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Contents

Topical articles

Recent economic and financial developments

Reports

Summaries of speeches and working papers

Appendices

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Topical articles

The UK productivity puzzle

By Alina Barnett, Sandra Batten, Adrian Chiu, Jeremy Franklin and María Sebastiá-Barriel of the Bank's Monetary Analysis Directorate.[1]

- Labour productivity growth in the United Kingdom has been particularly weak since the start of the crisis.
- The recent strength in hiring and modest pickup in productivity growth suggest that spare capacity within firms is unlikely to explain much of the current weakness.
- Factors related to the nature of the financial crisis are likely to be having a persistent impact on the level of productivity — but there remains considerable uncertainty around any interpretation of the puzzle.

Overview

Since the onset of the 2007–08 financial crisis, labour productivity in the United Kingdom has been exceptionally weak. Despite some modest improvements in 2013, whole-economy output per hour remains around 16% below the level implied by its pre-crisis trend. Even taking into account possible measurement issues and secular changes in some sectors, this shortfall is large — and often referred to as the 'productivity puzzle'.

Measures of productivity can be used to inform estimates of an economy's ability to grow without generating excessive inflationary pressure, which makes understanding recent movements important for the conduct of monetary policy. In this context a key challenge has been to understand better how much of the weakness in productivity has been due to (i) cyclical explanations related to demand conditions, compared to (ii) other more persistent causes related to the financial crisis. This article sets out some of the factors that might help to explain the UK productivity puzzle, grouped into these two categories. Based on recent research by Bank staff, the available evidence suggests that there is more likely to have been a range of factors at play rather than any one single explanation (see **summary table**).

During the initial phases of the recession, companies appear to have acted flexibly by holding on to labour and lowering levels of factor utilisation in response to weak demand conditions. Other cyclical explanations, such as having to work harder to win new business, are also likely to have played a role. But the protracted weakness in productivity and the strength in employment growth over the past two years suggest that other factors are likely to be having a more persistent impact on the level of productivity. These factors are likely to have manifested themselves in reduced investment in both physical and intangible capital, such as innovation, and impaired resource allocation from low to high productive uses.

But there remains a large degree of uncertainty around any interpretation of the weakness in productivity. The explanations covered in this article are unlikely to be exhaustive and are unable to explain the full extent of the productivity shortfall.

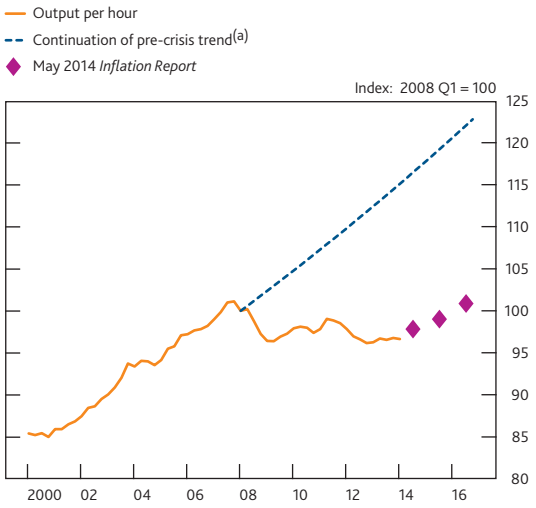
Summary table Factors contributing to the weakness in UK labour productivity by 2013 Q4

Shortfall in labour productivity relative to pre-crisis trend in 2013 Q4	**16pp**
Measurement issues	
Including: potential mismeasurement of output and changes to trend rates of growth in some sectors	Around 4pp
Actual shortfall to explain	**12pp**
Hypothesis I: cyclical explanations	
Including: measured spare capacity within firms, other cyclical factors reflecting changing demand conditions	Uncertain, but little evidence of spare capacity from business surveys and employment outturns
Hypothesis II: more persistent factors	
Including: reduced investment in physical and intangible capital, and impaired resource allocation and unusually high firm survival rates	Likely to be significant in recent years, contributing around 6 to 9pp
Total explained	**Around 6 to 9pp**

(1) The authors would like to thank Richard Galletly and Carleton Webb for their help in producing this article, and the ONS VML team for providing access to firm-level data.

Labour productivity is defined as the quantity of goods and services produced per unit of labour input. Since the onset of the 2007–08 financial crisis, labour productivity in the United Kingdom has been exceptionally weak. While labour productivity — measured by whole-economy output per hour worked — started to improve in 2013 alongside the recovery in output that was taking place at this time, it is still some 16% below the level implied by a simple continuation of its pre-crisis trend (**Chart 1**). This shortfall is sometimes referred to as the 'UK productivity puzzle', and has spurred a range of research both inside and outside the Bank of England in an effort to explain it.

Chart 1 Whole-economy labour productivity per hour



Sources: ONS and Bank calculations.

(a) Pre-crisis trend growth is calculated between 1997 and 2008 Q1, and is projected forward from 2008 Q1.

The level of labour productivity is an important macroeconomic indicator, as it measures the quantity of output that an economy is capable of producing with its existing resources. In the long run, technological progress, which leads to advances in measured productivity, is one of the main determinants of economic growth and improvements in standards of living. Measures of productivity are also important for the conduct of monetary policy, since they can be used to infer the economy's ability to grow without generating excessive inflationary pressure.

In the short to medium run, estimates of productivity can be affected by the intensity with which factors of production are utilised. Indeed, a key challenge in recent years has been to understand better how much of the weakness in productivity has been due to a temporary build-up of spare capacity in firms, compared to more persistent causes. As a result, productivity has been at the forefront of the discussions of the Monetary Policy Committee (MPC), and much attention has been devoted to discussing the various possible explanations for the productivity puzzle.(1) A key judgement in the May 2014 *Inflation Report* is for productivity growth to pick up gradually as the recovery progresses (shown by the diamonds in **Chart 1**).

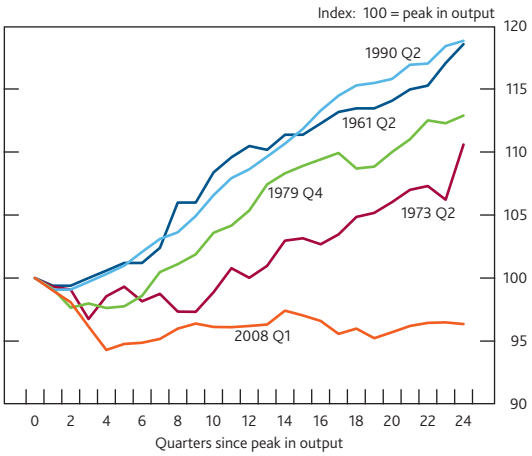
This article sets out some of the various factors that might be behind the UK productivity puzzle, based on results of recent Bank of England research.(2) It builds on discussions in recent Bank of England *Inflation Reports*(3) and a 2010 *Quarterly Bulletin* article, 'The impact of the financial crisis on supply'.

The first section of the article discusses the recent productivity experience in historical and international contexts, and introduces some possible explanations for the productivity puzzle. The two sections that follow discuss the available evidence under the two main hypotheses: that the weakness in productivity reflects cyclical explanations related to changing demand conditions, and that the weakness reflects more persistent factors. The penultimate section evaluates the relative importance of each of these explanations. The final section concludes.

The productivity puzzle: key facts and possible explanations

The fall in labour productivity during the recent recession has been larger than in any other post-war recession (**Chart 2**). And the recovery has been more protracted than previous experiences. Even six years after the initial downturn, the level of productivity lies around 4% below its pre-crisis peak, in contrast to the level of output, which has broadly recovered to its pre-crisis level.

Chart 2 Productivity after UK recessions



Sources: ONS and Bank calculations.

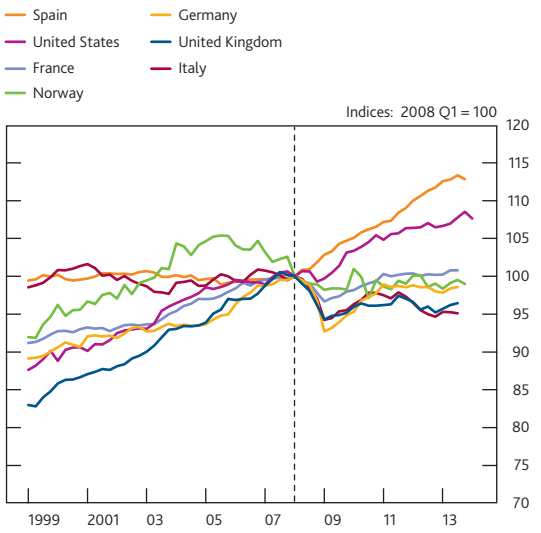
(1) For example, see the minutes of the Monetary Policy Committee meetings throughout 2013.
(2) This work contains statistical data from the ONS, which is Crown Copyright. The use of the ONS statistical data in this work does not imply the endorsement of the ONS in relation to the interpretation or analysis of the statistical data. This work uses research data sets that may not exactly reproduce National Statistics aggregates.
(3) See the November 2012 and May 2014 *Inflation Reports*.

The weakness in labour productivity is even more pronounced if one compares the current level with a simple continuation of its pre-crisis trend (**Chart 1**): this shortfall in productivity is currently 16%. And the shortfall is large whether one measures it as output per hour or output per worker, across the whole economy or only within the private sector.

But there are reasons why this comparison may overstate the size of the productivity puzzle. Output or labour inputs may be mismeasured, which in turn means that labour productivity may be mismeasured. In addition, trend productivity growth may also have slowed, for example due to the secular decline in North Sea oil output. This would result in a flatter profile for the dashed blue line in **Chart 1**.(1) These issues are discussed in more detail in the box on page 118. But, overall, although measurement issues may explain some part of the shortfall in productivity relative to a continuation of its pre-crisis trend, a large part still remains unexplained.

The United Kingdom's productivity weakness is also unusual in comparison with international experiences since the financial crisis. The United Kingdom's productivity performance, particularly relative to its pace of growth prior to the crisis, has been considerably weaker than that of most other advanced economies (**Chart 3**). While there may be important structural differences between the UK economy and other countries,(2) these are unlikely to explain fully the United Kingdom's productivity underperformance.

Chart 3 Whole-economy labour productivity per head across countries



Sources: Eurostat, ONS, Thomson Reuters Datastream and Bank calculations.

Possible explanations

The unprecedented weakness in productivity has spurred a range of research efforts both inside and outside the Bank of England in order to explain it.

At a basic level, economists often think of labour productivity as being composed of three main factors: the amount of capital available per hour worked (or 'capital deepening'); the degree of technical efficiency with which labour and capital inputs are combined ('total factor productivity' or TFP); and the degree or intensity of utilisation of capital and labour within firms. The box on page 119 provides a more detailed description of these components.

Various explanations have been put forward to explain the productivity puzzle, and each of them is likely to have a different impact on the three components described above. These explanations can also be broadly characterised into two main hypotheses:

(i) the weakness in productivity is cyclical, reflecting lower factor utilisation due to weak demand conditions, and is likely to be temporary in nature; and
(ii) other factors are slowing growth in either the amount of capital per worker or TFP, leading to a more persistent effect on the level of productivity.

In assessing the outlook for inflation, the MPC needs to form a view on how much of the weakness of productivity reflects either of these two hypotheses. The relative weights the MPC puts on these two hypotheses are likely to influence its evaluation of the United Kingdom's productive capacity and hence the economy's ability to grow without generating excessive inflationary pressure.

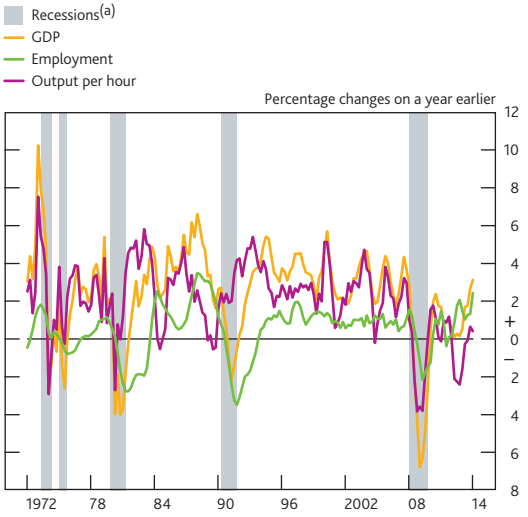
The first hypothesis suggests that the weakness in productivity is more cyclical in nature and driven principally by weak demand conditions. The mechanism at work here is that firms are unable or unwilling to dispose of capital or lay off workers, either because of minimum staffing levels required to keep the business going, or because they believe the weakness in demand to be temporary.(3) Holding on to resources in this way means that firms are able to maintain their capacity levels. In the meantime, these firms are not as productive as they might otherwise have been. The difference between this lower level of utilisation and more normal levels of capacity utilisation is what is sometimes called 'spare capacity within firms', an important element of spare capacity in the economy.(4) Here, normal levels of spare capacity are taken to be those consistent with no significant pressure on inflation relative to the 2% inflation target.

(1) See in particular Patterson (2012).
(2) For example, the business services sector (which includes financial services) in the United Kingdom is larger than in many countries, rendering the UK economy more susceptible to financial shocks (Hughes and Saleheen (2012)).
(3) Some studies, notably Blundell, Crawford and Jin (2013) and Grice (2012), also suggest that firms are better able to retain labour because of an increase in the flexibility of wages and increased labour supply.
(4) The other important element is spare capacity in the labour market — that is, the extra output that could be produced by those who are underemployed or out of work before the amount of slack stops pushing down on wage growth. See the box on page 29 of the May 2014 *Inflation Report* for further details.

It is plausible that there are other cyclical explanations for the weakness in productivity at work. The Bank's Agents have suggested that some firms diverted resources towards business development activities or generating custom which may not count as output, at least in the short term. Such firms may report that they have little spare capacity at present, but provided that there has been no deterioration in their ability to produce output, they should have scope to expand production should demand recover.

Labour productivity growth in the United Kingdom is strongly procyclical; as shown in **Chart 4**, periods of economic downturn are typically accompanied by a reduction in labour productivity, while periods of economic growth coincide with productivity improvements. However, since the onset of the recent financial crisis, productivity growth has been weaker than one would have expected given its normal cyclical relationship with GDP, particularly since 2010. Growth rates in output per hour (the magenta line in **Chart 4**) have been persistently weaker than GDP (the orange line), reflecting strong employment growth over the past few years. Therefore, cyclical factors alone are unlikely to explain the productivity puzzle fully.

Chart 4 GDP, productivity and employment



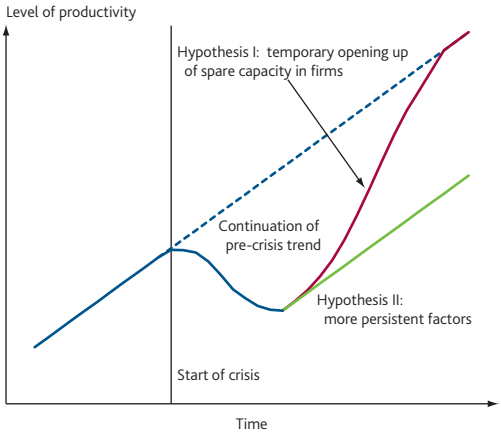
Sources: ONS and Bank calculations.

(a) Grey bars indicate recessions, defined as two consecutive quarters of falling GDP. The recessions are assumed to end once GDP begins to rise.

The second hypothesis suggests that the weakness in productivity is likely to persist for some time, as the underlying factors behind it may have disrupted the capacity of the economy to supply goods and services, through underinvestment or inefficient allocation of resources.(1) There are several mechanisms associated with the recent financial crisis that may have caused this to happen. Impaired access to finance for companies and heightened uncertainty with respect to the macroeconomic environment may have dissuaded firms wishing to invest in profitable projects from doing so, impeding growth in the amount of capital per worker. Tight credit conditions may also have slowed the investment in, and introduction of, new innovations. Furthermore, the crisis may have led to impediments in the movement of capital and labour towards their most productive uses, again slowing growth in productivity.(2)

Figure 1 is a stylised diagram which compares how one might expect productivity to behave under the two hypotheses described above. Under the first hypothesis, productivity weakens following a crisis and the subsequent deterioration in demand conditions as firms reduce their levels of capacity utilisation. Productivity then recovers, as demand conditions pick up, and any spare capacity is used up. By contrast, under the second hypothesis, productivity weakens and stays persistently weaker. Productivity growth starts to recover only when these more persistent factors start to wane, and the level of productivity never recovers to where it might have been in the absence of the crisis.

Figure 1 Evolution of labour productivity under two stylised hypotheses



Of course, in reality, it could well be that the evolution of productivity in the United Kingdom reflects a combination of the two hypotheses considered above. Moreover, even the more persistent causes of productivity weakness could unwind — at least partially — over some time horizon, in contrast to the scenario depicted by the green line in **Figure 1**, where the productivity shortfall is assumed to persist indefinitely. For either of these reasons, the actual path for labour productivity could fall somewhere between the stylised scenarios shown on **Figure 1**.(3)

(1) Oulton and Sebastiá-Barriel (2013) suggest that financial crises have tended to reduce the long-run level of productivity permanently. They estimate that a banking crisis reduces the long-run level of productivity by around 0.8%–1%, on average, for each year that the crisis lasts.
(2) See Broadbent (2012, 2013) and Barnett *et al* (2014b).
(3) Under a more pessimistic scenario, a financial crisis would lead to a permanently lower growth rate of productivity. In this case, the gap between the subsequent path of productivity and the pre-crisis trend would continue to grow indefinitely.

How much of the productivity puzzle might be explained by measurement issues?

This box outlines several reasons why the reduction in measured labour productivity might overstate the true size of the productivity puzzle. Since labour productivity is measured as the amount of output per worker (or the amount of output per hour worked), if output turns out greater — or employment (or total hours worked) weaker — than initially estimated, this might reduce the size of the shortfall. Furthermore, since the shortfall in productivity is often estimated relative to the level implied by a pre-crisis trend, any changes to this trend will also affect the size of the shortfall.

Output

Initial estimates of GDP are revised as new information becomes available. As described in the May 2014 *Inflation Report*, Bank staff expect that the latest level of measured GDP will ultimately be revised upwards. This is based on past revisions to the data and other indicators of economic activity, such as the business surveys. The expected cumulative revision to the level of GDP between 2011 Q1 and 2013 Q4 is only small at around 0.7%. Patterson (2012) also considers that measurement errors in GDP estimates could in principle account for some of the productivity weakness but concludes that this is likely to be very small.

In addition, the National Accounts data do not currently capture investment in intangible assets such as research and development (R&D) expenditure. R&D is an input into the production process, but its output might not be evident immediately: for this reason, it is currently treated as intermediate consumption and not as a form of investment. Arithmetically, this will lead to an underestimation of GDP. In the forthcoming 2014 *Blue Book*, expenditure on R&D will be considered as an investment and will be included in gross fixed capital formation rather than intermediate consumption. This means that, for the first time, expenditure on R&D will directly contribute to GDP.(1) Estimates suggest that intangible investment held up better during the recession than the physical (or tangible) investment captured in the official GDP data. As argued in Goodridge, Haskel and Wallis (2013), if intangible spending had been included, it could have lifted the level of GDP relative to 2008 by around 1½ percentage points.

Employment and total hours

Headline data are unlikely to overestimate substantially the amount of total hours worked. Although the ONS Labour Force Survey measure of employment is uncertain due to sampling variation, an alternative measure based on ONS Workforce Jobs points to a broadly similar rise in total employment since 2010. Similarly, changes in the Labour Force Survey measure of average hours worked have been corroborated by other indicators such as the Annual Survey of Hours and Earnings.

A notable feature of the rise in total employment has been the rise in self-employment. Since the trough in employment in 2010, self-employment has risen by more than 600,000 (just under half of the rise in total employment). However, even under the extreme assumption that none of the newly self-employed over this period has generated any output, this would only account for around 2 percentage points of the shortfall in the level of measured productivity.

Trend rates of growth

It may be that the trend rate of productivity growth started slowing prior to the onset of the crisis. For example, the growth of North Sea oil and gas extraction output has been in secular decline since around 2003 and this has slowed trend growth in labour productivity in this sector from a little under +1 percentage point to -2 percentage points per quarter. This would not affect the measurement of labour productivity *per se*, but would affect the trend rate of growth one would use to generate a counterfactual trend estimate. Multiplying the difference between these trends with the sector's share in output suggests it might account for around 1 percentage point of the current productivity shortfall. Similarly, it is also possible that productivity growth in the financial services sector will be persistently lower since the crisis, following its relatively rapid growth prior to 2007. It is difficult to quantify this effect, but a reasonable assumption could be that slower financial sector productivity growth could contribute a further 1 percentage point to the productivity shortfall.

Overall, although measurement issues and revisions to output may explain some of the shortfall in productivity — up to 4 percentage points — the rest remains unexplained.

(1) For more details see the recent ONS articles at: www.ons.gov.uk/ons/rel/naa1-rd/national-accounts-articles/impact-of-esa10-changes-on-current-price-gdp-estimates/art---impact-of-esa10-changes-on-current-price-gdp-estimates.html.

Accounting framework for labour productivity growth

Labour productivity growth is often decomposed into capacity utilisation, capital deepening and technological growth. This box briefly describes a way to account for these components, and relates these to the two hypotheses discussed in the rest of this article.

The framework is based on a simple set of assumptions about firms' production processes. Suppose that a firm produces output Y using capital K and labour L. Inputs are not always fully employed: capital is utilised only to a fraction W of its full potential and the labour force exerts a degree of effort E. Finally, A represents a measure of technological efficiency. The production of output can then be expressed as a function F of the inputs of production K and L, adjusted by their degree of utilisation W and E respectively, and augmented by technological efficiency:

$$Y = AF(WK, EL)$$

By rearranging the function above, **labour productivity**, defined as output per unit of employment (Y/L), can be expressed in terms of its three main components: the level of technological efficiency A, capital per hour worked or 'capital deepening' (K/L) and the degree of capacity utilisation ($Util$, which is a function of W and E):

$$\frac{Y}{L} = Af\left(\frac{K}{L}, Util\right)$$

Technological efficiency A, also called **total factor productivity (TFP)**, is sometimes used as an alternative measure of productivity, and reflects how efficiently labour and capital, as well as any other inputs, are combined to produce output. Technological progress and the associated improvements in TFP are key drivers of long-term economic growth. It is not directly observable and, therefore, is usually estimated as a residual by rearranging the equation above. A further challenge is that the degree of utilisation is also unobservable directly. In addition, there is currently a large degree of uncertainty around official estimates of the capital stock.

This article sets out various explanations that have been put forward to help explain the UK productivity puzzle. The evidence relating to each explanation is discussed in relation to two main hypotheses. First, that the weakness in productivity has been due to cyclical explanations, such as a temporary build-up of spare capacity in firms, and second, that the weakness has been driven by other more persistent causes. Whether an explanation falls under the first or second hypothesis depends on which component of labour productivity it is likely to affect. For example, lower levels of capacity or factor utilisation will directly affect the degree of utilisation $Util$ and are accordingly allocated under the first hypothesis. Factors affecting the level of capital per worker or TFP, on the other hand, are likely to have a more persistent effect on productivity and are categorised under the second hypothesis.

Hypothesis I: cyclical explanations

This section outlines the reasons why firms may have chosen to use their labour less intensively and therefore retain or 'hoard' labour. It then considers other cyclical factors which may have led productivity to respond to changes in demand conditions. Finally, it puts these pieces of evidence in context by considering the recent economic recovery.

Spare capacity within firms

Labour productivity often deteriorates in the initial stages of a recession, as the fall in output is not always accompanied by an immediate fall in employment. During the recent recession, employment has been more resilient than in the 1980s and 1990s downturns, despite the larger fall in output. This means that the drop in productivity has been more pronounced than in previous downturns.

Some companies may have been unable to cut employment below a minimum threshold. They may have required a certain amount of labour to keep the business going, so-called 'overhead labour'. An example could be the need to maintain a building's security guards as long as the building is in use, or until it is sold or demolished. It is likely that, relative to previous recessions, this may have played a larger role as the service sector is now a larger part of the economy and overhead labour is, arguably, more important for the service sector than for other industries.

Alternatively, the resilience in employment could reflect firms making the active decision to retain staff, despite weak demand, in the expectation of a recovery in demand. Companies might wish to retain underutilised labour to avoid the cost of firing and subsequent re-hiring when the economy picks up. But they might only be able to do so to the extent that they are able to contain wage costs in the interim. The increased flexibility of real wages over the past few decades, partly due to the decline in labour unionisation, may therefore have helped firms to hold on to their employees.(1) Between

(1) Martin and Rowthorn (2012) suggest that lower real wages may have also encouraged firms to create low-productivity, low-paid jobs in private service activities. Pessoa and Van Reenen (2013) suggest that the large fall in real wages associated with an increase in the cost of capital has also caused a fall in the capital to labour ratio which they expect will reverse as demand for goods and services improves.

2008 Q1 and 2013 Q4 real product wages, a measure of firms' real labour costs per employee, fell by 5%.(1)

Indeed, in the early stages of the recession, the Bank's Agents reported that business contacts had been wary of repeating their experiences of the 1980s and 1990s recessions. Having fired workers early on in the course of those downturns, companies then found it difficult to find workers with the appropriate, firm-specific skills when the economy recovered, and were thus less able to take advantage of improved demand conditions.

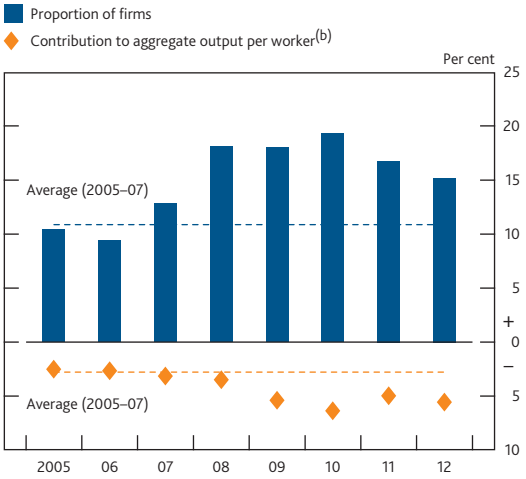
Barnett *et al* (2014a) also find some firm-level evidence of 'labour hoarding'. Using ONS firm-level data they show that aggregate movements in employment can be linked to individual firms' behaviour at different points in the cycle. As one might expect, before the crisis (2005 to 2007) hiring was concentrated among firms whose output was growing. Also somewhat predictably, during the trough of the recession (2008 to 2009), the proportion of firms with shrinking output and falling employment increased.

Beginning in 2008, a large proportion of firms with shrinking output began holding employment flat, rather than reducing it. **Chart 5** shows the proportion of businesses experiencing shrinking output but flat employment from 2005 to 2012 (the latest available data point). It rose from around 11% in 2005–07 to around 20% by 2010 and remained elevated even to 2012.(2) This group of firms has also consistently made one of the largest downward contributions to productivity growth relative to the pre-crisis period (shown by the diamonds in **Chart 5**). This suggests that some companies did react flexibly by holding on to labour in response to weak demand conditions, and that this contributed to the fall in measured labour productivity — at least until 2012.

If companies had been operating with underutilised resources in this way, then one would have expected to see it reflected in business survey measures of spare capacity. Indeed, these surveys pointed to a significant degree of slack within companies in the earlier stages of the crisis: reported levels of capacity utilisation fell considerably in 2009 (**Chart 6**). This is likely to have reflected an opening up of a degree of spare capacity in firms that persisted into 2012 — at least in the services sector — in line with the firm-level evidence presented above.

However, operating with underutilised resources is unlikely to be sustainable for long. Over time, the idea that firms are continuing to hold on to an excessively large workforce becomes less plausible. The survey measures of capacity utilisation have now closed substantially, which suggests, on the face of it, that firms are now operating at or slightly above normal levels of capacity.(3)

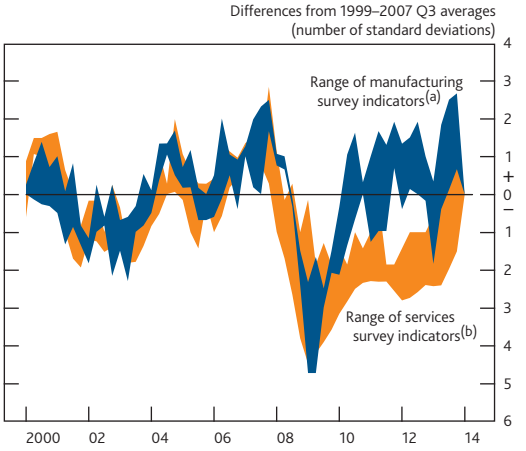
Chart 5 Proportion of firms experiencing shrinking output but flat employment(a)



Sources: ONS research data sets and Bank calculations.

