

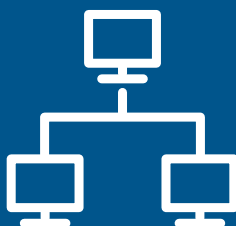
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One Bank Research Agenda

Discussion Paper



BANK OF ENGLAND



Introduction

The Bank of England is one of only a handful of institutions internationally with responsibility for monetary, macroprudential and microprudential policy, and the operation of all of these to achieve policy outcomes.

All of these areas face big questions, not least of which is the interaction between them. Conventional thinking about these policies has been challenged by the financial crisis. New policies and interventions have been deployed; new regulations introduced; new supervisory practices adopted. While enhancing understanding of the economy and financial system is of timeless importance, the recent explosion in the amount and variety of available data offers the prospect of deeper insight. And fundamental technological, institutional, societal and environmental change means that we have an ongoing need to reassess our thinking and policies over a long horizon.

World-class policymaking requires frontier research. The Bank of England is, therefore, publishing a co-ordinated [One Bank Research Agenda](#), spanning all aspects of central banking and focusing in particular on the intersections between policy areas. The five themes within it are broad, reflecting the diversity of the agenda. They deliberately emphasise new challenges and new directions, while recognising that familiar questions facing central banks remain no less important.

The five themes are summarised under the following headings:

- Theme 1: Central bank policy frameworks and the interactions between monetary policy, macroprudential policy and microprudential policy, domestically and internationally;
- Theme 2: Evaluating regulation, resolution and market structures in light of the financial crisis and in the face of the changing nature of financial intermediation;
- Theme 3: Operationalising central banking: evaluating and enhancing policy implementation, supervision and communication;
- Theme 4: Using new data, methodologies and approaches to understand household and corporate behaviour, the domestic and international macroeconomy, and risks to the financial system; and
- Theme 5: Central bank response to fundamental technological, institutional, societal and environmental change.

The first three themes focus on different aspects of policy design – Themes 1 and 2 cover different areas of the Bank’s policymaking responsibilities, placing particular emphasis on interactions between them, while Theme 3 covers aspects linked to operationalising and implementing these policies. Theme 4 is geared towards enhancing understanding of the economy and financial system, with a particular focus on the role of new data. Finally, Theme 5 takes a longer-run perspective, raising questions around how fundamental change might affect central banking over a longer horizon.

This Discussion Paper gives more details on these themes, setting out important questions and issues under each of them – some broad; others rather narrower. Although it is not intended to be an exhaustive literature review, it also gives examples of key contributions as appropriate and motivates several of the issues through existing Bank of England publications and research.

While the Bank of England strives to be an international intellectual leader in the areas of its policy responsibilities, making progress on such a broad agenda requires input from the wider community of academics, policymakers and experts, both within economics and finance and from disciplines well beyond it, ranging from psychology to epidemiology, from computer science to law. By publishing these research questions, we aim to open up our research agenda and learn

from external contributors. We wish to expand our external research connections, collaborate with those experts and begin to crowd-source solutions to key policy questions. To catalyse such research, the One Bank Research Agenda and Discussion Paper are also accompanied by the release of new data sets and the launch of new research and data visualisation competitions.

Contributing to the Bank of England’s research agenda and exploiting our data sets provides a unique opportunity to tackle some of the most important questions facing policymakers, while advancing the academic frontier. We encourage feedback and debate on both our research agenda and fruitful approaches for tackling questions within it. We look forward to discussing your comments and ideas. To contact us, please use the following mailboxes covering each of the five themes:

- [1. Policy frameworks and interactions](#)
- [2. Evaluating regulation, resolution and market structures](#)
- [3. Policy operationalisation and implementation](#)
- [4. New data, methodologies and approaches](#)
- [5. Response to fundamental change](#)

[Multiple themes/general comments](#)

Policy frameworks and interactions



1 Central bank policy frameworks and the interactions between monetary policy, macroprudential policy and microprudential policy, domestically and internationally

Since the financial crisis, the role of the Bank of England has expanded substantially. This, in part, reflects the Bank's own response to the crisis. As have other major central banks, the Bank has taken a range of actions to prevent the collapse of credit and other financial markets. In addition, the architecture for financial regulation was overhauled in the United Kingdom. This led to the creation of the Prudential Regulation Authority (PRA) – responsible for the prudential regulation and supervision of banks, building societies, credit unions, insurers and major investment firms – and the Financial Policy Committee (FPC) within the Bank of England – charged with taking action to remove or reduce systemic risks; and to the creation of the new Financial Conduct Authority (FCA). Consequently, the Bank is now one of a handful of institutions in the world which houses under its roof monetary, macroprudential and microprudential policy. This section outlines some of the key outstanding questions over central bank policy frameworks and the interaction between monetary, macroprudential and microprudential policy in the post-crisis world. It also discusses what the presence of uncertainty and international spillovers may imply for the use of these policies.

1. How do monetary policy actions, macroprudential policy changes and regulatory reforms affect the transmission mechanism of monetary and macroprudential policy?

In the current UK framework, monetary policy, macroprudential policy and microprudential policy each has its own specific primary objective: monetary policy is primarily aimed at maintaining price stability, macroprudential policy seeks to maintain the stability of the financial system as a whole, and microprudential policy is targeted at the resilience of individual financial institutions. But each of these can influence both monetary and financial conditions and can, therefore, affect the achievement of both monetary and financial stability.

Existing research has identified three possible channels through which conventional monetary policy – operated via the central bank policy rate – can affect financial stability: the balance sheet, the leverage and the risk-taking channels. First, lower interest rates improve financial stability via the balance sheet channel by stimulating aggregate demand, increasing the value of legacy assets and reducing the real debt-service burden of households and non-financial corporates. Second, lower rates

can increase financial instability via the leverage channel, by incentivising households, corporates and financial institutions to take on more debt (Adrian and Shin (2008)). Finally, a low interest rate environment can also affect risk-taking by reducing asset price volatility and hence perceptions of risk (Borio and White (2004) and Borio and Zhu (2008)), and increasing incentives to take risks in order to maintain nominal target returns (Rajan (2005)). A number of empirical studies point to evidence that lower interest rates are associated with greater risk-taking by banks (for example, Maddaloni and Peydro (2013), Dell'Ariccia *et al* (2013)).

By contrast, studies that examine the impact of unconventional monetary policy – such as asset purchases and forward guidance – on risk-taking and financial stability are still scarce. Chodorow-Reich's (2014) study of the impact of unconventional monetary policy announcements on various US financial institutions suggests that it had a stabilising impact on banks and life insurance companies through a positive impact on legacy assets, but may have encouraged risk-taking by money market funds and private defined benefit pension funds. At the macroeconomic level, Weale and Wieladek (2014) find that the VIX and the Move, two measures of risk-appetite and economic uncertainty, respond to asset purchase shocks in a vector-autoregressive framework.

Research on how monetary policy affects financial stability does not, by itself, clarify how monetary policy affects the transmission mechanism of macroprudential policy – and *vice versa*. As discussed in the next subsection, new theoretical literature is now emerging to consider the interactions of monetary policy and macroprudential policy. But the existing empirical literature suggests that the interaction between macroprudential capital requirements – such as the countercyclical capital buffer (CCB) – and monetary policy can be complex, as the evidence on how banks' capital affects the transmission channels of monetary policy is mixed (some examples include Gambacorta and Mistrulli (2004), Maddaloni and Peydro (2013), Altunbas *et al* (2010), Dell'Ariccia *et al* (2013), Jiménez *et al* (2014) and Aiyar, Calomiris and Wieladek (2014a)). Moreover, the issue of whether the stance of monetary policy affects the transmission mechanism of macroprudential policy in mitigating system-wide risks is yet to be fully explored.

In addition, further research is required to understand how the post-crisis regulatory reforms (see Theme 2) may affect the transmission mechanisms of monetary policy and macroprudential policy. Existing studies suggest that past regulatory reforms affecting the financial sector – such as financial liberalisation which increased households' access to credit – were associated with changes in the transmission mechanism of monetary policy (for example, Iacoviello and Minetti (2008); Assenmacher-Wesche and Gerlach (2008)). Certain regulatory reforms could potentially also affect the transmission mechanism of macroprudential policy. For instance, reforms to end 'too big to fail' could potentially encourage banks to hold larger voluntary capital buffers to reduce the possibility of being resolved, weakening the impact of changes in the CCB on bank lending.

Thus, further areas for research include:

- How do monetary policy actions – both conventional and unconventional – affect financial stability risks, both inside and outside the banking system?
- To what extent does the effectiveness of macroprudential policy depend on the stance of monetary policy – and *vice versa*?
- How do post-crisis regulatory reforms, such as tighter capital requirements or liquidity regulation for banks, alter the effectiveness of monetary policy? Do certain reforms alter the way in which macroprudential policy affects credit?

2. How should monetary policy, macroprudential policy and microprudential policy be co-ordinated?

A growing literature explores how monetary policy and macroprudential policy might be co-ordinated. But, as Smets (2014) discusses, the issue of whether monetary policy needs to take into account financial stability considerations is far from settled.

Some recent papers which examine optimal macroprudential and monetary policies in a New Keynesian macroeconomic model conclude that macroprudential policy can effectively respond to financial shocks, thus reducing the need for monetary policy to respond. For example, Collard *et al* (2012) examine the macroprudential and monetary policies in a New Keynesian model in which banks take socially excessive risks due to limited liability and deposit insurance. In this framework, time-varying capital requirements can effectively reduce banks' risk-taking incentives, while monetary policy has a limited influence on these incentives. So, in response to shocks that

increase banks' risk-taking incentives, only capital requirements need to be tightened while monetary policy can be eased to mitigate the effects of the macroprudential policy on output. Angelini, Neri and Panetta (2012) also find that countercyclical capital requirements can stabilise the economy more effectively than a 'monetary policy only' world, while Benes and Kumhof (2011) show that their response to contractionary shocks to borrower riskiness can improve welfare and reduce the magnitude of interest rate cuts required to stabilise the economy. Gelain and Ilbas (2014) argue that the gains from policy co-ordination depend on the weight on output stabilisation (versus credit stabilisation) assigned to the macroprudential policymaker, while De Paoli and Paustian (2013) suggest that monetary policy and macroprudential policy authorities should co-operate if faced with a cost-push shock. Rubio and Carrasco-Gallego (2014) develop a dynamic stochastic general equilibrium (DSGE) model with housing and conclude that monetary policy can focus on inflation if the macroprudential policy authority can vary loan to value (LTV) ratio limits.

Others, however, have questioned the assumptions that (i) monetary policy has limited impact on financial stability risks (see previous subsection) and that (ii) macroprudential policy can effectively mitigate these risks and any repercussions of financial shocks on the aggregate economy. Concerns that macroprudential policy may not be a panacea have led some to argue that exclusive reliance on macroprudential policy for maintaining financial stability can be hazardous, and that monetary policy should take financial stability explicitly into account (for example, Stein (2012, 2014), and Morris and Shin (2014)). One approach – advocated by Smets (2014) – might be to use monetary policy only as an 'instrument of last resort' when macroprudential policies fail. Yet others highlight that the use of monetary policy for financial stability purposes could come at a cost of de-anchoring inflation expectations, when the benefits of doing this are hard to quantify given the absence of well-defined measure of financial stability or systemic risk (eg Williams (2014)). Further research is therefore needed to enhance understanding of the interactions between macroprudential policy and monetary policy, including when and how these policies need to be co-ordinated.

In contrast to the growing literature on monetary and macroprudential policy co-ordination, there is currently only a limited literature on the co-ordination between macroprudential and microprudential policies. In most circumstances, the objectives of the two prudential policies are mutually consistent. In a downswing, however, there could be a

degree of uncertainty over the extent to which capital buffers should be released for macroprudential purposes without jeopardising the microprudential objective of maintaining the safety and soundness of individual institutions. For example, policymakers may face uncertainty over, say, how the release of capital buffers may influence market participants' behaviour and expectations, which could affect both financial stability risks and the flow of credit to the real economy. Further research is, therefore, needed to develop analytical frameworks for informing macro and microprudential policy decisions, including how bank stress tests and macro-financial indicators integrate to deliver capital requirements which meet both policy objectives.

Among these issues, some of the relevant questions include:

- Can we specify and quantitatively evaluate robust monetary and macroprudential policy rules that take account of their interactions?
- When, if ever, should monetary policy take account of its effect on risk-taking? And when should macroprudential policy help support the macroeconomy?
- When might monetary, macro and microprudential actions jar and how should each of these policies respond in a downturn? For example, how should bank stress tests and macro-financial indicators integrate to deliver capital requirements which meet both micro and macroprudential objectives? What can we learn from pre-crisis experience about how macro and microprudential policies should be co-ordinated?

3. Do we need to revisit the monetary policy framework in light of the financial crisis?

Inflation targeting – both in its implicit and explicit forms – has dominated the conduct of monetary and macroeconomic stabilisation policy in advanced economies for over two decades. Until the financial crisis, steady growth and low inflation – dubbed the 'Great Moderation' – was a hallmark of inflation-targeting economies. Widespread adoption of inflation-targeting regimes during the 1990s was accompanied by an influential New Keynesian research agenda (such as Svensson (1997), Clarida, Gali and Gertler (1999) and Woodford

(2003)) that provided an intellectual underpinning for inflation targeting and contributed a range of theoretical and econometric tools currently used by central banks. A number of papers tended to find that monetary policy should place less explicit weight on output fluctuations than on inflation and, in the case of some macroeconomic disturbances, monetary policy could perfectly stabilise the output gap and inflation – the so-called 'Divine Coincidence' (for example, Blanchard and Gali (2007)). The links between monetary policy and financial instability were, of course, recognised prior to the crisis. For example, some had argued that monetary policy should 'lean against the wind' (for example, Blanchard (2000), Cecchetti *et al* (2000), Borio and Lowe (2002) and Rajan (2005)). But despite some high-profile debates about whether monetary policy should respond to financial bubbles, the dominant view was that monetary policy should be used to 'clean up' the aftermath of a financial crash, rather than attempt to identify and prick exuberance in advance (eg Bernanke (2002)). Thus, insights from this body of research did not materially challenge the conduct of monetary policy prior to the crisis. Even as the crisis approached, few foresaw the extent of damage that a financial crash could cause to the economy and the operation of monetary policy.

