The linkages between monetary and macroprudential policies

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Macroprudential policy is a new policy area within the international regulatory framework for banks known as Basel III. In this article we study the linkages between monetary and macroprudential policies in a dynamic general equilibrium model. Macroprudential policy is exemplified by a countercyclical capital buffer. We show that the monetary policy response to the introduction of a countercyclical capital buffer depends on the particular shocks driving the economic fluctuations. This is one reason why it is difficult to foresee the consequences for monetary policy of introducing the capital buffer. We also show that coordination of monetary and macroprudential policies may lead to improved macroeconomic and financial stability for certain shocks, while for others it may reduce the uncertainty of the central bank's and the supervisory authority's decisions.

Introduction

The welfare cost of financial crises is often very high. The Swedish crisis in the 1990s and the global financial crisis that broke out after the crash of Lehman Brothers in the autumn of 2008 are two examples. Cleaning up after financial crises is a slow process, and they also often lead to periods of low employment, reduced investment and major cutbacks in public sector activities. In terms of output losses, the welfare cost of the global financial crisis is estimated to somewhere between 1 and 3.5 times total output in the world in one year, see Haldane (2010).

A lesson from the recent global financial crisis is that it is not solely individual financial institutions that require supervision; the supervisory authorities also need a better focus on preventing risks that threaten the function of the financial system as a whole, so called systemic risks. The greater focus on systemic risks derives from the greater interconnectedness of the financial markets. If problems emerge in one part of the financial system, the risk of contagion to other parts has greatly increased. Furthermore, the existing capital requirements proved insufficient to cover bank losses which, among other things, implied that taxpayers in several countries had to supply new funds.

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In view of this, the Basel Committee on Banking Supervision has drawn up new banking regulations, known as Basel III.[1] Macroprudential policy is a new policy area within that framework. The purpose of this new policy area is to enhance the financial system's resilience to shocks, as well as preventing the build-up of financial imbalances.[2] It is designed to function as a complement to microprudential policy, which is primarily aimed at the stability of individual financial institutions. Generally, the new regulatory framework implies a greater focus on systemic risks. More specifically for the banks it implies that they need to have more and better capital, among other things.

Macroprudential policy is a new policy area but many of the potential tools are already in use for the supervision of individual institutions. This applies, for example, to various capital requirements for banks, the mortgage cap and risk weights for mortgage loans.[3] However, the countercyclical capital buffer is a new tool that will be introduced with the introduction of Basel III.[4] It is intended to protect the banking system against potential losses when excessive credit growth is linked to higher systemic risks. As opposed to other capital requirements, the capital buffer will vary over time, being activated during periods of rising systemic risks, thus allowing banks to strengthen their capital position. When conditions deteriorate and the systemic risks are realised or decline, the buffer requirement is reduced, permitting banks to cover their losses without having to cut back on lending. Consequently, the capital buffer raises the banks' resilience, thereby reducing their vulnerability to economic crises.

An indirect effect of the capital buffer is that it can contribute to counteract an excessively high credit growth and debt accumulation. As a result, it could help mitigate the procyclicality that the regulations may give rise to; that is, the tendency of the financial system and the macroeconomy to reinforce each other in upturns and downturns. This represents an improvement to the previous regulatory framework, Basel II.

In this article we study the linkages between monetary and macroprudential policies in a dynamic general equilibrium model. Macroprudential policy is exemplified by a countercyclical capital buffer. The first part studies the impact of the capital buffer on the business cycle and the consequences of this for monetary policy. Changes in the capital buffer affect the bank's funding cost and the volume of credit throughout the economy. Normally, a rise in the capital buffer leads to higher interest rates and reduced lending, which ultimately may mitigate demand and inflation. Monetary policy needs to take these business cycle effects into account, just like it needs to take business cycle effects that arise in other parts of the economy into account.

1 The new regulations began to be applied in January 2014 throughout the EU and will gain full force in January 2019.

2 However, the concept of macroprudential policy or regulation has been around since the 1970s, see Clement (2010).

3 The capital requirements for banks regulate how much capital a bank must have in relation to its assets. The minimum requirement for the major Swedish banks is set at 10 per cent as of 1 January 2013 but will be raised to 12 per cent from 1 January 2015. The mortgage cap (loan-to-value ratio) sets a ceiling, currently set at 85 per cent, for the amount that can be borrowed in relation to the value of a property. Risk weights for mortgages represent a specific capital requirement for the housing sector.

4 For a detailed description and discussion of the countercyclical capital buffer, see Juks and Melander (2012).

The second part studies the trade-off between different objectives for the economy. Objectives such as price stability, macroeconomic stability and financial stability are not independent of each other. For instance, it is difficult to maintain price and macroeconomic stability when a financial crisis breaks out. If financial imbalances build up during periods when the economy is overheated, the two policy areas facilitate the attainment of the objectives through the pursuit of a tighter policy. On the other hand, financial imbalances can also build up in relatively calm conditions, as exemplified by the recent global financial crisis. An expansionary monetary policy during an extended time period may imply a more restrictive macroprudential policy in order to lower the risk of new financial crises. Consequently, monetary and macroprudential policies have the potential to both support and counteract the different policy objectives.

Macroprudential policy also interacts with other policy areas such as fiscal policy, competition policy and microprudential policy. Fiscal policy measures, such as the deductions of interest rate expenses, could affect the risk of a build-up of financial imbalances. Actions that impact on competition in the financial sector could also influence risk propensity. Combined, microprudential policy measures deemed appropriate in reducing risks in individual institutions could exacerbate the systemic risks in the financial system. In this analysis, however, we disregard any effects from these policy areas.

The remaining part of the article is organised as follows: in the next section, we describe the theory or model used in the analysis. We discuss in detail the role of the banks and why they need a certain amount of capital to finance their lending. We also address why this level is not necessarily sufficient from a welfare perspective. This is followed by a section analysing the linkages between monetary and macroprudential policies. In that section, we show, firstly, how the business cycle effects of macroprudential policy can affect monetary policy decisions and, secondly, why a trade-off between the different policy objectives of the central bank and the supervisory authority may arise. Within the latter analysis we also show the potential effects of coordinating the decisions. Finally, we summarise the results and provide some concluding comments.

A dynamic general equilibrium model with a banking sector[5]

To study the linkages between monetary and macroprudential policies we use a dynamic general equilibrium model with households, firms, banks, a central bank and a supervisory authority. Like all economic models it includes a number of simplified assumptions regarding the decision-making of the households and the firms as well as the restrictions they face. Hence, the results are an illustration of certain relationships and mechanisms based on economic theory rather than conventional forecasts of what will happen. The basic assumptions underlying the model are that households maximise their expected utility and that firms maximise their profits. Also, the decision-making of the economic agents are

5 For a more detailed and technical description of the model, see Christensen et al. (2011) and Meh and Moran (2010).

based on rational expectations. Overall, the model resembles the Riksbank's macro model Ramses.[6] A difference, however, is that this model includes an explicit banking sector.

