. The simple framework set out in this article provides some insights on understanding the effects of macroprudential capital policy. Like monetary policy, our understanding of the impact of macroprudential tools will improve as theory advances and experience in deploying them accumulates.

Annex

This annex describes the general equilibrium model presented in the main text in more detail and sets out the model equations used to generate the simulations in the text. It is a simplified version of Gerali *et al* (2010). The key additional ingredients relative to the partial equilibrium model are: first, a description of households' consumption and saving decisions; and second, a description of firms' borrowing, investment and production decisions. In the model, households save via the banking system by holding bank deposits and bank equity, and supply labour to firms. Firms borrow from banks to finance their production activities, which require labour and capital goods.

One important assumption of the model in this regard is that firms are 'borrowing constrained': they are unable to borrow fully up to their preferred level. Instead, their borrowing is limited by their collateral, which is taken to be the physical capital they use in production. Banks are assumed to lend to firms up to some fraction of the collateral they hold, where that fraction constitutes the firm's loan to value limit. In the partial equilibrium model, firms' collateral is implicitly treated as fixed — and under that assumption, the reduction in loan quantities that accompanies a rise in the loan rate moves one-for-one. But this approach ignores shifts in the demand curve for credit that occur in general equilibrium as a result of fluctuations in the value of borrowers' collateral.

The model describes the evolution of ten endogenous variables: household consumption (c), labour (n), output (y), physical capital (k), firm-owners' consumption (c^b), investment (i), the real interest rate (r), the loan rate (r^l), loans (l) and bank equity (e). A description of the parameters of the model and their calibration is contained in **Table A1**. The equations of the model are specified as:

- Households' consumption/saving and labour supply decisions are described by:

$$E_t[\beta c_t(1+r_t)]/c_{t+1}=1,$$
$$\chi c_t n_t^{\varphi}=(1-\alpha)(y_t/n_t)$$

  where E_t denotes the expectations operator.

- Firms' investment decisions and firm-owners' consumption are described by:

$$\alpha\frac{y_t}{k_t}-1+(1-\delta_k)(1-\theta)E_t\frac{\delta c_t^b}{c_{t+1}^b}+\frac{\theta(1-\delta_k)}{1+r_t^l}=0,$$
$$c_t^b+i_t=\alpha y_t+\frac{\theta(1-\delta_k)}{1+r_t^l}k_t-\theta(1-\delta_k)k_{t-1}$$

  and borrowing satisfies:

$$(1+r_t^l)l_t=\theta(1-\delta_k)k_t$$

- Output and capital satisfy:

$$y_t=k_t^{\alpha}n_t^{1-\alpha},$$
$$k_t=(1-\delta_k)k_{t-1}+i_t$$

  and market clearing implies that:

$$y_t=c_t+c_t^b+i_t$$

- The banking system prices loans and accumulates equity according to:

$$r_t^l=\mu_t\left[r_t-\gamma\left(\frac{e_t}{l_t}-k_t\right)\left(\frac{e_t}{l_t}\right)^2\right],$$
$$e_t=(1-\rho_t)e_{t-1}+\pi_{t-1}$$

  where $\pi_t=(r_t^l-r_t)\,l_t+r_te_t+Adj_t$, where Adj_t reflects the cost of capital ratio adjustment.

- Finally, the mark-up μ_t varies exogenously to generate a 'credit boom' shock, and the capital requirement k_t varies according to $k_t/k=(k_{t-1}/k)^{0.84}$ x $[(l_t/y_t)/(l/y)]^{\varphi_l}$ x ε_t^k where ε_t^k is an exogenous shock with AR(1) coefficient 0.84. To simulate capital requirement shocks that build from 1 percentage point to a peak of around 2.5 percentage points before unwinding, φ_l is set to zero and ε_t^k is increased by 10% on impact. Under systematic countercyclical macroprudential policy that responds to the ratio of credit to GDP, we set $\varphi_l=31.25$ and subject the model to a loan mark-up shock with AR(1) coefficient of 0.875. The shocks evolve as AR(1) processes with autoregressive coefficients of 0.85.