The global financial crisis challenged the prevailing conduct of monetary policy for at least two reasons. First, the prevalence of price and output stability did not necessarily imply that financial stability risks were low; and second, the aftermath of the crisis was far too costly for conventional monetary policy to 'clean up' efficiently, at least by itself. As a result, as interest rates hit the zero lower bound (ZLB), central banks in major economies engaged in large-scale purchases of private sector and government assets and experimented with a range of new policy tools such as forward guidance (see Theme 3). This has led to renewed interest in research on the risks around deflation and policies to deal with the ZLB (examples of earlier contributions include Benhabib, Schmitt-Grohe and Uribe (2002); Coenen and Wieland (2003), who looked at monetary policy in Japan; Eggertsson and Woodford (2003); and Braun and Waki (2006)), as well as studies on the role and effect of large-scale asset purchases (such as Curdia and Woodford (2010a, 2011)) and forward guidance (such as Carlstrom, Fuerst and Paustian (2012) or Del Negro *et al* (2013)).

The crisis also re-activated debate over the appropriate choice of the monetary policy target, with some researchers highlighting the benefits of nominal GDP targeting (for example Woodford (2012) and Sheedy (2014)), price-level targeting (Eggertsson and Woodford (2003)), or raising the inflation target (Blanchard *et al* (2010)). Reis (2013) provides an extensive discussion of issues around central bank design in general. There has also been renewed interest in macroeconomic models with financial imperfections, many of which support the idea that monetary policy should incorporate some financial considerations (for example, Curdia and Woodford (2010b), Woodford (2012) and Gertler and Kiyotaki (2014)). But in linearised models (with deterministic steady states to which the economy returns after a shock), the gains from doing so may be relatively small.

How monetary policy frameworks should respond to the possibility of the policy rate hitting the ZLB, and what role monetary policy guidance and unconventional monetary policy instruments such as quantitative easing (QE) play in normal times, are clearly areas where further research is needed. Indeed, even the transmission mechanism of conventional interest rate policy remains an important area of ongoing research (for recent contributions for the US and UK see, for example, Coibion (2012), Barakchian and Crowe (2013) and Cloyne and Huertgen (2014)). One active area of research considers whether the impact of conventional monetary policy might be state-dependent and whether heterogeneity, and indebtedness, matters for the transmission mechanism (Angrist *et al* (2013), Tenreyro and Thwaites (2013), Sterk and Tenreyro (2014) and Cloyne, Ferreira and Surico (2015)).

Another key area of research is what model and data uncertainties imply for monetary policy. Brainard (1967) had noted that, in the presence of uncertainty over the impact of policy and the relationships between key variables, the principle of 'one goal, one instrument' breaks down and multiple instruments should be used to achieve one goal. More recently, Levin and Williams (2003) have shown that a policy rule focused solely on inflation stabilisation could perform poorly when there is substantial uncertainty over expectation formation and inflation persistence. Monetary policymakers typically also face a high degree of uncertainty about the current state of the economy, in part due to the presence of uncertainty in the available data itself (Manski (2014)). Further research is therefore needed on how various

uncertainties should influence policy decisions and how this should be communicated to the public, including using tools such as inflation and output forecasts.

Thus, a number of open questions remain about the future of monetary policy. For example:

- How does inflation targeting compare to other monetary policy frameworks? How should monetary policy framework respond to the possibility of the policy rate hitting the zero lower bound? Should alternative targets, eg nominal GDP, be considered?
- Should interest rates continue as the primary instrument of monetary policy or should unconventional tools such as QE and forward guidance be continued even after economies return to more normal conditions?
- How should inflation and output forecasts deal with data and model uncertainties? How should such uncertainties be taken into account in policy decisions?

4. How should we design an appropriate macroprudential policy framework?

The recognition that the delivery of price stability was not sufficient to achieve financial or output stability, and that regulation focused on the safety and soundness of individual financial institutions did not guarantee stability of the system have led to the creation – or recreation – of macroprudential policy: using prudential tools to support financial system resilience and meet macroeconomic ends. Time-varying, or cyclical, macroprudential policy instruments include bank balance sheet instruments, such as countercyclical capital buffers, sectoral capital requirements, leverage ratios, and liquidity requirements; but they could also include instruments that affect the terms and conditions of transactions, such as LTV ratios, debt to income (DTI) ratios and margin requirements (Bank of England (2011)).

Ideally, macroprudential policy should be operated in a transparent and predictable manner so as to mitigate system-wide risks, but there are a number of challenges. First, there is no single reliable, quantifiable measure of systemic risk that is grounded in a well-articulated theory of how financial instability arises (see eg Hansen (2012) for an overview of the existing measures of systemic risk). Measuring systemic risk is complicated by the possibility that risks could migrate to parts of the financial system – such as non-banks – where data are less readily available. This is a key barrier to having a quantified

targeting regime for macroprudential policy akin to inflation targeting for monetary policy. Further research on the underlying drivers of time-varying systemic risk, building on the literature discussed by Bank of England (2009, 2011), could contribute to identifying the appropriate set of macroprudential policy objectives, and refinement of the approach to defining macroprudential policy decisions. In the meantime, however, progress on understanding the indicators of systemic risk is crucial. For example, credit-to-GDP gaps and credit growth have been found to have predictive power for past financial crises (eg Drehmann *et al* (2011); Schularick and Taylor (2012)), suggesting that such measures should be taken into account in determining the stance of macroprudential policy. But is it possible to develop indicator-based guides, similar in spirit to the Taylor (1993) rule for monetary policy, which might offer some perspective on the appropriate macroprudential policy stance?

Second, there is no consensus yet over the appropriate range of macroprudential policy instruments. Some instruments, such as sectoral capital requirements, operate at a more targeted level, while others, such as countercyclical capital buffers, operate at the more aggregated level. Even then, there is no single macroprudential policy instrument that directly affects the entire financial system, and the system itself is likely to evolve in response to policy. For example, increasing the countercyclical capital buffer only affects banks directly. Additional measures may be needed to prevent non-banks from building up excessive leverage – for example, by imposing floors on collateral haircuts that apply to securities financing transactions. Furthermore, the very nature of financial intermediation implies that the financial system is necessarily exposed to shocks in non-financial sectors. For that reason, some macroprudential policy authorities also operate instruments that aim to restrict the leverage of non-financial sectors, such as LTV and DTI limits. For example, the series of influential studies by Mian and Sufi (2014) provide empirical evidence that the build-up of household debt was responsible for the subsequent increase in household defaults and mortgage foreclosures, as well as the sharp contraction in consumption, in the post-crisis United States. These studies may support operating macroprudential policy instruments such as LTV and DTI restrictions to limit household indebtedness. Equally, deploying too many instruments could potentially complicate policy decision-making and hamper clear communication on macroprudential policy, which might be crucial for influencing beliefs and expectations across the system (see Theme 3).

Third, we currently have limited understanding of how macroprudential policy affects credit, systemic risk, and ultimately, welfare. In the case of the UK, recent research by the Bank and former Financial Services Authority (FSA) (for example, Francis and Osborne (2012), Aiyar *et al* (2014b) and Bridges *et al* (2014)) has found varying quantitative effects of tighter microprudential capital requirements – affecting individual banks – on bank lending. It is also not clear whether macroprudential capital requirements – which are publicly announced and affect the system as a whole – will have the same effect. Bank research also raises the possibility that the impact of macroprudential capital requirements could depend non-linearly on macroeconomic fundamentals (Aikman *et al* (2015)). Recent work by Clerc *et al* (2014) – which analyses macroprudential policy in a DSGE framework incorporating a possibility of default – suggests that countercyclical adjustments of capital requirements might be beneficial only when the initial capital requirement is sufficiently high. Further research on the impact of countercyclical capital requirements and other macroprudential policies, such as the use of dynamic provisioning (eg Jiménez *et al* (2012)) or instruments acting on the housing market (eg Crowe *et al* (2013); Kuttner and Shim (2013)), would help support policymaking.

Given the nascent state of the literature, uncertainty facing macroprudential policy is even greater than that facing monetary policy, and further research is also needed on what robust macroprudential policy under uncertainty looks like. A related question is how stress tests – which are based on specific ‘tail risk’ scenarios – should be designed and what role they should play in the macroprudential policy framework. Although the ability of individual institutions and the system as a whole to withstand a stress test depends on the scenario, there is no clear methodology for quantifying the likelihood of a particular scenario. In addition, there can be substantial uncertainty around projections of bank capital adequacy, even conditional on a particular stress scenario.

Possible questions for further research include:

- How might we design a well-articulated macroprudential policy framework akin to inflation targeting? Is it possible to have quantified targets for financial stability, and quantified responses of policy instruments to deviations from such targets?
- What are the key drivers of time-varying systemic risk? What are the underlying drivers of credit and financial cycles and how do these contribute to systemic risk? What indicators best capture these risks?
- What are the merits of different macroprudential instruments and when might each of them be most effectively deployed? Under what conditions does it make sense to deploy instruments that operate on terms and conditions of transactions, rather than lender balance sheets?
- How are banks and non-bank financial institutions likely to respond to different macroprudential policy instruments?
- What is the appropriate strategy for macroprudential policy given the uncertainties over the drivers of systemic risk and the impact of policy on them?

5. How is national monetary and macroprudential policy different in a world with global cycles and global long-term structural change?

After the collapse of the Bretton Woods System in 1971, the major economies attempted co-operation to stabilise exchange rates and reduce current account imbalances on a number of occasions during the 1970s and 1980s. But since the 1990s, attempts at international monetary co-operation among the major advanced economies have been limited outside the European countries that have formed a currency union. At the same time, the academic literature has often concluded that gains from co-operation may in any case be small (eg Oudiz and Sachs (1984); Obstfeld and Rogoff (2002); see Taylor (2013) for a critical review of the literature). The landscape for international monetary policy co-operation has not changed in any fundamental way since the crisis: with the exception of the co-ordinated monetary easing at the onset of the crisis, conventional monetary policy is still being set by individual central banks without co-ordination. Yet there is now evidence that international spillovers of unconventional monetary policies may have been sizable, including to emerging market economies (EMEs) (see, for example, Rajan (2013), Fratzscher *et al* (2013) and Bauer and Neely (2014) on the Fed's LSAP program). Nevertheless, the scope for international

co-ordination of unconventional monetary policies is a relatively unexplored area. By contrast, the potentially negative effects of globalisation on the ability of national central banks to control inflation and output within their own boundaries have become a subject of considerable research. For example, Corsetti *et al* (2010) offer a framework for thinking about optimal policies in an open economy.

Prior to crisis, many had expressed concerns about global current account imbalances and the pattern of net capital flows resulting from the exchange rate management policy of large emerging market economies. But relatively few were concerned about the pattern of gross capital flows among developed economies. Although there was an academic literature highlighting risks associated with global financial integration (for example, Obstfeld and Taylor (2004), who provide a 150-year perspective on global financial integration), gross capital flows between advanced economies were largely seen as evidence of improved risk sharing. But the crisis starkly illustrated that the pattern of capital flows among advanced economies contained important information about potential risks to the financial system and wider economy (Borio, James and Shin (2014)).

Capital flows also provide a key link between the monetary policies of major economies, asset prices across the world, and financial stability (see also Theme 4). Recent research shows that both risky asset prices and capital flows have a strong global component (for example, Rey (2013) and Forbes and Warnock (2012)). Furthermore, Bruno and Shin (2014) show that low policy interest rates at major central banks can have spillovers to financial stability in other countries that end up attracting capital inflows: as their local currency appreciates, local borrowers' balance sheets become stronger, leading to excessive foreign currency borrowing.

When global capital flows do not necessarily reflect efficient allocation of savings into investments, the role for capital controls and domestic macroprudential measures may take greater prominence, as noted by Brunnermeier and Sannikov (2014). But while capital controls are often adopted by emerging market economies to deal with the unwanted capital inflows resulting from foreign monetary policy easing, their effectiveness remains open to question. For example, Bengui and Bianchi (2014) examine the effects of imperfect capital flow management instruments – such as those which cannot be targeted on individual borrowers – and find that unaffected agents may expand their lending to take advantage of the effect that the instrument has on affected agents.

Research on international spillovers arising from macroprudential policy and capital controls is still nascent, but the available evidence suggests that they could potentially be large enough to be a policy concern. For example, recent research by Bank staff shows that UK banks cut lending abroad in response to an increase in bank-specific capital requirements, especially to non-core markets (Aiyar *et al* (2014)). Forbes *et al* (2012) also find that Brazil's taxes on fixed income and equity aimed at stemming capital inflows into these markets diverted capital flows into other EMEs. But the presence of spillovers, by itself, does not necessarily give rise to a case for international policy co-operation. For example, Korinek (2014) develops a multi-country model for analysing international policy co-operation and shows that there is no role for global co-ordination if national policymakers have a complete set of instruments and if there are no imperfections in international markets. If, however, these conditions do not hold – as is likely in practice – then global co-operation can improve welfare.

The above considerations raise the question of whether the combination of self-oriented monetary policy and macroprudential policy is sufficient to deliver stable and balanced global growth; and whether greater international co-ordination of macroeconomic policies is needed. Ostry and Ghosh (2013) suggest that a lack of a shared understanding of the potential (Pareto) gains from co-ordination is an important reason why there has been little policy co-ordination in the past. Past attempts to co-ordinate macroeconomic policies across

the G7 during the 1970s and 1980s achieved limited success (eg Eichengreen (2008)). So much more work remains to be done on the case for international co-ordination and why it may fail or succeed.

Possible research questions include:

- How large are the cross-border spillovers of policy and/or the effects of global common shocks in driving macroeconomic and financial fluctuations?
- How well do capital controls insulate economies from such spillovers, and can capital controls themselves become a source of spillovers?
- Could greater co-ordination of policies help to reduce cross-border spillovers or tackle common global shocks? Is there a stronger case for international monetary policy co-operation when a number of major economies are close to the zero lower bound? Should macroprudential policy co-ordination go beyond the CCB? If so, what instruments are most appropriate?
- What would international financial 'system-wide' risk management look like? What role might supra-national authorities play in monitoring and mitigating financial system-wide risks? And to the extent that policymaking becomes increasingly supra-national, what challenges does this pose for national central banks in meeting their own objectives?