THE DIFFERENT ROLES OF FIRMS AND HOUSEHOLDS IN THE MODEL

The model features two types of firms. The first type combines labour inputs and capital goods to produce the economy's consumer goods. These firms operate in a market characterised by monopolistic competition. As a result, there are a large number of competing firms in the same sector that produce and sell similar, though not entirely identical, goods. Thus, the firms have a certain degree of market power, meaning that they set prices. It is also assumed that there are a large number of buyers.

Prices are assumed to be sticky; that is, firms have a tendency to not fully adjust their prices despite changes in demand. The underlying reasons are not formally explained in the model but may be attributed to costs of changing prices or that there exists long-term price contracts between the firm and the customers. This is an important assumption, since it means that changes in the policy rate can affect the real interest rate.[7] It is the real interest rate that influences investment decisions and how households choose their consumption over time. Sticky prices are also crucial in determining the short-term fluctuations in inflation. The firms' real marginal cost, which depends, among other things, on the real wage and productivity, is the fundamental factor.

The second type of firms act in a perfectly competitive market in which they produce the capital goods used by the first type of firms in the production of consumer goods. In addition to their own funds, these firms require financing from external sources. Households provide those funds by depositing their savings with the banks, which then lend these funds to the firms. In addition to the saving decision, the households decide on how to allocate their time. They can choose between working, which provides a return in the form of a wage bill, or opt for leisure time, which offers relaxation. The model does not include a housing sector; that is, we disregard household indebtedness in the analysis.

BANKS REQUIRE CAPITAL TO GAIN ACCESS TO FUNDING

Banks play an important role in allocating savings and financing among different agents in the economy. There are a number of reasons why there is a demand for this service. One reason, which also is the reason in the model, is asymmetric information between lenders (households) and borrowers (firms), implying that lenders do not have perfect information regarding the borrowers' projects. The role of the banks as financial intermediaries is to mitigate or, in the best of cases, to overcome the effects of this information problem. Banks also have other roles in the economy such as payment intermediation and management of various types of risks, but we disregard these roles in the model.

We assume that asymmetric information between households and firms gives rise to a

6 For a description of the Riksbank's macro model, see Adolfson et al. (2013) and Christiano et al. (2011).

7 The real interest rate is defined as the nominal interest rate (the policy rate in the model) minus the expected inflation.

moral-hazard problem in the following way. Firms may invest in different types of projects. They may invest in good projects with a high probability of success, or in bad projects with a low probability of success.[8] To ensure investment in the good projects, the banks must monitor the firms, a task involving a monitoring cost. However, households cannot observe the degree to which the banks actually monitor. This gives the banks an incentive to ignore monitoring and letting the households take the risk that the firms invest in the bad projects. Realising this, the households demand that the banks also invest their own funds in the lending operations. This gives the banks a "skin in the game", ensuring that they monitor the firms. Consequently, the firms invest in the good projects.

The amount of bank capital that the households require the banks to hold may be viewed as a reflection of the solvency requirement that must be met to attract new lenders, or as commonly expressed: the market demands that the banks have a certain amount of capital. The solvency requirement is reflected in a market-based capital level that depends, among other things, on the return on bank capital and bank funding costs. Households prefer to lend to banks with a substantial portion of capital, since these banks have a greater incentive to monitor the firms' activities. As a result, a high capital position facilitates the bank's funding opportunities. In turn, this affects lending throughout the economy and thus investment and overall economic activity.

THE EXTERNALITIES OF BANK LENDING WARRANT CAPITAL REQUIREMENTS

From a welfare perspective, there may be several reasons why the banks have too little capital. Perhaps the most apparent reason is different forms of state guarantees and subsidies. These include support packages that the authorities frequently resort to in a bid to rescue troubled banks. Another example is the deposit guarantee, which entail that the state guarantees deposits up to a certain limit. A third example is that lenders are prioritised ahead of shareholders in the event of a bank failure. Lenders may therefore require less compensation for their risk-taking than shareholders. Finally, loan financing is also tax subsidised in the sense that the banks can utilise untaxed earnings to cover their interest rate expenses. Hence, a number of state guarantees and subsidies make it likely that the banks fund an excessive portion of their lending by means of loaned funds. This increases risk-taking and limits their buffers against losses warranting some form of regulation of the banks' operations.

Another reason that the banks may have insufficient capital is that their lending can give rise to negative externalities that are not internalised. In the model, this is the reason for the capital requirements. It is based on two assumptions: firstly, the credit gap – defined as the deviation of the credit-to-output ratio from the long run level – affects the aggregated risk of failure in the banking sector; secondly, when an individual bank decides on its lending, it does not take into account the fact that its decision also influences the aggregate risk of

8 The model provides no explicit explanation why firms would wish to invest in the bad projects. But a plausible reason could be that such projects offer firms private benefits that do not accrue to the project.

failure. Consequently, from a welfare perspective, lending volume can be excessive. The purpose of the capital requirements is to give banks an incentive to take this externality into consideration.

THE CENTRAL BANK AND THE SUPERVISORY AUTHORITY HAVE DIFFERENT LOSS FUNCTIONS

The main objective of monetary policy is to maintain price stability. The Riksbank has specified this as a target for inflation of two per cent. At the same time as monetary policy is aimed at attaining the inflation target, it is also to support the objectives of sustainable growth and high employment. This is achieved, in addition to stabilising inflation around the inflation target, by striving to stabilise output and employment around long run sustainable paths. In the model this can be formulated as a (quadratic) loss function that the central bank aims to minimise,

$$L_t^{CB} = 0.5(r_t - r_{t-1})^2 + (\pi_t - \overline{\pi})^2 + (y_t - \overline{y})^2, \qquad (1)$$

where L_t^{CB} denotes the central bank's loss during period t, π_t denotes inflation, $\overline{\pi}$ denotes the inflation target, y_t denotes output, and $\overline{y}$ denotes the long run output level. Hence, the difference, $y_t - \overline{y}$, is the output gap. In addition to targets for price stability and macroeconomic stability, in the form of the output gap, there is also a target for the change in the policy rate, $r_t - r_{t-1}$, with a weight of 0.5. This term is included in order to avoid excessive fluctuations in the policy rate, which would not be consistent with how a central bank normally varies the policy rate. A loss function for the Swedish economy along these lines can also be found in Adolfson et al. (2011).