Table A1 Baseline calibration used in simulations

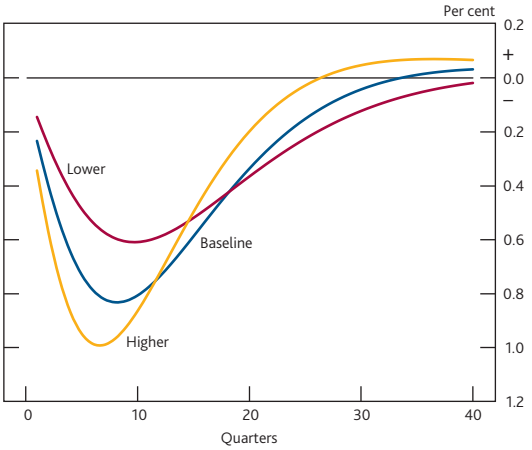
Parameter	Description	Value
α	Capital share in output	0.33
β	Discount factor (household)	0.9938
δ	Discount factor (firm owners)	0.8945
δ_k	Depreciation rate of capital	0.025
χ	Disutility of labour	4.0467
φ	Elasticity of labour supply	2.50
θ	Loan to value ratio	0.65
μ	Steady-state loan mark-up	1.98
ρ	Steady-state return on bank equity	0.067
κ	Steady-state capital ratio	0.10
γ	Baseline financial friction parameter	10.00

Additional simulations

The model can be used to perform several interesting simulations. It can be used to assess how the impact of macroprudential capital requirements on credit conditions varies with the severity of financial frictions and it can be used to assess the impact of *countercyclical* capital requirements versus *acyclical* capital requirements.

Chart A2 shows a range of responses generated by the model under a baseline value for financial frictions, together with lower and higher values. As the severity of financial frictions fall, the impact of capital requirements on loan quantities also reduces in the near term.(1)

Chart A2 Illustrative impact of a temporary tightening in macroprudential capital requirements on loan volumes for different severity of financial frictions(a)

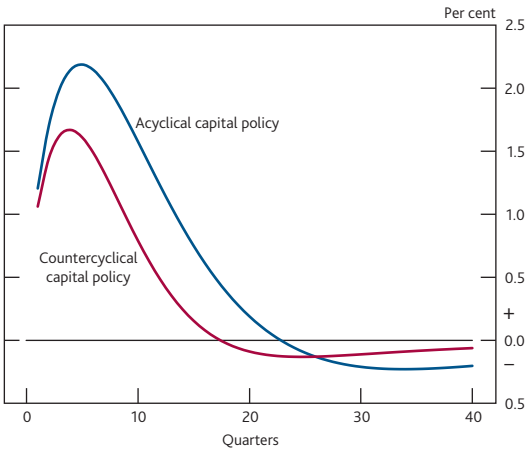


Sources: Gerali *et al* (2010) and Bank calculations.

(a) The chart shows the impact of a temporary tightening in macroprudential capital requirements on loan volumes under a baseline value for financial frictions, together with lower and higher values.

Chart A3 considers the different impact of acyclical versus countercyclical macroprudential capital requirements on loan quantities in the face of a 'credit boom'. Consider a situation where lending rates temporarily fall below their equilibrium level, perhaps reflecting intensified competition in the loan market, which drives down loan mark-ups. This triggers an expansion of credit supply and output that may be undesirable if it entails higher macroeconomic volatility. The blue line in **Chart A3** shows a baseline scenario in which capital requirements are held constant in the face of such a 'credit boom'. If, however, macroprudential policy is set countercyclically then this may help to smooth credit market outcomes and contribute to macroeconomic stabilisation. In this scenario, capital requirements respond only to deviations of the credit to GDP ratio from its trend (although in practice, the FPC would use a range of indicators to inform its decisions about the setting of countercyclical capital policy). This scenario is illustrated by the red line in **Chart A3**: tighter capital requirements ameliorate the leveraging-up of bank balance sheets, so that bank capital ratios fall by less under the countercyclical policy.(2) This, in turn, implies that loan rates fall by less, such that borrowing and output expand by less.