Evaluating regulation, resolution and market structures



2

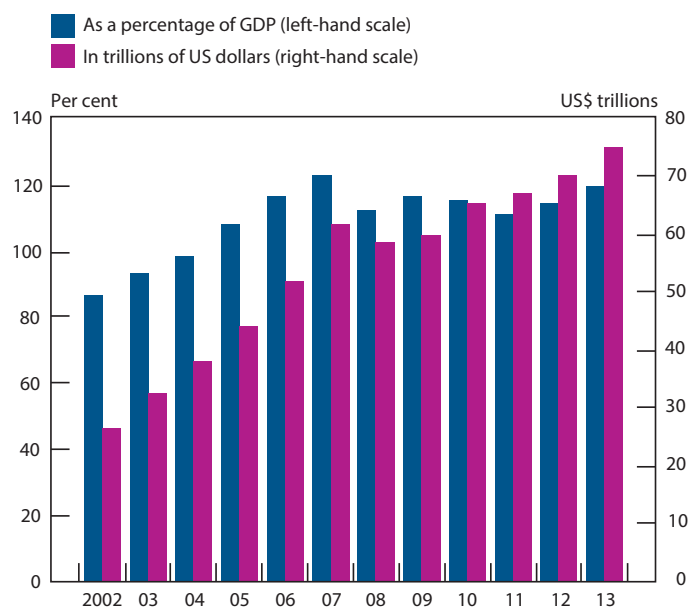
Evaluating regulation, resolution and market structures in light of the financial crisis and in the face of the changing nature of financial intermediation

The financial crisis precipitated substantial reforms to financial regulation, supervision and resolution. As well as strengthening microprudential rules, policymakers have introduced an explicitly macroprudential perspective to regulation – for example, by varying capital requirements through the cycle or according to the systemic importance of individual institutions. Bespoke resolution regimes have been introduced for banks and, increasingly, for certain categories of non-bank financial institution (NBFI). But there has been relatively little assessment of the overall effects of – and relationship between – different types of reform at the system-wide level, especially beyond the banking sector. Further work is needed to evaluate the post-crisis reform agenda in a systemic context, taking due account of the emergence of new stability risks, including from the non-bank sector.

One important objective of the post-crisis reform agenda has been to eliminate the perception that some financial institutions are too big to fail (TbTF). Banks perceived as more likely to receive taxpayer support have been shown to benefit from lower funding costs – an implicit subsidy – that may create an incentive to take additional risk and inhibit competition (Noss and Sowerbutts (2012)). But further work is needed to develop robust methodologies that can quantify TbTF subsidies at different points in the cycle, in different market conditions, and for NBFIs as well as banks. The strength of the relationship between implicit subsidies, risk-taking and competition also warrants deeper empirical investigation.

Researchers and policymakers also need to explore the appropriate structural configuration of the financial system in a post-crisis world. Tighter regulatory rules for banks have contributed to growth in financial intermediation outside the traditional banking sector, typically through NBFIs and capital markets (Chart 1). This presents new challenges for central banks in analysing and mitigating threats to financial stability, especially when activity takes place beyond the regulatory perimeter. New policy levers, such as minimum and/or time-varying haircuts on securities financing or other transactions, may be required to limit systemic risk (Financial Stability Board (2014a)). Further research is also needed to understand the implications of the growth in NBFI and market-based finance for the transmission mechanisms of monetary and macroprudential policy.

Chart 1 Assets of non-bank financial intermediaries



Source: Financial Stability Board (2014b).

More broadly, the interplay between regulatory reform and the changing nature of financial intermediation raises important questions about how incentives, market structures and regulation might evolve in future. Specific avenues for further research include the nexus between competition and stability in different segments of the financial sector, how regulatory regimes should adapt to the introduction of resolution regimes, and the extent to which complex regulatory rules should be complemented by simpler approaches that are easier to enforce, but which could be ineffective at capturing and mitigating risk if incorrectly calibrated. It is also important to understand the risks and opportunities arising from financial innovation, as well as how the system and the regulatory framework should respond to new and rapidly evolving non-financial risks such as the threat of cyber-attacks.

This section explores a number of potential avenues of research under Theme 2, grouped under six broad questions.

1. How should we evaluate the overall effects of regulatory change?

The financial crisis highlighted a number of flaws in the regulatory regime and has prompted a fundamental redesign of financial regulation. For example, the crisis made clear that microprudential regulation alone was not well-suited to addressing system-wide risk. The traditional view of microprudential regulation focused primarily on averting defaults of individual banks and paid relatively less attention to the fire-sale, liquidity hoarding and credit-crunch externalities that fostered instability during the crisis (Bernanke, Gertler and Gilchrist (1999); Kashyap and Stein (2004); Brunnermeier and Pedersen (2009)). The pre-crisis regulatory regime was also ill-equipped to recognise and deal with threats to financial stability emanating from non-traditional banking activities or risk outside the regulatory perimeter.

The post-crisis overhaul of financial regulation is underpinned by the idea that risk in the financial system is not simply the aggregation of individual risks. Instead it is largely endogenous, stemming from the behaviour of individual financial institutions and agents and the interaction between them (De Nicolo, Favara and Ratnovski (2012)). The regulatory framework thus needs to be built on a sound understanding of the appropriate configuration of intermediation between the bank and non-bank sectors as well as capital markets, and the interplay between different prudential regulation, accounting and valuation standards in shaping this configuration (Black (2012); Basel Committee on Banking Supervision (2015)).

The nature of financial innovation presents particular challenges for regulation. Threats to financial stability are constantly evolving – for example, through changes to the nature of financial intermediation, changes in the network of connections between financial institutions, and as a result of these institutions' reliance on complex technological systems that are potentially vulnerable to systems failures or cyber-attacks. Policymakers need to understand what can be done to make regulatory regimes better equipped to respond to such threats, including shocks which may not be financial in origin.

Indeed, future crises may have different origins to previous ones if, for example, regulatory reforms or continued financial innovation create an environment in which new and difficult-to-anticipate threats emerge. The implication is that a regulatory regime designed to support financial stability may need to consider a wide range of measures (Adrian, Covitz and Liang (2014)) and regulatory practices may need to adapt quickly to tackle emerging threats. Whether and how market discipline can help mitigate these threats remains an open issue that warrants further research.

Developing an appropriate framework for assessing the overall effect of regulatory change and the interaction between different regulations is also important. While some headway has been made, much of the extant research focuses on the banking sector and evaluates individual reforms in isolation (Barrell *et al* (2009); Basel Committee on Banking Supervision (2010); FSB-BCBS Macroeconomic Assessment Group (2010)), abstracting from other potentially important effects and interactions. Further research examining how regulatory reforms interact as a package is needed (Elliott, Salloy and Santos (2012); De-Ramon *et al* (2012)). It is also important to develop models that can help policymakers understand the likely impact of regulatory reforms on the insurance industry. These tools would provide a better foundation upon which to assess empirically the aggregate impact of policy and spot potential system vulnerabilities, and in turn allow policymakers to analyse open questions regarding the overall design of financial regulation in a systemic context.

Research questions include:

- What are the appropriate frameworks for assessing the effects of (recent) reforms aimed at mitigating financial stability?
- How have incentives collectively been reshaped by regulatory reform? What is the interplay between accounting, valuation and regulatory standards and what is their impact on behaviour?
- What does a robust regulatory structure look like and how can that be built in a credible way? What is the most effective way of ensuring that regulation addresses dynamically evolving risks to financial stability?
- What is the likely impact of reforms to capital regulation on the life insurance industry?

2. How do financial institutions (including non-banks) benefit from TBTF? How can we measure TBTF subsidies for banks and other institutions?

An expectation that the state will support institutions that are TBTF creates implicit subsidies in the form of funding costs that are artificially low and insensitive to risk. This can, in theory at least, create moral hazard – TBTF institutions may have an incentive to choose excessively high levels of risk. Similarly, institutions that do not already benefit from an implicit subsidy may have incentives to become larger and more complex, often by taking more risk, to increase their chances of receiving government support. Identifying moral hazard econometrically is notoriously difficult. Nonetheless, studies such as Morgan and Stiroh (2005), Alessandri and Haldane (2009) and Alfonso, Santos and Traina (2014) provide useful insights on the behaviour of firms for policymakers, supervisors and resolution authorities.

The literature has also explored various ways of measuring TBTF subsidies – for example, by examining the relationship between funding costs and bank size (Acharya, Anginer and Warburton (2014)), the impact of assumed government support on banks' credit ratings (Noss and Sowerbutts (2012)), or the effect of discrete events on bank funding costs (Baker and McArthur (2009)). Other methodologies seek explicitly to model the probability of bank failure, such that an estimate of the expected value of the implicit subsidy can be derived. Siegert and Willison (2015) provide a comprehensive overview of the literature, concluding that there is robust evidence that large banks have historically benefited from substantial funding cost advantages (Table A).

Robust measures of the evolution of implicit TBTF subsidies through time are less well-developed, suggesting that it may be helpful to develop measures that can be updated on a regular basis for financial institutions in the United Kingdom and elsewhere. This would allow monitoring of how funding cost advantages evolve over time and an assessment of whether policies to end TBTF – such as the introduction of bespoke resolution regimes and policies to ensure banks' liability structures can absorb losses – have been successful.

Moreover, the international post-crisis reform agenda is not restricted to the banking sector. In its work to address the systemic and moral hazard risks associated with systemically important financial institutions, the Financial Stability Board recognises that certain NBFIs can also be considered TBTF. But existing methodologies for measuring TBTF subsidies do not readily map across to systemically significant NBFIs such as large insurers and global central counterparties (CCPs) that are less reliant on debt finance. Similarly, it is not immediately clear how the moral hazard distortions associated with TBTF status would manifest themselves for different types of NBFIs.

Possible further avenues for research include:

- How have TBTF subsidies evolved over time? What measures should be used to track this evolution?
- What has been the impact of TBTF subsidies on moral hazard in the banking sector and can dynamic measures of these subsidies provide useful insights for policymakers, supervisors and resolution authorities?
- What is an appropriate method for analysing the extent of the TBTF subsidy for NBFIs such as insurers and CCPs? Could such measures be used as 'success criteria' for efforts being made to eliminate TBTF outside the banking sector?

Table A Range of funding cost advantages for different methodologies for calculating TBTF subsidies

Approach	Long-run average (basis points)	2009 (basis points)
Event studies	15–32	78
Cross-sectional studies		
Size-based	30	>100
Ratings-based (historic yields)	0–80	60–80
Ratings-based	47	630
Models of bank default	(-6)–25	10–350

Source: Siegert and Willison (2015).

3. How has the structure of financial intermediation changed as a result of the global financial crisis and the regulatory response to it? What are the implications for the occurrence, measurement and mitigation of systemic risk?

The financial crisis revealed that banking sector leverage had reached unsustainable levels, driven in part by the TBTF distortions highlighted above. The subsequent contraction in banks' balance sheets hindered some real economy borrowers' access to credit, catalysing renewed interest in the role of non-bank and market-based finance as a complement to traditional bank-based forms of financial intermediation. Tighter post-crisis regulation and supervision of banks is likely to entail a proportionately larger role for non-traditional methods of intermediating between borrowers and savers than in the previous cycle. Understanding the implications of this shift in the structure of financial intermediation is vital to central banks' ability to achieve their monetary and financial stability objectives.

Intermediation by the NBF sector is often supported by collateral. Bank funding is also now more often secured against assets than it was before the financial crisis. This increased use of collateral has greatly reduced counterparty credit exposures, which played a significant role in propagating and amplifying the recent financial crisis (Bullard, Neely and Wheelock (2009)). But while counterparty risk has diminished, increased collateral usage has other consequences. These include the effects on the pricing of collateral and non-collateral assets, the cost and availability of unsecured bank funding and the potential increase in liquidity risk stemming from cyclical changes in collateral values and margin requirements (Gai *et al* (2013); Bookstaber *et al* (2014); Murphy, Vasios and Vause (2014)). Policies such as minimum haircut or margin requirements, countercyclical macroprudential adjustments to these requirements, or enhanced disclosure of potential requirements may reduce these liquidity risks, although this should be weighed against the cost to institutions of having to source additional liquid assets.

Liquidity risk also emerges elsewhere in the non-bank financial system. Tighter regulation of banks and broker-dealers may affect market-making capacity and thus market liquidity. And asset managers may face client redemptions if the value of their

funds decline, potentially forcing them to fire-sale assets in a manner that precipitates a downward spiral in asset prices with wider systemic consequences (Feroli *et al* (2014)). Measuring the scale of this externality is an important research question for central banks.

One specific challenge is to develop suitable analytical tools for monitoring financial activity outside the traditional banking sector. Despite some recent improvements, good-quality data remain relatively scarce, especially for institutions operating outside the traditional perimeter of prudential regulation (Financial Stability Board (2014a)). By contrast, transaction and position data held in trade repositories offer the prospect of lifting the veil on the cross-border network of counterparty exposures in derivatives markets – for example, by drawing on emerging techniques for analysing large data sets discussed under Theme 4 (Brunnermeier, Gorton and Krishnamurthy (2013)). Further work is also required to identify how available data can be used to identify emerging risks to financial stability emanating from NBFs and capital markets (Duffie (2011)).

A further important strand of work is to identify potential barriers to the development of resilient and diverse sources of market-based finance. Frictions such as distorted incentives, incomplete or asymmetric information, and co-ordination failures can all hinder the emergence of credible alternatives to bank-based finance – or result in alternative sources of finance that introduce new risks to financial stability (Adrian and Ashcraft (2012)). For example, inadequate information on the credit history of retail borrowers and the opacity of some securitisation structures may discourage non-bank lending to households and corporates, either directly or through the purchase of securitised loans. A number of initiatives to tackle these and other frictions are currently under way (Bank of England (2014a and b)), the effects of which should be studied carefully.

Possible avenues for research include:

- What are the implications of more widespread use of collateral? Is the extra demand significant enough to pull down the yields of high-quality liquid assets? Could rising asset encumbrance squeeze unsecured debt holders out of the market by increasingly subordinating these creditors, perhaps especially where balance sheets are less than fully transparent?