It is more difficult to specify a loss function for the supervisory authority than for the central bank. Promoting a stable financial system is largely a matter of avoiding events that have a low probability of occurring but which may entail major costs when they do occur. This is difficult to capture in terms of a few values in a quadratic loss function. Moreover, because macroprudential policy is a relatively new policy area, experience of how it works in practice and how a loss function should be specified is limited. Nor is there a definite target for financial stability even though the credit gap is frequently used as an indicator of systemic risks. The Basel Committee on Banking Supervision has also proposed that this measure should serve as a key input when the level of the countercyclical capital buffer is determined, see Juks (2013) for a discussion. Consequently, we let the credit gap be one of the target variables in the supervisory authority's loss function.

The loss function also includes measures of the banks' capital ratio; that is, the capital-to-asset ratio.[9] Both the change in the capital ratio as well as the capital ratio's deviation from the long run level is included. The change in the capital ratio is included for the same

9 Formally, the capital-to-asset ratio is defined as bank capital in relation to risk-weighted assets. The risk weights should reflect the risks inherent in bank lending. Consequently, bank lending is multiplied by the risk weight, resulting in a risk-weighted amount, which is the amount that becomes subject to the capital requirement. In this analysis, however, we disregard risk weights.

reason as the change in the policy rate is included in the central bank's loss function. Normally, the countercyclical capital buffer can exceed the long run level by a maximum of 2.5 percentage points. The model can capture this fact in a simple manner – at least as long as the shocks are not excessive – by including the capital ratio's deviation from the long run level in the loss function. Formally, the supervisory authority minimises the following (quadratic) loss function,

(2) $$L_t^{SA} = (k_t - k_{t-1})^2 + (k_t - \bar{k})^2 + (l_t - \bar{l})^2,$$

where L_t^{SA} denotes the supervisory authority's loss. The capital-to-asset ratio is denoted by k_t while $\bar{k}$ denotes the long run level, which may be interpreted as the minimum requirement in Basel III. The credit-to-output ratio is denoted by l_t and $\bar{l}$ denotes the long run level. Hence, the difference, $l_t - \bar{l}$, is the credit gap.

The two loss functions specify only the authorities' objectives. Hence, they provide no guidance how the policy rate or the capital buffer changes if, for example, inflation begins to rise or indebtedness gains momentum. To find out this, the authorities' policy rules must be calculated, which can be done in several ways. One approach is to calculate the optimal policy rules that minimise the loss functions. This gives rise to complex rules that depend on a number of different variables and circumstances in many cases. To avoid this, we instead calculate so called optimised policy rules that only depend on a limited number of variables.

We assume that the central bank can react to three variables in its policy rule: deviations from the inflation target, the output gap and the credit gap. The credit gap is included to illustrate the degree to which the central bank takes financial imbalances into account. Note that despite the absence of financial imbalances in the loss function, it can still be optimal to react to them. The central bank selects the parameters γ_y and γ_l in the following policy rule to minimise its loss function,[10]

(3) $$r_t = \bar{r} + 1.5(\pi_t - \bar{\pi}) + \gamma_y(y_t - \bar{y}) + \gamma_l(l_t - \bar{l}),$$

where $\bar{r}$ denotes the policy rate's long run level. The supervisory authority is assumed to only be able to react to the credit gap. It minimises its loss function by selecting μ_l in the following policy rule,

(4) $$k_t = \bar{k} + \mu_l(l_t - \bar{l}).$$

The parameters γ_y and γ_l in the central bank's policy rule indicate the degree to which it adjusts its policy rate to changes in the output and credit gaps. If, all other things being equal, the output gap increases by one per cent, the central bank raises the policy rate by γ_y percentage points and similarly, if, all other things being equal, the credit gap increases by one percentage point, the policy rate is raised γ_l percentage points. The parameter value μ_l in the supervisory authority's policy rule indicates the degree to which the capital

10 The central bank's weight on the deviation from the inflation target is set at 1.5, which is in line with what is referred to as the Taylor rule, see Taylor (1993). Accordingly, we estimate the optimal weights on the output gap and the credit gap, given the weight on the deviation from the inflation target.

buffer is adjusted to changes in the credit gap. A key feature of the analysis concerns the selection of the optimised values for γ_y, γ_l and μ_l. These values will depend on the economic relationships in the model but also on the particular shocks driving the fluctuations in the economy.

The model is calibrated to fit Swedish data. The inflation target is set at two per cent and the long run level for the capital requirement is set at the currently prevailing minimum value of ten per cent. We assume that the firms adjust their prices once a year on average, which is in line with the conclusions of Apel et al. (2005). A number of key parameter values have been adopted from Christiano et al. (2011), who estimated a similar model on Swedish data.

The business cycle effects of macroprudential policy

A linkage between monetary and macroprudential policies involves the business cycle effects of macroprudential policy on demand and inflation. Monetary policy needs to take these effects into account, just like it needs to take the business cycle effects that arise in other parts of the economy into account.

HOW DO THE BUSINESS CYCLE EFFECTS OF MACROPRUDENTIAL POLICY AFFECT MONETARY POLICY?

The countercyclical capital buffer influences the banks' funding cost, since funding activities using capital is in many cases more costly than using loans. In turn, the funding cost affects bank lending rates and lending volumes. Normally, a higher capital buffer raises the funding cost and reduces the lending, leading to a decline in the firms' possibilities to finance new investments. A downturn in investments tends to inhibit both demand and inflation.

The transmission of monetary policy also works through the financial markets. A major part of bank lending is funded via short-term loans. Among other effects, the policy rate influences the overnight rates that the banks apply when they lend and borrow from each other from one day to the next. Thus, changes in the policy rate affect the banks' funding cost and the credit volumes in the economy. A rise in the policy rate typically slows demand and dampens inflationary pressure.

An insight in economic theory is that relationships or correlations among economic variables depend on the particular shocks driving the fluctuations. This suggests that it is important to identify the driving forces in order to analyse the implications for monetary policy of introducing the capital buffer. It also suggests that it will be difficult to predict how monetary policy will respond, since we do not know the nature of future shocks to the economy.[11]

11 How the introduction of different macroprudential tools may affect monetary policy is also discussed in "Macroprudential policy and monetary policy" in the Monetary Policy Report (2013).

We study the effects of introducing the capital buffer given two different shocks. The first is a shock that affects the firms' production possibilities or more precisely the productivity. Hence, it affects the supply of goods and services in the economy and is therefore referred to as a "supply shock".[12] The second shock affects public sector consumption. We refer to this shock as a "demand shock", since it affects the use of, or demand for, the economy's resources. These two shocks have different effects on the relationship between the output gap and the credit gap. A supply shock gives rise to a positive correlation between these variables, whereas a demand shock leads to a negative correlation. This will be an important factor for understanding the results that we present below.

We begin by illustrating a scenario in which the fluctuations in the economy are driven by supply shocks. The central bank follows a simple policy rule à la Taylor,[13]

(5) $$r_t = \overline{r} + 1.5(\pi_t - \overline{\pi}) + 0.12(y_t - \overline{y}),$$

while the supervisory authority follows an optimised policy rule,

(6) $$k_t = \overline{k} + 0.57(l_t - \overline{l}).$$

The weight 0.57 on the credit gap is the value that minimises the supervisory authority's loss function when the central bank follows the Taylor rule.