(a) Dashed lines represent the average between 2005 and 2007.
(b) Percentage point contribution to the annualised growth rate of output per worker.

Chart 6 Survey measures of capacity utilisation



Sources: Bank of England, BCC, CBI and ONS.

(a) Includes measures of manufacturing capacity utilisation from the Bank's Agents and CBI, and a measure of non-services capacity utilisation from BCC. The Agents' data are end-quarter observations. The BCC data are non seasonally adjusted.
(b) Includes measures of services capacity utilisation from the Bank's Agents, BCC and CBI. The Agents' data are end-quarter observations. The CBI measure weights together financial services, business/consumer services and distributive trades surveys using shares in nominal value added. The BCC data are non seasonally adjusted.

There are, however, reasons why one might not want to take these surveys at face value. First, most of the measures are qualitative, not quantitative, in nature; as such they only capture the average proportion of firms above or below capacity, and not the amount of spare capacity within individual firms.(4) Second, they ask companies to compare their current level of capacity utilisation relative to 'normal'

(1) Unit wage costs, however, increased over this period, as the fall in productivity more than offset the fall in wages.
(2) A firm is considered to have flat employment or flat gross value added growth if its respective annual growth rates range from -5% to +5%. Note that relative to Barnett *et al* (2014a) **Chart 5** expands the sample to 2012 and includes revisions to the ONS employment data resulting in some quantitative changes to previous estimates.
(3) Note that this section relates to spare capacity within firms. There remains a greater degree of spare capacity in the labour market as explained in Section 5 and the box on page 27 of the May 2014 *Inflation Report*.
(4) See Relleen *et al* (2013) for further details.

levels. What constitutes 'normal' is subjective and may well have evolved over time, particularly after six years of weak demand conditions.(1)

Other cyclical factors

There may be other reasons why productivity tracked demand conditions over the crisis, which are not captured by business survey measures of capacity utilisation.

One reason is that companies may have had to work harder during the economic downturn in order to win business or obtain work contracts — often termed 'thin market externalities'. For example, the Bank's Agents reported that some firms, particularly in the service sector, had diverted resources towards activities that might not immediately count as 'output' in the National Accounts. This may include working harder to drum up a given quantity of sales in a low-demand environment, or devoting time to less tangible 'business development' activities.(2) A large part of the fall in aggregate productivity was in the business services sector, which would lend some support to these hypotheses.(3)

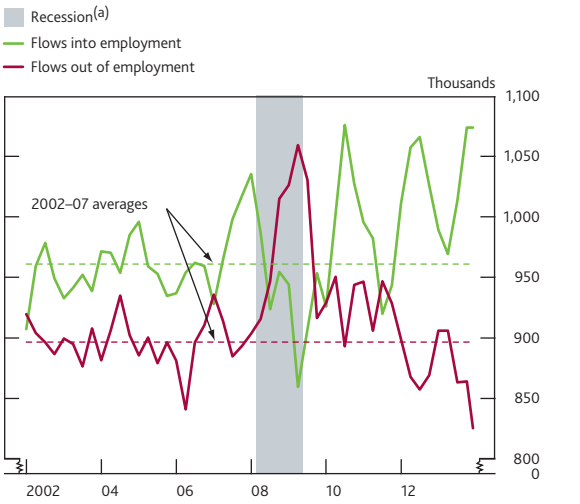
To the extent that these factors have been at play, firms would be unlikely to have reported significant quantities of truly 'idle' resources in business surveys. At face value, the survey results would thus understate firms' ability to improve productivity by increasing measured output without additional hiring. Moreover, such a recovery in productivity could be relatively gradual, especially if shifting employees across jobs is costly (due, for example, to the need to re-train workers). But it is possible that, if demand were to continue to grow strongly, businesses may find they can meet the extra demand by working more intensively, and that they have more spare capacity than expected.

Recent aggregate employment growth

The arguments presented above — with respect to spare capacity and other cyclical factors — can help explain why firms may have held on to existing staff during the recession despite weak demand growth. Consistent with this, the number of people flowing out of employment to either unemployment or inactivity — despite rising sharply at the start of the recession — has remained below the pre-recession average since 2012 (red line in **Chart 7**). But these arguments are less convincing as explanations for why hiring remains high — at (or above) pre-recession averages — despite the backdrop of weak output growth (green line in **Chart 7**). In fact, net employment, which is a combination of flows both into and out of employment, has increased since 2010 as a result of both stronger hiring and fewer people leaving their jobs.

The strength of employment growth became particularly striking from 2012. **Chart 8** shows that, since 2012 Q1, total employment has increased by over a million, of which the number of employees has increased by around 700,000.(4)

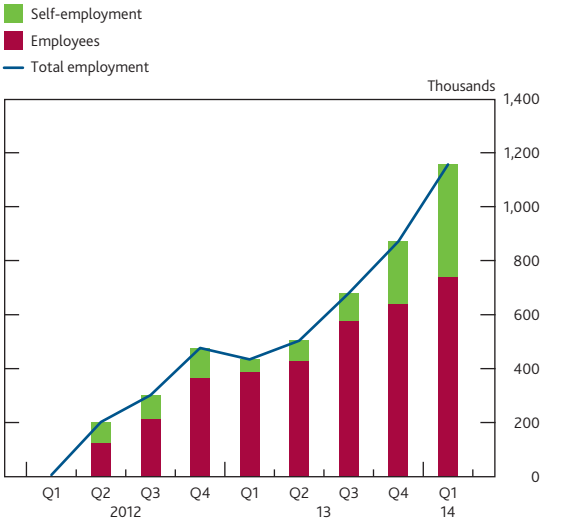
Chart 7 Employment flows



Sources: ONS and Bank calculations.

(a) Grey bar indicates recession, defined as two consecutive quarters of falling GDP. Recessions are assumed to end once GDP begins to rise.

Chart 8 Total employment change since 2012 Q1



Source: ONS Labour Force Statistics.

Although output growth began to gain momentum in 2013, this overwhelming strength in employment growth resulted in a dip in productivity which has only just started to recover: while output per hour grew by 0.2% a quarter on average during 2013, this was well below its pre-crisis average growth rate of around 0.6%.(5) Even taking into account Bank staff estimates of future revisions to official estimates of GDP, the increase in productivity remains muted.(6)

(1) See Bush (2008).
(2) See Miles (2012) and McCafferty (2013) for a further discussion.
(3) See King and Millard (2014).
(4) A discussion of self-employment over the crisis can be found in the May 2014 *Inflation Report*.
(5) The pre-crisis average is calculated between 1997 Q1 and 2008 Q1.
(6) See the box on page 118 as well as the discussion in the May 2014 *Inflation Report* and Bell *et al* (2014) for approaches taken by Bank staff to produce early estimates of GDP growth.

One possible rationalisation for the strength in aggregate employment is that it masks a range of different employment behaviours across firms. It may be that, although some firms have held on to labour despite falling output, other firms have been more successful in expanding both output and employment.

In addition, it may be that the financial crisis led to an increase in labour supply in the United Kingdom. The crisis is likely to have reduced both current real incomes and expected future labour incomes, which may have encouraged more people to seek work and participate in the labour market. Changes to the retirement age and benefit provision rules may also have affected incentives to participate.(1) These structural changes may have put downward pressure on wages and encouraged companies to both hold on to and hire additional staff, resulting in an increase in employment at the expense of measured labour productivity.(2)

Hypothesis II: more persistent factors

The strength in hiring over the past two years and the very persistent nature of the weakness in productivity suggest that cyclical factors alone are unlikely to explain the productivity puzzle fully. This section examines the evidence relating to the second hypothesis: that certain factors may have disrupted the capacity of the economy to supply goods and services, by causing an inefficient allocation of resources, and are having a more persistent impact on productivity growth. It begins by examining the role of lower levels of investment in different forms of capital, and then turns to the role of resource allocation.

Tangible and intangible capital investment and working capital

As explained in the box on page 119, the size of the capital stock available to each unit of labour is an important determinant of labour productivity. Investment in the physical capital stock has been subdued in the aftermath of the crisis. This could be a consequence of increased uncertainty surrounding the economic outlook — making firms more cautious when investing or disinvesting — or unfavourable credit conditions, if firms cannot obtain finance (or can only do so at a higher cost).(3) In addition, because real wages fell considerably whereas the cost of capital initially increased at the start of the crisis, the relative cost of labour to capital is likely to have fallen. This may have provided an incentive to businesses to use more labour-intensive forms of production.

Although the annual flow of business investment is small as a proportion of the total capital stock, protracted periods of weak investment could lead to a material deterioration in the capital stock per worker. As an illustration, if business investment had continued to grow at its pre-2007 average rate of around 1% per quarter, capital per worker would have been around 8% higher than was estimated for 2013 Q4.(4) The gap between the actual capital stock and this counterfactual level might account for around 2½ percentage points of the productivity shortfall.(5)

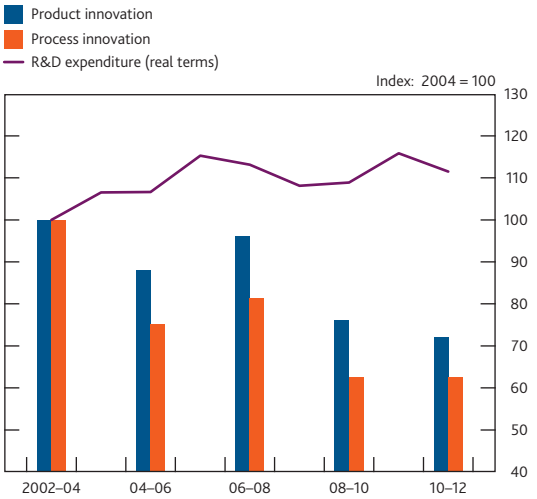
As well as physical capital, companies also invest in so-called 'intangible capital'. This might include knowledge-based capital like intellectual property rights, or sales-based capital like brand names. These types of investment are often complementary to physical (tangible) forms of capital. For instance, the implementation of innovative production processes might occur at the same time as the introduction of new plants and machinery.

Chart 9 shows that spending in Research and Development (R&D), a widely used measure of innovative activity, has been relatively stable during and after the crisis.(6) But R&D expenditure is only a measure of innovation *input*. Measures of innovation *output* are, for example, the proportion of companies that have introduced new goods or services ('product innovation') or new productive processes ('process innovation'). Available data on innovation outputs from the UK Innovation Survey indicate that spending on R&D has resulted in fewer implemented innovations in the years following the onset of the Great Recession. This is shown by the blue and orange bars in **Chart 9**.(7) And crucially, it is the *implementation* of innovation, not merely the investment in it, that matters for productivity.(8)

The UK Innovation Survey shows that the proportion of product innovators — defined as companies that have introduced a new or significantly improved product over the previous three years — has declined from 24% to 18% between 2008 and 2012. According to Bank analysis based on firm-level data from the same survey, product innovators were around 20% more productive over 2004 to 2010 than other companies.(9) This would imply that the reduction in the number of product innovators could account for a little over

(1) See the box on page 27 in the May 2013 *Inflation Report*.
(2) The impact on productivity may be even more pronounced if the increase in labour supply was among lower-skilled occupations. However, according to the Labour Force Survey estimates, much of the increase in employment has been in higher-skilled occupations.
(3) See Bloom, Bond and Van Reenen (2007) or Haddow *et al* (2013) for a discussion of the mechanisms through which uncertainty can affect investment and supply.
(4) These estimates are very uncertain, since the ONS has not published capital stock data since 2011. For the purpose of this comparison we use the Bank of England's internal estimates.
(5) Pessoa and Van Reneen (2013) use a different method to compute the capital stock, based on total investment rather than business investment, and find a larger impact of the capital stock on productivity.
(6) This is unusual, since R&D expenditure usually falls in recessions, and could be due to a number of factors, including policy initiatives such as the R&D tax credits.
(7) The UK Innovation Survey is conducted by the Department for Business, Innovation and Skills (BIS), see: www.gov.uk/government/collections/community-innovation-survey.
(8) See Hall (2011) for a survey of the evidence on the impact of implemented innovation on productivity.
(9) This refers to the median productivity across the two groups. While these estimates are somewhat higher than previous UK studies such as Griffiths *et al* (2006) and Criscuolo and Haskel (2003), they are in the range of other studies reported in Hall (2011).

Chart 9 Innovation measures for the United Kingdom



Sources: BIS UK Innovation Survey and ONS Business Enterprise Research and Development.

1 percentage point of the productivity shortfall between 2008 and 2012.(1)

It is possible, however, that as the recovery takes hold, companies might be able to bring to market a backlog of new goods and services resulting from their ongoing R&D efforts. While the timing of this is very uncertain, if new products are only introduced to the market when demand for them exists, then a strengthening of demand conditions could bring about a relatively prompt and significant improvement in productivity growth.

Another form of capital is 'working capital'. This is the net cash balance a company needs to hold in order to meet its day-to-day expenses. The contraction in the availability of credit during the financial crisis may have had a large negative effect on the working capital positions of UK firms, which would have forced companies to operate less efficient production processes, for example by restricting their holdings of inventory. This, in turn, may have affected measured labour productivity.(2)

Taken together, Bank staff estimates suggest that these capital channels might explain a significant proportion — 3 to 4 percentage points — of the productivity shortfall.

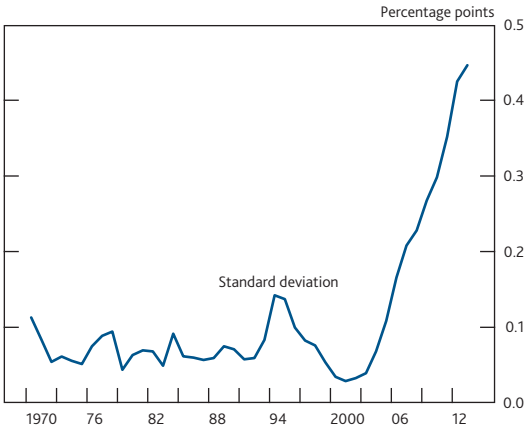
Impaired resource allocation

Another important explanation for the weakness in productivity is the slowdown in the reallocation of resources — capital and labour — to more efficient and productive uses. There are several reasons, discussed in this section, for why the process of reallocation could be impeded after a financial crisis.

Economic theory suggests that more efficient companies should be able to attract more inputs, be they capital or labour, relative to companies that are less efficient. Over time, the less efficient companies are forced to become more efficient or go out of business. This process of 'creative destruction' drives a more efficient allocation of capital and labour across the economy and leads to higher productivity growth at the aggregate level.(3) Several academic studies have shown that resource reallocation was indeed an important driver of UK productivity growth prior to the 2007–08 crisis.(4) However, if there are impediments to the free movement of these factors of production, then it is possible that differences in the level of efficiency across companies may persist, leading to slower productivity growth at the aggregate level.

In practice, differentials in productivity levels across markets and sectors are likely to exist even in normal times.(5) Some sectors are, by their nature, less labour intensive (hence more productive), and a healthy, dynamic economy requires such firms to coexist with others that may be more labour intensive, as both perform important economic functions. But if resource allocation is restricted, one would expect to see increased *differences* in productivity, prices and rates of return across firms and sectors relative to their levels before the crisis. **Chart 10** shows that, since 2007 and up to 2013, the difference between trend and actual productivity across UK industry sectors has been significantly more dispersed than during the pre-crisis period, indicative of little reallocation having taken place since that time.

Chart 10 Productivity dispersions across industries(a)



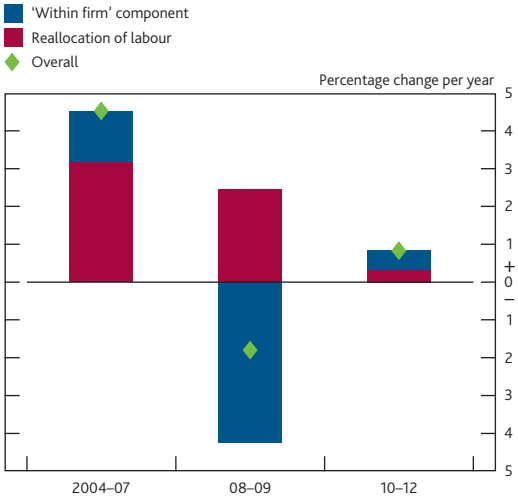
Sources: EUKlems, ONS and Bank calculations.

(a) The chart shows the standard deviation of productivity shortfalls (relative to a trend calculated between 1970 and 2006) across 1-digit Standard Industrial Classification (SIC) sectors.

(1) These are broadly consistent with other studies. For example, Goodridge, Haskel and Wallis (2013) find that the slowdown in intangible investment (of which innovation is a large part) before and during the crisis accounts for around 3½ percentage points of the UK productivity shortfall.
(2) See Fernandez-Corugedo *et al* (2011).
(3) See, for example, Caballero and Hammour (2000).
(4) For example, Disney, Haskel and Heden (2003) find that the formation of new production units, the failure of other units and changing market share could explain around 50% of UK labour productivity growth within the manufacturing sector between 1980 and 1992.
(5) See, for example, Bernard and Jones (1996) and Bernard *et al* (2002).

It is possible to examine the role of reallocation in more detail using ONS firm-level data from the Annual Business Survey. **Chart 11** decomposes private sector productivity growth into growth that can be attributed to changes in productivity within individual firms (the blue bars), and changes stemming from the reallocation of labour from less productive to more productive firms (the red bars). The reallocation of labour here includes the decisions by existing firms to expand or reduce their headcounts, hiring decisions associated with the creation of new firms, as well as the laying off of employees by failing companies.(1)

Chart 11 Decomposition of labour productivity(a)



Sources: ONS research data sets and Bank calculations.

(a) The chart includes UK private non-financial corporations, excluding those in the agriculture, mining and utilities sectors. Further details are provided in Barnett *et al* (2014a).

While the 'within firm' component accounts for the vast majority of the fall in productivity in 2008–09, the changes in the component that captures the reallocation of labour across UK firms are also striking. This component could explain more than half of labour productivity growth in the four years prior to the recession. At the beginning of the recession in 2008 and 2009, the contribution from reallocation fell slightly, rather than increasing significantly as a result of higher insolvencies or firing behaviour, as one might have expected.(2) Following this, the contribution from reallocation declined even further, becoming negligible between 2010 and 2012. This result is in line with Weale (2012), who finds evidence of reduced labour movement through fewer job changes.(3)

There are a number of possible reasons why the resource allocation process may have been impaired since the financial crisis. Increased uncertainty about the economic environment may have made firms more cautious when investing, and delayed capital and labour reallocation. In addition, a dysfunctional financial system is likely to have impaired the effective movement of resources across the economy.(4) Two mechanisms which may have slowed the movement of resources around the economy are:

- **impaired capital allocation** following large, asymmetric shocks to specific sectors or industries; and
- **higher firm survival** due to forbearance and other forms of public policy support.

These are discussed in turn below.

Impaired capital allocation

Broadbent (2012, 2013) considers the role of capital allocation across both firms and sectors for productivity growth. He finds that despite significant changes in sectoral rates of return on capital since the crisis, these have not been accompanied by subsequent movements of capital stocks across sectors. This is in contrary to what one would expect in an efficient economy, where capital responds by flowing towards sectors with the highest rates of return. More recently, Barnett *et al* (2014b) employ a highly stylised model of the economy, with multiple firms and sectors, to show that increased price dispersion can be a consequence of frictions to efficient capital allocation. And the size of this price dispersion since the crisis can be used to infer the size of the associated output and productivity loss. The authors find that this mechanism might explain around 3 to 4 percentage points of the weakness in aggregate productivity.

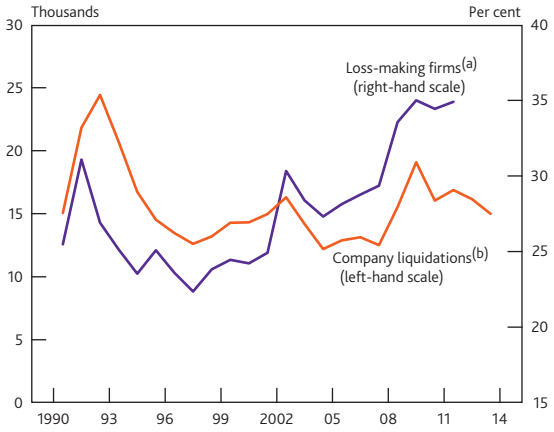
This study also directly examines whether the relationship between rates of return and subsequent capital movements has changed since the financial crisis, again using ONS firm-level data from the Annual Business Survey. The authors find that the positive correlation between profitability and investment weakened significantly after the financial crisis, which further supports the notion that capital allocation has become less efficient.

Higher firm survival

Since the start of the recession in 2008 Q2, the level of company liquidations has remained low, while the proportion of loss-making firms has increased significantly (**Chart 12**).(5) A lower rate of business failure, and the accompanying lower rate of unemployment, is likely to have meant that the loss to GDP and general welfare loss associated with the financial crisis was smaller than it otherwise would have been, but this may have pulled down on measured aggregate productivity growth.

(1) This chart is an updated version of the analysis presented in Barnett *et al* (2014a) and includes data for 2012, the latest year available in the Annual Business Survey micro data set provided to the Bank by the ONS. The calculations are based on changes in firms' labour shares, which can be interpreted as capturing movements in capital as well.
(2) These results are broadly in line with Riley, Rosazza Bondibene and Young (2014).
(3) Specifically, he finds that an apparent change in the workings of the labour market has resulted in there being fewer opportunities for career advancement through changing occupation or industry of employment than there were in the few years before the crisis, and that this could explain about 0.3 percentage points per annum of the fall in labour productivity.
(4) See Stiglitz (1989) for a discussion about the role of financial markets in allocating capital across firms.
(5) See also the Bank of England's August 2013 *Inflation Report*.

Chart 12 Company liquidations and loss-making firms



Sources: Bureau van Dijk, The Insolvency Service and Bank calculations.

(a) The number of companies that reported negative pre-tax profits in each year as a percentage of the total number of private non-financial corporations in the Bureau van Dijk data set that report data on pre-tax profits. Companies in the mining and quarrying, electricity and gas supply, and water supply sectors and extra-territorial organisations are excluded from the calculations. Data are to 2011.
(b) Changes to legislation, data sources and methods of compilation mean the statistics should not be treated as a continuous and consistent time series. Since the Enterprise Act 2002, a number of administrations have subsequently converted to creditors' voluntary liquidations. These liquidations are excluded from the headline figures published by The Insolvency Service shown in this chart.

There are several factors that may have helped companies survive the protracted period of weak demand. For instance, Arrowsmith *et al* (2013) examine the prevalence of bank forbearance across the small to medium-sized enterprises (SME) sector. Forbearance is the practice of providing measures of support to a customer or business struggling to meet its debt obligations.(1) The authors find that, although productivity is estimated to be 40% lower in SMEs in receipt of forbearance, only around 6% of SMEs were found to be in receipt of forbearance. This result would suggest that the direct impact on private sector productivity is likely to have been relatively small at around 1 percentage point.(2) However, the overall impact is likely to have been greater than this estimate to the extent that forbearance has been more widespread than occurring in just the SME sector.

Support by Her Majesty's Revenue and Customs (HMRC) in the form of its 'Time-to-Pay' scheme, whereby companies are granted extensions to pay their tax obligations, was also likely to have been a significant factor assisting firms over the recession. HMRC Time-to-Pay VAT approvals peaked at 118,000 in 2009, representing around 5% of the tax-registered business population. This fell to 20,700 in the first half of 2011.

In addition, the low level of Bank Rate has helped to keep borrowing costs for firms relatively low. This is in stark contrast to the 1990s recession, during which period Bank Rate was much higher. In fact, Arrowsmith *et al* (2013) note that commercial banks pointed to the low interest rate environment as a more significant factor in accounting for the low rate of company failure than loan forbearance *per se*.

Overall, there is likely to have been a variety of factors that have helped more companies survive the recent recession than the 1990s' experience, given the larger fall in output. To try and illustrate how significant the impact on productivity the higher rate of survival might have been, Barnett *et al* (2014a) consider a scenario in which firm deaths following the 2008 recession increased to a level more consistent with the 1990s recession. They find that the unusually low level of business failure is likely to have materially lowered measured labour productivity by up to around 5 percentage points. As mentioned above, however, there are important benefits associated with lower company failures. Unemployment is likely to have been lower, helping to prevent further erosion of the United Kingdom's supply capacity, and the loss to GDP, and general welfare, is also likely to have been smaller than it otherwise would have been.

Assessing the importance of the different explanations

Table A summarises estimates of the contribution from each of the possible explanations for the UK productivity puzzle, grouped into the two main hypotheses. It compares these to an estimate of the shortfall in productivity relative to a continuation of its pre-crisis trend (also shown in **Chart 1**). This 'shortfall' approach is useful to give a broad benchmark with which to assess the relative importance of each explanation. There may be, however, a number of reasons why such a benchmark may overstate or understate the true size of the shortfall.

Table A Factors contributing to the weakness in UK labour productivity by 2013 Q4

Shortfall in labour productivity relative to pre-crisis trend in 2013 Q4	**16pp**
Measurement issues, including:	≈ 4pp
Mismeasurement of output	*≈ 2pp*
Lower trend productivity in the mining and extraction and finance sectors	*≈ 2pp*
Actual shortfall to explain	**≈ 12pp**
Hypothesis I: cyclical explanations, including:	Uncertain
Lower levels of measured capacity or factor utilisation	*≈ 0pp*
Other cyclical factors reflecting changing demand conditions	*Uncertain*
Hypothesis II: more persistent factors, including:	Likely to be significant in recent years
Reduced investment in physical and intangible capital	*≈ 3 to 4pp*
Impaired resource allocation and unusually high firm survival rates	*≈ 3 to 5pp*
Total explained	**≈ 6 to 9pp**

(1) For banks, this may range from ignoring a breach of a loan covenant, to giving the borrower more time to meet its loan obligations, to providing some form of active payment relief.
(2) Arrowsmith *et al* (2013) builds on the discussion and findings from the Japanese experience of the 1990s documented in Caballero, Hoshi and Kashyap (2008). See also Nelson and Tanaka (2014).

None of the individual explanations covered in this article are able to fully explain the extent of the productivity puzzle. Rather, it seems likely that all of them, alongside the potential for data mismeasurement and changes to longer-term trends in mining and extraction output, have had a role to play.

Although the different explanations account for a large part of the measured shortfall, there is a wide margin of uncertainty surrounding each of these factors — and a significant proportion of the puzzle remains unexplained. Moreover, there are a number of caveats that are important to highlight. For instance, while the analysis examines each cause independently, it is possible that some of them overlap, resulting in some degree of double counting. Moreover, the list is unlikely to be exhaustive and ongoing research both inside and outside the Bank may yield further insights into the underlying drivers of the United Kingdom's productivity performance.(1)

Conclusion

The sharp fall in labour productivity experienced in the initial phases of the recession is likely to have reflected a cyclical reduction in the intensity of factor utilisation and an opening up of spare capacity within firms. More recently, while business surveys indicate that the levels of capacity utilisation within firms have returned to more normal levels, there is evidence to suggest that firms have shifted staff from revenue generating to business development activities. This leaves open the possibility that firms would be able to improve productivity by meeting any recovery in demand without additional hiring.

However, the protracted weakness of labour productivity — still 4% below its pre-crisis peak six years after the onset of recession — and the recent strength in employment growth suggest that cyclical factors alone are unlikely to fully explain the productivity puzzle.

There may be several factors associated with the financial crisis that may have led to the more persistent weakness in productivity, such as lower investment in both physical and intangible capital. Barriers or impediments to the efficient allocation of both capital and labour towards their more productive uses are also likely to have played a role. And it is possible that a number of factors have helped less productive firms survive the recession. All of these factors are likely to have dampened aggregate productivity growth in recent years.