- To what extent are collateral haircuts and initial margin requirements procyclical? Could countercyclical haircuts and margins be used as a macroprudential tool?
- To what extent have post-crisis reforms, including those that separate securities trading from deposit-taking, affected market-making and market liquidity?
- How could policy help to overcome informational frictions in NBFIs lending?
- How might NBFIs contribute to systemic risk and what might be appropriate policy responses?

4. What are the implications of regulatory reform for competition and the links between competition and financial stability?

The role that competition played in the financial crisis is not yet fully understood. Previous research on the competition-stability nexus offers only limited insights, as the generally mixed results leave the true relationship between competition and stability unclear (Van Hoose (2008)). For example, Vives (2010) undertakes a detailed review of the literature on bank competition and financial fragility and concludes that there is a trade-off between competition and stability. A study of inter-state and intra-state deregulation in the United States between 1976 and 1994 by Hanson, Kashyap and Stein (2011) also finds that firms tend to adopt lower and more uniform capital levels as the intensity of competition increases, indicating a negative relationship between competition and stability.

But other empirical studies reach different conclusions. Beck, Demirguc-Kunt and Levine (2006) find that both high concentration in the banking sector and pro-competitive institutions and regulatory environments are associated with a lower probability of a systemic crisis. These findings are supported by Schaek, Cihak and Wolfe (2009), who also find that systemic banking crises are less likely in more competitive and more concentrated banking systems. And in one of the few studies examining how competition affects stability at the level of the overall system, Anginer, Demirguc-Kunt and Zhu (2014) find a positive association between competition and stability.

Further research is required to deepen understanding of the interaction between regulatory changes and competition in the banking sector (and other parts of the financial system). This is

particularly important in view of the PRA's secondary objective to facilitate effective competition. Extant research is unclear about the impact of prudential capital and liquidity requirements on competition. Hakenes and Schnabel (2011) show an ambiguous effect of more stringent capital requirements on stability via their dampening effect on competition for loans and deposits. Ahrend and Arnold (2011) find no significant association between competition and capital requirements, but do uncover a positive relationship between levels of liquid assets and competition.

The impact of reform on competition can also affect assessments of the costs and benefits of specific policy measures. Reduced competition has generally been associated with higher loan spreads (Ruthenberg and Landskroner (2008); Basel Committee on Banking Supervision (2011)). If recent increases in capital and liquidity requirements for banks create additional barriers to entry, for example, the macroeconomic costs of the reform may be amplified. But the growth of market-based finance (discussed above) may mitigate some of this effect. Similarly, the likelihood and size of financial crises – and therefore estimates of the benefits of regulatory reform – are likely to be affected if new prudential standards materially change the nature of competition. Beyond the need for more consideration of the effects of competition on systemic stability, there are several issues related to the competition-stability nexus that could benefit from further research.

Specific questions include:

- How does banking competition influence contagion risk and network effects?
- How do market perceptions about bank fundamentals affect the competition-stability link?
- To what extent do non-traditional, (investment) banking activities, such as securitisation and trading, affect the competition-financial stability link? Are there lessons from the competition-stability nexus from the banking sector that are relevant for the insurance sector?
- How can we assess the impact on financial stability of competition in specific markets? For example, what is the impact of a reduction in search and switching cost for retail deposits on banks' liquidity management practices and, thus, maturity transformation and wider financial stability?

5. What is the impact of the development of resolution regimes for financial institutions on regulatory and supervisory arrangements for these institutions?

Much of the existing literature on resolution concentrates on the question of the impact and scale of the TBTF problem discussed above. Other avenues of research have sought to delineate shortcomings in resolution arrangements in order to identify areas for further policy development (French *et al* (2010) and Avgouleas, Goodhart and Schoenmaker (2013)). Some of these contributions have focused on particular approaches, such as the game-theoretic approach used by DeYoung, Kowalik and Reidhill (2013). But the adoption of feasible and credible resolution arrangements that allow even systemically important financial institutions to fail in an orderly fashion may also have significant implications for the existing regulatory approach.

The regulatory framework in the United Kingdom and more widely is constructed to promote safety and soundness of banks and other financial institutions, both as they carry on their business day-to-day and as they fail. Measures intended to promote safety and soundness, such as risk-weighted capital requirements, liquidity requirements and constraints on leverage and large exposures, have evolved over time from building blocks that were put in place when sophisticated legislative and practical arrangements to manage failure were absent. What implications does the introduction of statutory resolution regimes have for these aspects of regulation and supervision? Do these implications differ for large and small institutions? More broadly, how might the credible threat of resolution affect the behaviour of institutions in distress and are there any implications for regulatory design?

At one extreme, established regulatory arrangements could be subject to relatively minor amendments to reflect the introduction of resolution regimes, such as the establishment of new processes for sharing information between supervisors and the resolution authority as the financial condition of a bank deteriorates or adjustments to group-level supervision to ensure that loss-absorbing capacity is available in resolution. Alternatively, the adoption of credible resolution arrangements could warrant a more radical reassessment of elements of regulation and supervision. More research is needed to identify the appropriate policy response.

Potential research themes include:

- What model of supervision and regulation would be appropriate in the presence of a robust and credible resolution regimes to deal with failure?
- If the externalities from firm failure are eradicated by resolution arrangements, what role would there be for regulatory rules traditionally aimed at reducing the probability of failure? Should there be greater emphasis on pre-failure externalities such as deleveraging, liquidity hoarding and asset fire sales?
- How could robust recovery plans contribute to minimising these pre-failure externalities?

6. How should the complexity of the financial system influence the design of regulation?

The financial system consists of individually complex institutions that are connected to one another in a complex network of counterparty exposures. The regulatory framework within which the financial system operates has, historically, followed the same course, with the increased complexity of the system mirrored in an increasingly complex regulatory environment, especially over the past two decades.

One example of increasing complexity is allowing banks to use their own internal models to determine regulatory capital. These stand in contrast to usually simpler 'standardised approaches' defined by regulators. The trade-off between these is often described as being between better risk capture (internal models) versus being cheaper to implement and supervise (standardised approaches). But research on heuristics suggests that this trade-off is not always present and that simpler approaches can sometimes outperform more complicated approaches in certain environments (Gigerenzer and Brighton (2009); Haldane and Madouros (2012); Aikman *et al* (2014)). This raises questions over the appropriate approaches to use and how they should complement each other in the overall regulatory framework for banks (Tarullo (2014)) and insurers.

More broadly, the regulatory response to the global financial crisis includes a number of measures that aim to reduce complexity, for example by requiring banks to ring-fence certain functions such as retail deposit-taking and lending. These measures aim to insulate essential financial services from

shocks elsewhere in the financial system, but may also limit the extent to which banks are able to exploit economies of scale and scope (Independent Commission on Banking (2011)). There is an extensive but inconclusive literature on the existence of scale economies in banking (Mester (2008); Hughes and Mester (2013); Wheelock and Wilson (2012)), some of which attempts to control for the implicit TBTF subsidies discussed above (Davies and Tracey (2014)). Economies of scope, by contrast, have received less empirical attention. Further research is required to identify the circumstances under which full legal separation is preferable to softer forms of ring-fencing that allow some functions to be undertaken jointly by different parts of a single group.

Another set of reform initiatives aim to simplify the linkages between institutions by requiring central clearing of OTC derivatives. Central clearing helps to simplify the financial network and reduces aggregate counterparty exposures, but also concentrates risk in a small number of CCPs that may themselves become TBTF. Recent research has explored alternative ways in which the resilience of CCPs can be assessed (Murphy and Nahai-Williamson (2014)), but more work is needed on methods for ensuring that CCPs' margin calculations

are suitably robust and to identify the policy measures (such as bespoke resolution regimes and other loss-allocation mechanisms) that could be employed to prevent the re-emergence of a TBTF problem.

Broad research themes, related to the examples above, include:

- How could simple approaches complement more complex approaches in capturing and mitigating risk in the financial system?
- How can we define and measure complexity in finance and financial regulation? Is there an optimal degree of interconnectedness in the financial system, and how can regulation help to achieve this outcome?
- What are the stability benefits and economic costs of simplifying banks' internal structures, for example through ring-fencing? How should policymakers evaluate these costs and benefits, recognising that they will crystallise over different time horizons?
- How should CCPs mitigate model risk and limit procyclicality when calculating margin requirements?

Policy operationalisation and implementation

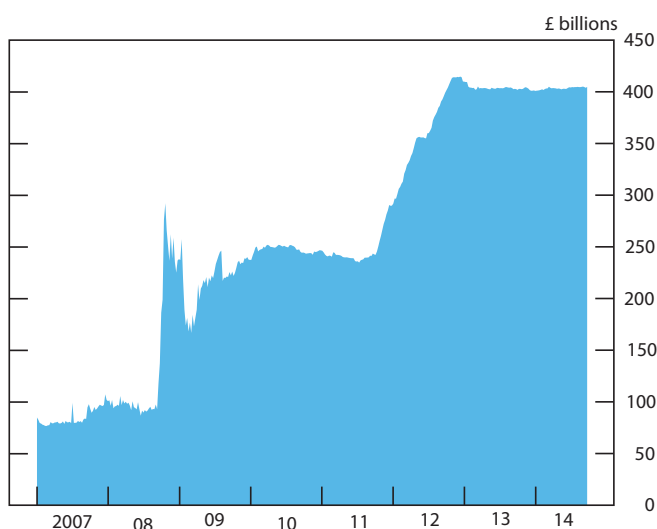


3 Operationalising central banking: evaluating and enhancing policy implementation, supervision and communication

The financial crisis has thrown up new questions on the implementation and communication of policy – issues that have been at the heart of central banking and supervision for decades, but which the crisis re-emphasised. These include the role of new central bank balance sheet tools for policy purposes, understanding the impact of communication and disclosure policies on incentives and behaviours, and re-assessing the approach towards the supervision of financial institutions.

Central banks around the world made extensive use of their balance sheets during the financial crisis (Chart 2 shows the evolution of the Bank of England's balance sheet over time). And the crisis also led to a number of changes in the design of central bank operational frameworks. With the benefit of hindsight, which of these interventions were most effective, through which channels and under what circumstances? Are there other tools which central banks should have available to deploy in the next crisis? What system should central banks use to control interest rates? Should central banks look to expand their counterparty lists further and provide liquidity insurance facilities to non-bank entities? What are the implications of expanded central bank collateral eligibility for asset prices and liquidity in various markets? More broadly, what is the impact of balance sheet policies on money markets, financial markets generally and the wider economy?

Chart 2 Bank of England balance sheet



Communication also played an important role in the crisis response, stretching from forward guidance to disclosure of stress-test results. This follows a long-term trend towards greater degrees of central bank transparency. But how frequently, in what form and about what, should central banks communicate? Is the communication strategy for financial stability, resolution and supervision different? And how can we improve our communication of uncertainty?

The crisis also re-emphasised the important role of judgement in the approach towards supervision and resolution. Discretionary models have real merits, allowing greater flexibility and information assimilation. But as with any area of technical decision-making, they can also be subject to some drawbacks, including various behavioural biases. How significant are these biases in the supervisory and resolution spheres? And are there useful insights from other professions on how to enhance judgement-based decision-making?

This section outlines some of the key outstanding questions around lessons from central bank crisis policy tools, the evolving role of collateral in the post-crisis financial landscape, the impact of communication policies on incentives and outcomes, and methods to support judgement-based supervision.

1. What can we learn from central bank and government crisis interventions?

Central banks have been significant innovators since the start of the financial crisis. Many deployed new and 'unconventional' tools. Some tools were aimed at stimulating nominal demand by lowering longer-term risk-free yields through private sector portfolio rebalancing (eg UK quantitative easing, Japanese quantitative and qualitative easing). Policies were also aimed at reducing the effective duration of private sector bond holdings (eg the FOMC large-scale asset purchase program 'twists'). Some central banks also used unsterilised FX intervention to target exchange rates (eg the SNB).

A number of other tools were aimed at improving the liquidity of specific institutions – central banks extended the term of their regular lending operations (eg UK move to six-month Indexed Long-Term Repo operations), and broadened the set of eligible collateral (eg UK accepting portfolios of loans), as well as launching a number of extraordinary policies offering liquidity to banks (ECB Longer-Term Refinancing Operations, UK Special

Liquidity Scheme) and certain non-banks (US Primary Dealer Credit Facility). Policies were also aimed at boosting bank lending (UK Funding for Lending Scheme; ECB Targeted Longer-Term Refinancing Operations) and improving the functioning of asset markets (UK Market Maker of Last Resort in the corporate bond and commercial paper markets). Several central banks introduced global networks of FX swap facilities to alleviate stresses in various offshore funding markets.

The introduction of these tools has broken new ground for many central banks. Understanding the efficacy of the various interventions is vital to improve our understanding of these tools. A number of theoretical models have attempted to analyse the impact of some of these on financial markets and the real economy. They illustrate the assumptions that are needed to generate an impact. These include heterogeneous agents (eg Curdia and Woodford (2010a, 2011)), credit frictions (eg Christiano and Ikeda (2011)) and segmented asset markets and portfolio adjustment costs (see Andrés, Lopez-Salido and Nelson (2004) and Chen, Curdia and Ferrero (2012)). Greenwood and Vayanos (2014) also find an active role for sovereign QE policies in stimulating the economy by showing that long-term bond prices are a function of their relative abundance.

There have also been a number of empirical assessments since the crisis. Evidence from UK (eg Joyce, Tong and Woods (2011)) and US (eg Gagnon *et al* (2011)) event studies suggest that initial QE and large-scale asset purchase announcements lowered long yields. Other studies have also found that scarcity (local supply) and duration channels both contributed significantly to estimated falls in bond yields and term premia (eg Banerjee, Latto and McLaren (2014), and D'Amico *et al* (2012)). The (potentially state-contingent) impact of central bank asset purchase facilities on bond yields, term premia and risk-taking behaviour, and the subsequent impact on real-economy variables such as output and inflation, remain important areas for further research. It would be interesting to compare the experiences across countries more broadly.

Looking ahead, it is important to further our understanding of the impact of the extraordinary policies that have been implemented in recent years. This research will be crucial in helping future policymakers make informed and confident decisions should such policies be required. For example, is it the size of the central bank balance sheet or the composition of its assets that matters more for monetary policy? Could central banks have achieved similar outcomes through smaller interventions in riskier asset markets?