Chart A3 Illustrative impact of macroprudential capital policy on loan volumes in the face of a credit boom(a)



Sources: Gerali *et al* (2010) and Bank calculations.

(a) The chart shows the impact of a tightening in capital requirements on loan volumes for two scenarios in the face of a credit boom. Under acyclical capital policy, capital requirements are held constant despite deviations of the credit to GDP ratio from its trend. Under countercyclical capital policy, capital requirements move in line with deviations of the credit to GDP ratio from its trend.

Table A4 Illustrative estimates of the impact of a 1 percentage point increase in banks' headline capital requirements on credit conditions

	Loan rates (basis points)	Loan volumes (per cent)
Aiyar, Calomiris and Wieladek (2014)(a)	–	[-5.7, -8.0]
Bridges *et al* (2014)(b)	–	-3.5
Elliott (2009)(c)	[4.5, 19.0]	–
Francis and Osborne (2012)(d)	–	0.0
Macroeconomic Assessment Group (2010)(e)	17.3 [5.1, 25.0]	-1.4 [-0.7, -3.6]

(a) Results based on an econometric analysis of the impact of the UK Financial Services Authority's microprudential Pillar 2 requirements over the period 1998–2007. Reported results show the cumulative impact across a range of estimated models on lending to private non-financial corporations, excluding the potential for leakages via foreign branch lending, with the maximum and minimum reported in square brackets. Monetary policy is held constant.

(b) Bridges *et al* (2014) undertake an econometric analysis of the impact of changes in microprudential regulatory capital requirements on bank capital and bank lending in the United Kingdom between 1990 and 2011. They analyse the lending response in four different sectors. They find that banks, on average, cut, in descending order of magnitude based on point estimates, loan growth for commercial real estate, other corporates and household secured lending in the year following an increase in capital requirements. The response of unsecured household lending is smaller and not significant over the first year as a whole. Loan growth mostly recovers within three years. The result for aggregate lending displayed in the table is calculated as the cumulative impact over three years for each sector, weighted by each sector's share of lending as at 2011. Monetary policy is held constant.

(c) Results based on a loan pricing equation calibrated for US banks linking capital requirements to lending rates. The maximum effect refers to the case where banks are able to pass through in full the costs of higher aggregate capital requirements to their customers. The minimum effect assumes a modest decline in banks' funding and administrative costs. Results are calculated from Tables 1 and 2 in Elliott (2009). Monetary policy is held constant.

(d) Taken from Francis and Osborne (2012), Table 5. Results based on an econometric analysis of the impact of microprudential Pillar 2 requirements imposed by the UK Financial Services Authority over the period 1996–2007. Results assume a 44% pass-through from regulatory capital requirements to banks' capital ratios. Monetary policy is held constant.

(e) The Macroeconomic Assessment Group (MAG) analysed the impact of the transition to Basel III across a range of alternative models, calibrated across a wide variety of jurisdictions (including the United Kingdom). The reported figures in the table refer to the median impact across a range of estimated models (see Annex 2.2 in MAG (2010)), with the maximum and minimum reported in square brackets. Estimation assumes implementation of permanently higher capital requirements over two years. Results are for the 18th quarter of the simulation. Monetary policy is held constant.

(1) The severity of financial frictions are not likely to be constant over time, meaning that a given change in macroprudential policy would have effects that vary over time (see Tucker (2013)).

(2) In this model, a bank's capital ratio and its leverage move inversely, so a low capital ratio implies a high ratio of loans to equity — or high leverage.

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