The extent to which productivity growth picks up in the short to medium term very much depends on the nature of the shocks that have hit the economy. As the recovery strengthens, productivity may start to recover endogenously as demand conditions improve, for example if companies switch staff from generating business to producing output. In addition, companies might be able to bring to market the new goods and services that result from their R&D efforts, thus bringing about relatively rapid improvements in their measured productivity. And productivity growth could also pick up if barriers to the reallocation of labour and capital start to wane, for example due to a reduction in macroeconomic uncertainty or an improvement in credit conditions. Indeed, these are good reasons to be optimistic about the outlook for UK productivity growth.(2)

A key judgement in the May 2014 *Inflation Report* is for productivity growth to pick up gradually as the recovery progresses. This implies that although the productivity growth rate is expected to reach its historical average rate by the end of the forecast period, the level of productivity is assumed to remain well below a continuation of its pre-crisis trend (the diamonds in **Chart 1**). But there remains considerable uncertainty around the timing and extent of any strengthening. In setting out its monetary policy guidance framework, first in August 2013 and then in February 2014, the MPC has noted both the central role of an assessment of productivity in guiding the appropriate policy actions, and the great uncertainty about how productivity might evolve looking ahead. Indeed, the aim of the MPC's guidance was not to predict what might happen to productivity, but rather, to describe the framework that will guide its response to economic developments as they unfold.

(1) One such factor, for example, could be 'learning by doing', whereby increases in productivity are achieved through practice in using existing equipment and through incremental improvements to current productive processes.
(2) See Carney (2013) for further discussion.

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The Bank of England as a bank

By Stuart Manning of the Bank's Customer Banking Division.[1]

- Much is published about the Bank of England's policy functions and its financial operations. But less is typically known about the Bank's role as a bank in the more traditional sense, offering accounts and banking services to its customers.
- The three main customer groups to which the Bank provides banking services are: the UK Government; overseas central banks; and certain other financial institutions, such as central counterparties.
- The Bank's approach is not to compete with commercial banks, but to provide banking services where doing so supports its mission and in particular its objective to maintain financial stability.

Overview

The public policy functions of the Bank of England are well documented. So too are a number of the Bank's core financial operations. Underpinning these operations is the Bank's capability to set the short-term risk-free interest rate, provide liquidity support to the banking system, facilitate the settlement of interbank payments and safely issue banknotes. These are activities which either the Bank alone can undertake in the United Kingdom, or for which there are clear financial stability benefits of it doing so.

But the Bank also has the capability to provide banking services to customers. This role as a bank in the more traditional sense may be generally less well known. This article provides an outline of the banking services which the Bank provides to its three main groups of customers. These customers are:

- **The UK Government**. The Bank was founded in 1694 to act as the Government's banker and debt-manager. The Bank's role has evolved over time and, focusing on the past two decades, there have been quite marked changes. In this period the Bank ceased to be the Government's agent for debt and cash management and also withdrew from providing it with retail banking services. Today the Bank provides the Government with wholesale banking services.
- **Overseas central banks**. The Bank provides a range of banking services to central banks around the world. Doing so can help those central bank customers to operate safely in sterling markets, which in turn can support international financial stability. Banking relationships are one way in which central banks can maintain a strong network — and this, in turn, helps to support the Bank's broader financial stability objective.
- **Certain other financial institutions**. One example is central counterparties (CCPs), which can play a key role in maintaining the stability of the financial system. By providing banking services to CCPs, whose systemic importance is expected to increase further, the Bank can facilitate a reduction in risk across the market as a whole.

The banking services that the Bank provides to its customers could, in principle, be provided by commercial banks. Therefore the Bank typically provides these services only where there is a clear financial stability rationale. Its approach is not to compete with commercial banks. As with the Bank's policy roles, the banking services it provides to customers have evolved over time while still remaining a key part of the Bank's functions.

Gold vault at the Bank of England

The Bank is one of the largest custodians of gold in the world, with over 400,000 gold bars stored in its vaults. Safe custody is provided for customers including the UK Government and overseas central banks.

(1) The author would like to thank Ian Dawes for his help in producing this article.

The roles and functions of the Bank of England have evolved and changed over its 320-year history. In the past two decades in particular, the Bank's responsibilities have expanded markedly. The 1998 Bank of England Act saw the establishment of the Monetary Policy Committee, following the Government's announcement in May 1997 of its intention to give the Bank operational responsibility for setting interest rates. In 2009, the Bank was given the role of resolution authority to deal with failing banks and building societies and the Bank's oversight of interbank payment systems was put on a statutory footing.

More recently, the introduction of wholesale changes to the UK regulatory landscape following the financial crisis included significant new responsibilities for the Bank. These came into force in April 2013. They included the microprudential regulation of insurers, deposit-takers and major investment firms through the creation of the Prudential Regulation Authority, as well as macroprudential regulation of the financial system as a whole through the creation of the Financial Policy Committee.(1)

Much has been published about these new public policy functions. But in contrast, the Bank's role as a bank in the more traditional sense — providing banking services to specific groups of customers — may be generally less well known. This article outlines this important aspect of the Bank's work. It begins by briefly highlighting some of the Bank's main financial operations used to deliver its mission to promote the good of the people of the United Kingdom by maintaining monetary and financial stability. It then moves on to discuss the Bank's banking activities undertaken for its three broad groups of customers: the UK Government, other central banks and certain other financial institutions.

The Bank's market and banking activities

The Bank's position as the central bank of the United Kingdom is integral to the market and banking activities (together called financial operations) that it undertakes. The Bank is the sole supplier of 'central bank money' in the United Kingdom. Central bank money takes two forms — Bank of England banknotes, and the balances ('reserves') that are held by commercial banks and building societies at the Bank.(2) An important property of central bank money is that it is close to risk-free: the risk of the central bank defaulting is generally considered to be the lowest of any agent in the economy, given the central bank is financially supported by its Government.

The Bank has the capability to carry out a number of activities which either it alone can undertake in the United Kingdom (no commercial bank could do so) or for which there are clear financial stability benefits of it doing so. These include:

- **Setting the short-term risk-free interest rate**. The Bank remunerates reserves balances, and in so doing establishes a benchmark short-term risk-free rate. That remuneration rate is typically Bank Rate. From day to day, banks can choose to change their holdings of reserves, and the level of Bank Rate will influence the rates they are willing to charge or pay on short-term loans or borrowings in the market.

- **Providing liquidity support to the banking system**. The Bank, as the supplier of central bank money, is able to be a 'backstop' provider of liquidity, and can therefore provide liquidity insurance to individual, creditworthy institutions and to the banking system as a whole.

- **Facilitating the settlement of interbank payments**. The Bank is the settlement agent to the major sterling UK payment systems, providing accounts to commercial banks that allow them to transfer money to settle interbank obligations.(3) Interbank payment obligations arise, for example, whenever payments are made between the accounts of customers at different commercial banks through one of the interbank payment systems. Were a settlement agent to default, account holders would lose the mechanism for settling interbank obligations. This risk is largely eliminated by the Bank fulfilling this role, given that its default risk is generally considered to be the lowest of any agent in the economy.

- **The safe issuance of banknotes**. The high level of public trust in Bank of England banknotes stems from their being a liability of the central bank, financially supported by the Government.(4)

- **Providing banking services to customers**. The Bank provides a number of banking services to specific groups of customers. These services could, in principle, be provided by a commercial bank. However, the Bank's approach is not to compete with commercial banks and typically it provides customer banking services only where there is a clear financial stability rationale. The Bank seeks only to cover its costs from providing these services.(5) As the central bank of the United Kingdom, the Bank's banking services differ from those of commercial banks in several ways: they are close to credit risk free; they are not likely to be adversely

(1) For more details on the changes to the Bank's responsibilities, see Chancellor of the Exchequer (1997), Murphy and Senior (2013) and the Bank's website at www.bankofengland.co.uk/about/Pages/legislation/default.aspx.
(2) For more information on the different types of money in the modern economy, see McLeay, Radia and Thomas (2014).
(3) The Bank acts as the settlement agent for the CREST securities settlement system and the following payment systems: Bacs, CHAPS, Cheque and Credit Clearing, the Faster Payments Service, LINK, and Visa Europe. For more details see Dent and Dison (2012).
(4) Some Scottish and Northern Ireland commercial banks are authorised to issue their own banknotes, but they must back their note issue with a combination of Bank of England notes, funds in an interest-bearing bank account at the Bank or UK coin.
(5) The Bank's customer banking activities are not financed by cash ratio deposits (CRDs). For more information on CRDs, see www.bankofengland.co.uk/statistics/Pages/faq/faq_crds.aspx.

affected by stressed market conditions; and they are free of profit motives.

The remainder of this article focuses on this latter customer banking activity. It sets out the main groups of customers, gives an overview of what banking services are provided to them and explains how this fits into the Bank's wider mission. The box on page 132 addresses the other activities listed above and how they underpin the Bank's core financial operations.

The Bank's customer banking activities

The Bank provides customer banking services to three main groups of customers. First, it provides the Government with wholesale banking services. This can reduce the credit risk the Government would otherwise face holding sterling deposits overnight in the commercial sector and may help to avoid potential conflict for the Government in discharging its own functions. Second, it provides other central banks with a range of banking services. The provision of these services can help these central bank customers to operate safely in sterling markets which in turn can support international financial stability. Banking relationships are one way in which central banks can maintain a strong network, which can enhance co-operation and contribute to strong working relationships between central banks more generally. This helps to support the Bank's broader financial stability objective. And third, the Bank provides customer banking services to certain other financial institutions such as central counterparties (CCPs), where the provision of such services to them clearly supports the stability of the financial system.

The Bank has to exercise judgement in deciding which customer banking services to provide. This assessment may change over time as circumstances change, and central banks across the world may reach different conclusions on the banking services they are willing to offer to their own customers. In the Bank's case, there have been two significant shifts in recent years: one has restricted the provision of banking services; the other has acted to widen availability to certain customers.

First, there has been a restriction on the types of banking service offered to Government customers. Following a review of its customer banking activities, the Bank decided in 2004 to withdraw from the provision of retail banking services to its customers, including to Government departments (for example, clearing cheques and processing Bacs Direct Credits and Direct Debits). The Bank concluded that the provision of these services did not form an integral part of its role as a central bank and could be carried out by the private sector. The Bank now focuses on those customer banking activities which support its mission and in particular its objective to maintain financial stability; this includes providing wholesale banking services to the Government.

Second, the Bank has increased the availability of intraday banking services offered to CCPs — a type of financial market infrastructure. These are entities that place themselves between counterparties to contracts traded in financial markets, becoming the buyer to every seller and the seller to every buyer. The Bank's provision of banking services to CCPs (discussed in more detail later in the article) can facilitate a reduction in risk for these CCPs and thereby across the market as a whole. Making banking services available to CCPs is consistent with international standards, as set out in the 'Principles for financial market infrastructures' published by CPSS-IOSCO in April 2012.(1) The intraday banking services the Bank offers to CCPs provide distinct benefits from those which banks can gain from accessing the Sterling Monetary Framework (see the box on page 132).

The following subsections outline the range of banking services that the Bank offers to its three main groups of customers: the Government, other central banks and, where there are financial stability reasons to do so, certain other financial institutions.(2)

Government customers

The Bank was founded in 1694 to act as the Government's banker and debt-manager. From the beginning it had kept the state's banking accounts; the Bank's first transaction — and its reason for being — was to loan money to the Exchequer in order to finance a war with France. The Bank's role has evolved over time and, focusing on the past two decades, there have been two quite marked shifts in relation to banking for Government.

The first came in 1997 when the Chancellor of the Exchequer announced that the Bank's role as the Government's agent for debt and cash management would be transferred to HM Treasury, as part of reforms to the monetary policy framework. The Debt Management Office (DMO), an executive agency of HM Treasury, was established on 1 April 1998 to take up this role and gained full responsibility for Government Exchequer cash management on 3 April 2000.(3)

The second shift came in 2004 when the Bank announced its intention to withdraw from the provision of retail banking and clearing services to its customers — including to its Government customers. Following a managed transition programme that was completed in 2010, the Bank's Government customers found alternative providers for their retail banking requirements (such as making and receiving payments through Bacs and Cheque and Credit Clearing).

(1) See Committee on Payment and Settlement Systems Technical Committee of the International Organization of Securities Commissions (2012).
(2) A limited range of banking services is also provided to Bank staff and pensioners.
(3) See Chancellor of the Exchequer (1997). For more information on the DMO, see www.dmo.gov.uk/.

The Bank's financial operations

As explained in the main text of this article, there is a set of activities which the Bank alone has the capability to perform, or for which there is a clear financial stability benefit for it doing so. These activities underpin a number of core financial operations which the Bank undertakes today. This box provides a brief outline of three of those: operating the Sterling Monetary Framework; operating the United Kingdom's Real-Time Gross Settlement (RTGS) infrastructure; and issuing banknotes. All of these are well documented in other Bank publications. This box also outlines a core financial operation the Bank can undertake outside the Sterling Monetary Framework, in its capacity as lender of last resort.

Operating the Sterling Monetary Framework

The Bank's operations in the sterling money markets — known as the Sterling Monetary Framework (SMF) — are designed to implement the Monetary Policy Committee's decisions in order to meet the inflation target and to reduce the cost of disruption to the liquidity and payment services supplied by banks and building societies to the UK economy. The SMF has been substantially reformed in recent years as the Bank responded to the financial crisis. In 2012, the Court of the Bank asked Bill Winters to review the Bank's framework for providing liquidity to the banking system. That review made a number of recommendations of which the Bank accepted the majority. Most of the Bank's responses were implemented by early 2014; further work is being undertaken on some issues and the Bank will say more on them in 2014.(1)

Operating the United Kingdom's Real-Time Gross Settlement infrastructure

The Bank operates the RTGS infrastructure, which acts as an accounting system in which banks and building societies hold their sterling reserves (central bank money) in reserves accounts. Reserves are among the safest and most liquid assets a bank can hold, are the ultimate means of payment between banks and form part of the monetary policy transmission mechanism. Whenever sterling payments are made between the accounts of customers at different commercial banks, they are ultimately settled by transferring reserves between the reserves accounts of those banks in RTGS. In this regard, accounts in RTGS are effectively sterling current accounts for banks.(2)

Issuing banknotes

The Bank's issuance of banknotes, making central bank money available to individuals and organisations, is one of the Bank's most recognisable functions. The public has confidence in banknotes because of the stability in the value of money — through low and stable inflation (the focus of monetary policy) — and also because of confidence that the physical notes in circulation are genuine, can be easily exchanged and are readily available in a variety of denominations.(3)

The Bank as lender of last resort

In times of stress, the Bank can also provide liquidity insurance outside the SMF by providing Emergency Liquidity Assistance (ELA). An example of the Bank discharging its responsibilities as lender of last resort was at the height of the financial crisis in 2008–09 when it provided ELA on a large scale to Royal Bank of Scotland and HBOS. In 2012, the Court of the Bank commissioned Ian Plenderleith to conduct a review into these operations. That review made a number of recommendations to improve the Bank's capability to conduct ELA operations in the future. The Bank accepted the majority of the recommendations and work to implement them is ongoing.(4)

(1) For more details on the SMF, see Bank of England (2014). For more details on the Winters Review and the Bank's initial response, see Winters (2012) and Bank of England (2013).
(2) For more details, see Dent and Dison (2012).
(3) See Allen and Dent (2010). For information on current security features on banknotes, see www.bankofengland.co.uk/banknotes/Pages/educational.aspx.
(4) For more details on the Plenderleith Review and the Bank's initial response, see Plenderleith (2012) and Bank of England (2013).

Today, retail banking services to Government are provided by commercial banks and managed by the Government Banking Service, which was established in April 2008.(1)

The role that the Bank has retained in banking for the Government is the provision of wholesale banking services. This includes maintaining a number of sterling accounts which come together in the so-called 'Exchequer Pyramid'.

The Exchequer Pyramid is made up of a total of 35 separate accounts, some of which are operated by HM Treasury, others by the DMO and some by the Government Banking Service. Three key accounts in the Exchequer Pyramid are:(2)

- **The Consolidated Fund** operated by HM Treasury. This can be considered as the Government's current account which, for example, receives tax revenues collected by HM Revenue and Customs and makes payments to fund the spending of Government departments.

- **The National Loans Fund** operated by HM Treasury. This is the Government's main borrowing and lending account, the main role of which is to finance outgoings from the

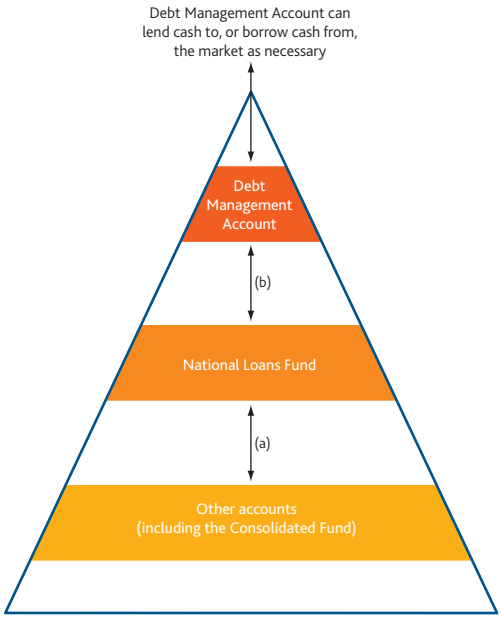
(1) For further information, see www.hmrc.gov.uk/gbs/.
(2) For more details on the Consolidated Fund, the National Loans Fund and the Debt Management Account, see HM Treasury (2013a, 2013b) and United Kingdom Debt Management Office (2013a).

Consolidated Fund where that Fund's receipts are insufficient.

- **The Debt Management Account** operated by the DMO. The purpose of this account is to fund the requirements of the National Loans Fund. The Debt Management Account undertakes day-to-day borrowing and lending with the market in order to manage the Government's cash requirements.

A stylised representation of the Exchequer Pyramid is shown in **Figure 1**. Outside the Exchequer Pyramid, during the business day, the Government Banking Service will make and receive payments on behalf of the Government, using commercial banks. At the end of the business day, all of the Government's significant sterling cash balances are transferred into Exchequer Pyramid accounts so that they can be held at the Bank overnight. Holding these cash balances within the Bank serves to minimise the credit risk that the Government faces from holding sterling deposits overnight.

Figure 1 Stylised representation of the Exchequer Pyramid



(a) At the end of the business day, any surplus cash balances sitting in accounts within the Exchequer Pyramid are swept into the National Loans Fund. Deficit cash balances are covered by drawing cash down from the National Loans Fund.
(b) Once these sweeps are complete, any surplus cash sitting in the National Loans Fund is swept up into the Debt Management Account. Any deficit cash balance in the National Loans Fund is covered by drawing cash down from the Debt Management Account.

The Exchequer Pyramid is also designed to make the Government's daily cash management more efficient by reducing gross funding requirements through the netting of surplus and deficit cash balances across the numerous Government accounts. At the end of the business day, any surplus cash balances sitting in accounts within the Exchequer Pyramid (for example from other Government departments) are swept into the National Loans Fund. Deficit cash balances are covered by drawing cash down from the National Loans Fund. So, for example, if the Consolidated Fund has a surplus cash balance at the end of the business day, that cash is swept up to the National Loans Fund; any deficit on the Consolidated Fund is covered by drawing cash down from the National Loans Fund.

Once these sweeps are complete, a similar sweep process happens between the National Loans Fund and the Debt Management Account. Based on forecasts of these flows within the Exchequer Pyramid, funds can be lent to, or borrowed from, the market by the Debt Management Account as necessary to reach a targeted credit balance on the Debt Management Account. The workings of the Exchequer Pyramid are designed to minimise the amount of money the Debt Management Account needs to borrow to meet the Government's daily cash requirements.(1)

As well as providing its Government customers with wholesale banking services in sterling, the Bank provides the Government with other banking services, including foreign currency accounts and payment services, and securities custody and settlement services. The Bank also acts as HM Treasury's agent in the day-to-day management of the Exchange Equalisation Account (EEA). The EEA holds the United Kingdom's reserves of gold, foreign currency assets and International Monetary Fund Special Drawing Rights.(2)

Central banks

Another main group of customers is overseas central banks. The Bank currently provides a range of banking services to 154 overseas central banks and official sector financial organisations.

Central banks may hold foreign currency assets, for example to support their monetary policy objectives or reserves management, or may wish to undertake transactions in a foreign currency. The Bank's provision of banking services to these central bank customers can help them to operate safely in sterling markets, reducing the credit risk they would otherwise face from holding assets at, or transacting directly with, commercial banks. This can support international financial stability.

The banking services provided to central banks include sterling call accounts (broadly similar to a current account) and payment services.(3) The Bank also provides a service allowing them to deposit sterling, or certain foreign currencies, for a fixed term to earn an agreed rate of return. The Bank invests these 'fixed-term deposits' in money market instruments subject to risk management guidelines. While this service is

(1) For more details on Government cash management, see United Kingdom Debt Management Office (2013a, 2013b).
(2) For more details on the EEA, see HM Treasury (2013c).
(3) As part of this sterling service, the Bank also offers central bank customers a foreign currency conversion payment service.

provided for the benefit of central bank customers, it also facilitates market intelligence gathering by the Bank.

The Bank is one of the largest custodians of gold in the world, with over 400,000 gold bars stored in its vaults. A picture from inside a gold vault at the Bank is shown in **Figure 2**. Alongside providing safe custody for the United Kingdom's gold reserves, the Bank also provides gold custody services to its central bank customers. Gold storage is provided on an allocated basis, meaning that the customer retains the title to specific gold bars in the Bank's vaults, rather than a claim on the Bank for a certain weight of gold. This means that gold held on behalf of customers does not appear on the Bank's balance sheet.

Figure 2 Gold vault at the Bank of England

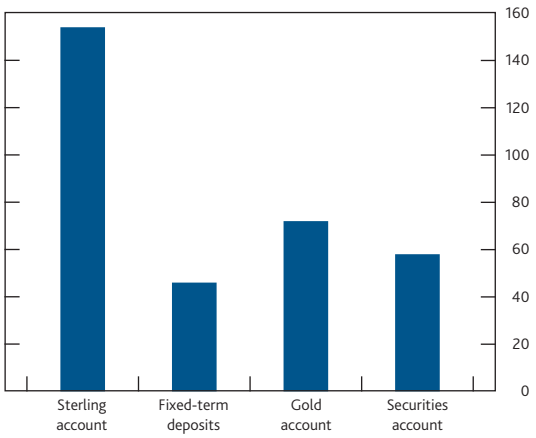
The average gold bar weighs around 13 kilos (or 28 pounds).

The Bank's gold custody service also provides an interface for its central bank customers to access the liquidity of the London gold market. Providing this bridge between central banks and the London gold market supports the international network of central banks. This, in turn, helps to support the Bank's broader financial stability objective.

Just as the Bank holds gold in custody for its customers, it can also provide custody and settlement services for securities. As a direct member of CREST (the securities settlement system operated by Euroclear UK and Ireland) the Bank can hold certain CREST eligible assets on behalf of customers. The Bank can also hold eligible domestic and international bonds on behalf of customers through an International Central Securities Depository. This enables central banks to hold and trade securities without the overheads of being direct members of these securities settlement systems.

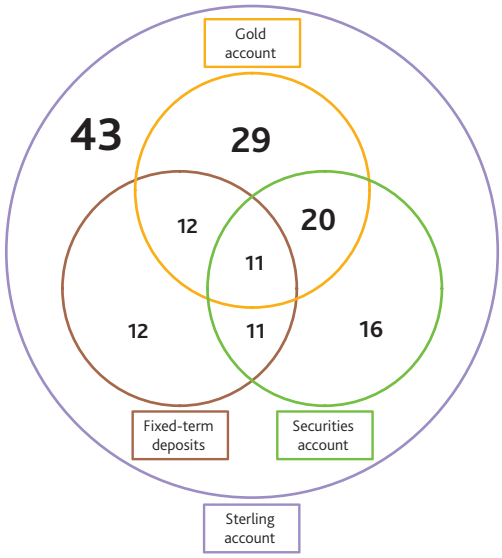
The number of central bank customers by banking service is shown in **Chart 1**. The 'sterling account' service constitutes the largest number of customers because it is a requirement to hold a sterling account at the Bank in order to access the additional services. **Chart 2** shows the number of these customers with various combinations of banking services. There are only a minority with all three additional services, while around a quarter have only a sterling account.

Chart 1 Number of central bank customers, by banking service[a]



(a) This includes a small number of official sector financial organisations.

Chart 2 Number of central bank customers, by combination of banking service[a]



(a) This includes a small number of official sector financial organisations.

Other financial institutions

In addition to the UK Government and other central banks, the Bank also acts as a bank to certain other financial institutions. One example is central counterparties (CCPs). CCPs place themselves between the buyer and seller of an original trade and effectively guarantee the obligations under the contract agreed between the two counterparties. If one counterparty were to fail, the other is protected via the default management procedures and resources of the CCP.[1]

(1) For a primer on central counterparties, see Nixon and Rehlon (2013).

CCPs can play a key role in maintaining the stability of the financial system by managing counterparty credit risk and facilitating the smooth settlement of financial market transactions. But a consequence of clearing trades centrally is that CCPs themselves become crucial links in the financial network. The systemic importance of CCPs is expected to increase further as the clearing through CCPs of standardised over-the-counter derivatives becomes mandatory in line with commitments made by G20 leaders following the financial crisis.(1) The ability of CCPs to minimise and manage their risk is therefore a key consideration for the Bank, and the banking services it provides to CCPs are intended to contribute to reducing these risks.

The Bank provides intraday banking services to a number of CCPs, including cash accounts known as 'concentration accounts'. A CCP can receive significant values of cash payments from its clearing members each day which are often collected through a network of commercial banks. Typically, these funds are then 'concentrated' intraday at a single bank — the so-called 'concentration bank'. Similarly, payments can also be made out from the concentration account. The Bank's provision of banking services to its CCP customers can allow them to hold large amounts of near risk-free balances on an intraday basis, thereby reducing the credit risk they would otherwise face holding those balances in the commercial sector.

Providing these banking services to CCPs is in line with international standards which stipulate that a CCP should settle 'in central bank money where practical and available'.(2) The provision of these services is an example of how the Bank is implementing this international principle in the United Kingdom and how its role in terms of its provision of banking services has evolved in response to developments in financial markets.

Risk management

The Bank's customer banking activities are supported by robust risk management processes with a separation of duties between the operations and control functions. The area of the Bank which undertakes customer banking activities is monitored by staff with separate reporting lines who are responsible for developing and overseeing a framework to ensure that risks are effectively managed.

Conclusion

This article has described the Bank of England's role in providing banking services to its three main groups of customers. The services it offers to the Government, overseas central banks and certain other financial institutions largely reflect its position as the central bank of the United Kingdom and are typically provided only where there is a clear financial stability rationale. While the banking services provided by the Bank have changed over time, as external circumstances have changed and judgements are made on what supports the Bank's mission, banking nevertheless remains an integral part of the Bank's role.

(1) An over-the-counter trade is executed bilaterally between two counterparties, rather than through an exchange.
(2) See Committee on Payment and Settlement Systems Technical Committee of the International Organization of Securities Commissions (2012).

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Credit spreads: capturing credit conditions facing households and firms

By Nick Butt and Alice Pugh of the Bank's Monetary Assessment and Strategy Division.[1]

- Changes in credit conditions have been one of the main headwinds affecting the UK recovery since the financial crisis.
- The likely path of credit spreads is a key determinant of the Monetary Policy Committee's projections for output and inflation.
- This article explains how staff at the Bank of England calculate measures of credit spreads which can be used to help inform the Monetary Policy Committee's central macroeconomic projections.

Overview

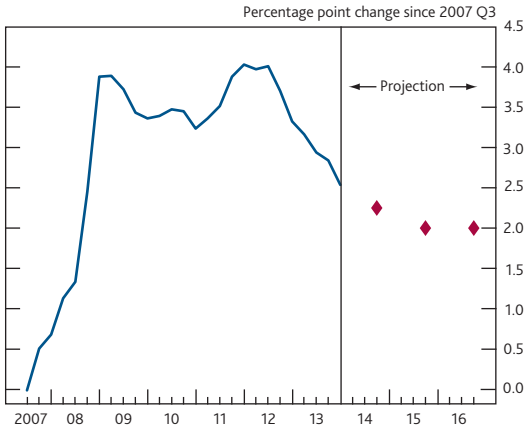
Following the onset of the financial crisis in 2007, the interest rates facing households and firms diverged from the Bank of England's policy rate, Bank Rate. The wedge which resulted is known as a credit spread. Despite sharp cuts to Bank Rate in 2008 and 2009, the cost of finance remained elevated and credit spreads widened, weighing on the economic recovery.