When the policies are unwound, central banks will introduce operational frameworks for more normal times. But these should not necessarily be the same as those that operated before the crisis. It is important to learn any relevant lessons from the use of unorthodox instruments in recent years. Many central banks (including the Bank of England) have moved from a 'corridor' system of interest rate control (where the rates on the central bank's standing borrowing and lending facilities form a corridor within which market rates move) to a 'floor' system (where all central bank reserves are remunerated at the policy rate). Bernhardsen and Kloster (2010) explore the relative merits of the two types of framework directly. Others consider the properties of additional tools to steer market rates (eg Martin *et al* (2013)) and the role of unorthodox instruments in supporting the effective transmission of monetary policy (eg Cour-Thimann and Winkler (2012)). It is clear from experience with quantitative easing that there are circumstances in which central banks can both steer interest rates and (separately) determine the volume of central bank reserves. The potential for using these two operational instruments merits further research.

In many countries, central bank policies were accompanied by substantial and unorthodox government interventions, including recapitalisation of troubled institutions, partial or outright nationalisation, and new or extended guarantees of certain forms of borrowing by banking institutions generally. One justification for such intervention is that unexpected changes in the value of bank assets that leads to 'debt overhang' may also create conflicts of interest between banks' equity holders and creditors, preventing socially efficient lending from being undertaken. Bernanke (2009) also draws attention to the uncertainty generated by hard-to-value assets on institutions' balance sheets, which might need to be removed or supported by government guarantees of those assets. More generally, any assessment of different types of government intervention necessarily depends on whether existing property rights can be adjusted. For example, Philippon and Schnabl (2013) argue that, when property rights cannot be adjusted, equity investment is the preferred form of intervention. The ability of different parties, including the government, to value bank assets also clearly affects the relative merits of alternative interventions.

Interventions during the crisis offer the opportunity to gather empirical evidence on the efficacy of such actions. For example, Veronesi and Zingales (2010) examine the 'Paulson Plan' which combined an infusion of preferred equity with guarantees of new bank debt issuance, arguing that its announcement did create value (but also transferred value from taxpayers to holders of bank debt). Elyasiani, *et al* (2014) investigate investor reactions to a number of different types of announcements of large capital infusions and find that investors reacted negatively to private capital offerings but positively to TARP. And Laeven and Valencia (2013) show the positive impact of bank capitalisation on the real economy.

But the issue of containing moral hazard as a result of interventions remains contentious and debate on how to limit it has raged ever since Bagehot (1873). 'Constructive ambiguity' as an attempt to minimise moral hazard was a cornerstone of lender of last resort policies before the crisis, but it is not clear how credible this is in light of the crisis experience of large interventions. Overall, the net effect of public guarantees is ambiguous and depends on the interaction of charter value and moral hazard effects (Keeley (1990), Cordella and Yeyati (2003), Gropp *et al* (2011)). Damar, Gropp and Mordel (2012) show how the effects of increased bailout expectations on risk-taking differ markedly between calm and crisis times. The crisis has allowed us to observe some of these moral hazard effects in action. Black and Hazlewood (2013) uncover evidence that the US Troubled Asset Relief Program (TARP) may have increased risk-taking by larger banks. Duchin and Sosyura (2014) find that bailed-out banks initiate riskier loans and shift assets toward riskier securities after receiving government support, but this risk remains undetected by regulatory capital ratios.

Specific areas of interest include:

- What has been the impact of central bank asset purchase facilities on bond yields, term premia, and risk-taking? What has been the subsequent impact on real-economy variables like output and inflation?
- Is the impact of QE-like policies state-contingent? How effective are the interventions under different monetary conditions? What are the lessons for exit strategies?
- To what extent does the composition of the central bank's assets matter relative to the absolute size of the central bank balance sheet? Could central banks have achieved similar outcomes through smaller interventions in riskier asset markets?

- What system should central banks use to control interest rates? How should central banks balance the need for monetary control and the provision of liquidity insurance? Should central banks look to expand their counterparty lists further, and provide liquidity insurance facilities to non-bank entities?
- What can be learnt from government crisis interventions?

2. What are the monetary and financial stability implications of the increased role of collateral in markets?

Central banks have made significant changes to their liquidity insurance facilities during the crisis – expanding their counterparty lists, extending the term of their lending facilities, and widening their eligible collateral frameworks. But there is still limited understanding of how those changes have affected asset markets, incentives for market monitoring, capital structure preferences, or financial interconnectedness. Understanding these issues is crucial for central banks to ensure they understand their roles as providers of liquidity insurance in the post-crisis world. This is particularly important given the introduction of tougher liquidity regulation and the growing role of the non-bank sector in the provision of financial services.

A number of papers have looked at demand/supply dynamics in collateral markets over time and suggest that, given increasing demand for collateral, central banks may need to offer routine collateral transformation services. For example, Bleich and Dombret (2014) argue that providers of collateral will become increasingly reluctant to allow the reuse of their collateral in times of stress due to an increased awareness of counterparty risks, reducing collateral velocity. And Singh (2011, 2013a, 2013b) argues that the reduction in collateral velocity has potential contractionary implications, and hence argues that quantitative easing instruments are likely to be counterproductive when it comes to correcting demand deficiency. It is important to develop our understanding, theoretically and empirically, of the near-monetary functions of collateral assets (as stressed by Pozsar (2014)), and what that implies for monetary policy. Geanakoplos and Zame (2013) argue that increasing collateralisation can lead to a shortage of collateral, which in turn creates incentives to create new collateral and to stretch existing collateral (allowing the same collateral to back many different promises). Further work to estimate the scarcity value of collateral and its impact on asset allocation decisions would be of particular interest to policymakers.

Others have looked at the impact of central bank collateral eligibility decisions on asset markets and intermediaries, which may provide an insight into whether and how issuance behaviour of banks and financial institutions adapts in response to changes to central bank frameworks. For example, Bindseil (2013) argues that a tightening of central bank collateral policies can have destabilising effects over bank funding costs whereas an extension of the eligibility base can be used as a policy tool to deliver further accommodation. Any benefits, however, would need to be weighed against the cost of prolonging the reliance on central bank as opposed to market financing (Sinn and Wollmershauser (2011); Allen and Moessner (2013)). Central banks may suffer from adverse selection in their collateral practices. But Bindseil and Papadia (2006) fail to find evidence of a material eligibility premium when analysing the impact of additions to the Eurosystem's eligibility base. For the purposes of monetary theory (and practice), it is important to understand the extent to which central bank decisions on collateral can, by changing the effective supply of near-money assets, affect the stance of monetary policy.

Finally, as discussed in a broader context in Theme 2, a number of papers have focused on the implications of collateral markets and leverage for financial stability. Fostel and Geanakoplos (2013) show that the combination of 'optimistic investors' and assets that can be pledged as collateral leads to higher asset prices and lower volatility, leading to a further increase in leverage and increased system vulnerability. Other papers that focus on rehypothecation, the leverage of financial intermediaries and the proliferation of financial imbalances include Adrian and Shin (2010), Singh and Aitken (2010) and Gorton and Metrick (2012).

Specific questions include:

- Is there any evidence to support the idea that banks and other financial institutions have changed their issuance behaviour, such as their use of securitisation, following changes to central bank frameworks?
- Can we estimate the (time-varying) scarcity value and velocity of collateral? Is there any evidence that the acceptance of non-marketable assets has led to reduced collateral scarcity premia, by effectively raising the supply of marketable assets?

3. How do public communications and disclosure policies affect behaviour and incentives?

Since the financial crisis, there has also been a significant push to improve transparency, through increased disclosure and public communications, including by central banks. An important question is how these policies have affected incentives and the behaviour of participants in financial markets.

In the field of financial stability, several authorities have conducted and published stress tests on their banking sectors. These stress tests have resulted in the publication of detailed accounts of the nature of the tests themselves, outcomes for individual firms and the supervisory actions taken as a result. Enhanced arrangements for handling struggling or failing firms have been adopted and publicised in the form of policy statements and guidance on recovery and resolution arrangements. These changes are an important part of efforts to reduce moral hazard and sharpen market incentives, reducing the problem of too big to fail. But is the appropriate degree of communication for financial stability purposes affected by whether the communication relates to markets, sectors or individual firms?

Another important question is whether central banks should disclose details of the use of their lending facilities. During the crisis, counterparties reported that certain central bank facilities were somewhat stigmatised, reducing incentives to consider using them in both normal times and in times of stress. This was a key element of the Winters Report (2012) into the Bank of England's provision of liquidity insurance in the crisis. Ennis and Weinberg (2013) develop a theoretical model which explains why banks are willing to pay a premium to avoid using backstop liquidity facilities. Other work on estimating the extent of any stigma and its causes, including research by Armantier *et al* (2011), Kleyменова (2012) and Haltom (2011), can help central banks design and implement better liquidity insurance facilities, including whether they can or should be disclosed and which facilities are likely to be of greater use in a stress.

One of the widely accepted aims of modern monetary policy is to manage inflation expectations. Central bank communication has emerged as a key tool in this endeavour. Blinder *et al* (2008) define it broadly as the information that the central bank makes available about its current and future policy objectives, the current economic outlook, and the likely path for future monetary policy decisions.

The trend towards increased transparency in monetary policymaking has accelerated in light of the financial crisis, with the introduction of 'forward guidance'. Woodford (2012) notes that the use of explicit forward guidance has increased in recent years in part because many central banks reduced policy rates to their effective lower bounds in response to the financial crisis, limiting the scope for further cuts. The objectives of recent forward guidance (and the methods by which they have been communicated) are varied. In some cases, the guidance has been intended to clarify the stance of monetary policy that policymakers think is appropriate. In other cases, the purpose of the guidance has been to clarify the nature of the monetary policy reaction function. There is an active debate over the desirability and efficacy of the various forms of guidance as evidenced by, for example, the contributions to the volume edited by den Haan (2013).

There is also active research into wider issues around transparency. It is an attribute that modern central banks value, but there remains an open debate about the appropriate degree and how this might vary across different policymaking functions within a central bank. This partly reflects a debate over whether or not increased transparency could lead households and firms to place too much weight on noisy information provided by policymakers, leading to worse macroeconomic outcomes (see Morris and Shin (2002), Svensson (2006), Morris *et al* (2006) and Dale *et al* (2011)). This raises questions over whether efforts to communicate could sometimes prove excessive or counter-productive. Warsh (2014) reviews some of these issues in the context of a wider discussion in relation to monetary policy at the Bank of England.

Specific questions include:

- What is the appropriate degree of central bank transparency and communication over different areas of policy focus (eg stress tests, supervisory information and decisions, use of central bank facilities, macroprudential policy, monetary policy etc)?
- What are the estimated impacts of various central banks' forward guidance policies, and what lessons can we draw from these experiences about the efficacy of guidance as a policy tool?
- How can disclosure policies be designed to minimise stigma and adverse selection, and maximise their impact on desired forms of behaviour, such as accurate pricing of risk and expectations of inflation?

4. How can we best support judgement-based supervision, and guard against potential biases in decision-making?

Since the crisis, a number of central banks and regulators have changed their approach towards supervision. In the United Kingdom, responsibility for prudential supervision was returned to the Bank of England via the Prudential Regulation Authority (PRA) in 2013.

The PRA has two primary statutory objectives – to promote the safety and soundness of the firms it regulates; and (for insurers) to contribute to the securing of an appropriate degree of protection for policyholders – as well as a competition objective. The post-crisis supervisory model focuses on the largest and most systemically important firms and is done on a forward-looking basis. Individual line supervisors conduct analysis, make day-to-day decisions and recommendations, and support discussions and decision-making on significant issues at a series of panels/committees comprising senior and experienced staff. Supervision inevitably involves uncertainty – driven by limited information, the inability to conduct experiments and assess the implications of different decisions *ex post*, and plausible differences of view about expert interpretation of the relevant information. As a result, judgement is required. This offers flexibility and also allows a wide range of information and experience to shape decision-making processes.

There is, however, a body of experimental evidence that shows that under certain circumstances, decision-making processes can go wrong. Since the early 1970s, researchers have discovered several behavioural biases which can affect judgements. There are many reasons why they may arise, including social pressures and memory limitations (see, for example, Tversky and Kahneman (1974)). In addition, researchers have observed and debated how biases can affect professional judgements, such as in medical treatment (Marewski and Gigerenzer (2013) and legal decision-making (Weinstein (2002)). Of particular interest in a regulatory context is Kahneman and Tversky's (1979) work on risk aversion.

Research based on experimental evidence has its limitations, however. For example, experiments generally have a clearly defined and unambiguous answer – something that is absent from most real-world applications. Regulatory decisions are rarely clear-cut. It is impossible to know whether a decision is 'right' and decisions that appear prudent at the point they are

made may, with the benefit of hindsight, turn out to be sub-optimal. Faced with uncertainty about the right course of action, heuristics can be a 'fast and frugal' way to arrive at decisions where there is no clear indicator of the right or wrong answer (Gigerenzer (2002)).

Potential biases that may arise in judgement-based supervision include, for example, 'group-think', conservatism biases (ie failure to adapt opinion in light of new evidence, perhaps due to 'sunk investment' in the prevailing view), confirmation biases (ie noticing/seeking evidence which supports your point of view), anchoring biases (putting too much weight on the recent past) and making overly defensive decisions (eg overweighting 'bad' outcomes). In order to meet its objectives, it is important

that the Bank understands these potential risks and biases and ensures its decision-making processes are robust to them.

Some potential areas for further exploration include:

- What is the risk of such biases and how could they be detected/measured?
- How could an enhanced understanding of potential behavioural biases help to assess mechanisms, structures and rules which could be used to support effective judgement-based supervision?
- What role might heuristics play in handling uncertainty and supporting decision-making?

New data, methodologies and approaches



4 Using new data, methodologies and approaches to understand household and corporate behaviour, the domestic and international macroeconomy, and risks to the financial system

The financial crisis and its aftermath have challenged beliefs about the way financial systems, businesses and households behave. At the same time, an increasingly wide range of data sources and analytical tools can be used to improve our understanding of economic and financial behaviour. Recently this has been driven by technological improvements, in part arising out of the commercial and scientific desire to exploit the extremely large data sets newly available. But it also reflects greater awareness of the advantages that come from using micro-data, better access to administrative data held by authorities, and technological improvements that have lowered the cost of online surveys.