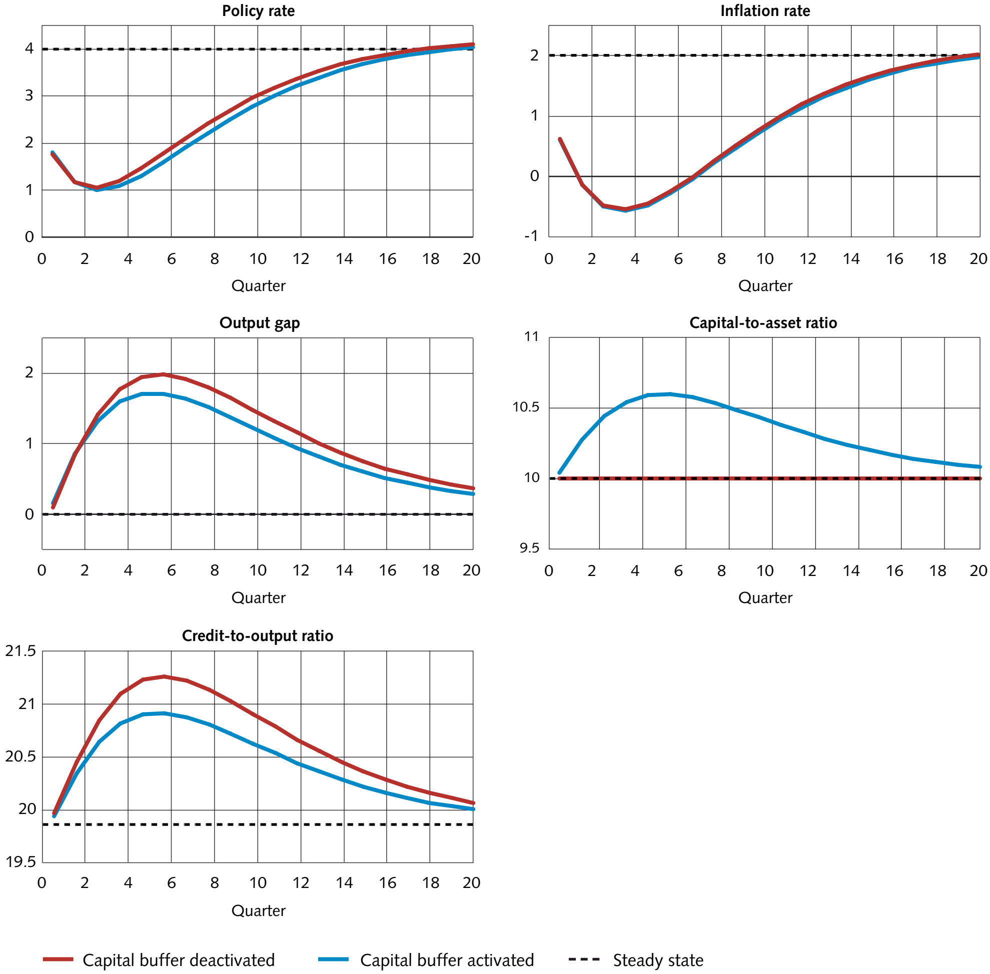
Figure 1 shows the effects of a temporary positive supply shock. The red line shows the case when the capital buffer is deactivated and the blue line when it is activated. Hence, the difference between the red and blue lines shows the effects of introducing the capital buffer.

The firms raise output in response to the improvement in productivity and thus the output gap increase. The improvement in productivity also reduces firm's marginal cost and prices are therefore cut. It also becomes more profitable to invest and, since the investments are financed through borrowed funds, the credit gap expands.

12 In the academic literature this shock is usually referred to as a technological shock.

13 Note that in this section, the central bank does not optimise the parameters in its policy rule but instead follows a simple Taylor rule, see Taylor (1993). The Taylor rule is a benchmark regarding how monetary policy should be pursued under normal circumstances, see Plosser (2008). The Taylor rule has also proved to work well in many different models, which is also discussed in Plosser's speech. However, in the section entitled "The trade-off between the different objectives for monetary and macroprudential policies" both the central bank and the supervisory authority optimise the parameters in their policy rules.

Figure 1. Effects of introducing a countercyclical capital buffer: responses to a positive supply shock
Percentage points respectively percentage deviation from steady state (output gap)



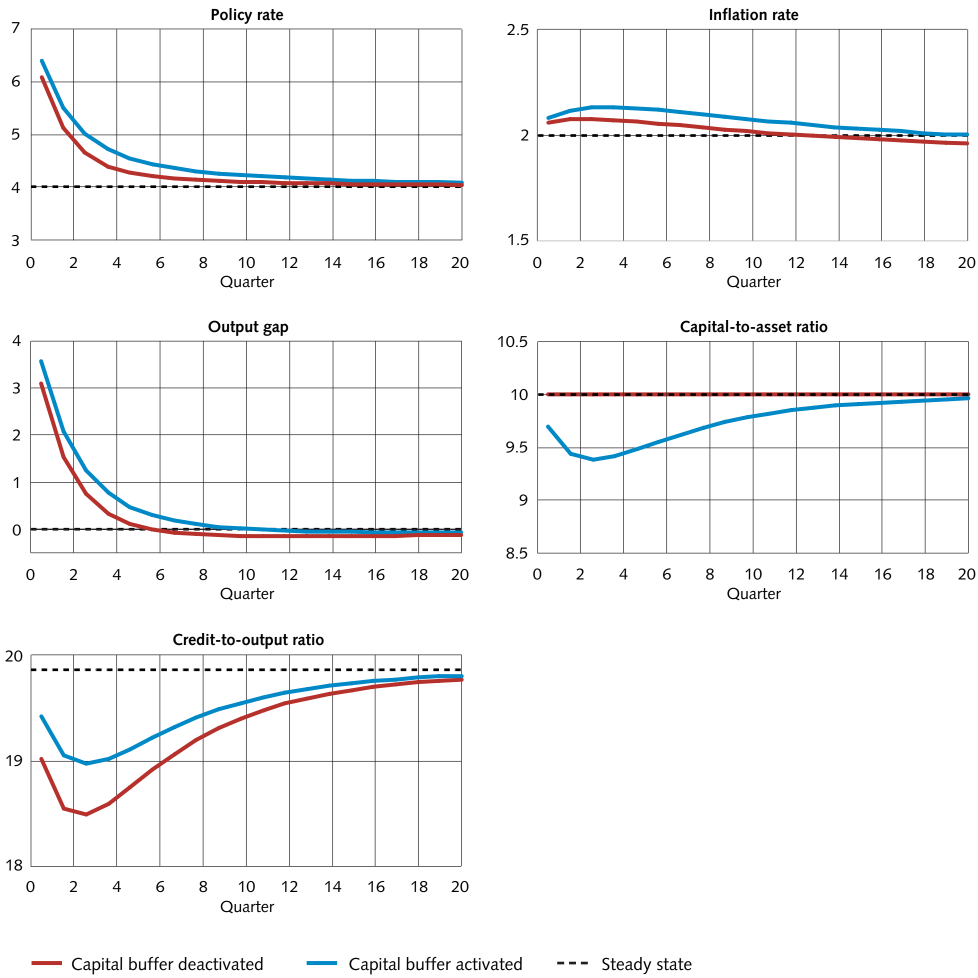
How do the two authorities respond to such a development? The central bank has an inflation target and reduces the policy rate in order to move inflation back towards the target. The supervisory authority responds to the rising credit gap by raising the capital buffer. The higher capital buffer mitigates the upturn in both the credit gap and output gap. However, it has little impact on inflation, since inflation is primarily determined by monetary policy. Thus, the capital buffer's business cycle effects have a limited impact on monetary policy in this scenario.