This article describes how staff at the Bank of England calculate movements in credit spreads for households and firms, which can be weighted together to form a summary measure of credit conditions in the United Kingdom. The blue line in the **summary chart** shows the change in this summary measure since the start of the financial crisis.

The Bank of England's measures of credit conditions are largely based on changes in the cost of credit for households and firms. But there are many dimensions to credit conditions, including price and non-price terms and the quantity of credit supplied for given terms and conditions. Attempts are made to capture variation in credit availability, but they are likely to do so imprecisely. The methodology has evolved over time, as more has been learned about the evolution of credit conditions and their impact on the UK economy.

Changes in credit conditions are likely to continue to influence economic activity in the future. Staff at the Bank of England form a projection for credit spreads by considering both near-term indicators and the likely long-run level of credit spreads. This level will be influenced by conditions in the banking sector, including the cost of bank funding in the longer run.

Summary chart The summary measure of credit spreads[a]



Sources: Bank of England, BDRC Continental *SME Finance Monitor*, Bloomberg, BofA Merrill Lynch Global Research, used with permission, British Household Panel Survey, Department for Business, Innovation and Skills and Bank calculations.

(a) The diamonds show the profile of the summary credit spread at one, two and three years ahead that was published in the May 2014 *Inflation Report*. The blue line shows the back data.

The diamonds in the **summary chart** show the projection for credit spreads at the one, two and three-year horizons that was published in the May 2014 *Inflation Report*. This projection is used to inform the Monetary Policy Committee's central projections for inflation, GDP and unemployment.

Click here for a short video that discusses some of the key topics from this article.

(1) The authors would like to thank Niamh Reynolds for her help in producing this article.

Following the onset of the financial crisis in 2007, the interest rates facing households and firms diverged from the Bank of England's policy rate, Bank Rate. Despite sharp cuts to Bank Rate in 2008 and 2009, the cost of finance remained elevated and so credit spreads widened. Tighter credit conditions have weighed on the recovery in economic activity by constraining consumption and investment.

Changes in credit conditions are likely to continue to influence economic activity in the future. In recent *Inflation Reports*, the estimated future path of credit spreads has helped determine the Monetary Policy Committee's (MPC's) 'Key Judgements' which underpin their central economic forecasts. The May 2014 *Inflation Report* contained the judgement that improving credit conditions would aid a revival in productivity and real incomes that would, in turn, help to underpin a sustained expansion in demand.

This article focuses on credit spreads as a measure of credit conditions. It starts by defining credit spreads and explains why they matter for economic forecasting. It then explains how the Bank's preferred measures of credit spreads are constructed. The final section outlines a framework for forming projections of credit spreads — and the role of such projections in the MPC's forecasts for output and inflation. A short video explains some of the key topics covered in this article.(1)

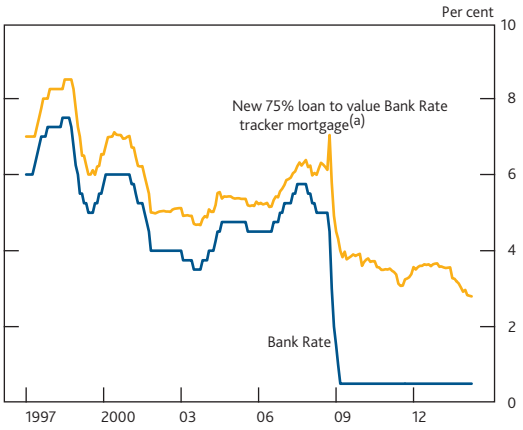
What are credit spreads and why do they matter for economic forecasting?

The cost of new borrowing and saving is an important determinant of households' and firms' consumption and investment decisions. A key feature of the recent crisis has been the divergence between the policy rate and interest rates facing households and firms. This wedge is known as a credit spread. **Chart 1** illustrates the change in the credit spread — shown as the gap between the blue and orange lines — over time for a new Bank Rate tracker mortgage. In the period shortly before the onset of the crisis, the credit spread for tracker mortgages was typically small and stable. But that spread has widened significantly since the start of the financial crisis: despite significant cuts to Bank Rate — from 5% in September 2008 to 0.5% in March 2009 — borrowing costs have remained elevated.

Estimates by Bank staff suggest that tighter credit conditions played an important role in explaining the weakness in output seen during the crisis. For example, the estimates outlined in Barnett and Thomas (2013) suggest that, between 2007 and 2012 Q3, credit supply shocks could account for between a third and a half of the observed fall in GDP relative to pre-crisis trends.

Given their importance for consumption and investment, the inclusion of variables that capture changes in credit conditions improves the ability of macroeconomic models to explain, and forecast, economic developments. There are a variety of mechanisms outlined in the economic literature through which credit conditions may affect demand and potential output.(2) But there is no clear consensus about how best to capture credit conditions in the models used by central banks and other macroeconomic forecasters. When credit spreads are low and stable — for example, in the period leading up to the financial crisis — movements in loan rates can be approximated by changes in Bank Rate. During times when the rates facing households and companies diverge from policy rates, however, a more sophisticated approach is required.

Chart 1 A representative household borrowing rate and Bank Rate



(a) Quoted rates on 75% loan to value Bank Rate tracker mortgage. The Bank's quoted interest rates series are weighted averages of interest rates derived from relevant products offered by a sample of the largest banks and building societies.

Staff at the Bank of England construct measures of credit spreads for households and firms. These can be weighted together to form a summary measure of the change in credit spreads for the 'average' borrower in the United Kingdom since the start of the financial crisis.(3) And since the end of 2007, staff projections for credit spreads have also been used to help the MPC formulate its macroeconomic projections.

Calculating measures of credit spreads

Staff at the Bank of England construct measures of credit spreads for households and firms. These are based on spreads between the interest rates offered by banks and building societies (hereafter referred to as 'banks') on new lending and deposits, and appropriate risk-free rates.

To calculate the measure of household credit spreads, households are grouped together depending on the source of finance they would be most likely to use if they were to

(1) See http://youtu.be/3vpDKQ7FWdk.
(2) See, for example, Bernanke, Gertler and Gilchrist (1999), Kiyotaki and Moore (1997) and Gertler and Karadi (2011).
(3) The summary measure of credit spreads was referred to as the 'credit spread adjustment' in Burgess *et al* (2013).

increase spending: high and low loan to value (LTV) secured borrowers, unsecured borrowers and savers. For each of these groups, credit spreads are calculated using 'quoted' interest rates — that is, the rates advertised for new lending and savings products. Appropriate risk-free rates are subtracted from each of these loan and deposit rates to form a credit spread. More detail on how the household credit spread is calculated can be found in the box on pages 140–41.

The measure of corporate credit spreads groups businesses together depending on their size. Loans to smaller businesses have tended to be riskier than loans to large firms, meaning that interest rates have typically been higher in order to compensate banks for bearing additional risk. Calculating credit spreads for companies requires more judgement than for households because data on the cost of new bank loans to companies are limited. This means that the corporate credit spread is calculated using a range of data, including from surveys. More detail on how the corporate credit spread is calculated can be found in the box on pages 142–43.

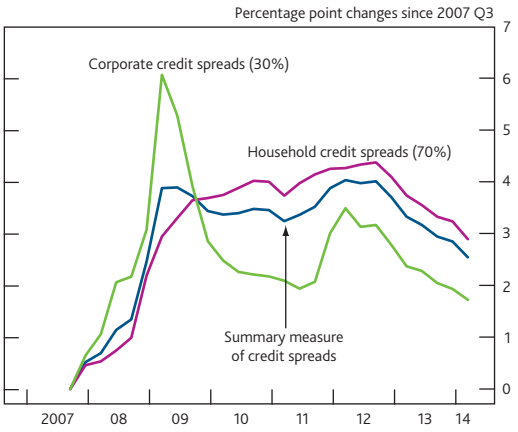
The methodology used by Bank staff to calculate these measures of credit spreads may be revised over time as more is learned about the evolution of credit conditions and their impact on the UK economy. Indeed, several alterations have been made since the measures were first constructed following the onset of the financial crisis, reflecting, for example, the availability of new data series and findings from staff analysis.

The household and corporate credit spread components can be weighted together, according to their relative share in the stock of lending, to form a single summary measure of credit spreads.(1) The weights are fixed over time, at 70% and 30%, respectively, to avoid capturing any endogenous response of the relative shares of household and corporate lending to changes in credit spreads. For example, suppose that credit conditions tightened by more for companies than for households over the crisis, and corporate credit demand consequently fell by more than that of household demand in response. If weights were allowed to vary in line with lending, then the associated reduction in the weight placed on the corporate credit spread could mean underestimating the effect of the crisis on credit conditions.

Chart 2 illustrates the change in the summary measure of credit spreads, together with the household and corporate components, since 2007 Q3. While by definition this means that credit spreads are set equal to zero in 2007 Q3, this does not mean that credit conditions were normal at that time. Spreads were in fact unsustainably compressed at the start of the crisis. Rather, 2007 Q3 is used as a reference point to show how conditions have evolved since then.

Credit spreads rose sharply following the onset of the financial crisis, driven by a higher cost of bank funding, an increase in

Chart 2 Measures of credit spreads(a)



Sources: Bank of England, BDRC Continental *SME Finance Monitor*, Bloomberg, BofA Merrill Lynch Global Research, used with permission, British Household Panel Survey, Department for Business, Innovation and Skills and Bank calculations.

(a) Figures in parentheses show the weights used to construct the summary measure of credit spreads from the measures for households and companies. These weights are calculated using the shares of loans to households and to companies in the outstanding stock of sterling loans, calculated using M4 lending data.

expected losses on bank lending and a re-evaluation of the loss absorbency of their capital positions. The increase was more pronounced for corporates than for households, possibly because of a greater increase in perceived default risk. But although corporate credit conditions loosened between 2009 and mid-2011, particularly for large companies, household credit conditions remained tight. Since mid-2012, credit spreads have fallen continuously following the introduction of new policy measures in both the euro area and the United Kingdom. These policies — including the Funding for Lending Scheme (FLS) in the United Kingdom and the announcement of Outright Monetary Transactions in the euro area — are likely to have contributed towards a fall in banks' funding costs, which in turn led to lower lending rates.(2)

Capturing non-price terms and credit availability

It is likely that some of the tightening in credit conditions in the aftermath of the financial crisis came about through a fall in the *quantity* of credit supplied as well as through an increase in the cost of credit. Evidence for this includes a sharp reduction in high LTV mortgage lending in the immediate post-crisis period. Surveys of corporate credit conditions also suggest that the availability of credit for businesses fell after the onset of the crisis.

Although the measures of credit spreads are based on the price, rather than the quantity, of credit, they are likely broadly to reflect changes in credit availability. Evidence of that can be seen in the correlation between the cumulated survey balances for credit availability from the Bank of England's *Credit Conditions Survey* (*CCS*) and secured household credit

(1) The summary measure of credit spreads aims to capture the impact of a change in credit spreads on spending. It should not be confused with the cost of bank intermediation (the wedge between borrowing and saving rates).
(2) See the box on pages 14–15 of the May 2014 *Inflation Report* and Churm *et al* (2012).

The household credit spread

To calculate the measure of household credit spreads, households are grouped together depending on the source of finance they would be most likely to use if they were to increase spending. The four groups of households considered are:

Low loan to value (LTV) secured borrowers: homeowners who hold mortgages with LTV ratios of 75% or below. These households are able to borrow against the value of their home. Lower LTV ratios mean that less risk is borne by the lender and so the loan rate is likely to be lower.

High LTV secured borrowers: as above, but for homeowners with LTV ratios of above 75%. High LTV ratios mean that more risk is borne by the lender and so the loan rate is likely to be higher.

Unsecured borrowers: this group represents individuals who do not own a home or have insufficient savings to finance additional spending. Extra spending must then be financed through unsecured borrowing using credit cards, overdrafts or personal loans.

Savers: the gap between savings rates and reference rates is not strictly a 'credit spread'. Nevertheless, for households with sufficient savings, the opportunity cost of additional spending may be the deposit rate they could have earned had they continued to save rather than spend. It therefore makes sense to consider this within the household credit spread.

Within each of these four categories of households, a range of representative interest rates (shown in the third column of **Table 1**) are weighted together according to their share of gross new lending. These weights vary over time.(1)(2) The rates are taken from 'quoted' rates data, which are a weighted average of the rates advertised by banks and building societies for new lending or saving products.

Each rate is then expressed as a spread over the appropriate risk-free reference rate (fourth column of **Table 1**). The risk-free rates used are Bank Rate or, for longer-maturity products, overnight index swaps (OIS) of the appropriate maturity.(3)(4)

The four components of the household credit spread are shown in **Chart A**. The red line, for example, takes the quoted rate for high LTV borrowers and subtracts the appropriate reference rate (in this case the two-year OIS, as shown in the last column of **Table 1**). **Chart A** shows that spreads on all products rose sharply at the beginning of the financial crisis, reflecting a higher cost of bank funding, an increase in expected losses on bank lending and a re-evaluation of the loss absorbency of their capital positions. Spreads have fallen since mid-2012, following the introduction of new policy measures in both the euro area and the United Kingdom, including the Funding for Lending Scheme.

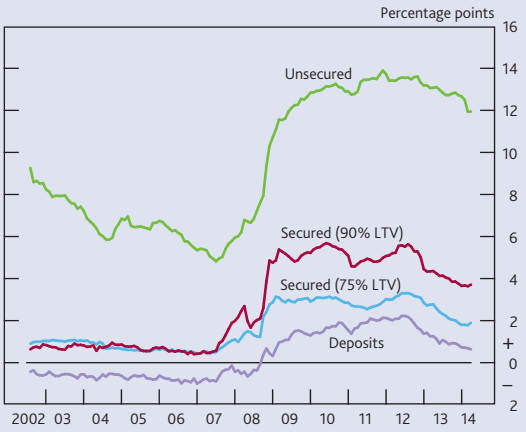
Table 1 Interest rates used to estimate the household credit spread

Household category	Proportion of households[a] (per cent)	Interest rate	Risk-free reference rate[b]
Low LTV borrowers	21	75% LTV two-year fixed-rate mortgage	Two-year OIS
		75% LTV five-year fixed-rate mortgage	Five-year OIS
		75% LTV Bank Rate tracker mortgage	Bank Rate
High LTV borrowers	4	90% LTV two-year fixed-rate mortgage	Two-year OIS
Unsecured borrowers	25	Credit card	Bank Rate
		Overdraft	Bank Rate
		£5,000 personal loan	Weighted average[c]
		£10,000 personal loan	Weighted average[c]
Depositors	50	One-year fixed-rate bond	One-year OIS
		Three-year fixed-rate bond	Three-year OIS
		Instant access deposit	Bank Rate

Sources: British Household Panel Survey and Bank calculations.

(a) Figures show the weights used to construct the overall household credit spread from the credit spread for each group. These weights reflect the proportions of households that are most likely to rely on each type of finance to fund extra spending, estimated using responses to the British Household Panel Survey.
(b) Prior to the August 2008 *Inflation Report* forecast, nominal gilt yields were used in place of OIS since OIS data were not available.
(c) Weighted average of Bank Rate, two-year and five-year OIS according to the proportions of fixed and floating, and the average maturity, of personal loans in the stock of lending each month.

Chart A The household credit spread components[a]



Sources: Bank of England, Bloomberg and Bank calculations.

(a) Spreads in **Chart A** are shown as absolute values, however, the overall household and summary credit spread measures are calculated as changes since 2007 Q3 (see **Chart 2**).

Weighting the groups together

The four components of the household credit spread are weighted together, according to the importance of these different types of credit for spending. The weights are taken from the 2005 British Household Panel Survey, and reflect the share of households facing different marginal sources of finance (the weights are shown in the second column of **Table 1**).

The components of the household credit spread could instead be weighted according to the outstanding stock of loans in each category. But this method would be likely to underestimate the level of household credit spreads. This is because unsecured loans — which tend to be priced at higher rates — form a relatively small proportion of the stock of lending, but are likely to be the marginal borrowing rate for a larger proportion of households. Any change in new unsecured borrowing rates is therefore likely to have a larger impact on consumption than implied by the share of unsecured loans in the total outstanding stock of loans.(5)

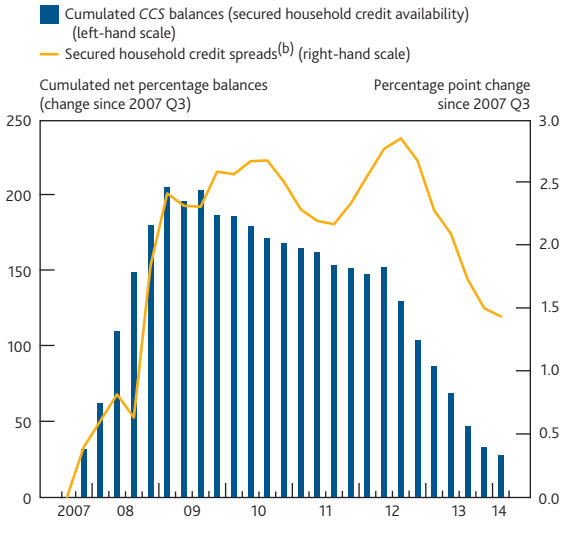
Once weighted together, the four components of the household credit spread form an estimate of the cost of finance for UK households as a whole. The household credit spread is shown in the magenta line in **Chart 2** in the main text of the article.

Capturing changes in non-price aspects of credit conditions

The household credit spread contains additional allowances for the effect of 'quantity rationing' — a reduction in the availability of certain loan products — on credit spreads. These are made through variations in the weights attached to each category of household borrower (see column 2 of **Table 1**). For example, when many banks stopped offering high LTV mortgage products in 2008, the weight on high LTV mortgage lending was reduced from 4% to 0% and the weight on unsecured borrowing was increased by the same amount. In other words, it was assumed that households who would previously have borrowed at high LTV rates could only borrow at unsecured rates (which are higher on average). As high LTV products have become increasingly available since then, the weight on these products has been increased.

(1) The weights are ideally based on each product's share of gross new lending so as to capture changes in the quantity borrowed over time. But due to a lack of suitable data, some weights are based on the stock of lending. These weights will vary more slowly over time.
(2) The weights on products within each category of households (third column of **Table 1**) are time-varying, since households of the same category — for example low LTV borrowers — may switch between lending products within that category — for example between two-year and five-year fixed-rate mortgages. But the overall weights on each category of households (second column of **Table 1**) and on the relative shares of households and businesses in the summary measure of credit spreads are generally kept constant to reflect the fact that it is difficult to switch between these categories.
(3) OIS is an interest rate swap where the floating leg of the swap pays SONIA (the sterling overnight index average), a daily weighted average of unsecured trades brokered by members of the Wholesale Markets Brokers' Association. Jackson and Sim (2013) provide a summary of recent developments in these overnight money markets.
(4) Prior to the August 2008 *Inflation Report* forecast, nominal gilt yields were used in place of OIS since OIS data were not available. This is consistent with the MPC judgement at the time that gilt yields provided an adequate indication of Bank Rate expectations.
(5) Other potential methods of weighting include weighting by households' shares of income; according to whether households are net debtors; and — since some households hold more than one loan product — by assuming that households' marginal borrowing rate is either the highest or the lowest cost of credit which they hold. Previous estimates suggested that the household credit spread falls within this range of methods.

Chart 3 Credit spreads and availability: secured household lending(a)



Sources: Bank of England, Bloomberg, British Household Panel Survey and Bank calculations.

(a) The question asked in the *Credit Conditions Survey* is 'Has the availability of credit which you provide to households become tighter or looser over the latest three months relative to the previous three months?'.
(b) The orange line is calculated as the weighted sum of the low and high LTV components of the household credit spread, where the weights are equal to those in the second column of **Table 1** in the box on pages 140–41. At times, these weights have been altered to attempt to capture changes in credit availability as discussed in the box on pages 140–41.

spreads (**Chart 3**).(1)(2) The profile for mortgage spreads has correlated well with the availability of household secured credit reported by banks in the *CCS*, especially at times when there have been large movements in credit spreads, for example in the early years of the crisis and since mid-2012. The measures were less well correlated in between these periods.

Provided that credit spreads are correlated with such measures of non-price terms and conditions, both the price terms (directly captured in the measures of credit spreads) and non-price terms are likely to be captured in the Bank of England's forecasting model. This is discussed in the following section.

Additional allowances for changes in credit availability are made within the calculation of the household and corporate credit spread measures. These are discussed further in the boxes on pages 140–43.

(1) The *Credit Conditions Survey* is a survey of UK banks which collects information on recent and expected developments in credit conditions. The latest survey can be found at www.bankofengland.co.uk/publications/Pages/other/monetary/creditconditions.aspx.
(2) The *CCS* balances refer to the change in credit conditions over the past three months. They are not normally cumulated, since this requires the assumption that a linear relationship holds between the different answer categories to each survey question, and could be biased by the entry and exit of certain banks from the sample. Nevertheless, the cumulated balances give a crude proxy of the change in the level of credit conditions over time.

The corporate credit spread

Calculating credit spreads for companies requires more judgement than for households because data on the cost of new bank loans to companies are limited. In particular, since corporate borrowing rates tend to be bespoke (in contrast to the more standardised loan products offered to household borrowers), there are no 'quoted' interest rates for businesses.

Data on 'effective' loan rates capture the average interest rates paid by companies that have successfully obtained finance. However, these data have several limitations. Effective rates may be affected by changes in the risk profile of borrowers, which could vary over time. This means that it is difficult to know whether an increase in effective rates represents a tightening or a loosening in credit conditions: for example, rates may rise because banks have charged higher interest rates to a given subset of borrowers, or because they have started to lend to a more risky category of borrowers who could not previously access credit. In addition, the variation in spreads over time calculated using effective interest rates appears small relative to other information on the cost of credit for businesses wishing to borrow. Therefore a range of other data, including information from surveys, is used to inform the corporate credit spread.

Corporate credit spreads are constructed using separate estimates for large businesses and for small and medium-sized enterprises. Borrowing rates tend to vary by firm size for a variety of reasons. In the past, rates on loans to smaller businesses have tended to be higher than those charged on loans to large companies, since smaller businesses are likely to be less established in their market and are less likely to have credit ratings. This means that banks tend to charge higher rates to smaller businesses in order to compensate for bearing that additional risk or uncertainty.

In contrast to the household credit spread, the corporate credit spread does not contain a deposit rate component. Companies typically need to maintain some cash holdings, for example to facilitate financial transactions or for a precautionary motive. And it appears that over the past decade UK companies have increased their cash holdings due to structural reasons, including increased substitution of cash for inventories and an increased volatility of firms' cash flow. But because holding cash incurs an opportunity cost, companies may be expected to return any excess cash to shareholders.

Groups of businesses

Large businesses

The corporate credit spread is designed to measure credit spreads on bank borrowing for firms. But many large companies issue corporate bonds as well as, or in place of, borrowing from banks. Credit spreads for large businesses are therefore estimated as the spread between the yield on corporate bonds and a risk-free rate of similar maturity.[1] This is assumed to be a reasonable proxy for the spread on bank borrowing for large businesses.

At times, however, conditions in corporate bond markets have differed from those in the market for bank credit. One example is following the launch of the MPC's programme of asset purchases or 'quantitative easing' (QE), including the Corporate Bond Secondary Market Scheme in March 2009,[2] when corporate bond spreads fell considerably more than spreads on bank lending. At these times, Bank staff have applied additional judgement based on information on credit spreads from the *Credit Conditions Survey* (*CCS*), in order to bring the level of corporate credit spreads closer to those on bank lending.

Corporate bonds are separated into different ratings categories depending on their riskiness. Investment-grade bonds (those with a rating between AAA and BBB-)[3] are viewed as less risky — since the issuer is considered less likely to default — and have a lower yield. High-yield bonds (with a rating below BBB-) are viewed as higher risk. Both types of corporate bonds are weighted together by market value to form the main component of the credit spread for large companies.

Small and medium-sized enterprises

Small and medium-sized enterprises (SMEs) do not typically obtain funds by issuing bonds.[4] Credit spreads for SMEs are therefore calculated using Department for Business, Innovation and Skills (BIS) interest rate data for SMEs and quoted credit card rates.[5][6] Credit card rates are used reflecting evidence from the *SME Finance Monitor* on the proportion of SMEs that use credit cards as a borrowing instrument. The use of credit card rates may also help to capture the subset of SMEs that borrow at very high rates from non-bank lenders.

The BIS interest rate data have remained fairly flat since mid-2009, at a relatively low level. This pattern does not appear wholly consistent with some other measures of credit conditions for SMEs, which tend to indicate a sharper increase in the cost of credit at the start of the crisis and in 2012.

In order to try to capture more of the variation in SME credit conditions since the start of the crisis, the SME component of the credit spread also incorporates the spreads balances for small and medium-sized businesses from the *CCS*. The net percentage balances of lenders reporting changes in spreads on lending to small and medium-sized businesses each quarter are cumulated over the period since 2007 Q3.[7] This

cumulated series provides a crude measure of the change in the cost of credit to SMEs since the start of the crisis.

Weighting the groups together

The two components — those for SMEs and large businesses — are weighted together to form the overall corporate credit spread, according to the share of both of these sectors in the stock of corporate lending (second column of **Table 1**). An alternative method would be to weight the two categories according to their share of corporate investment. But since large businesses account for around 60% of investment, these weights would be very similar to the weights based on the stock of lending. The corporate credit spread is shown by the green line in **Chart 2** in the main text of the article.

Capturing changes in non-price aspects of credit conditions

The corporate credit spread may not fully capture the impact of tighter non-price terms and lower credit availability for businesses. In particular, the BIS and effective rates data are likely to be poor proxies for the rates faced by potential borrowers, since they represent the cost of credit for companies that have been able to borrow rather than those that are seeking, but may struggle to obtain, additional finance. Nevertheless, the inclusion of spreads on high-yield bonds and credit card rates may help to capture the subset of firms for whom bank credit is less easily available.

Table 1 Interest rates used to estimate the corporate credit spread

Corporate category	Proportion of the stock of lending to firms[a] (per cent)	Interest rate	Risk-free reference rate
Large corporates	63	Investment-grade bonds	Maturity-matched government curve, adjusted for the gilt-OIS spread at five-year maturity.[b]
		High-yield bonds	Maturity-matched government curve, adjusted for the gilt-OIS spread at five-year maturity.[b]
		Judgement based on the *CCS*	
SMEs	37	BIS indicative SME interest rates	Bank Rate
		Credit card rates	Bank Rate
		Judgement based on the *CCS*	

Sources: Bank of England and Bank calculations.

(a) Weights are calculated as averages over 2013.
(b) Spreads over the maturity-matched government curve are adjusted for the spread between gilts and OIS at the five-year maturity (Bank of England adjustment).

(1) The spreads are obtained from BofA Merrill Lynch (spreads are option-adjusted, and apply to UK non-utilities companies). Spreads over the maturity-matched government curve are adjusted for the spread between gilts and OIS at the five-year maturity (Bank of England adjustment).
(2) See www.bankofengland.co.uk/markets/Pages/apf/corporatebond/default.aspx.
(3) Ratings definitions vary by ratings agency. The lowest rating for investment-grade bonds is BBB-, or Baa3 for Moody's.
(4) See the box 'Characteristics of companies with access to capital markets' on page 367 of Farrant *et al* (2013).
(5) The BIS rates data are only available from November 2008. Therefore the BIS data are spliced on to the Bank of England effective rates series for loans of less than or equal to £1 million in the quarters preceding 2009 Q1. The level of these two series is very similar.
(6) The credit card quoted rates are the same as those used in the household credit spread.
(7) See footnote 2 on page 141 for a discussion of some problems associated with cumulating the *CCS* balances.

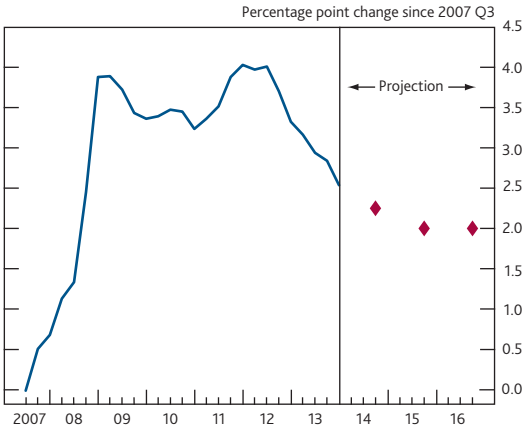
Forecasting credit spreads

Changes in credit conditions are likely to play an important role in influencing future economic activity. Projections for credit spreads are produced by Bank staff and are an important input into the MPC's macroeconomic forecasts. The diamonds in **Chart 4** show the projection of the summary measure that was published in the May 2014 *Inflation Report*. This section outlines the general approach used by Bank staff to project credit spreads, before discussing the forecast performance of the credit spread projections and how they are used to help inform the MPC's forecasts for output and inflation.