Ninety per cent of all data in the world were created in the past ten years. This rate of expansion is unlikely to slow (Haldane (2013)). On the supply side, increases in the volume, velocity and variety of data have been driven by technological advances that have increased storage capacity and processing power, while lowering costs. And on the demand side, there is increasing interest in understanding how analysis of these data might enhance productivity and profits (for example, Bakhshi *et al* (2014), Brown *et al* (2014) and Einav and Levin (2013)). For these reasons, some commentators see a structural shift to a new era of 'big data' (Mayer-Schönberger and Cukier (2013); Davenport (2014)).

Several researchers have also made their mark by compiling and applying novel structured data sets to shed light on policy-relevant issues. For example, Thomas Piketty's *Capital in the Twenty-First Century* (2014) has prompted public reflection on income and wealth inequalities, by drawing on tax records spanning several countries and centuries. And research conducted by Reinhart and Rogoff (2009, 2013) using long-run, cross-country data has sparked debate about whether there exists an inverse relationship between public debt and economic growth.

These research projects, and the data underpinning them, have not been without controversy. But they exemplify how previously unavailable or under-used data can recast research and wider public debates. More broadly, theoretical and methodological advances continue to shed light on timeless economic questions, while offering the prospect of helping to

enhance forecasting and stress-testing capabilities. So how can new data, methodologies and approaches be used to understand household and corporate behaviour, the domestic and international macroeconomy, and risks to the financial system?

In addition to making more creative use of data in its research, the Bank plans to make more of its own data publicly available to support its efforts to crowd-source answers to key policy questions and catalyse external research collaboration. The Bank is publishing several new data sets, which add to the statistical and regulatory data it already publishes via its Interactive Database and other channels. These include the Bank's historical balance sheets from 1696, just after its founding, up to today; more granular data underpinning the *Inflation Attitudes Survey*; anonymised historic firm-level quantitative assessments by the Bank's Agents; and updates to its previously released 'three centuries of data' series covering a wide range of macroeconomic and financial data reaching back as far as the early 18th century. More information about these data sets can be found on the Bank's webpages.

While new data, methodologies and approaches would be useful for addressing all parts of the Bank's research agenda, we have identified five broad research questions where further empirical work and better methodologies are particularly sought.

1. How can the potential of big data and other new data sets best be realised?

A standard definition of big data (eg Bholat (2014)) is that it displays one or more of the following characteristics:

1. High volume, often because data are reported on a granular basis, for example, loan-by-loan or security-by-security;
2. High velocity, because these data are frequently updated and, in the limit, collected and analysed in real time;
3. Qualitatively various, meaning they are either non-numeric, such as text and video, or information from biometric sensors.

Economists are increasingly attuned to the potential of big data to improve their understanding of economic and financial systems. For example, Sendhil Mullainathan used the Hahn lecture at the 2014 Royal Economic Society conference to

describe how artificial intelligence techniques and big data offer ways to find interesting new empirical relationships, which may induce new theories. And textual information has been quantified systematically using machine-learning algorithms to assess a wide variety of questions about the communication of central bank policy decisions and the propagation of ideas and policy messages (eg Schonhardt-Bailey (2013) and Hansen, McMahon and Prat (2015)). Others have measured sentiment and uncertainty by text mining newspaper archives and social media sources (eg Tuckett *et al* (2014)). The premise of this research is that future economic actions can be gauged from text sources using natural language processing techniques (eg Rubin *et al* (2006)). Such analysis could help inform how consumer and financial sentiment evolves. Internet and social media data could also be beneficial for nowcasting. For example, work within the Bank has found that exploiting Google-based queries can improve the nowcasting of variables such as unemployment benefit claims, and car and housing sales (McLaren and Shanbhogue (2011)).

Greater volumes of data are also being collected on financial markets. For example, trade repositories are storing transaction-by-transaction data from derivatives markets and this is now available to regulators. The FCA also collects transactional data, including on the price and quantity of each transaction in all financial instruments admitted to trading on regulated markets, which it uses to help detect market abuse. Could these data be used to help understand broader financial market dynamics and risks – for example, dislocations in market prices, negative feedback loops or spikes in liquidity premia? And can these data be combined with insights from other disciplines to deepen understanding of financial networks (Haldane and May (2011))?

A number of questions arise from this:

- How can we apply quantitative techniques to synthesise qualitative information from market intelligence, supervisory assessments and wider sources of text-based information?
- How do price data collected from the web compare with price data collected by surveys?
- How can data on individual asking prices, selling prices and transactions be used to improve understanding of housing market dynamics?
- How can transactional, payments and regulatory data be used as early warning indicators of risks to the solvency and liquidity of households, businesses and financial institutions?

- How might trade repository data be exploited to enhance understanding of risks in capital markets and to the infrastructure that supports them? Is it possible to develop close to real-time maps of the financial network to support risk assessment?

2. How can surveys and detailed structured data sets be used to improve understanding of household and corporate behaviour?

Understanding the behaviour of households and businesses plays an important role in how the Bank formulates policy. For example, we are interested in how households and businesses react to changes in interest rates and how homebuyers are affected by macroprudential policy instruments, such as loan to value or debt to income restrictions. More generally, there is a growing body of evidence that the reaction of the economy to shocks is affected by income and wealth distributions (eg Mian, Rao and Sufi (2013); and Mian and Sufi (2014)).

There is an increasing desire to explore different assumptions about how households and businesses react to changes in their circumstances or follow the behaviour of others. For example, evidence from household-level data suggests that marginal propensities to consume vary across households and that spending reacts more to income losses rather than gains, consistent with loss aversion (Anderson *et al* (2014)). This has important implications for the transmission mechanism of monetary and macroprudential policy. Herding behaviour may also be prevalent across a range of economic choices (Banerjee (1992)). While such insights may be incorporated into conventional macroeconomic models, agent-based approaches, which incorporate calibrated rule-of-thumb decision-making and social interactions more readily, may offer fruitful insights into key segments of the economy, such as the housing market (Geanakoplos *et al* (2012)).

Substantial progress has been made over a number of years in improving understanding of the behaviour of households and businesses by using detailed individual-level data sets. For example, in the United Kingdom, many researchers have made use of the *Family Expenditure Survey*, the *Understanding Society* longitudinal household data set and the Office for National Statistics (ONS) *Wealth and Assets Survey* to improve understanding of household behaviour (Attanasio, Banks and Tanner (2002)), and company-level data sets based on financial accounts to investigate corporate behaviour (Bloom, Bond and van Reenen (2007)).

The Bank is undertaking work to improve its access to, and analysis of, data regarding these two key non-financial sectors. On households, one key source is the Bank's NMG survey which is used to enhance understanding of the distribution of balance sheet risks for financial stability purposes, and different household responses to monetary policy normalisation (Anderson *et al* (2014)). While household surveys are a key source of information on the distribution of income and wealth, they are unlikely to be completely reliable. For example, asset holdings and unsecured debt are known to be under-reported (eg Redwood and Tudela (2004)). So the Bank is aiming to integrate different sources of household-level information including the NMG survey, statistics from the ONS, and the FCA Product Sales Database (PSD) on individual mortgages to try to build a more reliable picture of household finances.

Similar efforts are being made with respect to company-level data. Recent Bank research stitched together company accounts and survey information from large lenders on loans to those same companies to investigate the extent of loan forbearance in the small and medium-sized enterprise sector (Arrowsmith *et al* (2013)). One motivation for the research was to understand if forbearance was a factor behind the weakness in UK productivity, since it might slow the reallocation of resources to more productive uses. But there are many other questions concerning the behaviour of companies – why they are currently holding so much cash, for example – that can be investigated using this type of data.

Possible improvements to corporate-level data are discussed in the Bank's consultation paper *Should the availability of UK credit data be improved?* (Bank of England (2014)). The paper asks whether competition in credit provision could be increased and better risk management decisions be made if a central repository of credit information was established in the United Kingdom, along the lines of credit registries already in existence in many continental European countries. If available, such data could complement and be integrated with other firm-level data sourced from external credit rating agencies or collected internally for regulatory purposes. Corporate data could also be linked with survey responses to understand the nature of corporate risk-taking; for example, using the Bank's *Credit Conditions Survey* or the Bank's Agents' company visit scores.

Behavioural economics points out that households, corporates and investors do not always make decisions that maximise their wealth or profitability (Kahneman and Tversky (1979), Rabin, (1998)). Moreover, such behaviour can be persistent and

predictable (eg FCA (2013)). With this in mind, it may be fruitful to collect first-hand data from surveys or experiments to improve understanding of market participants' choices and demands, for example when entering insurance or mortgage contracts. Among other things, this could help inform our understanding of risk-taking behaviour, indebtedness, and the potential drivers of waves of exuberance and pessimism, both within and across countries.

Specific research questions include:

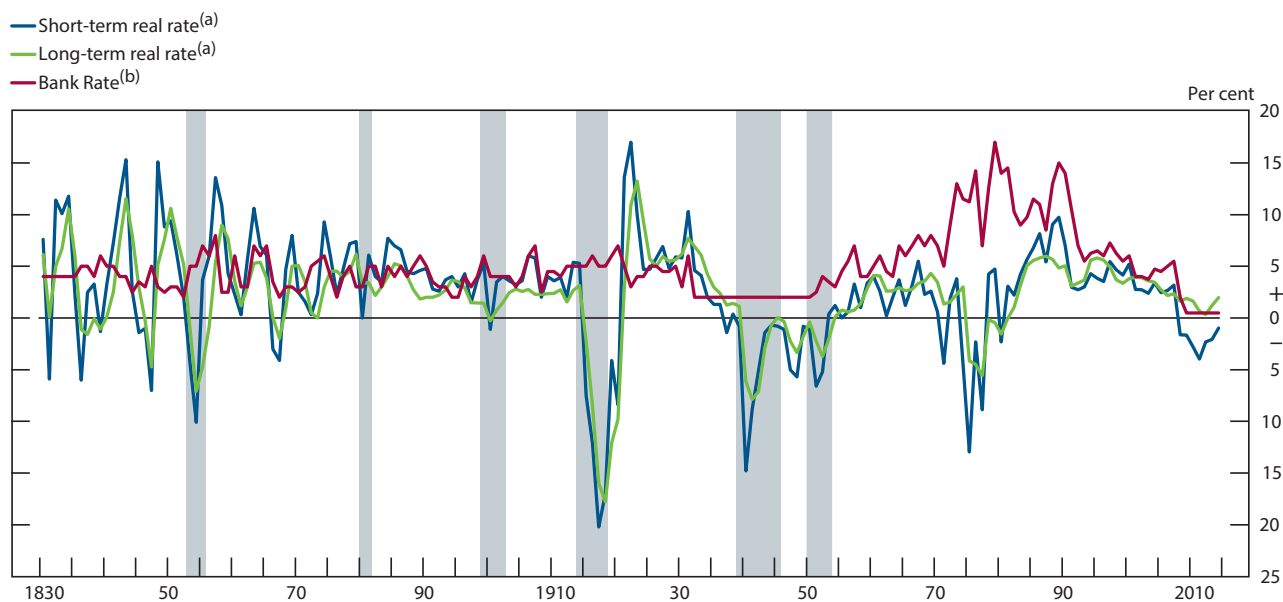
- What determines marginal propensities to consume across households and how they differ across household types?
- What determines the distribution of household indebtedness and mortgage arrears? Could pressures building up in unsecured lending signal future stresses in secured portfolios and *vice versa*?
- How is the reliability of household and corporate data sets affected by survey methodology?
- What role do behavioural biases, heuristics, social interactions and prior personal experiences play in driving household, corporate and financial institution behaviour? How can such factors be quantified and incorporated into conventional economic or agent-based models?
- How can we use market research, laboratory experiments, field experiments, or randomised controlled trials, to analyse market-wide issues that can accelerate or exacerbate financial crises?

3. How can historical data and archive information be used to enhance understanding of the economy and the financial system?

The United Kingdom benefits from having some extremely long time series for both macroeconomic and financial variables that can be used to analyse the interaction of financial and business cycles across different regimes (eg see **Chart 3** for historic UK interest rate series).

The use of long-run data is important given that financial cycles are long-lasting (Aikman, Haldane and Nelson (2014)). The United Kingdom also has a long history of financial crises stretching back to the 18th century, and the Bank is a unique source of information on the past management of these. The Bank has contributed research in a historical vein in recent years such as Benati's (2005, 2006) articles marshalling long-run evidence on money growth and inflation, and a 2010 *Quarterly Bulletin* article (Hills, Thomas and Dimsdale (2010)) that examines the recent recession in the context of the past three

Chart 3 UK nominal and real interest rates



Sources: Hills, Thomas and Dimsdale (2010), Bank of England and ONS. Major wars are shaded.

(a) Short-term real interest rates are defined as Bank Rate minus the actual rate of inflation. Long-term real interest rates are defined as the consol yield minus a weighted three-year moving average of inflation.

(b) Bank Rate 1830–1972 and 2006–14, Minimum Lending Rate 1972–81, London clearing banks' base rate 1981–97, repo rate 1997–2006.

centuries. As noted earlier, the Bank is making additional data sets publicly available. In particular, we will leverage the Bank's comparative advantage in historical time series on money and banking, such as data on changes in bank liquidity and capital, extending the work of Capie and Webber (1985), among others. We also plan to tap into our archives, building on recent successful projects that have digitised these materials, some of which date back to the 17th century.

Compiling further historical series and making them more accessible could help address a number of timely topics such as the impact of macroprudential policies and the effectiveness of different approaches towards crisis management and resolution (see also Themes 1 and 3 respectively). For example, during the 1950s and 1960s, the UK operated a variety of direct controls on credit alongside an explicit liquidity policy. The rich financial data set available over the immediate postwar period, alongside archival material at the Bank, may be able to shed greater light on the efficacy of such tools, which may inform the use of today's macroprudential tools. The Bank is also a unique source of historical and archival material which could be used to assess different types of financial crisis management including the role of lender of last resort. For example, Turner (2014) shows how detailed analysis of historical data on bank balance sheets can shed light on the nature of financial crises.