Next we show what happens if the economy is instead hit by demand shocks. We assume that the central bank follows the same Taylor rule. The supervisory authority's optimised weight on the credit gap is slightly higher in this case,

(7) $$k_t = \overline{k} + 0.69(l_t - \overline{l}).$$

Figure 2 shows that a temporary rise in demand, in the form of higher public sector consumption, drives up total output and the output gap. But higher public consumption also crowds out investments, which means that the demand for credit falls, leading to a fall in the credit gap. The central bank attempts to counter the rising output gap by raising the policy rate while the supervisory authority reduces the capital buffer to increase the credit gap. An indirect effect of the supervisory authority's action is that the output gap tends to increase even more. To counteract this, the central bank raises the policy rate to an even higher level. Thus, in this scenario the introduction of a capital buffer means that the central bank is more active in using the policy rate.

Figure 2. Effects of introducing a countercyclical capital buffer: responses to a positive demand shock
Percentage points respectively percentage deviation from steady state (output gap)



These two scenarios show that the implications for monetary policy of introducing a countercyclical capital buffer will depend on the nature of the shocks underlying the fluctuations in the economy. But they also illustrate a more general macroeconomic principle, namely, that relationships between different variables cannot generally be described by simple rules of thumb.

MONETARY POLICY MAY MITIGATE FINANCIAL IMBALANCES IN A SIMILAR WAY AS THE COUNTERCYCLICAL CAPITAL BUFFER

Both monetary policy and the countercyclical capital buffer work via the financial markets and may therefore have similar effects on the economic development. Hence, monetary policy may mitigate financial imbalances in a similar way as the capital buffer. We show that this is the case when the economy is driven by supply shocks. In this context, financial imbalances refer to the credit gap and the lending gap (deviations of lending from the long run level).

We compare three different policy regimes. The first two are the same as those described in the previous section. In the **first regime**, which is our reference regime, neither the central bank nor the supervisory authority attribute any weight on fluctuations in financial imbalances. The central bank follows a simple Taylor rule,

$$r_t = \overline{r} + 1.5(\pi_t - \overline{\pi}) + 0.12(y_t - \overline{y}). \tag{8}$$

The supervisory authority deactivates the capital buffer and accordingly does not assign any weight on fluctuations in financial imbalances,

$$k_t = \overline{k}. \tag{9}$$

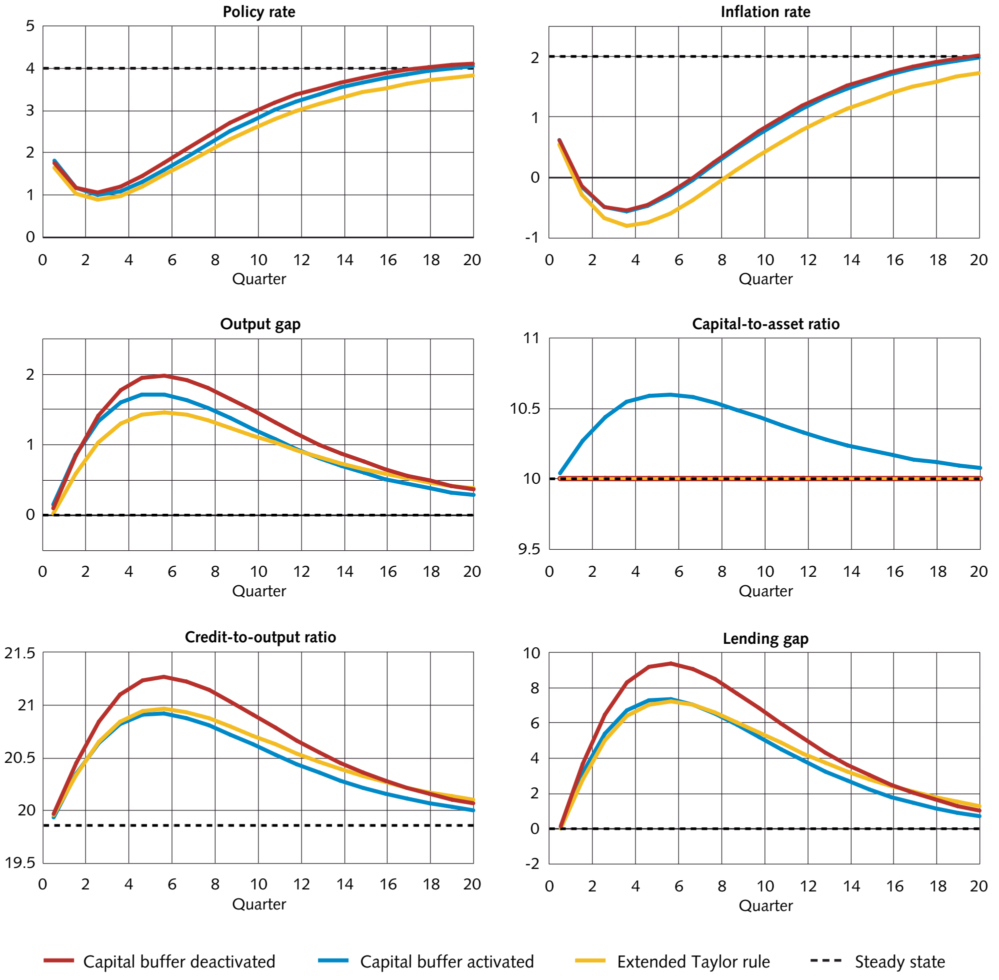
The red line in Figure 3 shows the responses to a temporary supply shock. The basic mechanisms are the same as those in the previous section. The firms' productivity rises and their costs fall, leading to higher output and lower inflation. Lending rises to finance new investments. This leads to positive credit and lending gaps.