Forecasting credit spreads: the general approach

The credit spread forecast methodology has been refined over the crisis to help to improve accuracy and to provide a clearer narrative of credit conditions over the forecast. Under the current approach, Bank staff produce individual forecasts for each of the lending and savings products discussed in the boxes on pages 140–43. Although the precise forecasting approach varies by product — reflecting differences in data

Chart 4 The summary measure of credit spreads[a]



Sources: Bank of England, BDRC Continental *SME Finance Monitor*, Bloomberg, BofA Merrill Lynch Global Research, used with permission, British Household Panel Survey, Department for Business, Innovation and Skills and Bank calculations.

(a) The diamonds show the profile of the summary credit spread at one, two and three years ahead that was published in the May 2014 *Inflation Report*. The blue line shows the back data.

availability for households and firms, for example — the general process can be summarised in four steps. These are discussed in turn below.

Step 1: the near-term forecast

The latest data, together with other relevant indicators and market intelligence, are used to inform the near-term forecast for credit spreads. For example, if banks' funding costs rise sharply but the latest mortgage rates data remain unchanged, Bank staff would draw on market intelligence and evidence from surveys (such as the *Credit Conditions Survey* and *Bank Liabilities Survey*)(1) to assess whether mortgage rates were likely to rise in the near term.

Step 2: the loan price framework and the end-point of the forecast

The projected level of credit spreads at the end of the forecast horizon is based on estimates of the factors affecting banks' pricing of loans and deposits over the longer term. Using the loan pricing framework outlined in Button, Pezzini and Rossiter (2010), new lending rates can be decomposed into the following main factors:

- **Banks' funding costs.** These include the spreads on long-term wholesale funding (typically senior unsecured bonds) and the costs of interest rate swaps (hereafter 'swap costs').(2) Funding costs are likely to be affected by investors' perceptions of the riskiness of bank debt as well as the extent of implicit government guarantees.

- **Compensation for the risk that firms or households may not repay their loans in full (that is, 'credit risk').** This risk can be thought of as the sum of (i) the average expected losses associated with a given loan, and (ii) the cost of capital to cover losses that exceed banks' central expectations. The cost of capital will be affected by national and international regulation, including the Basel III minimum capital requirements.(3)

- **Other factors including banks' operating costs and mark-ups.** Banks will incur operating costs associated with the origination and servicing of loans. The mark-up ensures that new loans generate an expected rate of return over their lifetime.

Some of these components can be obtained from forward-looking financial market indicators.(4) But others, such as banks' term funding spreads, capital positions, the cost of capital and expected loan performance,(5) are estimates based on analysis by Bank staff. This analysis takes account of the impact of regulation, for example by incorporating the likely transition path of banks to the new Basel III capital regime.

Policy actions or other macroeconomic developments may also impact the likely path of credit spreads over the forecast. One example of this was the launch of the FLS in 2012, which was designed to incentivise banks and building societies to supply more credit by making more (and cheaper) funding available to them if they lent more to UK households and firms. The FLS was estimated to affect the profile, but not the steady-state level, of credit spreads, since the Scheme is temporary.(6) The use of any macroprudential tools that are expected to affect the credit conditions facing households and firms can also be considered when forecasting credit spreads. The projection for credit spreads is a key channel through which policies announced by the Financial Policy Committee can enter the MPC's forecast.(7)

Step 3: speed of adjustment of credit spreads

The remainder of the forecast profile is based on an assessment of how quickly changes in the factors outlined above, such as banks' funding costs, feed through into rates on new loans and deposits. The likely speed of pass-through is determined by estimating equations of the form:(8)

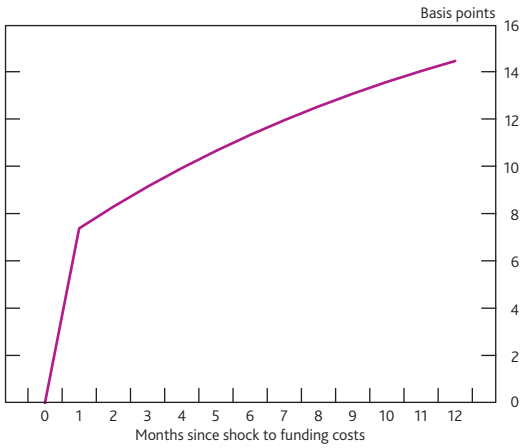
$$\Delta r_t = \alpha + \beta_1 ECM_{t-1} + \beta_2 \Delta swaps_t + \beta_3 X_t + \varepsilon_t$$

where Δr_t is the change in the interest rate charged on the loan or deposit product in question; $\Delta swaps$ captures changes in swap costs; X_t is a vector of control variables specific to each loan or deposit rate, α is a constant and ε_t is the residual term in the estimation. ECM_{t-1} is an error correction term, calculated as the rate charged on the product in the previous period minus the longer-run 'equilibrium' rate based on the factors in the loan pricing framework above. The estimated coefficient for the error correction term is negative — so when the observed rate on a product is higher than the equilibrium rate suggested by the loan price framework, the equation predicts the interest rate to fall in the current period (and *vice versa*). The coefficients in the equation therefore capture the average speed of pass-through to lending rates from contemporaneous changes in swap rates, along with the more gradual pass-through of other factors that affect banks' loan pricing in the longer run via the error correction term.

(1) See Driver (2007) and Bell, Butt and Talbot (2013).
(2) The funding cost typically used by each lender's treasury is the cost of raising variable-rate long-term wholesale debt. This is the cost of issuing fixed-rate senior unsecured bonds and entering into an interest rate swap where the lender receives a series of fixed-rate cash flows and pays a series of floating-rate cash flows. This means that the funding cost has two components: the stream of variable-rate cash flows paid in the interest rate swap (the 'swap costs'), and the spread of the fixed-rate bond yield over the swap rate. See the box on page 174 of Button, Pezzini and Rossiter (2010) for more details.
(3) See Farag, Harland and Nixon (2013) for more details on expected and unexpected losses, bank capital and prudential regulation.
(4) The relevant maturity swap rate (for instance the two-year swap rate for a two-year fixed-rate mortgage), and the overnight index swap (OIS) rate used in calculating the spread (for instance the two-year OIS for a two-year fixed-rate mortgage), can be obtained from financial markets.
(5) See Burrows *et al* (2012) for details on a model which can be used to forecast loan performance under different macroeconomic scenarios.
(6) See pages 14–15 of the May 2014 *Inflation Report* for more details on the impact of the FLS on lending rates.
(7) Tucker, Hall and Pattani (2013) describe the new powers for macroprudential policymaking in the United Kingdom in the wake of the recent financial crisis.
(8) The estimation period used for most products at the time of writing is from mid-2002 to early 2014.

Chart 5 shows the estimated pass-through of a 20 basis point funding cost shock. For illustrative purposes, this is assumed to comprise a 10 basis point increase in banks' swap costs and a 10 basis point widening in banks' term funding spreads. The chart shows regression estimates of the impact of this shock over successive months: the mortgage interest rate rises immediately as changes in swap costs are assumed to pass through quickly to loan rates, while the remainder of the shock, largely accounted for by the shock to term funding spreads, is passed through more slowly via the error correction term.

Chart 5 Estimated pass-through of a 20 basis point increase in funding costs to the interest rate charged on a two-year fixed-rate mortgage(a)



Sources: Bank of England, Bloomberg and Bank calculations.

(a) Effect of a +20 basis point funding cost shock, composed of +10 basis points to swaps and +10 basis points to five-year senior unsecured bond spreads, on the interest rate on a two-year fixed-rate 75% loan to value mortgage.

Step 4: aggregating forecasts and applying judgements on credit availability

The projections for each loan and deposit rate are weighted together to produce forecasts for household and corporate credit spreads and the summary measure of credit spreads. The previous section and boxes discuss the weighting procedure and the ways in which the weights can be varied to help capture changes in credit availability.

Chart 4 shows the projection for credit spreads that was published in the May 2014 *Inflation Report*. It declines over the forecast horizon, but remains elevated relative to the pre-crisis period. This partly reflects the judgement that, relative to before the crisis, banks are likely to continue to face a higher cost of funding in the future — reflecting a shift in investors' perceptions of risk and regulatory changes, including to reduce the problem of 'too important to fail' banks — which in turn will affect the cost of borrowing for households and firms. Of course, there is considerable uncertainty around this central projection.

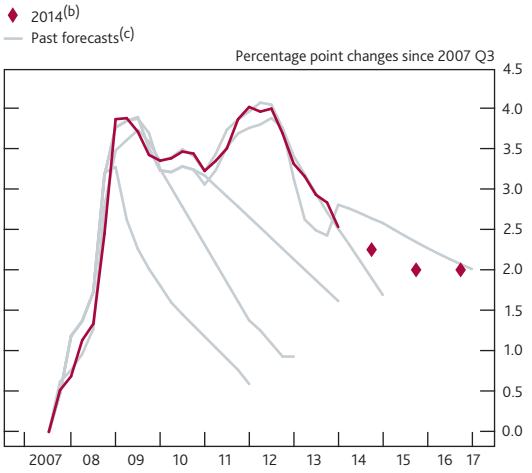
If credit spreads continue to remain elevated relative to the pre-crisis period then, all else being equal, the level of Bank Rate required to keep inflation close to the target and maintain demand in line with supply may be lower than pre-crisis. In other words, higher credit spreads are likely to be one reason why the appropriate level of Bank Rate may remain below the 5% level set on average by the Committee prior to the financial crisis for some time to come.(1)

Performance of the credit spread forecast

Bank staff have produced forecasts for credit spreads since 2007. The financial crisis created great uncertainty over this period meaning that, although each forecast incorporated the staff's best estimates of future developments in credit conditions, credit spreads often differed from the central projection due to unexpected shocks. One example is the intensification of the euro-area crisis in 2011, which led to a sharp, unanticipated rise in banks' funding costs.

Chart 6 illustrates the credit spread projections made at the start of each year for the past five years, together with the latest projection contained in the May 2014 *Inflation Report*. Earlier forecasts anticipated more of a pass-through of the cuts to Bank Rate in 2008 and 2009 into lending rates than subsequently occurred, as conditions in the banking sector remained strained.(2) And forecasts made at the beginning of 2010 and 2011 did not fully anticipate the rise in banks' funding costs which occurred as a result of the intensification of the euro-area crisis. Forecasts made after mid-2011 have coincided more closely with the subsequent changes in credit spreads. The forecasts show how the projected 'end-point' for the summary credit spread has typically been revised up over time.

Chart 6 The evolution of credit spread projections over time(a)



Sources: Bank of England, BDRC Continental *SME Finance Monitor*, Bloomberg, BofA Merrill Lynch Global Research, used with permission, British Household Panel Survey, Department for Business, Innovation and Skills and Bank calculations.

(a) Back data differ between forecasts due to data revisions and methodological changes.
(b) The diamonds show the profile of the summary credit spread at one, two and three years ahead that was published in the May 2014 *Inflation Report*.
(c) The grey lines show the summary credit spread profiles that were used to inform the MPC's modal macroeconomic projections in the February *Inflation Report* of the years 2009–13.

(1) See the box on page 40 of the February 2014 *Inflation Report*.
(2) See Bell and Young (2010) for a more detailed discussion of shocks to credit supply and the weakness of bank lending between 2007 and 2010.

Credit spreads in the MPC's forecast

The credit spread profile provides a means for the MPC to include judgements about credit conditions in their forecasts for output and inflation. But incorporating credit spreads into the Bank's central forecasting model is not straightforward.

At the time of writing there is no canonical model in the academic literature that captures all of the effects of the financial sector on the wider economy.(1) As outlined in Burgess *et al* (2013), however, the Bank's 'suite of models' contains a variety of methods that can be used to estimate the impact of developments in credit spreads (captured in the credit spread projections) on key economic variables.(2) One approach is to 'adjust' the path of Bank Rate in the forecast using the credit spread projections, in order to capture the wedge between Bank Rate and the marginal interest rates facing households and firms. A second method is a structural VAR model (described in Barnett and Thomas (2013)) which traces through the implications of shocks to credit supply and credit demand for key macroeconomic variables. The suite of models also contains a version of the Gertler-Karadi model (Gertler and Karadi (2011)) estimated for the United Kingdom by Villa and Yang (2011). This model assumes that banks face financial frictions, which result in higher interest rates on new lending for non-financial companies.

A more recent approach used by Bank staff is to estimate the impact of credit spreads separately for each sector of the economy using a vector error correction model (VECM). This allows changes in credit spreads for different sectors — for example, secured or unsecured household borrowers, or firms — to have different impacts on the economy. In addition to the price of credit, the VECM should also capture broader developments in credit conditions, such as changes in non-price terms. This is because — to the extent that unobserved changes in non-price terms are correlated with measures of credit spreads (as shown in **Chart 3**) — the estimated coefficients of the VECM should capture both of these aspects of credit conditions. This sectoral approach to modelling the impact of credit conditions was used to inform the MPC's central macroeconomic projections published in the May 2014 *Inflation Report*.

Conclusion

This article introduced the Bank of England's preferred measures of credit spreads and the role they play in the MPC's forecasts for output and inflation. Credit spreads measure the difference between the new interest rates faced by households and firms on loans and savings products and appropriate risk-free rates. The summary measure of credit spreads provides an estimate of the extent to which credit conditions have changed for the 'average' UK borrower since the start of the financial crisis.

The summary measure suggests that credit spreads rose sharply following the onset of the financial crisis and after the intensification of the crisis in the euro area in 2011. Since mid-2012, credit spreads have fallen continuously following the introduction of new policy measures in both the euro area and the United Kingdom. These policies — including the FLS in the United Kingdom and the announcement of Outright Monetary Transactions in the euro area — are likely to have contributed towards a fall in banks' funding costs, which in turn has led to lower lending rates.

Given the importance of credit conditions for households' and firms' consumption and investment decisions, future changes in credit spreads will affect GDP growth and inflation. In the May 2014 *Inflation Report*, credit spreads were expected to ease further as conditions in the banking sector continue to normalise. But credit spreads are likely to remain higher than at the start of the crisis, partly because changes in investors' perceptions of the riskiness of bank debt and a reduction in implicit government guarantees mean that banks may continue to face higher costs of funding in the future, relative to the pre-crisis period.

(1) This is not to say that there has not been progress in this regard. See, for example, Bernanke, Gertler and Gilchrist (1999), Kiyotaki and Moore (1997) and Gertler and Karadi (2011). Such approaches introduce market frictions, which results from an agency problem between borrower and lender, and result in higher borrowing costs than would otherwise be the case.
(2) The suite of models approach is described in detail in Burgess *et al* (2013).

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Assessing the risk to inflation from inflation expectations

By Gareth Anderson and Becky Maule of the Bank's Monetary Assessment and Strategy Division.[1]

- Well-anchored inflation expectations play an important role in the achievement of the Monetary Policy Committee's (MPC's) 2% inflation target.
- At the moment, available measures are consistent with inflation expectations remaining well anchored to the MPC's target.
- Empirical work suggests that unexplained 'shocks' to households' expectations may have had a significant impact on inflation over the past.

Overview

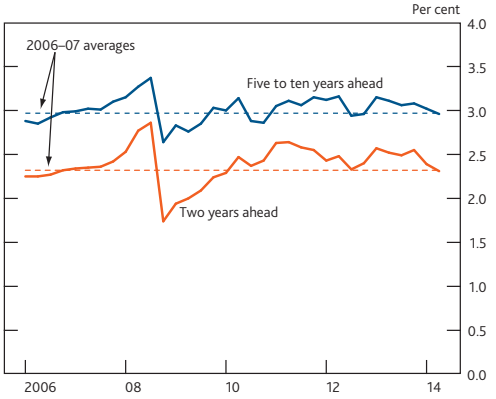
People's expectations about future inflation play an important role in determining the current rate of inflation: when people believe that inflation will be low and stable, they set wages and prices in a way that is consistent with those beliefs. Given that, the Monetary Policy Committee (MPC) monitors indicators of inflation expectations and they are a crucial factor in policy decisions.

There is a wide range of external indicators that the MPC draws on to assess whether inflation expectations remain well anchored, and there are a number of metrics that can be used to shed light on the risks around inflation expectations. Given that indicators of inflation expectations are numerous, and can move in different ways, it is helpful to provide an overview of the information they contain. This article introduces two methods to do that. One is based on a 'heat map' which uses statistical tests to analyse how unusual the latest outturns for various indicators are. Another relies on constructing summary measures of the various indicators of the levels of inflation expectations. These measures extract the overall signal from all the indicators of inflation expectations at each horizon.

Based on the latest data, the heat map and the summary measures are both consistent with inflation expectations remaining well anchored at all horizons. For example, the summary measures for expectations both two and five to ten years ahead are close to their pre-crisis levels, when inflation was close to the target, on average (see **summary chart**). And they have varied relatively little over the past few years. Across a wider set of metrics, most indicators also remain consistent with expectations being anchored.

The article also assesses the impact of the expectations of different economic agents — such as households and professional forecasters — on the actual rate of inflation. The analysis presented suggests that shocks to households' inflation expectations can have a significant impact on inflation. Inflation is estimated to increase by around 0.7 percentage points at the one-year horizon in response to a 1 percentage point shock to households' inflation expectations. In contrast, the empirical work suggests that shocks to professional forecasters' inflation expectations generally do not have a significant impact on inflation. But the analysis presented in this article is consistent with professional forecasters' expectations providing information to households on which to base their expectations, via reports in the media, for example.

Summary chart Summary measures of the levels of various indicators of inflation expectations[a]



Sources: Bank of England, Barclays Capital, Bloomberg, CBI (all rights reserved), Citigroup, GfK NOP, HM Treasury, ONS, YouGov and Bank calculations.

(a) Data are non seasonally adjusted. For more information on how these measures are constructed, see Annex 2 on page 160.

(1) The authors would like to thank Nicola Worrow for her help in producing this article.

The Bank's monetary policy objective is to deliver price stability — defined by the Government's inflation target of 2%, as measured by the consumer prices index (CPI) — and, subject to that, to support the Government's economic objectives including those for growth and employment. Well-anchored inflation expectations are an important part of the monetary policy framework. People's expectations about future inflation play an important role in determining the current rate of inflation: when people believe that inflation will be low and stable, they set wages and prices in a way that is consistent with those beliefs.

There is a wide range of external indicators that the Monetary Policy Committee (MPC) draws on to assess whether inflation expectations remain well anchored. An article in the 2013 Q2 *Quarterly Bulletin* concluded that most of those indicators were consistent with inflation expectations remaining anchored to the target.(1) The article noted, however, that there continued to be a risk that expectations could become less well anchored while inflation was above the target. At the time of publication, CPI inflation had been above 2% for around three and a half years.

Over the past year, inflation has fallen, and is currently a little below the target. While the outlook is uncertain, the MPC's latest forecasts contained in the May 2014 *Inflation Report* project that, in the central view, inflation is likely to remain close to 2% over the next few years. This article discusses how indicators of inflation expectations have evolved over the past year, and the impact of those expectations on inflation. The first section discusses recent movements in inflation expectations, and assesses the extent to which they remain anchored by monetary policy. The second section analyses the impact that different measures of inflation expectations have on inflation, and the channels through which those effects might occur. The final section concludes.

Assessing the extent to which expectations remain anchored

The MPC is able to meet its objective more easily when inflation expectations are anchored by the monetary policy framework. Inflation expectations are considered to be anchored if deviations of inflation from the target are expected to be transitory, so that people have a reasonable degree of confidence that inflation will return to the target in the medium term and remain there. In that case, companies and households are likely to set prices and wages in a way that will help to limit the extent to which any deviation in inflation persists. Conversely, if inflation expectations were to become less well anchored, deviations of inflation from the target might trigger changes in price-setting and wage-setting behaviour that could make those deviations more persistent and more costly to reverse.

If inflation expectations were to become less well anchored, that might become apparent in indicators of expectations at both short and longer-term horizons. Shorter-term inflation expectations might become less well anchored if people believe that the MPC has become more tolerant of deviations of inflation from the target, even if they expect inflation to return to the target eventually. And longer-term inflation expectations might become less well anchored if people doubt the determination of the MPC to return inflation to the target in the long run.

The MPC has three main metrics for monitoring the risks to inflation expectations: the level of inflation expectations; uncertainty about future inflation; and the sensitivity of longer-term expectations to economic news. And the MPC monitors a broad range of indicators of these metrics, including measures from surveys of households and companies, forecasts by professional economists and indicators based on financial market instruments.(2) This section reviews the latest data to assess whether expectations appear to be well anchored.

The levels of inflation expectations

Tables A and **B** show indicators of inflation expectations at shorter and longer-term horizons. Interpreting whether the levels of the series shown in these tables are consistent with expectations remaining well anchored around the MPC's target can be difficult. This is because some measures are not direct indicators of expectations for CPI inflation — the MPC's target variable. For example, measures derived from financial instruments reference RPI inflation, and the surveys of households ask about general price movements, not a specific price index (see Annex 1 for details of the questions asked). One way to try and assess whether indicators of expectations are consistent with well-anchored CPI inflation is to compare the series' current levels with their historical averages — particularly averages taken over a time when CPI inflation averaged close to the MPC's 2% target.

There is an additional complication in assessing the implications of expectations data at shorter horizons because, although the inflation target applies at all times, the MPC's remit recognises that the actual inflation rate will occasionally move away from 2% as a result of disturbances to the economy. So, even if inflation expectations remain anchored, shorter-term indicators are likely to move in response to economic shocks that are projected to push inflation away from the target temporarily. One way to assess whether differences between the levels of indicators and their past averages reflect economic shocks is to compare them to the MPC's forecast for inflation, which captures the Committee's judgement about how various economic developments have affected the outlook for inflation.

(1) See Maule and Pugh (2013).
(2) The available measures are described in more detail in Annex 1.

Table A Indicators of shorter-term inflation expectations[a]

Per cent

	Start of data	Whole-sample average	Averages to 2007[b]	Averages since 2008[c]	2013 Q1	2013 Q2	2013 Q3	2013 Q4	2014 Q1	2014 Q2[d]
One year ahead expectations:										
Surveys of households[e]										
Bank/GfK NOP	Dec. 1999	2.8	2.3	3.3	3.6	3.6	3.2	3.6	2.8	2.6
Barclays Basix	Dec. 1986	3.6	3.8	3.1	3.1	2.6	2.8	2.8	2.3	2.4
YouGov/Citigroup	Nov. 2005	2.7	2.5	2.7	2.8	2.5	2.6	2.8	2.2	2.0
Survey of companies										
CBI[f]	June 2008	2.0	n.a.	2.0	1.4	0.9	1.2	1.0	1.4	n.a.
Surveys of professional forecasters										
Bank	Feb. 2006	2.0	1.9	2.1	2.2	2.5	2.5	2.4	2.1	2.0
HM Treasury[g]	Feb. 2004	2.1	2.0	2.1	2.2	2.3	2.3	2.4	2.0	1.9
Measures derived from financial instruments[h]										
Swaps	Oct. 2004	2.7	2.6	2.7	3.2	3.0	2.9	3.0	2.8	2.9
MPC *Inflation Report* forecast[i]	Feb. 2004	2.0	1.9	2.1	3.0	2.6	2.5	2.1	1.8	1.7
Two year ahead expectations:										
Surveys of households[e]										
Bank/GfK NOP	Mar. 2009	2.9	n.a.	2.9	3.4	3.3	3.0	3.4	2.8	2.5
Barclays Basix	Dec. 1986	3.9	4.1	3.4	3.5	2.8	3.1	3.2	2.7	2.8
Surveys of professional forecasters										
Bank	Feb. 2006	2.0	2.0	2.0	2.2	2.3	2.2	2.2	2.2	2.0
HM Treasury[g]	Feb. 2004	2.0	2.1	2.0	2.2	2.2	2.2	2.2	2.1	2.0
Measures derived from financial instruments[h]										
Swaps	Oct. 2004	2.8	2.8	2.8	3.1	3.0	3.0	3.0	3.0	3.1
MPC *Inflation Report* forecast[i]	Feb. 2004	1.8	2.0	1.6	2.3	2.0	2.0	1.9	1.9	1.9
Memo:										
CPI inflation	Jan. 1997	2.1	1.6	3.1	2.8	2.7	2.7	2.1	1.7	1.8

Sources: Bank of England, Barclays Capital, Bloomberg, CBI (all rights reserved), Citigroup, GfK NOP, HM Treasury, ONS, YouGov and Bank calculations.

(a) Data are non seasonally adjusted.
(b) Averages run from the start of the series to 2007 Q4.
(c) Averages run from 2008 Q1 (or the start of the series if later) to the latest data.
(d) YouGov/Citigroup data point is an average of April and May 2014. Financial markets data are the averages from 1 April 2014 to 20 May 2014. CPI inflation data point is April 2014.
(e) The household surveys ask about expected changes in prices but do not reference a specific price index, and the measures are based on the median estimated price change.
(f) Mean estimated price change for the distribution sector. Companies are asked about the expected percentage price change over the coming twelve months in the markets in which they compete.
(g) Data are taken from the quarterly surveys of medium-term forecasts, which, for CPI inflation, start in February 2004. Before that date, the surveys asked about RPIX inflation.
(h) Financial market measures are RPI inflation at various horizons implied by swaps.
(i) Data are the MPC's modal projections for CPI inflation. CPI inflation projections have been published since February 2004; before that date, the MPC projected RPIX inflation, the Bank's previous target measure of inflation.

In contrast, longer-term inflation expectations would not be expected to move in response to transitory economic shocks if they are anchored; they would be expected to remain relatively stable at levels consistent with the inflation target. For example, announced increases in household energy bills might be expected to raise inflation — and therefore inflation expectations — in the near term. But if expectations are well anchored, they should not be affected further ahead: at that point, the price rises will have dropped out of the annual inflation calculation.

Overall, indicators of shorter-term inflation expectations appear to be well anchored. In general, the current levels of one year ahead inflation expectations measures are close to, or somewhat below, their historical averages (**Table A**). This is consistent with the MPC's central projection for inflation in the May 2014 *Inflation Report* at the one-year horizon, which was also a little below historical averages and the inflation target — reflecting judgements about economic developments. Over the past year, some measures of expectations one year ahead have fallen quite sharply, as has the MPC's projection at that horizon. Two years ahead, indicators of financial markets' and professional forecasters' expectations — and the MPC's central projection — are close to their historical averages, although households' expectations are a little below theirs.

All indicators of longer-term expectations are currently relatively close to historical averages (**Table B**), consistent with inflation expectations remaining anchored. Measures of households' inflation expectations have not been particularly stable over the past year though — most increased towards the end of 2013, before falling back sharply in early 2014.

Table B Indicators of longer-term inflation expectations[a]

Per cent

	Time horizon	Start of data	Whole-sample average	Averages to 2007[b]	Averages since 2008[c]	2013 Q1	2013 Q2	2013 Q3	2013 Q4	2014 Q1	2014 Q2[d]
Surveys of households[e]											
Bank/GfK NOP	5 years	Mar. 2009	3.3	n.a.	3.3	3.6	3.6	3.5	3.7	3.2	2.9
Barclays Basix	5 years	Sep. 2008	3.8	n.a.	3.8	3.6	3.5	4.0	3.9	3.6	3.7
YouGov/Citigroup	5–10 years	Nov. 2005	3.4	3.5	3.4	3.5	3.3	3.3	3.7	3.0	3.0
Surveys of professional forecasters											
Bank	3 years	Feb. 2006	2.0	1.9	2.0	2.2	2.2	2.2	2.2	2.1	2.1
HM Treasury[f]	4 years	Feb. 2006	2.1	2.1	2.2	2.4	2.2	2.2	2.1	2.2	2.1
Measures derived from financial instruments[g]											
Swaps	5–10 years	Oct. 2004	3.3	3.0	3.5	3.4	3.5	3.5	3.5	3.4	3.4
Memo:											
CPI inflation		Jan. 1997	2.1	1.6	3.1	2.8	2.7	2.7	2.1	1.7	1.8

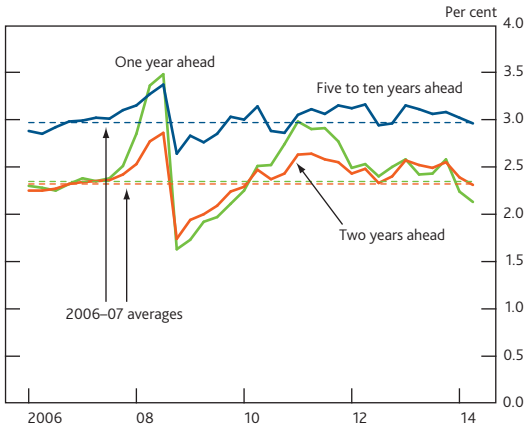
Sources: Bank of England, Barclays Capital, Bloomberg, Citigroup, GfK NOP, HM Treasury, ONS, YouGov and Bank calculations.