More generally, the United Kingdom has extremely long time series for both macroeconomic and financial variables. These

could be used to analyse the interaction of financial and business cycles across different regimes, in the spirit of Schularick and Taylor (2012), or they could be used to explore the role of monetary policy in previous recessions and recoveries. Crafts (2013), for example, has looked at the role of monetary policy in the recovery of the 1930s, part of which involved influencing inflation expectations through an explicit price-level target. More generally, recent research by Broadberry *et al* (2015) and Mitchell, Solomou and Weale (2012) has provided annual GDP data back to 1700 and monthly GDP data back to January 1920 respectively. This can be used alongside existing series for interest rates, exchange rates and inflation to allow more in-depth analysis of the role of policy in historical cycles.

Specific questions include:

- What are the stylised facts about repeated, but relatively rare, events which help us to understand how the economy and financial system work?
- How have UK financial and economic cycles interacted in the past and to what extent does this depend on the monetary policy regime and structure of the banking system?
- How large are the costs of financial crises, what are their sources and how do they depend on crisis management strategies?
- What lessons can we learn from history about the role and efficacy of macroprudential policy in the United Kingdom?

4. How can we better model and assess risks to the financial system, the economy and their interaction?

The crisis has brought home the importance of the two-sided transmission channels between the real and financial sectors of the economy and re-emphasised the need to enhance models to assess risks to the financial system. Methodological advances and the use of comprehensive data sets are important in designing a risk assessment framework and improving macroeconomic forecasting.

As a tool for assessing systemic risk and gauging the resilience of the financial system, stress testing has become a central aspect of financial stability surveillance as exemplified by the Bank of England's RAMSI model (Burrows, Learmonth and McKeown (2012)). To be most useful, stress-testing models would describe the joint dynamics of all possible 'scenario' variables in normal times and following large adverse shocks, and suggest how they might translate to financial institutions' balance sheets and behaviour. Ideally, stress-testing models should also incorporate feedbacks within the financial system (eg Allen and Gale (2000); Cifuentes, Ferrucci and Shin (2005); Brunnermeier and Pedersen (2009)) and the bi-directional feedback loops between the financial sector and real activity (Bernanke, Gertler and Gilchrist (1999)). So what features should stress-test models exhibit to satisfy these requirements?

First, to analyse jointly the relevant set of variables under different macro-financial scenarios, the models are likely to be detailed and rely on large data sets. In many econometric studies, factor analysis is applied to summarise the information available in large-scale sets of variables. But it cannot substitute entirely for structural models. An alternative approach is to make use of large Bayesian Vector AutoRegressions (BVARs) (eg Banbura, Giannone and Reichlin (2010)). But although large BVARs produce good point forecasts, their performance in forecasting entire distributions is poor relative to density forecasting models. Given that the focus of stress testing is on tail events, improved models for density forecasting are required. And although the idea of density forecasting is not new (eg Diebold, Gunther and Tay (1998)), developing a successful method that could rely on the relatively short time series available remains a challenge.

Second, the models should capture the channels through which financial developments and economic activity affect each other via, for example, credit crunch effects. It is also important to consider asset price-based channels, uncertainty-based

channels, contagion and feedback effects within the financial system (eg Kapadia *et al* (2013)). And some models might also usefully incorporate non-optimising behaviour on the part of economic agents, including insights from behavioural economics and other disciplines.

Together with risk assessment models, macroeconomic forecasting models are vital to the conduct of policy. These models are under constant development in order to improve inflation and output forecasts. For instance, the regular forecasting activities of the Bank's Monetary Policy Committee make use of a wide range of models and the full range of information available by calling upon a structural central organising model – COMPASS (see Burgess *et al* (2013)) – along with other economic models and more statistically orientated methods.

In both of these areas, models should deal with the behavioural implications of structural changes in the economy and financial systems. For example, the financial landscape has changed significantly (see Theme 2). So borrowers' and lenders' responses to shocks may differ from historical experience, with likely implications for some estimated parameters in models. Thus it is important to incorporate time variation and structural change when forecasting, and older data may need to be either discarded or downweighted. There are methods which are robust to many forms of structural change (eg Pesaran, Pick and Pranovich (2013) and Giraitis, Kapetanios and Price (2013)), but further research could be useful.

In summary, research to enhance macroeconomic forecasting and stress-testing models could serve monetary, macro and microprudential purposes.

Specific questions include:

- How can we better forecast densities, especially tail events?
- How can we enhance stress-testing capability, including via modelling the feedback between real and financial variables and potential amplification mechanisms between liquidity and solvency risks?
- How can we further develop statistical or other procedures to combine information from a range of models?
- Can the insights of behavioural economics and other disciplines be incorporated into stress-testing models?
- What can be learned from approaches to risk modelling and management in different parts of financial services (eg insurance versus banking) and from other industries (for example managing risks associated with natural hazards)?

5. What accounts for the correlation of economic cycles and asset prices across countries?

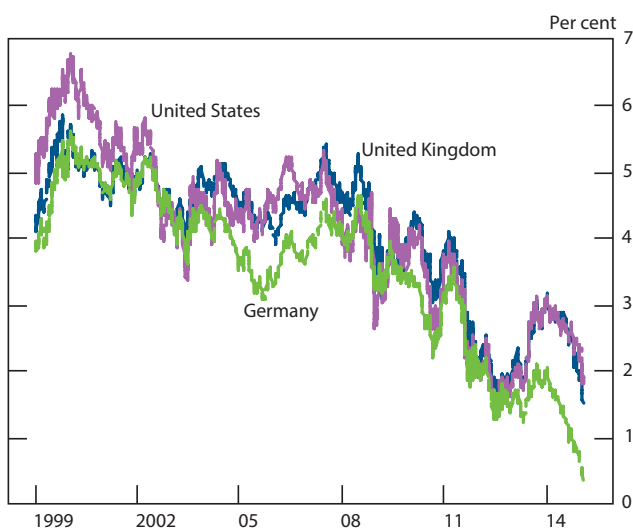
Modelling the economy and financial system requires a deep understanding of international spillovers and asset price dynamics. At the macroeconomic level, both the business and financial cycles are becoming more correlated internationally. A number of papers have analysed the issue of business cycle synchronisation generally (eg Backus, Kehoe and Kydland (1992)), with some highlighting that financial linkages between countries and financial frictions are needed to explain the high degree of business cycle comovement (eg Forbes and Warnock (2012)). Others focus on specific channels of cross-border spillovers, for example of housing demand shocks (eg Cesa-Bianchi (2013)). The United Kingdom may be particularly susceptible to international factors in driving domestic movements in risk and activity, not least because it is a small open economy with a large international financial sector. The emergence of new data sets makes it possible to get a better understanding of how foreign shocks are transmitted through the economy. They can help shed light on questions such as how important, empirically, are the global risk and activity cycles in driving fluctuations, and what transmission channels are most important? How might things change if the dollar lost its status as a reserve currency? And what implications does this have for domestic monetary policy, financial stability and international policy co-ordination (see also Theme 1)?

At the corporate level, the open-economy literature stresses the importance of distinguishing between adjustment at the intensive (existing exporters sell more) and extensive (firms start exporting) margins. Typically short-term variation in trade across countries is due mostly to adjustment at the intensive margin, but over longer time horizons the extensive margin becomes more important. Firm-level micro-data may allow a number of outstanding research questions to be answered.

Returns on financial assets across countries are highly correlated. Since the 1990s, this has been increasingly well documented for assets such as government bonds (see **Chart 4**); equities (eg Karolyi and Stulz (1996)); and housing. More recent studies have documented how international returns on a range of different assets are highly correlated (eg Rey (2013)). Understanding the reasons for this is important, particularly in small open economies with large financial sectors. The impact of monetary policy on asset prices is viewed by policymakers as a key part of the transmission mechanism to the real economy both for conventional and unconventional policies

(see King (1994), and Dale (2010), respectively). Therefore understanding the marginal impact of domestic UK monetary policy relative to global factors is crucial. Similar questions arise for macro and microprudential policymakers – for example, do movements in asset prices contain any signals about the risk-taking behaviour of domestic financial institutions?

Chart 4 Ten-year government bond yields



Sources: Bloomberg and Bank calculations.

An obvious question is whether the high correlation between returns on financial assets is due to correlation of future cash flows, risk-free returns or risk premia. Changes in risk premia appear to account for the large majority of the variation in asset prices. High asset prices today tend to predict low future excess returns relative to risk-free assets, rather than high cash flows, across a wide range of different markets (see Cochrane (2011) for a summary). So we might expect correlations between risk premia to explain the high correlation of returns across countries. But since we cannot separately observe cash-flow expectations and discount rates, we need models of asset prices. Focusing on bond markets, there is a growing literature on joint reduced-form models of the term structures of interest rates in multiple countries (eg Bauer and Diez de los Rios (2012); and Kaminska, Meldrum and Smith (2013)). A common finding from these studies is that there are common components driving the risk premia on bonds.

Another possible explanation for the low-frequency correlation of asset prices across countries is that they are subject to common long-run factors. For example, long-term real interest rates have fallen over the past few decades across a range of countries (eg Laubach and Williams (2003); King and Low (2014)). Long-term real interest rates can be decomposed into expectations of expected future short-term real rates and additional risk premia. New techniques for decomposing long-run real interest rates that model structural change would be useful. It is also important to gain a better understanding of the structural drivers of these long-run trends; this is discussed in more detail under Theme 5.

Specific questions include:

- How has financial globalisation changed the transmission of shocks across borders to output and asset prices?
- What risks do sharp fluctuations in gross capital flows pose to financial stability and monetary policy?
- Are models of gross international capital flows more promising than traditional net flow models in explaining comovements in asset prices?
- What are the structural determinants of the close comovement in asset prices internationally?
- What are the drivers, empirically and in theoretical models, of common long-run movements in real rates of return across countries?
- How could new detailed transactional data sets be used to help understand correlations in asset prices?

Response to fundamental change



5

Central bank response to fundamental technological, institutional, societal and environmental change

In recent decades, substantial changes have altered the structure of the economy and global financial system. These show no signs of reversing. New technologies have radically and permanently reshaped both the financial and real sectors of the economy. In many countries, including the United Kingdom, inequality of income and wealth has risen to levels not seen in over 50 years. The dependency ratio has started to increase in many countries and it is expected to continue for the coming decades. Several important commodities have exhibited signs of increasing scarcity. Climate change, and policy, technological and societal responses to it, could have significant effects on financial markets and financial institutions, as well as exacerbating other threats to economic and financial stability. Although these changes are beyond the control of any one institution, central banks may have to respond to the challenges presented by these forces.

As an example, payments and credit have seen innovations recently in the shape of digital currencies and alternative sources of finance. Digital currencies, potentially combined with mobile technology, may reshape the mechanisms for making secure payments, allowing transactions to be made directly between participants. This has potentially profound implications for a financial system whose payments mechanism depends on bank deposits that need to be created through credit. Similarly, technology has enabled the emergence of new business models, such as peer-to-peer lending and crowdfunding, which create alternative sources of finance for both individuals and businesses.

Demographic shifts and an ageing society have potential implications for both the financial and economic system. As longevity risks increase, a greater proportion of society will be allocating assets to hedge these risks and their decisions will have important implications, for example due to their impact on asset prices. Increased demand in this sector could also lead to increasing financial innovation, as evidenced by Cocco and Gomes (2012), with implications for the supervision of life insurers. Meanwhile demographic trends, along with other

secular trends such as increases in inequality, feed into the risk of 'secular stagnation' and a long-term decline in the equilibrium real interest rate, for example as discussed by Summers (2014).

As well as possibly contributing to secular stagnation, increases in inequality have also been linked to increased risks to financial stability. Rajan (2010) identifies widening access to credit, driven by a policy response to inequality, as a significant underlying driver of the financial crisis. Kumhof *et al* (2013) note the similar build-up of inequality prior to the Great Depression. In both, a link is established between rising inequality and demand for credit, and ultimately a financial crisis. Given the Bank's mandate for financial stability, it is important to fully understand and investigate these potential channels.

While global economic impacts from climate change are difficult to estimate, there is high agreement that aggregate economic losses accelerate with increasing temperature (IPCC (2014)) and Stern (2006) argues that, without action, future changes in climate will lead to significant reductions in global economic output. Physical risks, such as catastrophic weather events, could affect economic growth, particularly in developing countries, and be translated directly into financial losses through an increase in insurance claims (Lloyds of London (2014)). The Global Commission on the Economy and Climate (2014) argues the next fifteen years will be critical, as the global economy undergoes a deep structural transformation that will determine the future of the world's climate system. This transformation may present a second category of 'transition' risk for central banks to consider, including the potential for carbon-intensive assets becoming 'stranded'.

Although this theme covers distinct areas of interest on the forces shaping the economy and financial system, they are fundamentally connected and interact with each other. This section outlines our areas of focus, in particular the questions raised for central banks.

1. Why might central banks issue digital currencies?

The emergence of private digital currencies (such as Bitcoin) has shown that it is possible to transfer value securely without a trusted third party. While existing private digital currencies have economic flaws which make them volatile, the distributed ledger technology that their payment systems rely on may have considerable promise. This raises the question of whether central banks should themselves make use of such technology to issue digital currencies.

There are two parts to this question. The first is whether there is any rationale for a central bank to issue a digital currency supported by some form of distributed ledger payment system. The second addresses the economic, technological and regulatory challenges of doing so.

There are several different ways in which a central bank might make use of a digital currency. It could be used as a new way of undertaking interbank settlement, or it could be made available to a wider range of banks and NBFIs. In principle, it might also be made available to non-financial firms and individuals generally, as banknotes are today. The costs and benefits for monetary and financial stability would likely vary in the different cases, being more pronounced the more widely a digital currency is held. For example, making central bank money widely available could have an impact on deposits held at commercial banks and a knock-on effect on the banking system. Another relevant issue is the impact that offering a new method of settlement in central bank money would have on existing payment systems.

One important issue is the type of technology which could be deployed. There is more than one way in which a distributed ledger system can work, and remuneration would have to be designed in such a way as to incentivise honest participation in the system without leading to socially inefficient over-investment in transaction verification. Further research would also be required to devise a system which could utilise distributed ledger technology without compromising a central bank's ability to control its currency and secure the system against systemic attack.

Digital currencies also raise regulatory issues. These fall into three categories: systemic, prudential and conduct. The systemic issue is developing the protocol itself, the rules of which govern how a technological system works. The first question is whether a protocol for a central bank issued digital currency could be developed at all. This would need to engage both the technology and financial sectors as each brings important and distinct expertise. Creating such a system would

entail creating a protocol for value transfer over the internet, akin to what Berners-Lee (1989) did for information.