In the **second regime**, the central bank still follows the Taylor rule, while the supervisory authority activates the capital buffer. Thus, the supervisory authority takes fluctuations in financial imbalances into account in terms of the credit gap. The optimised policy rule is the same as in the previous section,

$$k_t = \overline{k} + 0.57(l_t - \overline{l}). \tag{10}$$

The capital buffer is raised in an effort to counter the rising credit gap, see the blue line in Figure 3. Financial imbalances in terms of both the credit gap and the lending gap are thus mitigated compared with the reference regime. The output gap is also reduced. However, the impact on inflation resulting from the higher capital buffer is minor.

Figure 3. Monetary policy may mitigate financial imbalances in a similar way as the countercyclical capital buffer: responses to a positive supply shock
Percentage points respectively percentage deviation from steady state (output gap and lending gap)



In the **third regime**, the central bank follows an extended Taylor rule, which in this case means that it also assigns a weight on the credit gap. We assume that the weight on the credit gap is the same as that assigned to the output gap,

(11) $$r_t = \bar{r} + 1.5(\pi_t - \bar{\pi}) + 0.12(y_t - \bar{y}) + 0.12(l_t - \bar{l}).$$

The supervisory authority, however, deactivates the capital buffer,

(12) $$k_t = \bar{k}.$$

Consequently, the central bank takes fluctuations in financial imbalances into account while the supervisory authority does not, see the yellow line in Figure 3. The increases in the credit and lending gaps are mitigated compared with the reference regime and are essentially equivalent to those in the second regime. The effects on the other variables also resemble those of the second regime, although the output gap rises a little less and inflation falls slightly more. The greater impact on inflation is due to relatively less weight on the inflation target in the central bank's policy rule. Hence, a cost of mitigating financial imbalances using monetary policy is that the deviations from the inflation target may be higher.

Each economic model illustrates certain economic relationships and mechanisms while disregarding others. Consequently, when interpreting results from a model, it is important to also take into account of what is not in the model. For example, a factor that is not dealt with in this scenario is that raising the capital buffer strengthens the banks' capital position, thereby enhancing their resilience to new shocks in a manner that is not generally achieved by a rise in the policy rate.

The trade-off between the different objectives for monetary and macroprudential policies

In many cases the objectives of monetary and macroprudential policies complement each other. Monetary policy that stabilises both inflation around its target and the output gap promotes stability in the financial system. Conversely, a stable financial system facilitates the monetary policy's possibilities to achieve price and macroeconomic stability. However, the objectives of the two policy areas – price stability, macroeconomic stability and financial stability – are not independent of each other. Trade-offs may therefore arise in certain cases; that is, the monetary policy may prefer a tightening of the economy while the macroprudential policy advocates a more expansive approach, or vice versa. These trade-offs typically arise when the objectives move in different directions.

A scenario in which a trade-off could arise is if inflation falls while the output and credit gaps rise. We have seen that this scenario occurs when the fluctuations are driven by supply shocks. For the central bank, this gives rise to a trade-off between stabilising deviations from the inflation target and the output gap. The central bank's main focus is to bring inflation back towards the target, leading to a cut in the policy rate. Meanwhile, the supervisory authority raises the capital buffer in response to the positive credit gap. As a result, a trade-off arises, since the central bank prefers an expansive policy in its efforts to stabilise inflation around its target while the supervisory authority prefers a restrictive policy in order to stabilise the credit gap.

Another scenario that also could result in a trade-off is one in which inflation is close to the target while the output gap is rising and the credit gap is falling. This scenario occurs when changes in demand are driving the fluctuations. Rising demand, in the form of higher public consumption, increases the output gap, but crowds out investments. A decline in investment demand dampens the credit gap. The rising output gap prompts the central bank to tighten monetary policy, while the falling credit gap induces the supervisory authority to a more expansive policy.

COORDINATION COULD RESULT IN MORE SUBDUED FLUCTUATIONS IN THE OUTPUT AND CREDIT GAPS

From a welfare perspective, it is usually desirable to coordinate decisions when a trade-off arises among the objectives of different authorities. This means that the authorities consider the impact of their decisions on the objectives of the other authority. This may take various forms. The decisions could, for example, be brought together under the auspices of a single authority or some form of joint decision-making could be introduced that actively weighs the different objectives against each other. In the model, coordination implies that the loss functions for the central bank and supervisory authority are combined into an aggregated loss function. Each authority thus minimises the joint loss function, L_t^{TOT},

(13) $$L_t^{TOT} = L_t^{CB} + L_t^{SA}.$$

Coordination can be compared with a non-coordination case. If the decisions are not coordinated, each authority minimises its own loss function, given the other's policy rule. In other words, how the other authority acts is taken into account but how one's own policy impacts on the objectives of the other authority are not accounted for.

We first show how a trade-off between the objectives of the central bank and the supervisory authority can influence their policy rules in the event of supply shocks. When decisions are coordinated, the authorities select the parameter values in their policy rules to minimise the joint loss function, L_t^{TOT}. This gives rise to an individual policy rule through which each authority considers the effects of its own decisions on the objectives of the other authority. The central bank's optimised policy rule is,

(14) $$r_t = \overline{r} + 1.5(\pi_t - \overline{\pi}) + 0.76(y_t - \overline{y}) + 0.08(l_t - \overline{l}),$$

while the supervisory authority's policy rule is,

(15) $$k_t = \overline{k} + 0.93(l_t - \overline{l}).$$

Without coordination the central bank's policy rule is,

(16) $$r_t = \overline{r} + 1.5(\pi_t - \overline{\pi}) + 0.68(y_t - \overline{y}) + 0.06(l_t - \overline{l}),$$