(a) Data are non seasonally adjusted.
(b) Averages run from the start of the series to 2007 Q4.
(c) Averages run from 2008 Q1 (or the start of the series if later) to the latest data.
(d) YouGov/Citigroup data point is an average of April and May 2014. Financial markets data are the averages from 1 April 2014 to 20 May 2014. CPI inflation data point is April 2014.
(e) The household surveys ask about expected changes in prices but do not reference a specific price index, and the measures are based on the median estimated price change.
(f) Data are taken from the quarterly surveys of medium-term forecasts, which, for CPI inflation, start in February 2004. Before that date, the surveys asked about RPIX inflation.
(g) Five-year, five-year forward RPI inflation implied by swaps.

Given that the various indicators of the levels of inflation expectations often move in different ways, it can be helpful to use summary measures to assess the general message, abstracting from the 'noise' in individual series. Summary measures of inflation expectations at a number of horizons are shown in **Chart 1**. Annex 2 on page 160 of this article discusses how these measures have been constructed.

The summary measures suggest that inflation expectations are well anchored at all horizons. The one year ahead measure is a little below its pre-crisis average, but that is consistent with the MPC's central projection at that horizon, and so probably reflects economic developments (**Chart 1**). At the five to ten-year horizon, the summary measures are close to pre-crisis levels, and have varied relatively little over the past few years.

Chart 1 Summary measures of the levels of inflation expectations[a]



Sources: Bank of England, Barclays Capital, Bloomberg, CBI (all rights reserved), Citigroup, GfK NOP, HM Treasury, ONS, YouGov and Bank calculations.

(a) Data are non seasonally adjusted. For more information on how these measures are constructed, see Annex 2 on page 160.

Uncertainty about inflation

Individuals' uncertainty about future inflation may increase if they become less sure that the MPC will respond to shocks that would push inflation away from the target persistently. Alternatively, an increase in people's uncertainty about inflation could also result from a change in view about the size or persistence of shocks that might affect the economy in the future. For example, the uncertainty around the MPC's inflation projections has increased since the financial crisis. In that case, while the decisions of households and firms might be affected,[1] it would not necessarily signal that inflation expectations have become less well anchored by monetary policy.

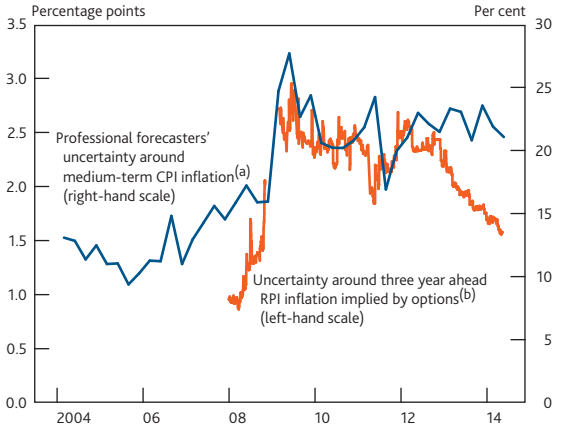
The Bank's survey of external forecasters (SEF) provides one indicator of the amount of uncertainty over the level of future inflation. It provides information about how wide or narrow the distribution of professional forecasters' expectations is, given the probabilities they attach to various outcomes for future inflation. Alternatively, options prices can be used to estimate the weight that market participants attach to different future inflation outcomes.[2]

Over the past year, neither measure suggests that inflation uncertainty has increased. The uncertainty around

(1) See Haddow *et al* (2013) for a discussion of how uncertainty matters for economic activity.
(2) See Smith (2012) for a detailed discussion of how implied probability density functions for UK RPI inflation can be calculated from inflation options.

professional forecasters' expectations has been relatively stable, while the implied volatility from inflation options prices suggests that uncertainty has declined somewhat (**Chart 2**). Both measures remain elevated relative to the period preceding the financial crisis, however.

Chart 2 Uncertainty around three year ahead inflation for professional forecasters and financial market participants



Sources: Bank of England, Bloomberg and Bank calculations.

(a) Professional forecasters' uncertainty is calculated as the average probability that inflation will be more than 1 percentage point away from the target, calculated from the probability distributions for inflation reported by forecasters responding to the Bank's survey. Forecasters' reported probability distributions for CPI inflation two years ahead between February 2004 and February 2006; and for CPI inflation three years ahead from May 2006 onwards.
(b) Standard deviation of the probability distribution of annual RPI inflation outturns three years ahead implied by options. It is not possible to construct a full set of probability distributions for some days due to technical reasons.

Responses to a survey of households also suggest that uncertainty about the future rate of inflation has not increased over the past year. The Bank/GfK NOP survey asks respondents how confident they are about inflation being within 1 percentage point of the target in two to three years' time. In 2014, just under 40% of households reported that they were very or fairly confident that inflation would be close to the target, slightly higher than the proportion giving these responses in 2013.

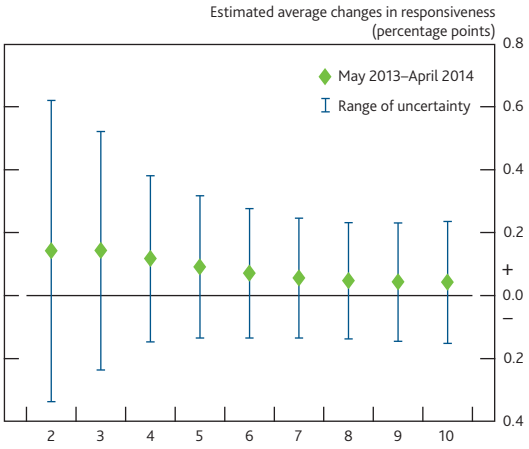
The responsiveness of longer-term inflation expectations

As discussed above, unexpected economic news might be expected to result in changes to individuals' inflation expectations in the near term, but not to those at longer horizons. If longer-term inflation expectations become more responsive to news, it could indicate that people have begun to expect deviations of inflation from the target to be more persistent, or have begun to attach less weight to the MPC bringing inflation back to the target in the long run.(1)

One source of news that might be expected to affect near-term inflation expectations is a 'surprise' in the outturn for CPI inflation. For example, if inflation is unexpectedly high, individuals might revise up their forecast for inflation in the short term. But longer-term expectations should not move in response to such news if they remain well anchored.

Market participants' sensitivity to the news in inflation outturns can be estimated by observing movements in financial market measures of inflation expectations on the day CPI inflation data are published, and comparing those movements to the difference between the inflation outturn and the market median expectation for the data before its release. Over 2004–07, on average, market measures of expected inflation did not respond significantly to CPI news at horizons greater than one year ahead. The green diamonds in **Chart 3** show the change in the responsiveness over the past year relative to that period. For example, the green diamond at the five-year horizon shows the estimate of how much more responsive five year ahead inflation expectations have been to CPI news over the past year than they were during 2004–07. And the bar shows a measure of the uncertainty around that central estimate.

Chart 3 Change in responsiveness of instantaneous forward inflation rates to CPI news relative to pre-crisis(a)



Sources: Bloomberg, ONS and Bank calculations.

(a) The diamonds show the estimated slope coefficients for the change in responsiveness of instantaneous forward inflation rates (derived from inflation swaps) to news in the CPI release over the past twelve months relative to the pre-crisis period (2004–07). The bars cover two standard errors either side of the estimated slope coefficients.

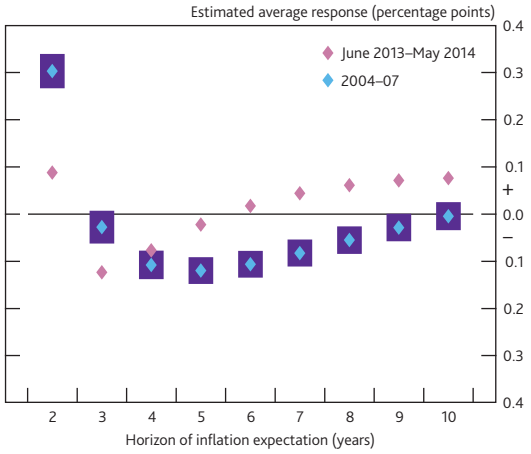
Over the past twelve months, inflation expectations appear to have been a little more responsive to news in the CPI release than they were during 2004–07, although the size of the changes is very small relative to the uncertainty surrounding the estimates, as indicated by the bars showing statistical significance.

An alternative approach of assessing whether the responsiveness of longer-term expectations has increased is to estimate the sensitivity of measures of expected inflation at longer horizons to changes in one year ahead expectations. One year ahead expectations might well be reassessed if there is news, but expectations at longer horizons should not change much in response to economic developments if they are well anchored.

(1) For more on this topic, see Gürkaynak, Levin and Swanson (2006).

For market measures of inflation expectations, movements in two year ahead inflation expectations were correlated with those one year ahead during 2004–07, but beyond that horizon, inflation expectations tended to change little (**Chart 4**). Over the past year, inflation expectations six to ten years ahead have tended to move in a similar direction to one year ahead expectations, unlike during 2004–07. But these movements are small — less than 0.1 percentage points in response to a 1 percentage point increase in one year ahead expectations. And the correlation between changes in market measures of shorter-term and longer-term expectations could also reflect other factors, for example variations in liquidity in the markets for short and long-maturity instruments.

Chart 4 Estimated changes in instantaneous forward inflation rates derived from swaps in response to a 1 percentage point increase in one year ahead inflation expectations[(a)]



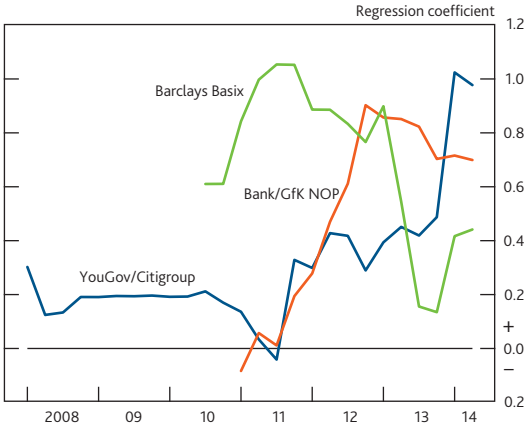
Sources: Bloomberg and Bank calculations.

(a) The average changes are estimated using the slope coefficients from regressions of daily changes in instantaneous inflation forward rates at each horizon on the daily change in the one year ahead instantaneous forward rate. The instantaneous forward rates are derived from inflation swaps. Data start in October 2004. Data for May 2014 are based on daily data from 1 May to 20 May 2014. The bars cover two standard errors either side of the estimated slope coefficients for the 2004–07 period.

Some longer-term household measures of inflation expectations appear to have become more sensitive to shorter-term indicators over the past few years. **Chart 5** shows the coefficient estimates from rolling regressions of changes in longer-term household inflation expectations on one year ahead expectations. For the Citigroup measure in particular, the sensitivity has increased recently, although the sample period is short. And the same pattern is less evident for the Basix measure of households' expectations. Differences between the sensitivities of the measures might, in general, reflect differences in the questions asked in the various surveys.

Assessing whether inflation expectations are sensitive to inflation outturns might also provide evidence about how well anchored inflation expectations are. **Chart 6** shows the estimated coefficients from rolling regressions of five to ten

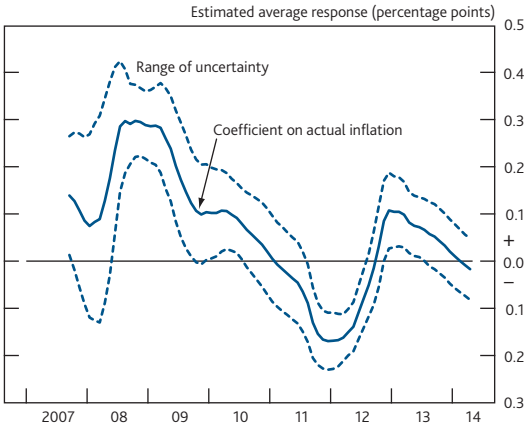
Chart 5 Two-year rolling estimates of changes in longer-term household inflation expectations in response to a 1 percentage point increase in one year ahead expectations[(a)]



Sources: Bank of England, Barclays Capital, Citigroup, GfK NOP, YouGov and Bank calculations.

(a) The lines show the estimated slope coefficients from two-year rolling regressions of quarterly changes in five or five to ten-year inflation expectations from each survey on the equivalent change in the one year ahead measure. YouGov/Citigroup data point for 2014 Q2 is based on an average of data for April and May 2014.

Chart 6 Three-year rolling estimates of the responsiveness of five to ten year ahead inflation expectations to inflation outturns[(a)]



Sources: Bloomberg and Bank calculations.

(a) Data from September 2007 to April 2014. The solid line shows estimated slope coefficients from three-year rolling regressions of monthly-average five to ten-year forward RPI inflation rates (derived from swaps) on CPI inflation. The dashed lines cover two standard error bands either side of the estimated slope coefficients.

year ahead inflation expectations derived from financial markets on CPI inflation outturns. If longer-term inflation expectations were well anchored, one would expect them not to be sensitive to the level of actual inflation, and so the estimated coefficient to be zero. The estimated coefficients have varied over the past, but the most recent estimates are close to zero, suggesting that longer-term inflation expectations have not been related to inflation outturns.

Inflation expectations 'heat map'

To help assess whether inflation expectations remain well anchored, summary 'heat maps' can be constructed. These

perform tests of statistical significance on the latest outturns for many of the indicators of inflation expectations in this section.

When a cell is coloured green, the indicator is unlikely to provide cause for concern. A green cell signals either that the indicator is close to a historical average, or for the shorter-term indicators, that it is close to the level that might be expected, given economic circumstances — with those summarised by the MPC's projections. To the extent that those averages provide a good proxy for what level the indicators might be expected to be at when inflation expectations are well anchored, a green cell suggests that the indicator is consistent with well-anchored expectations.

When cells are not green, the indicator might be signalling that there is a risk to inflation expectations. For the various indicators of the levels of inflation expectations, cells are coloured amber and red when measures are above their historical averages — with the darker colour showing those that are further away — and so might suggest that inflation expectations pose an upside risk to inflation. And those coloured light and dark blue signal the opposite. If the indicators of uncertainty and responsiveness increase relative to their historical averages, that might suggest that inflation expectations are becoming less well anchored, although not the direction of that risk. For those indicators, grey and black cells indicate where risks could be arising. White cells indicate where we do not have data.

Figure 1 Heat map for the levels of inflation expectations[a]

	Financial markets[b]	Professional forecasters[c]		Households[d]			Companies[e]
	Swaps	Bank SEF	HM Treasury	Bank/NOP	Citigroup	Barclays Basix	CBI
Short-term expectations (one year)							
– relative to MPC's forecast[f]							
Medium-term expectations (two year)							
– relative to MPC's forecast[f]							
Medium-term expectations (three year)							
– relative to whole-sample average							
– relative to post-crisis average[g]							
– relative to pre-crisis average[h]							
– relative to MPC's forecast[f]							
Longer-term expectations compared to series average							
– relative to whole-sample average							
– relative to post-crisis average[g]							
– relative to pre-crisis average[h]							

Key: π^e more than 2 standard deviations (SD) higher; π^e more than 1 SD higher; π^e less than 1 SD away; π^e more than 1 SD lower; π^e more than 2 SD lower

Figure 2 Heat map for uncertainty and the responsiveness of inflation expectations[a]

	Financial markets[i]	Professional forecasters[j]		Households			Companies
	Swaps	Bank SEF	HM Treasury	Bank/NOP	Citigroup	Barclays Basix	CBI
Inflation uncertainty relative to series average							
– relative to whole-sample average							
– relative to post-crisis average[g]							
– relative to pre-crisis average[h]							
Longer-term inflation expectations more responsive to:							
– shorter-term inflation expectations[k]							
– CPI news[k]							
– deviations of inflation from target[l]							

Key: Uncertainty/responsiveness considerably above average; Uncertainty/responsiveness above average; Uncertainty/responsiveness around or below average

Sources: Bank of England, Barclays Capital, Bloomberg, CBI (all rights reserved), Citigroup, GfK NOP, HM Treasury, ONS, YouGov and Bank calculations.

(a) Data are non seasonally adjusted. The latest data for the Bank and HM Treasury surveys of professional forecasters and the Bank/GfK NOP and Barclays Basix household surveys are for 2014 Q2. For the YouGov/Citigroup household survey, the data are for May 2014 and for the financial markets measure, the data are the averages for the 20 working days to 20 May 2014. For the CBI company survey measures, the latest data are for 2014 Q1.
(b) Financial market measures for each horizon are instantaneous RPI inflation one, two and three years ahead and five-year, five-year forward RPI inflation, derived from swaps.
(c) Taken from the Bank's survey of external forecasters and HM Treasury's medium-term *Forecasts for the UK economy: a comparison of independent forecasts*.
(d) The household surveys ask about expected changes in prices but do not reference a specific price index, and the measures are based on the median estimated price change.
(e) Mean estimated price change for the distribution sector. Companies are asked about the expected percentage price change over the coming twelve months in the markets in which they compete.
(f) Comparisons use the MPC's modal projections for CPI inflation at the relevant horizon.
(g) Post-crisis averages run from 2009 Q1 to 2013 Q2.
(h) Pre-crisis averages run from the start of the series to 2007 Q4.
(i) Inflation uncertainty is measured by the standard deviation of the probability distribution of annual RPI inflation outturns three years ahead implied by options. For the tests of whether longer-term inflation expectations have become more responsive to shorter-term inflation expectations and CPI news, instantaneous RPI inflation forward rates at horizons between one and ten years (derived from swaps) are used. For the test of whether longer-term inflation expectations have become more responsive to deviations of inflation from target, the monthly-average five to ten-year forward RPI inflation rate (derived from swaps) is used.
(j) Professional forecasters' uncertainty is calculated as the average probability that inflation will be more than 1 percentage point away from the target three years ahead, calculated from the probability distributions for inflation reported by forecasters responding to the Bank's survey.
(k) This tests whether inflation expectations are more responsive than during 2004–07.
(l) This tests whether inflation expectations are more responsive, relative to a null hypothesis of zero.

Based on the latest data, the inflation expectations heat maps suggest that inflation expectations remain sufficiently well anchored. The vast majority of cells are green; those that are not are relatively evenly split between signalling tentative upside and downside risks. The black cell indicates that financial market measures of longer-term inflation expectations have been more sensitive to movements in shorter-term expectations than they were during 2004–07. But, as noted above, the estimated average responsiveness has been small.

It is worth noting that these statistics, by themselves, do not say anything about the economic significance of the various measures of inflation expectations. In order to fully assess the implications of these indicators, it is important to consider the extent to which they have affected inflation in the past. This is discussed in the next section.

Assessing the impact of inflation expectations on inflation

Channels through which inflation expectations affect inflation

There is a wide range of data about the inflation expectations of different groups, such as companies, households, professional forecasters and financial market participants. The expectations of these different groups could affect inflation through a variety of mechanisms.

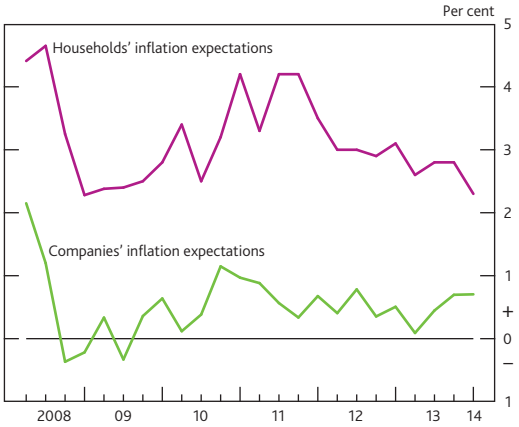
Companies' expectations have an important role in determining inflation since firms set wages and prices. If companies expect prices to rise in the future, they may increase the prices of the goods and services they produce and they may agree to pay higher wages (in order to maintain their employees' income in real terms, for instance). They might also choose to increase their investment if their inflation expectations increase and the nominal interest rate remains fixed, such that the real rate of interest they face falls. This would increase demand and put upward pressure on prices.

Data on the inflation expectations of UK companies are limited. The Confederation of British Industry (CBI) surveys companies in the distributive trades, manufacturing and services industries on their price expectations, but these surveys only began in mid-2008.

Some studies have suggested that households' inflation expectations can be used to infer companies' expectations. For example, Coibion and Gorodnichenko (2013) present evidence from the United States and New Zealand which suggests that households' inflation expectations provide a good proxy for companies' inflation expectations.

Plotting the data that are available on UK companies' inflation expectations — as measured by the CBI surveys — against households' inflation expectations at the same horizon shows that there is a positive correlation between the two indicators (**Chart 7**). The correlation coefficient between the two is 0.6. Households' inflation expectations have been persistently higher than those of companies, however. This might reflect the different questions that are asked in surveys of companies and households. Alternatively, each group may consider different measures of prices when responding: for example, companies might respond on the basis of their selling prices excluding duties and Value Added Tax (VAT), which households are likely to include in their responses.

Chart 7 Households' and companies' inflation expectations twelve months ahead(a)



Sources: Barclays Capital and CBI (all rights reserved).

(a) Households' inflation expectations are based on the one year ahead Barclays Basix series. Companies' inflation expectations are from CBI surveys and reflect companies' expectations of prices twelve months ahead in their own industry. The series is based on data for the manufacturing, business/consumer services and distribution sectors, weighted using nominal shares in value added. Data are to 2014 Q1.

Households' expectations can also affect inflation directly. Expectations of higher future prices reduce households' expected future spending power, which might lead them to bargain for higher wages, raising the input costs of companies. Companies may in turn respond to these higher costs by raising prices so that profit margins are maintained. In addition, like companies, households expecting future inflation to be high may bring forward their spending.

Professional forecasters' inflation expectations might not affect economic decisions directly, but they might have an indirect effect if households or companies use them as a source of information for their own expectations. For instance, households may be exposed to professional forecasters' expectations through the media. This is discussed in the box on page 158).

Financial market measures of inflation expectations could be used in a similar way to professional forecasters' expectations. In addition, they might affect the exchange rate. If UK inflation is expected to be higher than inflation in other countries, the nominal exchange rate may depreciate so that

the real exchange rate remains constant. A lower nominal exchange rate might increase import prices and CPI inflation.(1)

The impact of inflation expectations on inflation

One way of assessing the economic significance of recent movements in inflation expectations and the extent to which they affect inflation is to use a structural vector autoregression (SVAR) model. An SVAR is a way of analysing the underlying economic relationships between a number of variables. The inflation expectations SVAR estimated here includes seven variables: households' inflation expectations, professional forecasters' inflation expectations,(2) CPI inflation, annual average earnings growth,(3) annual GDP growth, Bank Rate and real oil price inflation. That set of variables allows us to analyse the relationships between measures of inflation expectations and actual inflation, while controlling for the impact of other factors that are also likely to be important in determining inflation and inflation expectations — the latter four variables.

In the structural model, each variable depends on lagged values of itself and contemporaneous and lagged values of the other variables, which means changes in one variable affect all the variables in the system. Under certain assumptions we can decompose movements in each variable into those that can be explained by developments in the variables in the model, and unexplained 'shocks'.(4) At a given point in time, it can be shown that each variable depends on a combination of the contemporaneous and past shocks to all the variables in the model.

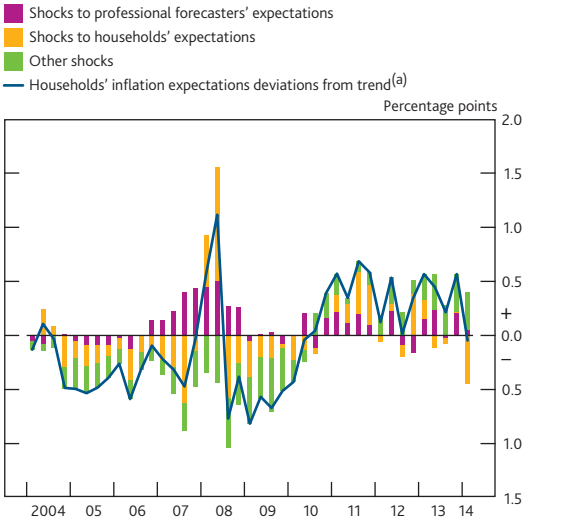
Using the SVAR, it is possible to decompose movements in CPI inflation into those that the model attributes to past or current shocks to inflation expectations and movements caused by past or current shocks to the other variables within the system. The extent to which inflation expectations shocks account for movements in CPI inflation away from its model-implied trend depends on both the frequency of the unexplained shocks to inflation expectations and how they affect all of the variables within the system.

Shocks to inflation expectations

Chart 8 shows the contributions of past and contemporaneous shocks to movements in households' inflation expectations away from trend. Over the past, a significant proportion of the movement in households' inflation expectations has been accounted for by shocks to professional forecasters' expectations and to the other variables in the model — the magenta and green bars in **Chart 8**.

In recent quarters, shocks to the other variables in the model have tended to push up households' inflation expectations, as shown by the positive green bars in **Chart 8**. Only a small proportion of the movements in households' inflation expectations has been explained by shocks to professional forecasters' inflation expectations, as illustrated by the magenta bars. That is likely to reflect the fact that professional forecasters' expectations have been relatively stable around the inflation target (**Table A**). In general, though, there is evidence that households' inflation expectations do respond to shocks to professional forecasters' inflation expectations (see the box on page 158).

Chart 8 Historical decomposition of movements in households' inflation expectations relative to trend



Sources: Bank of England, Barclays Capital, Bloomberg, GfK NOP, ONS and Bank calculations.

(a) Deviations in households' inflation expectations from the model-implied trend over the period 1998–2014 Q1.

Over the past year, shocks to households' inflation expectations have exerted some downward pressure — as shown by the orange bars in **Chart 8**. The shocks to households' inflation expectations may reflect the influence of variables which are omitted from the model but which households' expectations respond to. For example, some of the shocks could reflect the impact of changes in VAT rates between 2008 and 2011 which are not captured by the model. They might also be driven by news about household utility prices or central bank communication that are not captured by the model.

(1) This channel is discussed in Maule and Pugh (2013).
(2) Companies' inflation expectations and expectations derived from financial markets are not included in the model, since these data are only available with a short backrun. Households' expectations are measured by the Barclays Basix survey of inflation expectations at the two-year horizon until 2009 Q4. From 2010 the Basix survey is spliced forward using changes in inflation expectations at the two-year horizon in the Bank/GfK NOP survey. The Bank/GfK NOP measure has been spliced to abstract from volatility in the Barclays Basix measure. Professional forecasters' inflation expectations are based on expectations of inflation at the two-year horizon reported in the Bank's quarterly survey of external forecasters. Prior to 2004, the expectations of professional forecasters have been adjusted downwards by 0.5 percentage points to account for the change in the inflation target in December 2003, from 2.5% on the RPIX measure of inflation to 2% on the CPI measure.
(3) The quarterly average of average weekly earnings is used. Prior to 2000, data are projected backwards using the average earnings index.
(4) The reduced-form SVAR is estimated at a quarterly frequency over the period 1998–2014 Q1 and includes two lags of all of the variables. The identification of households' and professional forecasters' inflation expectations shocks is based on a timing restriction. A Cholesky ordering is assumed in which professional forecasters' inflation expectations are ordered first and households' inflation expectations are ordered second. More detail on the SVAR model is provided in Harimohan (2012) and Maule and Pugh (2013).