Firms offering digital currency services, such as wallets or currency exchange, would operate on top of the platform, raising the question of how they should be regulated (eg see Yee (2014) who sets out how this could work in relation to Bitcoin). As they would not be offering to hold funds on their own account, the prudential regulatory issues would probably be different from the conventional focus on capital and liquidity requirements at existing banks. Conduct issues, particularly those relating to know your customer (KYC) and anti-money laundering (AML), would also have to be addressed by such firms. Further research would also be required into how digital identity management could be achieved (Brown (2014)) while balancing privacy considerations.

Relevant research questions include:

- From a monetary and financial stability point of view, what are the costs and benefits of making a new form of central bank money accessible to a wide range of holders? What would be the impact on existing payment and settlement systems?
- What are the implications for government-backed deposit insurance if central bank money is widely accessible by households and businesses?
- Should central bank issued digital currency balances be remunerated and if so, should remuneration be linked to the official monetary policy interest rate? How would the monetary policy transmission mechanism then be affected?
- If transactions balances could migrate to digital currency, how would banks compete? Would there be any implications for the availability of credit?
- What would be the costs and benefits of different central banks using a common platform for issuing digital currencies? What type of distributed ledger technology would be most appropriate for a central bank backed system?
- How could institutions offering access to central bank issued digital currencies be regulated?

2. What are the implications for central bank policy of sustained growth of technology-enabled alternative finance?

Alternative finance is an umbrella term that covers a wide array of models, ranging from donation-based crowdfunding to invoice trading and peer-to-peer lending. From the perspective of a borrower or lender, some services, such as peer-to-peer lending, closely resemble activities undertaken by prudentially regulated deposit-takers. But there are also important differences. For example, in traditional banking models, depositors lend to a financial institution, whereas with peer-to-peer lending, investors lend directly to individual borrowers. In 2014, the FCA introduced new regulations for peer-to-peer lending and investment-based crowd-funding, but a number of other forms of alternative finance remain unregulated (FCA (2014)).

While the alternative finance sector is currently small in absolute terms, it is growing rapidly. If this growth is sustained, the sector may change the way in which consumers and businesses understand and manage their finances, and the way in which they use traditional banks and insurers. These developments raise questions about the optimal business models for the provision of financial services, such as whether lending and deposit-taking are natural counterparts. For example, Kashyap *et al* (2002) argue that there are indeed natural synergies between these two activities, whereas Benes and Kumhof (2012) find support for deposits to be backed fully by government-issued money.

More generally, the changes that may arise from technology-enabled alternative finance could have implications for all areas of central bank policy, including monetary policy, microprudential policy and financial stability policy. For example, they could alter the transmission mechanism of monetary policy (see also Theme 1). And if they grow sufficiently, they could be a source of macroprudential and microprudential risks, with potential implications for regulation.

Relevant research questions include:

- How might a shift towards alternative finance change the way in which new money is created and distributed through an economy? What are the implications for measuring monetary conditions?
- Would a shift towards alternative finance change the way in which households and businesses respond to changes in monetary policy?
- How might growth in alternative finance change the business models of prudentially regulated banks and insurers? What implications would this have for macroprudential and microprudential regulation?
- Could the distress or failure of a technology-enabled alternative finance provider have implications for financial stability? Are there any implications for the design of resolution regimes?

3. How might shifts in demographics and income distribution affect equilibrium real interest rates and the wider economy and financial system?

One aspect of the recent debate over 'secular stagnation' concerns the evolution of the equilibrium real interest rate. This may be affected by fundamental developments such as changes in demographics, the distribution of wealth and income, and the relative price of investment goods. A potential decline in the equilibrium real rate raises the possibility that monetary policy may be unable to provide sufficient stimulus to deliver on its objective at current levels of inflation targets, given the zero lower bound on nominal policy rates.

Existing work already explores some of these mechanisms. For example, Krueger and Ludwig (2007) estimate that ageing economies will exert significant downward pressure on equilibrium interest rates, while the fact that richer individuals save more (Carroll *et al* (2014)) means that rising inequality could also be putting further downward pressure on interest rates. But many important questions remain unanswered.

Given the global aspect of many of these trends, it is also important to understand how equilibrium real interest rates are determined globally, and how these global rates affect equilibrium real rates in the United Kingdom (see also Theme 4). In a standard small open-economy model (eg Mundell (1963)), the domestic interest rate is determined purely by global factors. But, in practice, this may be a poor guide as the real-world mechanisms and frictions absent from the standard model may complicate the link between the global and domestic interest rates. Models that shed light on those mechanisms could give us a better understanding of the impact global trends have on the UK economy.

Shifts in demographics or income distribution may also have wider implications. For example, Imam (2013) and Wong (2014) discuss the possibility that monetary policy might be less effective in ageing societies as the expenditure of older households is less sensitive to interest rate shocks. Similar questions regarding the effectiveness of monetary policy in

relation to the distribution of wealth and income have received relatively less examination.

The role of many of these trends in affecting financial stability is also prominent in recent debates. A body of work has started to explore the links between inequality, leverage, asset prices and financial crises. Stiglitz (2014), for example, argues that increases in inequality can partially explain increases in land prices as the rich compete for real estate with a fixed supply in prime locations. Rajan (2010) and Kumhof *et al* (2013) link increases in inequality and associated changes in credit provision to greater leverage in economies, which, in turn, leads to asset price increases and heightened financial stability risks. The surge in inequality, leverage and asset prices seen before both the Great Depression and the recent crisis give support to this line of investigation. But the precise nature of the links between inequality and leverage remains uncertain. For example, Coibion *et al* (2014) find evidence against this channel. Given the large welfare implications of this debate, further research is warranted.

If these distributional shifts continue, the role of the financial system as intermediary and insurer may need to evolve. Capital may need to flow increasingly from old to young and from rich to poor. It is possible that these trends will also increase international capital flows. Kumhof *et al* (2012) suggest that increasing inequality within countries with underdeveloped domestic financial markets might lead to increasing global flows, as the rich in developing countries look for returns on their assets in international capital markets. Speller *et al* (2011) similarly argue that as inequality between countries decreases and EMEs grow and are increasingly integrated into the global financial system, global financial flows are likely to dramatically increase. These processes may carry important macroeconomic and financial stability implications.

In this context, it is also worth noting that the Bank's policy tools could themselves affect the distribution of wealth and income in society. For example, Saiki and Frost (2014) use evidence from Japan to show that unconventional monetary policy has increased inequality, primarily through portfolio effects. By contrast, Coibion *et al* (2012) present evidence that suggests expansionary monetary policy lowers inequality. And while much focus has been put on the distributional implications of monetary policy, macroprudential policies have received less attention. Many prudential tools look to restrict credit provision in the economy – for example, by placing restrictions on high DTI or LTV ratios on mortgages. While this may be important to safeguard the financial stability of the UK, it could affect the ability of some groups to access credit, with potential distributional consequences.

Possible questions:

- To what extent have secular trends and/or policies, such as changes in inequality and demographics, affected equilibrium rates of interest? Which of these trends has been the key driver? And are these effects likely to be permanent or temporary?
- How do demographics and the distribution of wealth and income in society affect the monetary transmission mechanism?
- How might shifts in inequality, within and across countries, affect leverage and financial stability? What are the implications for policy?
- What are the effects of income distribution and the growth of EMEs on global capital flows? What are the roles of, and the relationship between, net and gross capital flows?
- What are the distributional implications of monetary and macroprudential policies?

4. How might changes in longevity risk, both forecast and unexpected, affect the financial system and the wider macroeconomy?

As the population ages and the dependency ratio increases, the decisions that individuals and firms make about how to insure against longevity risk may have implications for the macroeconomy and wider financial stability. For example, when considering individual insurance strategies, if the elderly increasingly use equity release products to access housing wealth, this could further boost the housing market and constrain supply. Alternatively, if the elderly sell off assets which they have accumulated in order to fund their retirement, this could exert downward pressure on asset prices.

The decisions made by life insurers or companies funding defined benefit pension schemes also have important implications. For example, life insurance companies typically attempt to fund annuity liabilities through investing in corporate bonds. Some might argue that corporate bond risks and longevity risks are relatively uncorrelated. But is this assumption reasonable?

It may also be valuable to consider what the effects might be of more unlikely longevity scenarios, especially if these compound current risks. For example, while clearly beneficial for society, the introduction of a new medical technology which leads to a significant increase in life expectancy might cause disruptions to the financial system. Under such a scenario, the business models of companies with significant exposure to

longevity risk might become unsustainable, with the increased costs of funding existing pension or annuity guarantees adversely affecting companies' profitability, solvency and growth. Similarly, household finances may become stressed if they have insufficient savings or insurance against such risks. This becomes more likely if increases in life expectancy are predominantly associated with increases in the number of years spent in poor health.

Specific questions include:

- How do individuals and companies, especially life insurers, currently manage known longevity trends and longevity risk? What are the implications for asset prices and financial stability?
- What would be the impact of a shock to longevity on the economy and the financial system? What might the implications be for the supervision of life insurers?

5. What determines the supply potential of the economy?

One issue at the heart of the current economic debate is whether the production possibility frontiers of advanced economies are growing more slowly than before. This debate is clearly relevant to the United Kingdom where the 'productivity puzzle' has been especially pronounced. Since the financial crisis, UK labour productivity has been weak and is still 4% below its pre-crisis peak (Barnett *et al* (2014), among others). Understanding these supply-side developments is of first-order importance.

Puzzles in productivity and labour market dynamics are not unique to the United Kingdom and comparisons between countries may shed light on some of them. For example, Weale (2014) has drawn attention to the similarities in productivity performance across countries. Recent papers looking at different patterns of unemployment and underemployment across countries include Hoffman and Lemieux (2014) and Daly *et al* (2014).

One promising line of enquiry might be to focus on whether differences in business finances and banking structures could help explain why productivity has been especially weak in countries where banks have suffered substantial losses. For example, evidence for the United Kingdom and Spain suggests that businesses were affected by whether they banked with good or bad banks (Bentolila *et al* (2013)). But it is less clear that this was a key driver of aggregate productivity. In Spain, for example, the exit of businesses and resulting job losses may have reduced employment and boosted productivity. Similarly, there is

no consensus that problems in the banking sector contributed much to the UK productivity slowdown (Riley *et al* (2014)). Further cross-country research is important in improving our understanding of the macroeconomic consequences of a distressed banking sector on productivity and aggregate wages.

Another explanation of the productivity puzzle is that it stems from the return to slow growth in technological innovation characteristic of most of human history (Gordon (2012)). Balanced against this pessimism, however, are other commentators who think increasingly sophisticated data analytics will enable the more efficient allocation and exploitation of resources (Brynjolfsson and McAfee (2014)). The productivity puzzle could also just reflect measurement error. Measuring productivity and output has long been fraught with difficulties (for example, Coyle (2014)), despite admirable attempts to do so (Broadberry (1997)). Furthermore, this problem has likely intensified in recent years given the difficulties of measuring digital capital and output.

One potential reason for the presence of measurement error is that relevant factors could have been omitted from the production function. The traditional value added or net production function only features labour and capital, with total factor productivity (TFP) as a residual. Three additional factors may be worth pursuing, some of which involve switching from a net production function to a gross production function. First, as already mentioned above, banking, through its key role in financing and money creation, can be thought of as an essential input into production that can partly account for changes in TFP. Second, a significant portion of what is treated as capital in national accounts is in fact land, and accounting for this is again likely to affect measured TFP. Third, as any physical scientist will attest, energy is an indispensable factor in any physical process, and better understanding, modelling and estimating its role in production would again affect TFP estimates.

Specific questions which arise from this include:

- How is the long-run supply capacity of the economy shaped by the financial sector, and by factors of production other than labour and capital?
- How can new sources of data be used to improve productivity measurements?
- Has the relationship between the output gap, unemployment and inflation dynamics fundamentally changed? How is the equilibrium rate of unemployment evolving?

6. What is the role of central banks in addressing risks from climate change?

Fundamental changes in the environment could affect economic and financial stability and the safety and soundness of financial firms, with clear potential implications for central banks. To date, the Bank's work in this area has primarily focused on how insurance firms might adapt to the effects of climate change given that any future increases in the frequency and severity of weather-related catastrophes places the industry at the front line of responding to the financial impacts of climate change. In July 2015, the Bank will submit a Climate Change Adaptation Report, focused on insurance, to the Department for Environment, Food and Rural Affairs (Defra) to inform the 2017 UK Climate Change Risk Assessment.

At the same time, the impact of environmental change is not limited to the insurance industry. The recent Intergovernmental Panel on Climate Change's 5th Assessment Report suggests that the effects of a changing climate are increasing risk levels more broadly and the Global Commission on the Economy and Climate (2014) argues that the next fifteen years will be critical as the global economy undergoes a deep structural transformation that will determine the future of the world's climate system.

Financial regulators and central banks are beginning to take action related to environmental change. For example, UNEP (2014) highlight a number of innovative practices, ranging from climate reporting in the US to the introduction of Green Credit Guidelines in China. Research might therefore examine whether financial regulation and central banking can play a role in addressing systemic environmental risks.

There are two key aspects to this. The first is the implications of physical changes in the environment, such as future changes in climate or related issues of resource scarcity, on financial stability and policyholder protection. A key element is considering the time horizons over which these physical changes may occur, and how they may be translated into financial impacts.

The second is how changes in public policy to address environmental risks, as well as wider factors, such as associated technological and financial innovation, may affect the economy or financial system. For example, could rapid improvements in renewable energy technology, such as energy storage, or the introduction of new financial instruments to manage environmental risk, affect financial markets? Is there a risk that carbon-intensive assets may become 'stranded' as part of a low carbon transition?

Alongside examining the impact of environmental changes, it is also important to consider if there are any linkages between central bank policies and systemic environmental risk. For example, are there areas where enhanced risk disclosure and reporting of environmental risks may be beneficial? What other financial, monetary and regulatory innovations are possible or desirable?

Specific questions include:

- What are the effects of environmental and climate change on the economy and the financial system?
- What role, if any, do central banks have in addressing systemic environmental risks?

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