while that for the supervisory authority is,

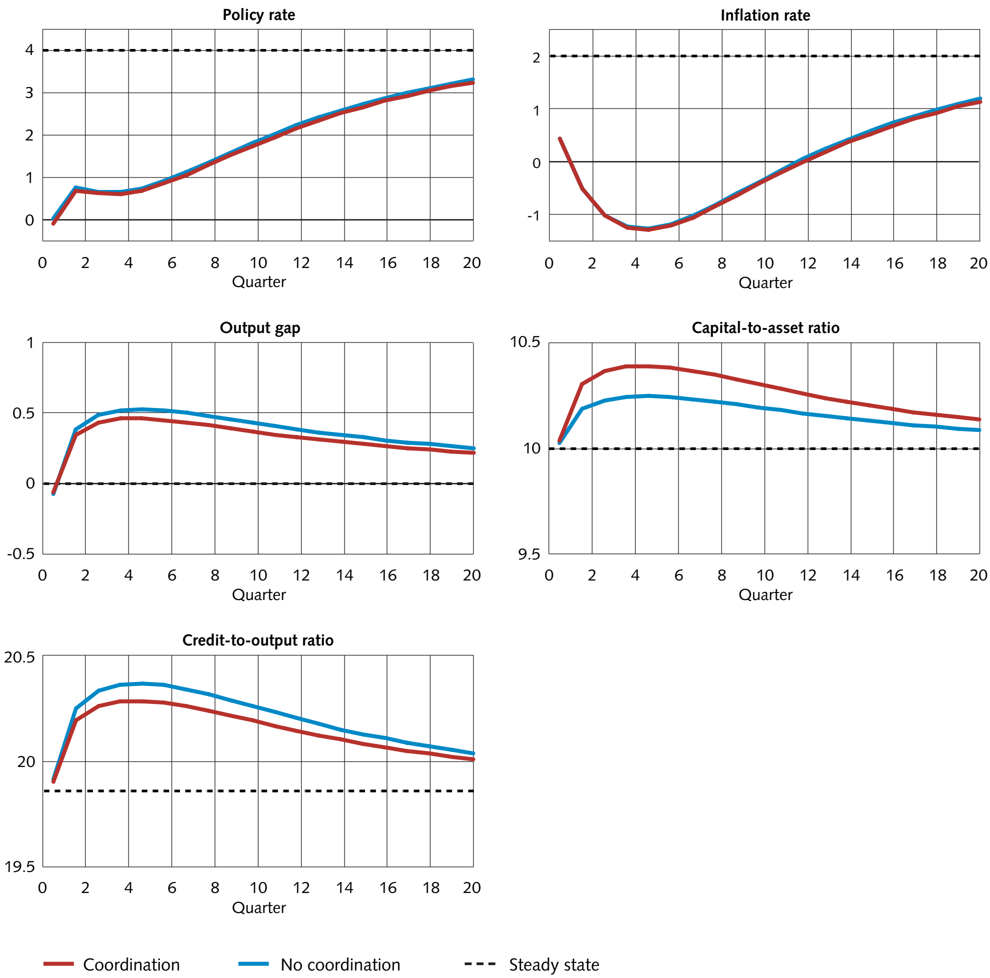
(17) $$k_t = \overline{k} + 0.49(l_t - \overline{l}).$$

The central bank attaches a somewhat higher weight on the output gap when the decisions are coordinated than when they are not; that is, 0.76 compared with 0.68. Under coordination the credit gap is part of the central bank's loss function and since the credit gap and the output gap move in the same direction, a higher weight on the output gap reduces fluctuations in both gaps. Consequently, there is no trade-off between stabilising the credit gap and the output gap. The weight assigned to the credit gap is also slightly higher when the decisions are coordinated. However, the central bank cannot assign excessively high weights to the two gaps because that would result in too much variation in the inflation rate.

Neither does a trade-off between stabilising the credit and output gaps arise for the supervisory authority when the decisions are coordinated. The supervisory authority almost doubles the weight on the credit gap, 0.93 when the decisions are coordinated compared with 0.49 without coordination. That the supervisory authority can raise the weight to such an extent is because the capital buffer does not affect inflation to the same degree as monetary policy.

Figure 4 shows the effects of a temporary increase in the supply when the authorities follow the optimised policy rules (14)-(17). The red line shows the coordinated case while the blue line shows the non-coordinated case. Fluctuations in the output and credit gaps are reduced when the decisions are coordinated. This is because the central bank assigns a

Figure 4. Effects of coordinating the decisions: responses to a positive supply shock
Percentage points respectively percentage deviation from steady state (output gap)



higher weight on both gaps and that the supervisory authority attributes a higher weight on the credit gap when the decisions are coordinated. However, the stabilisation of the two gaps occurs at the expense of higher fluctuations in the capital buffer. Nonetheless, in terms of welfare, the more subdued fluctuations in the output and credit gaps outweigh the higher fluctuations in the capital buffer.

COORDINATION COULD ALSO RESULT IN MORE SUBDUED FLUCTUATIONS IN THE TOOLS

In the following scenario, we show how a trade-off between the authorities affects the policy rules when the fluctuations are instead driven by demand shocks. When the decisions are coordinated, the policy rule for the central bank is,

(18) $$r_t = \overline{r} + 1.5(\pi_t - \overline{\pi}) + 0.20(y_t - \overline{y}) + 0.04(l_t - \overline{l}),$$

and for the supervisory authority it is,

(19) $$k_t = \overline{k} + 0.00(l_t - \overline{l}).$$

Without coordination, the policy rule for the central bank is,

(20) $$r_t = \overline{r} + 1.5(\pi_t - \overline{\pi}) + 0.38(y_t - \overline{y}) + 0.00(l_t - \overline{l}),$$

and for the supervisory authority it is,

(21) $$k_t = \overline{k} + 0.47(l_t - \overline{l}).$$

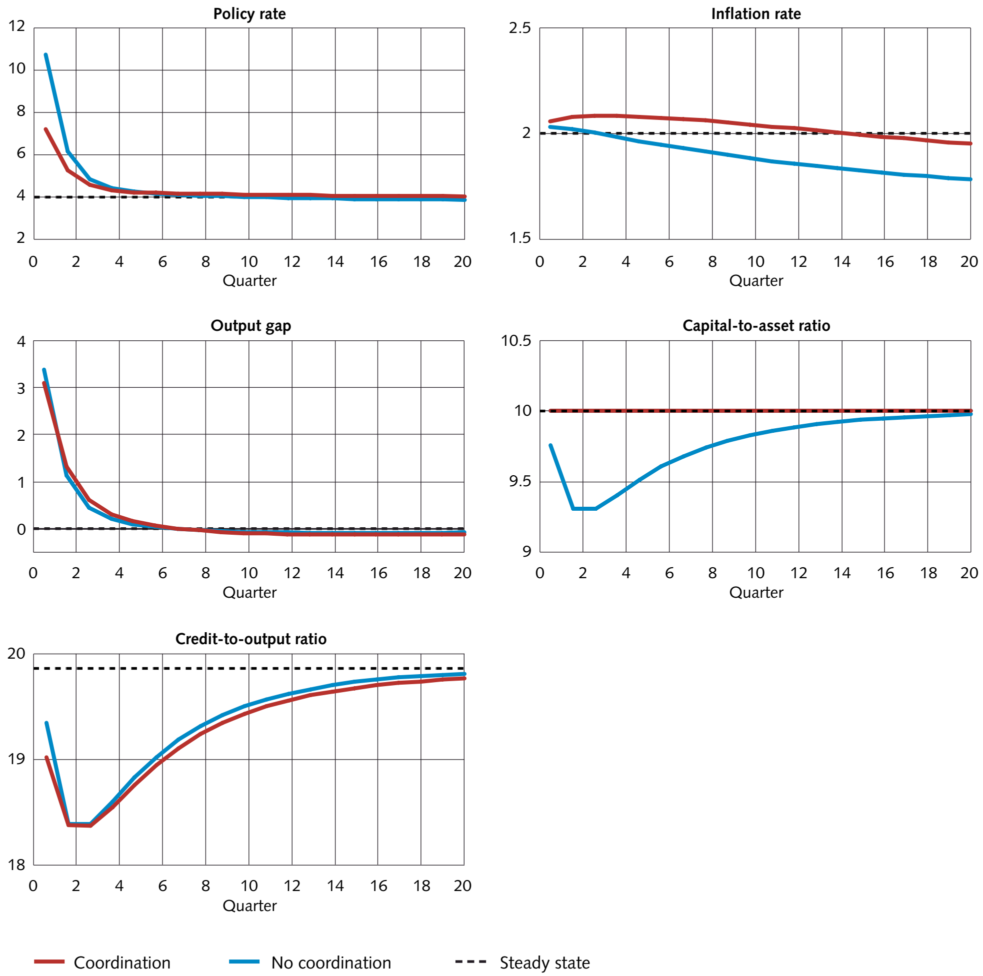
The central bank assigns a slightly lower weight on the output gap when the decisions are coordinated in this scenario, 0.20 compared with 0.38. This is because if the central bank attempts to mitigate a rise in the output gap by raising the weight on the output gap, the credit gap will fall even more. The central bank takes this into account when the decisions are coordinated. In the trade-off between stabilising the output gap and the credit gap, slightly higher fluctuations are permitted in the output gap in a bid to reduce the fluctuations in the credit gap. The central bank assigns a small weight on the credit gap if the decisions are coordinated which, per se, tends to stabilise the credit gap at the expense of the output gap.