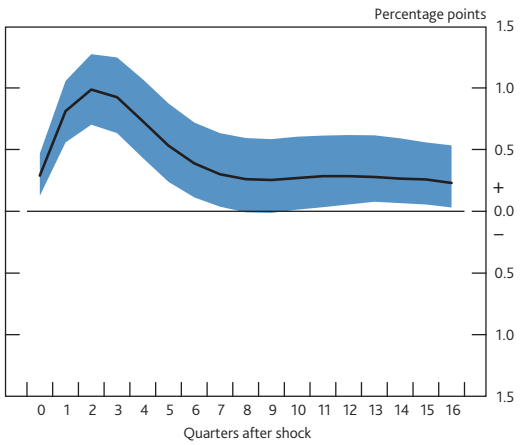
Alternatively, the shocks could reflect information which households have about the future values of the variables included in the model. The SVAR model implicitly assumes that households form their expectations based on the current and past values of variables in the model. But it might be the case that households use information about the future movements of variables within the model as an input to their inflation expectations. For example, households might revise their inflation expectations upwards if they receive information which suggests that oil price inflation is likely to be higher in the future.(1)

The effect of inflation expectations on inflation

Using the SVAR, it is also possible to identify how a simulated 'shock' to one variable would impact on all of the variables within the system. An 'impulse response function' traces the response over time of a variable of interest, for example inflation, to a one-period shock to one of the variables in the system.

The results of the model suggest that shocks to households' inflation expectations do have an economically significant impact on inflation outcomes. **Chart 9** shows the impact on CPI inflation, over time, from a 1 percentage point shock to households' inflation expectations. The swathe illustrates the confidence bands around that impulse response. The SVAR suggests that an unexplained 1 percentage point increase in households' inflation expectations would typically increase CPI inflation by around 0.7 percentage points at the one-year horizon and would still be pushing up inflation by around 0.3 percentage points at the two-year horizon.(2) This significant impact might reflect the role that households play in wage bargaining, or, as mentioned above, households' expectations might be serving as a proxy for companies' expectations.(3) In contrast, the SVAR suggests that shocks to professional forecasters' inflation expectations generally do not have a significant impact on CPI inflation.

Chart 9 Impulse response of CPI inflation to a 1 percentage point shock to households' inflation expectations(a)



Sources: Bank of England, Barclays Capital, Bloomberg, GfK NOP, ONS and Bank calculations.

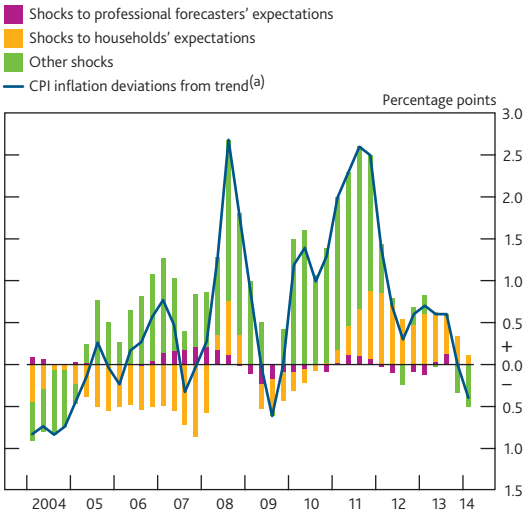
(a) The chart shows the impact on CPI inflation of a one-period shock to households' inflation expectations occurring in period zero. The swathe covers one standard error either side of the impulse response.

The impact of inflation expectations on inflation

Bringing together information on the shocks to inflation expectations, and the estimated impact of those on inflation, it is possible to decompose movements in CPI inflation away from its model-implied trend into those attributed to shocks to inflation expectations and those caused by shocks to the other variables within the system.

Chart 10 shows that, since 2008, deviations of inflation from trend have been large relative to the preceding period in which inflation was more stable. In large part, those deviations of inflation above trend have been driven by shocks to variables in the model other than inflation expectations — for example, oil prices. These are shown by the green bars.(4)

Chart 10 Historical decomposition of movements in CPI inflation relative to trend



Sources: Bank of England, Barclays Capital, Bloomberg, GfK NOP, ONS and Bank calculations.

(a) Deviations in CPI inflation from the model-implied trend over the period 1998–2014 Q1.

In the most recent quarter, shocks to households' expectations have exerted little upwards or downwards pressure on inflation relative to trend. The model suggests that shocks to households' inflation expectations have played a bigger role in the past, though — pushing down CPI inflation between 2004 and 2008, but tending to push inflation above trend during 2011 to 2013. Shocks to professional forecasters' expectations appear to have had little impact on CPI inflation over the entire period.

(1) See Mehra and Herrington (2008) for a detailed discussion.
(2) Changing the ordering of the variables does not lead to a material change in the shape of the impulse response functions.
(3) While companies' inflation expectations are not included in the SVAR due to the short backrun of data, previous analysis by the Bank suggests that companies' inflation expectations (for the industries in which they compete) have a large impact on the prices they set. See Maule and Pugh (2013).
(4) The restrictions imposed on the model allow shocks to households' and professional forecasters' inflation expectations to be identified. However, without imposing further restrictions it is not possible to identify which shocks in the model are driving the contributions from 'Other shocks' in **Chart 10**.

What are the drivers of households' inflation expectations?

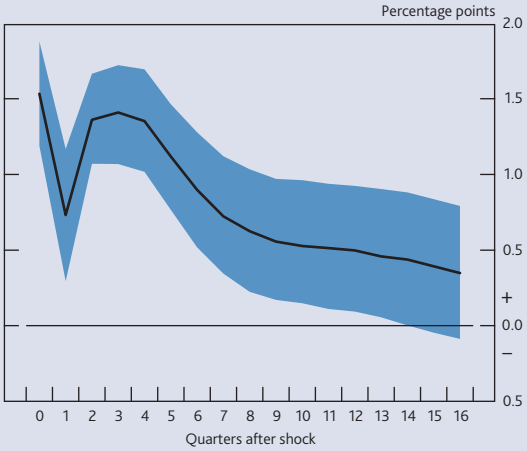
Given the evidence suggested by the SVAR that households' inflation expectations are important determinants of CPI inflation, it is important to understand what influences them and how they are formed. There are a number of theories about how households might form their expectations, and the factors that are important might differ depending on the monetary policy regime.

Many conventional economic models are based on the assumption that individuals make decisions and form their expectations using all of the relevant information available to them. Individuals who behave in this way are said to have 'rational expectations'. But gathering the latest information about the economy can be time-consuming and costly. Some individuals may update their information about the economy and their expectations infrequently.(1) Alternatively, it might be the case that some individuals form their inflation expectations using a limited amount of information. For example, one simple rule of thumb would be to assume that inflation in the future will be similar to its level in the recent past. When individuals form their expectations in this way, using backward-looking information, they are said to have 'adaptive expectations'.

Some individuals might use newspaper reports and other forms of media as a source of information, since it is unlikely that they gather all of the latest information themselves. This is one mechanism through which professional forecasters' expectations could affect households' expectations. For example, Carroll (2003) presents a formal model in which households' inflation expectations are influenced by what is reported in the media. In the model, only a fraction of households update their inflation expectations in each period of time. Those households that do update each period are assumed to mimic the expectations of rational professional forecasters (which are reported in the media).

The SVAR model provides a way of assessing whether households' inflation expectations respond to shocks to professional forecasters' inflation expectations. The results are shown in **Chart A**, which presents the response of households' inflation expectations to a 1 percentage point shock to professional forecasters' inflation expectations.

Chart A Response of households' inflation expectations to a 1 percentage point shock to professional forecasters' inflation expectations(a)



Sources: Bank of England, Barclays Capital, Bloomberg, GfK NOP and Bank calculations.

(a) The chart shows the impact on households' inflation expectations of a one-period shock to professional forecasters' inflation expectations occurring in period zero. The swathe covers one standard error either side of the impulse response.

The model suggests that a 1 percentage point shock to professional forecasters' inflation expectations increases households' inflation expectations by more than one-for-one at the one-year horizon. This implies that households are very sensitive to the movements in professional forecasters' expectations which cannot be accounted for by other variables in the model. In contrast, the model suggests that professional forecasters do not respond to shocks to households' inflation expectations. These two results provide some support for the framework suggested by Carroll (2003) in which households update their inflation expectations by adopting the forecasts of professional forecasters.

(1) See, for example, Mankiw and Reis (2002).

Conclusion

People's expectations about the likely evolution of prices play an important role in determining inflation. The analysis in this article suggests that shocks to households' inflation expectations are important, perhaps in part because they also provide information about the expectations of companies. Professional forecasters' expectations appear to have a smaller impact on inflation, but seem to play a role in providing information to households on which to base their expectations.

In the most recent data, indicators of inflation expectations remain consistent with expectations being anchored. And those few measures that statistically signal that expectations may be away from the target are currently relatively evenly split between those pointing to upside and downside risks. Consistent with that, an SVAR model suggests that shocks to inflation expectations are currently exerting little upward or downward pressure on inflation relative to trend. But the MPC will continue to monitor these indicators closely and they remain an important factor in policy decisions.

Annex 1
Available indicators of inflation expectations

	Time horizon	Start of data	Survey question/measure of inflation
Surveys of households			
Bank/GfK NOP	1 year 2 and 5 years	Dec. 1999 Mar. 2009	How much would you expect prices to change over the next one, two and five years?
Barclays Basix	1 and 2 years 5 years	Dec. 1986 Sep. 2008	What do you expect the rate of inflation to be over the next twelve months and over the next five years?
YouGov/Citigroup	1 and 5–10 years	Nov. 2005	How do you expect consumer prices of goods and services will develop over the next one and five to ten years respectively?
Surveys of companies			
BCC	3 months	Feb. 1997	Over the next three months, has your intention to increase prices increased/remained the same/decreased?
CBI	1 year	June 2008	Over the next twelve months, what do you expect the percentage change to be in the general level of selling prices in the UK markets that your firm competes in?
Surveys of professional forecasters			
Bank	1, 2 and 3 years	Feb. 2006	Point forecasts for CPI.
HM Treasury	1 and 2 years 3 years 4 years	Feb. 2004 Feb. 2005 Feb. 2006	Point forecasts for CPI. Point forecasts for CPI. Point forecasts for CPI.
Consensus	5–10 years	Oct. 2004	Point forecasts for CPI.
Measures derived from financial instruments			
Swaps	1 to 25 years ahead	Oct. 2004	RPI-linked.
Gilts	1 to 25 years ahead	Jan. 1985	RPI-linked.

Annex 2
A summary measure of inflation expectations

The MPC looks at a wide range of indicators of the level of inflation expectations, from surveys of households, companies and professional forecasters, as well as those derived from financial market instruments. The Committee does not have a preferred indicator: each of the external measures has value and can shed some light on developments in inflation expectations, and each indicator has strengths and drawbacks. But the numerical forecasts of each measure vary considerably. To try and assess the overall signal contained in the various indicators of inflation expectations, while ignoring the 'noise' in individual series, a summary measure can be constructed. This annex outlines how this is done.

Constructing the summary measure

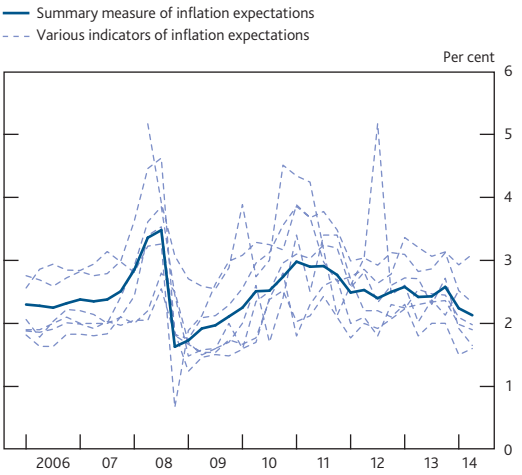
The broad approach taken is to use factor methods to extract the underlying signal from different indicators of inflation expectations that are presumed to be subject to some measurement error. The underlying series used include indicators from three different surveys of households, the CBI survey of distribution sector companies' inflation expectations, two surveys of professional macroeconomic forecasters and a series inferred from financial market inflation swaps. For each indicator, expectations at all the horizons for which they are available are used. For the estimation, data are used from 2006 onwards, or when the series starts if later than that. These indicators are not all directly comparable, as they do not all measure expectations about the same measure of inflation. For example, measures derived from financial instruments reference RPI inflation, and the surveys of households ask about general price movements, not a specific price index. So as a first step, each of these series is transformed by removing an estimate of the wedge between the measure of inflation that they explicitly or implicitly reference and CPI inflation.(1)

To extract the common factors underlying the various indicators, we use a dynamic statistical model to estimate the term structure of inflation expectations, using a similar method to the Nelson-Siegel approach to modelling the term structure of interest rates.(2) The term structure is fitted using three factors, which are interpreted as representing the level, slope and shape of the yield curve. The factors are assumed to evolve over time according to an autoregressive process.

The model allows for the presence of multiple measures of each given maturity of inflation expectations, and the three common factors are estimated across all of the different measures of inflation expectations simultaneously. And a summary measure of inflation expectations at each horizon can then be constructed by taking an average across all of the fitted values of different measures of inflation expectations at each maturity.

Chart A1 shows a time series of the derived summary measure for one year ahead inflation expectations alongside all of the transformed individual measures of one year ahead inflation expectations. The summary measure appears to capture the broad movements in the data, abstracting from the volatility in individual series.

Chart A1 One year ahead inflation expectations: summary measure and individual components(a)



Sources: Bank of England, Barclays Capital, Bloomberg, CBI (all rights reserved), Citigroup, GfK NOP, HM Treasury, ONS, YouGov and Bank calculations.

(a) Data are non seasonally adjusted. Data for the CBI measure of expectations are to 2014 Q1. Data point for 2014 Q2 for YouGov/Citigroup is an average of April and May 2014 data and for the financial markets measure is an average of daily data from 1 April 2014 to 20 May 2014.

(1) We have adjusted the survey measures that do not ask about CPI inflation specifically by the average wedge between CPI inflation and inflation perceptions, where available, or one year ahead inflation expectations between the start of the series and 2013 Q2. We have done the same for the financial market implied series at shorter horizons. At longer horizons, we have subtracted a fixed wedge of 95 basis points, based on information from market contacts about their expectations for the RPI-CPI inflation wedge in the long run. See the box on pages 34–35 of the February 2014 *Inflation Report* for more information; www.bankofengland.co.uk/publications/Documents/inflationreport/2014/ir14feb.pdf. No attempt has been made to adjust for the risk premium implicit in financial market prices. Professional forecasters are asked about their expectations for CPI inflation.

(2) See Nelson and Siegel (1987).

Annex 3
Calculating standard errors for the Bank of England/GfK NOP inflation attitudes survey

Standard errors measure the standard deviation of sample statistics. They are useful because they provide an indication of the degree of uncertainty around the sample statistics. This annex explains the process for calculating the standard errors of the statistics reported in the Bank of England/GfK NOP inflation attitudes survey, one of the indicators the MPC draws on when assessing developments in inflation expectations (see **Tables A** and **B**).

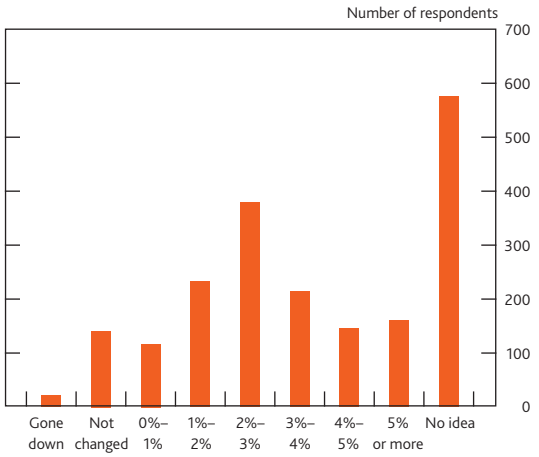
The Bank of England/GfK NOP inflation attitudes survey

Typically when responding to UK surveys about inflation expectations, individuals are asked to select a range in which their expectations lie. In the Bank of England/GfK NOP inflation attitudes survey, individuals are asked to choose from the following options:

1 Gone down.
2 Not changed.
3 Gone up by 1% or less.
4 Gone up by 1% but less than 2%.
5 Gone up by 2% but less than 3%.
6 Gone up by 3% but less than 4%.
7 Gone up by 4% but less than 5%.
8 Gone up by 5% or more.
9 No idea.

Chart A2 shows the number of respondents in each bucket for the question about two year ahead inflation expectations in the 2014 Q2 survey.

Chart A2 Two year ahead inflation expectations responses in the 2014 Q2 Bank/GfK NOP survey



Sources: Bank of England and GfK NOP.

The tables of results published on the Bank of England's website show the proportion of respondents in each of the buckets listed above, as well as an estimate of the median expectation. The median is the 'middle' expectation, when the responses are ordered from highest to lowest. For this survey, it is calculated by first converting the categorical data into a continuous data set. To do this, it is assumed that within buckets responses are uniformly distributed.(1) Once the continuous data set has been created, the data are ordered by size and the median is calculated in the conventional way.(2)

To provide an indication of the uncertainty around this estimate, it is possible to calculate the standard error of the sample median. Since the precise nature of how inflation expectations in the population are distributed is unknown, a bootstrapping technique is used to calculate the standard error of the sample median.(3)

First, as described above, the *n* observations in the original sample are converted into specific values by assuming that responses within buckets are uniformly distributed. Second, using this sample, a number of other samples of size *n* are then created by sampling with replacement. For each generated sample, the median is computed. As a result, we generate a series of estimates for the median, and the standard error of the sample median can then be computed by calculating the standard deviation of those.

Table A3 reports estimates of median expectations in the 2014 Q2 survey, with standard errors for the estimates reported in parentheses. Typically there were around 2,000 responses to each of the inflation expectations questions. This sample size is judged to be appropriate to produce reliable results, given the trade-off between sample size and the cost of the survey.

Table A3 Median inflation expectations in the 2014 Q2 Bank/GfK NOP survey

Horizon	Median expectations and standard errors
One year ahead	2.56
	(0.05)
Two years ahead	2.51
	(0.05)
Five years ahead	2.92
	(0.07)

Sources: Bank of England, GfK NOP and Bank calculations.

It is also possible to estimate the standard errors around the proportions of responses that lie within each bucket. To calculate the standard errors of the sample proportions, it is

(1) So, for example, if there were three individuals in the bucket 'Up by 4% but less than 5%', those individuals are assumed to be located at 4.25%, 4.5% and 4.75%.
(2) Those responding 'No idea' are excluded from the median calculation. Respondents answering 'Gone down' or '5% or more' are asked to provide more detail on how much they think prices have fallen or risen respectively. The lowest possible response is 'Down by 5% or more' and the highest possible response is 'Up by 10% or more'. For those answering 'Down by 5% or more', a lower bound of -10% is assumed. For those answering 'Up by 10% or more', an upper bound of 15% is assumed. Given the nature of how the sample median is calculated, the standard error of the sample median is not very sensitive to these two assumptions.
(3) For a discussion of bootstrapping techniques, see Greene (2012).

assumed that the number of observations within a given bucket follows a multinomial distribution. The true proportion of the population in bucket j is given by π_j. The estimated probability of being in bucket j is given by the observed proportion of individuals from the sample in that bucket, $\hat{\pi}_j$.

Under a multinomial distribution, the sample proportion has a standard error given by:

$$\text{standard error}_j = \sqrt{\frac{\pi_j\left(1-\pi_j\right)}{n}} \qquad (1)$$

where n is the number of observations in the sample.

Because the true population proportion is unknown, the sample proportion is used in the place of the population proportion in equation **(1)** to estimate the standard error.

For example, in the 2014 Q2 survey, 12% of the 1,986 respondents reported that their expectations for prices at the two-year horizon were for them to go up by 1% but less than 2%. The estimated standard error of this sample proportion is given by:

$$\text{standard error}_{1\%-2\%} \approx \sqrt{\frac{0.12\left(1-0.12\right)}{1{,}986}}$$
$$= 0.007 = 0.7\%$$

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Public attitudes to monetary policy

By Lewis Kirkham of the Bank's Monetary Assessment and Strategy Division.[1]

- Satisfaction with the way the Bank sets interest rates in order to control inflation has picked up in the past year to the highest level since 2007, according to the latest Bank/GfK NOP surveys. This is likely to reflect falls in households' perceptions of inflation, as well as the general improvement in the economic outlook.
- Households expect increases in Bank Rate to be gradual, which seems consistent with recent guidance from the Monetary Policy Committee.
- Over the past year public awareness of the monetary policy framework has remained unchanged and public support for the inflation target has remained strong.

Overview

The Bank is committed to building public understanding of, and support for, the monetary policy framework. Indeed, the Bank uses a variety of methods to explain to the public the Monetary Policy Committee's (MPC's) role of setting monetary policy to meet the 2% inflation target. This article examines the latest results from the Bank/GfK NOP survey concerning households' awareness of, and support for, the monetary policy framework, and their satisfaction with the way the Bank is conducting monetary policy.

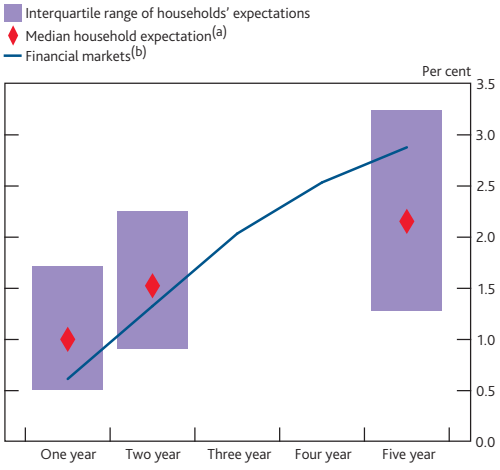
Results from the latest surveys indicate that over the past year public awareness of the policy framework has remained unchanged. And across a range of survey questions, there is evidence that public support for the Bank's objective of maintaining low and stable inflation remains strong.

The largest group of households thought that interest rates had stayed about the same over the past year. Following the MPC's announcement of 'forward guidance' in August 2013, the proportion of households expecting interest rates to stay about the same over the following twelve months reached a series high. Since then, as GDP growth has strengthened and the unemployment rate has fallen sharply, there has been an increase in the proportion of households expecting interest rates to rise.

Responses to a new question showed that households do not expect a large increase in Bank Rate in the near term. Looking further ahead, households, on average, expected increases in Bank Rate to be gradual (**summary chart**), which seems consistent with recent guidance from the MPC.

Satisfaction with the way the Bank sets interest rates in order to control inflation has picked up in the past year to its highest level since 2007. This is likely to reflect falls in households' perceptions of inflation, as well as the general improvement in the economic outlook. Satisfaction with the Bank remains a little lower than during the pre-crisis period.

Summary chart Indicators of Bank Rate expectations



Sources: Bank/GfK NOP survey and Bloomberg.

(a) Median household response to the question: 'The level of interest rates set by the Bank of England (Bank Rate) is currently 0.5%. At what level do you expect that interest rate to be in one, two and five years' time?'. Households were not given the option to answer 'no idea'.
(b) Forward curve estimated using overnight index swap rates over the period from 6 February to 18 February 2014. This is the period over which the household survey was conducted.

(1) The author would like to thank Alistair Strathern for his help in producing this article.

The Bank of England's mission is to promote the good of the people of the United Kingdom by maintaining monetary and financial stability. Monetary stability is defined by the Government's inflation target, which is currently 2% as measured by the annual change in the consumer prices index (CPI). Subject to that, the Bank is also tasked with supporting the Government's economic objectives, including those for growth and employment.

The Monetary Policy Committee (MPC) has historically sought to achieve its objectives by setting the level of Bank Rate. In response to the financial crisis and the subsequent period of weak demand, a number of 'unconventional' policies have also been implemented in order to meet these objectives. In March 2009, the MPC began a programme of asset purchases, financed through the issuance of central bank reserves, commonly referred to as quantitative easing (QE).(1)

In August 2013, the MPC provided 'forward guidance' about the future path of monetary policy, stating its intention not to raise Bank Rate at least until the unemployment rate fell to a threshold of 7%, provided this did not entail material risks to either price or financial stability.(2) Since then, unemployment has fallen sharply, ahead of the expectations of the MPC and other professional forecasters, as the recovery has gained momentum. The 7% unemployment threshold was reached in data for the three months to February 2014.

Prior to the release of these data, the MPC used its February *Inflation Report* to provide further guidance on the setting of monetary policy as the economy recovers.(3) The MPC noted that when Bank Rate does begin to rise, it is expected to do so only gradually. Moreover, Bank Rate is expected to remain below average historical levels for some time to come. In the May 2014 *Inflation Report* the MPC reaffirmed that guidance.

The Bank is committed to building public understanding of, and support for, the monetary policy framework.(4) The Bank's success in meeting its objective of price stability will depend, in part, on this. If people understand the MPC's objective, then they may behave in such a way that deviations of inflation from target are more short-lived: households, for example, may moderate their wage demands and companies may be less likely to raise prices in response to higher costs.(5) Furthermore, it is important for the Bank to maintain public trust and confidence in order for it to fulfil successfully all of its different policy functions.

The Bank uses a variety of methods to explain to the public the MPC's role of setting monetary policy to meet the inflation target. For example, in addition to its quarterly *Inflation Report*, the Bank also publishes the minutes of the MPC's monthly meetings and articles that explain some of the key concepts relevant for understanding the setting and transmission of monetary policy; MPC members give speeches, lectures, press conferences and interviews, and make appearances before the Treasury Select Committee; and a number of social media channels are used in order to reach a range of audiences. In addition, the Bank's twelve regional agencies hold regular meetings with businesses throughout the United Kingdom, and the Bank has an education programme that includes the 'Target Two Point Zero' competition for schools and colleges.

The Bank has sought to quantify the impact of its efforts to increase the public's understanding of, and support for, the monetary policy framework. Since 1999, the Bank has commissioned GfK NOP to conduct a quarterly survey of households' attitudes to inflation and monetary policy on its behalf.(6) Around 2,000 households from across the United Kingdom are surveyed each quarter, with a larger sample of around 4,000 households used in the February survey each year.(7) This article, the latest in a series published in Q2 of each year, draws on the results from the latest surveys to assess the public's awareness of monetary policy and their satisfaction with the way in which the Bank has set monetary policy to control inflation.

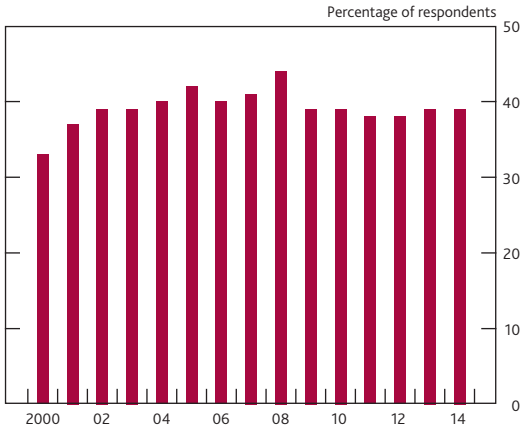
Public awareness of monetary policy

Public awareness of the monetary policy framework has remained broadly constant over the past year at a similar level to previous surveys. In the February 2014 survey, 39% of survey respondents were able to name, unprompted, the MPC or the Bank of England as the group that sets the level of the United Kingdom's basic interest rate. This result is very similar to past surveys (**Chart 1**). When asked to choose from a list, 65% of respondents selected the Bank of England as the group that sets interest rates, rather than government ministers, high street banks, civil servants or the European Central Bank. This was also in line with recent surveys, although a little below the series average of 67%.

The Bank/GfK NOP survey monitors the level of understanding among households of the way in which monetary policy affects inflation — the transmission mechanism of monetary

(1) For further discussion of QE, see Joyce, M, Tong, M and Woods, R (2011), 'The United Kingdom's quantitative easing policy: design, operation and impact', *Bank of England Quarterly Bulletin*, Vol. 51, No. 3, pages 200–12, available at www.bankofengland.co.uk/publications/Documents/quarterlybulletin/qb110301.pdf.
(2) For more information, see *Monetary policy trade-offs and forward guidance*, available at www.bankofengland.co.uk/publications/Documents/inflationreport/2013/ir13augforwardguidance.pdf.
(3) For more information, see 'Monetary policy as the economy recovers', available at www.bankofengland.co.uk/publications/Documents/inflationreport/2014/ir14febeconrec.pdf.
(4) In March the Bank announced its Strategic Plan which included an initiative to 'work to deliver a strategy for building public understanding and a constituency for maintaining monetary and financial stability'. For more information, see www.bankofengland.co.uk/about/Documents/pdfs/stratplanback.pdf.
(5) For more information on inflation expectations, see 'Assessing the risk to inflation from inflation expectations' in this edition of the *Bulletin*.
(6) Data from the survey are available on the Bank's website at www.bankofengland.co.uk/publications/Pages/other/nop.aspx. The spreadsheets show the precise wording of the questions.
(7) Some questions are asked only once a year, in February. Other questions are asked in each quarterly survey, so data from May 2014 are available.