The supervisory authority is faced with a similar trade-off when the decisions are coordinated. If, for example, it raises the capital buffer to mitigate a positive credit gap, the decline in the output gap is amplified. The supervisory authority takes this into account and, thus, does not assign any weight on the credit gap.[14] On the other hand, if the decisions are not coordinated it is optimal for the supervisory authority to assign a positive weight on the credit gap, since in this case it does not take into account the negative effects on the output gap.

14 The supervisory authority (and the central bank) cannot assign negative weights on the credit gap in the policy rules.

Comparing the central bank's policy rules in this section with the ones in the previous section, we see that the weights are smaller on the output and credit gaps and this applies irrespective of whether or not the decisions are coordinated. This also applies to the supervisory authority as it puts a smaller weight on the credit gap in this section. This can be understood as follows. The actions taken by the authorities tend to counteract each other's objectives in the event of demand shocks but support each other's objectives when supply shocks are the driving force. If, for example, the central bank attempts to mitigate a rise in the output gap by raising the policy rate in response to a demand shock, this would result in a further decline in the credit gap. The supervisory authority would then reduce the capital buffer even more to increase the credit gap, which at the same time would tend to increase the output gap. Hence, the central bank's possibilities to stabilise the output gap is countered by the supervisory authority's actions. The opposite applies in the

Figure 5. Effects of coordinating the decisions: responses to a positive demand shock
Percentage points respectively percentage deviation from steady state (output gap)



case of supply shocks. If the central bank attempts to mitigate a rise in the output gap by pursuing a tighter policy, this would be facilitated by the supervisory authority attempting to conduct a more restrictive policy to narrow the credit gap. Consequently, it is optimal to assign a higher weight on the output gap (and the credit gap) when the authorities' actions support each other's objectives. A similar story can also explain why the supervisory authority assigns a higher weight on the credit gap in response to supply shocks than to demand shocks.

Figure 5 shows the effects of the optimised policy rules, (18)-(21), following a temporary increase in demand. The fluctuations in the output and credit gaps are not notably reduced when the decisions are coordinated. However, the fluctuations in inflation become more subdued in the event of coordination. This is due to the central bank's relatively higher weight on stabilising deviations from the inflation target when the decisions are coordinated. Fluctuations in the policy rate and the capital buffer are also reduced when the decisions are coordinated. Consequently, welfare is higher when decisions are coordinated, since fluctuations in the policy rate, the capital buffer and inflation are more subdued, while fluctuations in the output and credit gaps remain approximately unchanged.

Summary and concluding comments

We have studied the linkages between monetary and macroprudential policies, by means of a dynamic general equilibrium model. A countercyclical capital buffer has been used to exemplify macroprudential policy. The primary objective of macroprudential policy is to increase the resilience of the financial system to shocks. However, the tools for macroprudential policy may also affect business cycle fluctuations. Monetary policy has to take this into account, but how and to what extent depends on a number of factors. The nature of the shocks driving the economic fluctuations is one such factor, which has been the focus of this analysis.

We have shown that when the economy is driven by supply shocks, the introduction of a countercyclical capital buffer does not affect monetary policy to any major degree. However, in the event of demand shocks, variations in the capital buffer may require a more resolute monetary policy response. This illustrates one reason why it is difficult to foresee the consequences for monetary policy from introducing the capital buffer. It also illustrates a more general macroeconomic principle, namely, that relationships between different variables cannot generally be described by simple rules of thumb.

Both monetary policy and the countercyclical capital buffer work through similar channels and have similar business cycle effects. Hence, the impact of both policy areas on financial imbalances may also resemble each other. We have shown that this is the case when the economy is driven by supply shocks.

The linkages between monetary and macroprudential policies have also been studied on the grounds of policy objectives, such as price stability, macroeconomic stability and financial stability. These objectives are not independent of each other. A key question is therefore what the welfare effects will be if the central bank and the supervisory authority coordinate their decisions. Again, the answer to this question depends on the nature of the shocks driving the fluctuations. In cases in which the output gap and the credit gap move in the same direction, as in the event of supply shocks, coordination leads to more subdued fluctuations in these variables. In the case of demand shocks, the output and credit gaps move in opposite directions, coordination does not offer any major benefits in terms of more muted fluctuations in these particular variables. However, the two authorities do not need to act quite as forcefully to achieve this, which reduces the degree of uncertainty in the authorities' tools and increases welfare.

As yet, there are few academic articles – theoretical or empirical – that study the linkages between monetary and macroprudential policies. However, Angelini et al. (2012) is a recent study that has attempted to quantify the welfare effects of coordinating monetary policy and macroprudential policy, in the form of a countercyclical capital buffer. They have a model that resembles ours but it also includes a housing sector, which means that households are not only lenders but also borrowers. Among other things they find that there may be substantial welfare gains from coordination when shocks hit financial markets. Another recent study, Christensen et al. (2011), shows that the countercyclical capital buffer could play a positive role in terms of stabilising fluctuations in the economy, and notably so when they are due to changes in the banks' capital. The study also illustrates how the central bank's reaction could influence the positive effects of the capital buffer. These studies are relatively technical. For less technical and perhaps more easily comprehensible studies, see, for example, IMF (2012), Smets (2013), Svensson (2012) and Woodford (2012).

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