Chart 1 Indicator of public awareness of the monetary policy framework(a)



Source: Bank/GfK NOP survey.

(a) Percentage of respondents answering that either the Bank or the MPC set Britain's basic interest rate level. From 2001, this question was only asked in the Q1 survey.

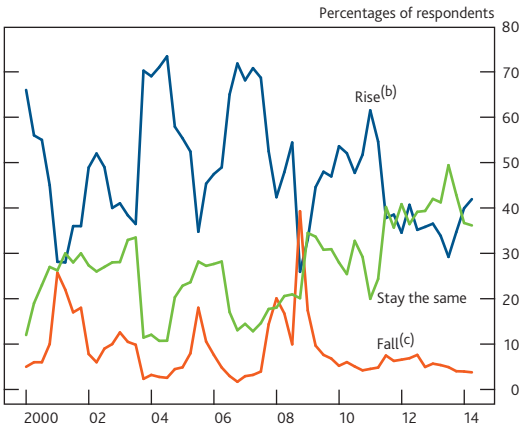
policy. Economists generally believe that a rise in Bank Rate would tend to push down inflation one or two years ahead, since higher interest rates would reduce demand in the economy, thus weakening companies' ability to charge higher prices. That view was shared by 32% of respondents to the February 2014 survey, who either agreed or strongly agreed with the statement that 'a rise in interest rates would make prices in the high street rise more slowly in the medium term — say a year or two'. This is below the series average of 38%.

Across a range of survey questions, there is evidence that public support for the Bank's objective of maintaining low and stable inflation remains strong. Respondents are asked whether they think the inflation target of 2.0% is too low or too high. In May 2014, 53% of respondents thought that the target was 'about right', which is equal to the series average. That is materially above the 19% of respondents who thought the target was too high, and the 12% who thought it was too low. Households are also asked whether, if a choice had to be made, they would prefer to raise interest rates to keep inflation down, or keep interest rates down and allow prices to rise faster. In February 2014, 58% of households preferred to keep inflation down via higher interest rates, while only 14% preferred to keep interest rates low and accept higher inflation.

Respondents to the Bank/GfK NOP survey are asked how they think interest rates on things like mortgages, bank loans and savings have changed over the preceding twelve months. Over the past year, the largest group of households (43% on average) thought that interest rates had stayed about the same — well above the series average (22%). This probably reflects the fact that Bank Rate has remained unchanged, and that the average interest rates paid on households' outstanding deposits and loans have fallen only slightly.

Households' expectations for interest rates have varied somewhat in recent surveys. In August 2013, 49% of respondents reported that they expected rates to stay about the same over the next twelve months, a series high (**Chart 2**). That survey was conducted shortly after the MPC announced 'forward guidance', which may have affected some households' view of the likely timing of future increases in Bank Rate.(1) In more recent surveys there has been an increase in the proportion of households expecting interest rates to rise. This is likely to reflect the strengthening of the economic recovery. For example, annual GDP growth increased in the second half of 2013, while unemployment fell sharply. Even so, the proportion of households expecting higher interest rates over the next twelve months in May 2014 — 42% of households — was lower than during the period in 2010 and early 2011 when GDP was recovering from the 2008/09 recession.

Chart 2 Interest rate expectations over the next twelve months(a)



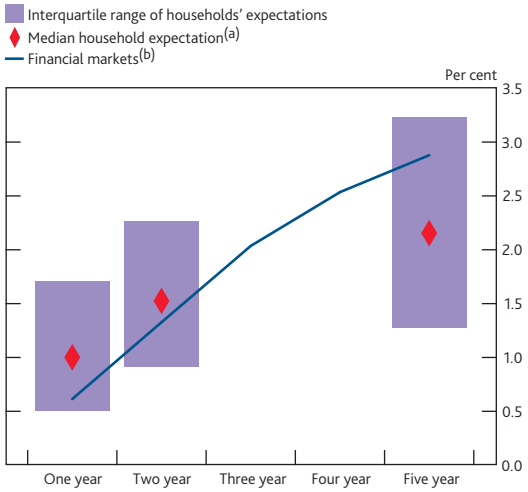
Source: Bank/GfK NOP survey.

(a) Respondents who answered 'no idea' are not shown on the chart. On average, around 15% of respondents answer in this way.
(b) Percentage of respondents who thought that interest rates would rise 'a lot' or 'a little'.
(c) Percentage of respondents who thought that interest rates would fall 'a lot' or 'a little'.

A new question was included in the February 2014 survey, asking households for their expectations for the level of Bank Rate, the interest rate set by the Bank of England. This is distinct from other questions in the survey that ask about 'interest rates on things like mortgages, bank loans and savings' which are offered by commercial banks. Changes in Bank Rate ordinarily feed through to changes in interest rates offered by banks, although banks also take into account a number of other factors when pricing loans and deposits.(2) Responses showed that households do not expect a large increase in Bank Rate in the near term from its current level of 0.5%. Half of the respondents expected Bank Rate to lie

(1) A box on page 12 of the February 2014 *Inflation Report* summarises surveys of households' and businesses' responses to 'forward guidance'.
(2) For an explanation of how banks price new loans, see Button, R, Pezzini, S and Rossiter, N (2010), 'Understanding the price of new lending to households', *Bank of England Quarterly Bulletin*, Vol. 50, No. 3, pages 172–82, available at www.bankofengland.co.uk/publications/Documents/quarterlybulletin/qb100301.pdf.

Chart 3 Indicators of Bank Rate expectations



Sources: Bank/GfK NOP survey and Bloomberg.

(a) Median household response to the question: 'The level of interest rates set by the Bank of England (Bank Rate) is currently 0.5%. At what level do you expect that interest rate to be in one, two and five years' time?'. Households were not given the option to answer 'no idea'.
(b) Forward curve estimated using overnight index swap rates over the period from 6 February to 18 February 2014. This is the period over which the household survey was conducted.

between 0% and 1% in one year's time. The median expectation in one year's time was 1% (**Chart 3**).

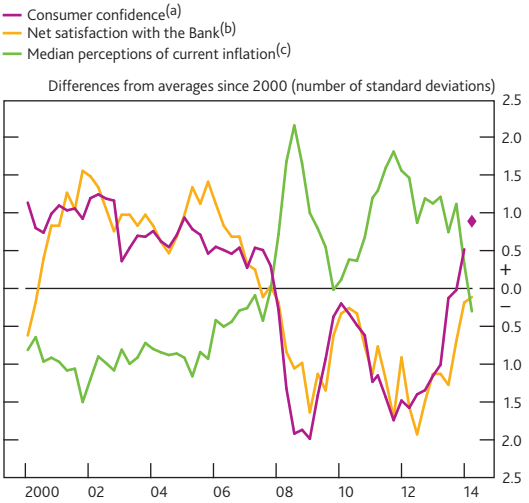
Looking further ahead, households, on average, expected increases in Bank Rate to be gradual. The median expectation for Bank Rate in two years' time was 1.5%. This seems consistent with recent guidance from the MPC. In the February 2014 *Inflation Report*, the MPC provided guidance that when Bank Rate does begin to rise, the appropriate path over the next two to three years is expected to be gradual. And even when the economy has returned to a more normal state, the appropriate level of Bank Rate is likely to be materially below the 5% level set on average prior to the financial crisis.

Households' Bank Rate expectations at the one and two-year horizon were similar to the mean expectation of financial market participants from the time of the February survey, as implied by the forward overnight index swap curve (blue line in **Chart 3**).(1) At the five-year horizon, where the outlook for Bank Rate is more uncertain, households' expectations were a little lower than those of financial market participants.

Satisfaction with monetary policy at the Bank of England

The Bank/GfK NOP survey asks respondents how satisfied or dissatisfied they are with the way the Bank is doing its job to

Chart 4 Satisfaction with the Bank, inflation perceptions and consumer confidence



Sources: Bank/GfK NOP survey and research carried out by GfK NOP on behalf of the European Commission.

(a) The aggregate consumer confidence index is derived by averaging the answers to questions 1, 2, 3, 4 and 8 in the GfK NOP survey carried out on behalf of the European Commission. This chart shows quarterly averages of monthly data. The diamond is an average of the April and May observations.
(b) The percentage of respondents who were fairly or very satisfied with the way in which the Bank of England is doing its job to set interest rates in order to control inflation, less the percentage who were fairly or very dissatisfied. Data are to 2014 Q2.
(c) Respondents were asked how they thought prices had changed over the past twelve months. Data are to 2014 Q2.

set interest rates in order to control inflation. Over the past year, 'net satisfaction' — the difference between those fairly or very satisfied, and those fairly or very dissatisfied — has picked up (**Chart 4**). In the May 2014 survey, net satisfaction was 31%, the highest balance recorded since 2007, and only marginally below its series average. But it remains a little lower than during the pre-crisis period.

Households' satisfaction with the Bank has tended to be lower when their perceptions of the current rate of inflation have been higher (**Chart 4**). Since the financial crisis, higher than average inflation perceptions have coincided with lower net satisfaction. But over the past year households' perceptions of inflation have fallen and net satisfaction has picked up. The fall in inflation perceptions is likely to partly reflect falls in measured CPI inflation, which has declined and currently lies a little below the 2% target. The MPC's latest forecast for inflation is set out in the May 2014 *Inflation Report*.

The pickup in satisfaction with the Bank is also likely to reflect the improvement in the economic outlook more generally. Survey measures of consumer confidence have recently reached their highest levels since the financial crisis. These measures are closely correlated with satisfaction with the Bank (**Chart 4**).

(1) Measures of financial market participants' median expectations are a little lower than the corresponding mean measures.

How have world shocks affected the UK economy?

By Shiv Chowla, Lucia Quaglietti and Łukasz Rachel of the Bank's International Economic Analysis Division.[1]

- The UK economy is closely integrated into the wider global economy. These ties mean that global developments affect the economic fortunes of the United Kingdom.
- This article presents model-based estimates which suggest that world shocks have driven around two thirds of the weakness in UK output since 2007.
- Trade linkages are an important channel for the transmission of world shocks to the UK economy. But financial linkages and spillovers through uncertainty are significant, too — and together are likely to account for the majority of the impact of world shocks on the United Kingdom since 2007.

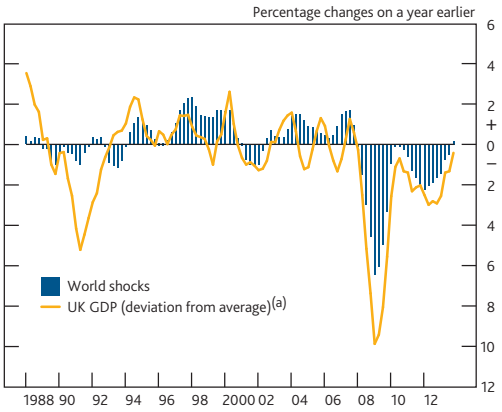
Overview

The UK economy is closely integrated with the rest of the world through the trade of goods and services, and the exchange of financial assets. This interconnectedness means that the UK economic environment is shaped, in part, by events in the wider global economy. These events can be external to the United Kingdom, or common to many economies, including the United Kingdom.

Based on analysis described in this article, the **summary chart** presents estimates of the impact that world shocks have had on UK GDP growth. Integration into the global economy benefited the United Kingdom for much of the two decades prior to the crisis. But global influences drove the bulk of the decline in UK output during the 2008/09 recession, and they held back growth over 2011–12. Overall, world shocks account for around two thirds of the weakness in the level of UK output since 2007.

As well as assessing the *impact* of world shocks, this article considers the *channels* through which they have affected the UK economy. Three channels are likely to have been particularly important since 2007. First, some of the impact of world shocks has come through the **trade channel**, as demand for UK exports weakened and UK import prices increased. Second, world shocks have led to a tighter supply of credit and more volatile asset prices in the United Kingdom — the key mechanisms of the **financial channel**. And third, the close comovement of measures of UK economic uncertainty with those of other countries suggests that the **uncertainty channel** has also played a role in the transmission of world shocks.

Summary chart Estimates of the historical impact of world shocks on UK GDP growth



Sources: Bloomberg, Bureau for Economic Policy Analysis, IMF, OECD, ONS, Thomson Reuters Datastream and Bank calculations.

(a) Line shows UK GDP growth relative to the average over the period 1988–2007, which is 3.1%. The contributions of world shocks are relative to model-consistent trend growth rates.

The Bank's main forecasting model suggests that around one fifth of the total impact of world shocks experienced by the United Kingdom since 2007 was transmitted through the trade channel. The remaining four fifths, therefore, appear to have affected the UK economy through other channels.

This analysis highlights the importance of policymakers understanding the international environment so that domestic monetary and financial policy can be set in a way which takes into account the impact that world shocks are expected to have.

Click here for a short video that discusses some of the key topics from this article.

(1) The authors would like to thank Tsvetelina Nenova for her help in producing this article.

As an open economy, activity in the United Kingdom is not only affected by domestic economic developments, but also by events taking place in the rest of the world. This article assesses the role that global developments have played in driving the UK business cycle, with a particular focus on the post-2007 period.

There are two ways in which the world will affect the UK economy. First, *events outside of the United Kingdom* can be transmitted to the domestic economy through cross-border linkages. And, second, the UK economy can be affected by *global economic events*, common to large parts of the world. These two concepts can be understood as 'spillovers' and 'common shocks', respectively. This distinction is conceptually helpful but, in practice, it is hard to distinguish between the two. For that reason, the focus of this article is to investigate the combined role of both these global influences on the United Kingdom, and they are referred to collectively as 'world shocks'. In that context, this article focuses on two questions. First, what has the total impact of world shocks on the UK economy been? And, second, what are the channels through which those shocks have had an impact on the United Kingdom?

Understanding world shocks is important for the Monetary Policy Committee (MPC) for the setting of monetary policy and the Financial Policy Committee (FPC) for the setting of macroprudential policy.(1) Gauging their impact on the United Kingdom allows the MPC and FPC to set policy in a manner which takes into account the effect that world shocks are expected to have on the UK economy and financial system over coming years. And identifying transmission channels can allow policymakers to put in place policies that help either to limit or to offset the impact of shocks. A strong understanding of how the rest of the world affects the United Kingdom can also assist the Bank in its aim to support the setting of policy in international fora, such as the G20.(2)

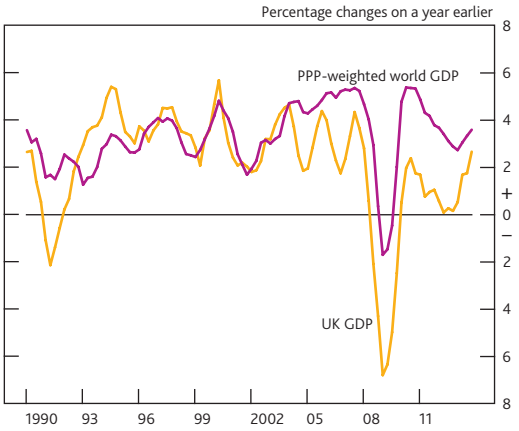
The first section of this article discusses how the events of the 2007–09 financial crisis and subsequent UK recovery have been shaped by global events. The next section uses a modelling approach to analyse *how much* world shocks have affected UK activity. The results presented in that section show that world shocks have played a first-order role in driving the UK business cycle. Given their importance, the final section explores the *ways* in which world shocks made their impact, documenting that financial linkages and uncertainty appear to have been more important than trade linkages for the transmission of world shocks. A short video explains some of the key topics covered in this article.(3)

How have global developments affected the United Kingdom since 2007?

Economic developments in other countries matter for the United Kingdom because it is exposed to the rest of the world — that is, it is an 'open' economy. This means that the international environment can affect a number of economic variables in the United Kingdom, including output and inflation. There are two key dimensions in which the UK economy is open: first, by how much it trades with the rest of the world, and second, by how financially integrated it is with other countries in terms of capital flows. On these two dimensions, the United Kingdom has a high level of trade and financial openness compared to other advanced economies.(4)

If an economy is open, like the United Kingdom, then domestic activity is likely to display some comovement with global activity because developments abroad transmit to the United Kingdom, or because the United Kingdom is affected by the same shocks that affect other countries. **Chart 1** shows that the correlation coefficient between annual UK and world GDP growth is reasonably high at 0.6, consistent with world shocks having a material influence on the United Kingdom.

Chart 1 UK and world GDP growth(a)



Sources: IMF, OECD, ONS, Thomson Reuters Datastream and Bank calculations.

(a) World GDP is constructed using data for the real GDP growth rates of 144 countries weighted according to their shares in world GDP using the IMF's purchasing power parity (PPP) weights. For more information, see Callen (2012). Data are shown up to the end of 2013. The weight of UK GDP within PPP-weighted world GDP has been around 3.4%, on average, over 1988–2013, such that it is only a minor contributor to the magenta line.

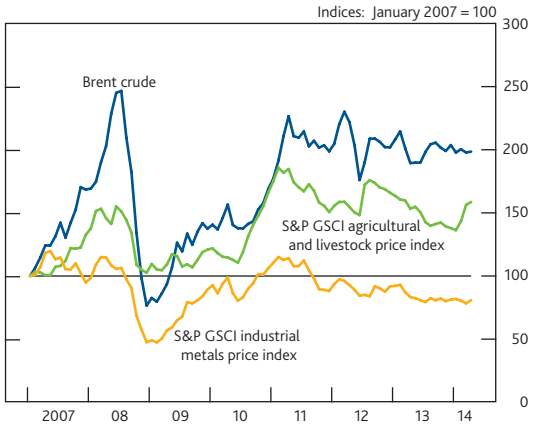
(1) Tucker, Hall and Pattani (2013) describe the new powers for macroprudential policymaking in the United Kingdom in the wake of the recent financial crisis.
(2) Carney (2014), for example, notes the Bank's aim to support the G20's programme of financial reform.
(3) See http://youtu.be/bPWAWOAvTA4.
(4) The United Kingdom's trade openness, measured by adding together the value of its exports and imports as a share of GDP, is greater than 60%. The United Kingdom's financial openness, measured by adding together its stock of assets and liabilities with the rest of the world, is around 1,400% of GDP. These two measures indicate how much the United Kingdom trades in goods and services and financial assets, respectively, relative to its size. They are based on an updated and extended version of the data set constructed by Lane and Milesi-Ferretti (2007), as well as the IMF April 2014 *World Economic Outlook*. Around half of the UK external assets are held by banks, indicating that international banking is integral to the United Kingdom's financial openness.

The importance of world shocks for the UK economy is well illustrated by the period since 2007. Over that time, world events — the stresses in global financial markets over 2007–09, the steep fall and rise in global commodity prices over 2008–11 and, since 2010, the euro-area crisis — have shaped macroeconomic developments in the United Kingdom.(1)

Over 2007–09, the United Kingdom, like many countries, was adversely affected by the sudden deterioration in risk appetite and increased uncertainty associated with the global financial crisis. The downturn in the US sub-prime market triggered stress in international banking systems and money markets. As the crisis escalated, credit conditions tightened and households and firms became more uncertain about the outlook for activity across many advanced economies. The crisis was associated with a severe downturn in the United Kingdom, as demand for UK exports collapsed and borrowing costs in the UK private sector increased severely.(2) The peak-to-trough fall in UK output was 7.2%, the largest recession in the post-war period.(3)

Prices of oil and other commodities have also been volatile since 2007. Having reached historically high levels in mid-2008, the dramatic weakening in prospects for world activity led to a sharp fall in commodity prices. This increased the amount of income available to UK households to spend on goods other than energy and food, thereby providing some offset to the downward pressure on demand associated with the financial crisis. But commodity prices recovered strongly from 2009 onwards, driven in part by strong demand associated with the robust recovery in emerging economies. And subsequent supply shocks in several markets led to further increases in these prices, even as the recovery in global activity moderated from mid-2011 (**Chart 2**). Hackworth, Radia and Roberts (2013) argue that the consequent price pressures contributed to UK inflation exceeding the MPC's target of 2% after 2010. And, by squeezing real incomes, they were also a factor in the sluggishness of the recovery in UK demand between 2010 and 2012.

Chart 2 Commodity prices(a)



Sources: Thomson Reuters Datastream and Bank calculations.

(a) Monthly data. All indices are priced in US dollars.

The euro-area crisis, which began in 2010, was also a significant world shock for the United Kingdom. As concerns mounted in financial markets from mid-2010 about the solvency of several euro-area governments and banking systems, borrowing costs in a number of countries increased. Alongside fiscal consolidation to reduce government deficits, a tightening in credit conditions reduced demand across much of the euro area. The United Kingdom was negatively affected by this as demand for UK exports from major trading partners diminished. Moreover, concerns about the UK banking system's exposure to the euro area also led to higher funding costs for banks with a presence in the United Kingdom. This in turn raised the price and reduced the availability of credit to UK households and firms, weighing on domestic activity.(4)

In response to world shocks, as well as some more UK-specific factors, UK monetary policy was loosened significantly, with Bank Rate reduced from 5.75% in late 2007 to 0.5% in early 2009 in order to support UK output and inflation during the global financial crisis. Having reached the effective lower bound for interest rates, the MPC then began a series of asset purchases, often referred to as quantitative easing, in a further attempt to stimulate UK economic activity.(5) And as the euro-area crisis intensified from late 2011, measures were also taken to alleviate the increase in UK banks' funding costs and the associated tightening of credit conditions. The Funding for Lending Scheme, introduced in mid-2012, provided a source of cheap funding to banks and building societies, with more (and cheaper) funding made available to banks that extended loans to the UK real economy.(6) All of these policies can be viewed — at least in part — as responses to world shocks, rather than exogenous actions in themselves. And without them, UK GDP growth would have been substantially weaker.

Which world shocks have been most important for the United Kingdom since 2007?

To analyse world shocks in a more systematic way, it is useful to distinguish between the *source* of the underlying economic

(1) Another important economic development for the United Kingdom since 2007 was the 25% nominal depreciation of the sterling effective exchange rate index between mid-2007 and early 2009. Kamath and Paul (2011) note that this depreciation induced 'expenditure switching' such that UK net trade improved, supporting domestic output.
(2) Astley *et al* (2009) provide a similar account of the financial crisis, but focus on the role of global imbalances as a cause in the years preceding 2007.
(3) Hills, Thomas and Dimsdale (2010) discuss the features of the 2008/09 UK recession in a historical perspective.
(4) Similarly, Hackworth, Radia and Roberts (2013) argue that the intensification of the euro-area crisis can explain part of the unexpected weakness of UK GDP from mid-2010 to mid-2013. Note that the analysis presented in that article focused on explaining the news in economic developments relative to the MPC's projections, whereas this article analyses the total impact of world shocks.
(5) Joyce, Tong and Woods (2011) discuss the United Kingdom's quantitative easing programme in detail.
(6) Churm *et al* (2012) discuss the Funding for Lending Scheme in detail.

disturbance and the *transmission channels* through which these shocks operate. The next section of this article considers these transmission channels in more detail. This section focuses on the source (or nature) of world shocks, and presents some quantitative estimates of the impact of those shocks, operating through all channels, on UK GDP.

In the real world, each event will be associated with unique circumstances, so that each 'shock' that causes economic agents to adjust their behaviour is slightly different to any other. Nonetheless, it is useful to classify world shocks into three broad types, according to their source.

(i) **World demand shocks.** These are associated with a rise or a decline in spending and confidence abroad. This group of shocks includes changes to fiscal plans of foreign governments, as well as changes to foreign firms' and households' confidence and thus their appetite to spend, hire and invest.

(ii) **World supply/price shocks.** These shocks originate in the production sector of the global economy and affect the global supply and prices of goods and services. For example, an unexpected fall in the supply of a commodity that is traded globally would likely trigger a rise in its price.

(iii) **World financial shocks.** These occur in the global financial system, such as increased stress in the international banking system or financial markets. They might relate, among other things, to changes in the price of risk, driven by investors reassessing their perceptions of the riskiness of an asset class.

This categorisation, which explicitly allows for financial shocks, is supported by much of the theoretical literature: several studies have highlighted the importance of financial frictions in driving business cycle fluctuations,(1) while others emphasise that financial crises have particularly large effects on output. Reinhart and Rogoff (2009), for example, find that financial crises are associated with larger output losses and slower recoveries than more 'conventional' recessions (such as those driven by central banks actively raising interest rates to dampen demand). Indeed, Hills, Thomas and Dimsdale (2010) argue that the recent UK recession had a defining characteristic that 'the financial sector was both the source and propagator of the crisis'. Given this, it is logical to capture the role of financial shocks separately to more traditional demand and supply shocks.

For countries with a flexible exchange rate, like the United Kingdom, standard macroeconomic theory suggests that the exchange rate can act as a stabiliser against shocks. In the event of an adverse domestic demand shock, for example, depreciation of the UK real exchange rate should induce domestic consumers to import less from the rest of the world, and foreign consumers to import more from the United Kingdom, supporting UK net trade and output. In practice, however, movements in the exchange rate do not appear to fully insulate economies from the effect of shocks. For that reason, the analysis in this article is based on the premise that sterling may not adjust sufficiently to prevent world shocks from affecting the United Kingdom.(2)

Modelling world shocks: a VAR approach

The common difficulty in quantitatively assessing the impact of different forces on the macroeconomy is distinguishing between the original shocks and the endogenous responses by economic agents — such as households, companies, employees and policymakers — to those shocks. This is because patterns observed in the data could be consistent with several different underlying causes. Higher inflation in an open economy, for example, could be consistent with a positive domestic or foreign demand shock, as well as a negative domestic or foreign supply shock.

A frequently used approach in macroeconomics to deal with this issue of identification of shocks is a vector autoregression (VAR).(3) This approach allows a high degree of interconnectedness — or endogeneity — meaning that all the variables can, in principle, be affected by each other. This is desirable when modelling, as it captures the interconnectedness of economic variables in the real world. The VAR models presented here allow for the classification of the shocks as described above. And, by imposing a simple economic structure on the data, it also makes it possible to trace their impact on the UK economy.(4)

There are several ways in which such a structure could be imposed. Most techniques focus on the response of each variable 'on impact': the structure imposes restrictions on how each variable responds to the shock as it happens. The models used here rely on two different techniques. The first focuses on *which* variables respond to each shock. For example, asset prices are assumed to respond to activity shocks immediately, but not *vice versa*. This corresponds to the intuition that asset price movements take some time to feed through to households' and businesses' decisions and thus to activity. The second technique restricts the *sign* of the response of variables on impact. For example, positive demand shocks boost output and prices, while negative supply shocks put upward pressure on prices and depress activity.

(1) Kiyotaki and Moore (1997) and Bernanke, Gertler and Gilchrist (1998), for instance, are two seminal contributions that introduce credit and financial frictions to the analysis of the business cycle.
(2) Farrant and Peersman (2006), for example, argue that the exchange rate is a source of shocks, rather than a stabiliser.
(3) Sims (1980), for instance, proposes the use of VAR models to capture the endogeneity of macroeconomic variables.
(4) Of course, this is only one potential technique that can be applied in this context. Alternative estimates could be obtained from general equilibrium models, for example. These are not considered in this article.

As with every modelling exercise, there is uncertainty about how well any given technique fits the data and how accurately it represents the real world. For that reason, this article presents results from four models that use different techniques. This demonstrates how robust the conclusions are to any particular approach. The set-up of the models rests on the assumption that the rest of the world can have a large impact on the UK macroeconomy, while home-grown UK-specific shocks have no impact on the rest of the world. Of course, in practice, this assumption only holds approximately: several smaller countries most tightly linked with the United Kingdom may be affected by shocks that originate here. And the relatively large UK financial system could in principle be a source of shocks for other countries. But those effects are likely to be limited in a global context.

This means that the models contain two sets of variables — or 'blocks'. The UK block is relatively simple, as it contains only real GDP, consumer prices index (CPI) inflation and Bank Rate. This simplicity is intentional, and reflects the objective of the modelling exercise, which is to identify world, rather than domestic, shocks (this is explored in more detail below). Correspondingly, the world block is more complex, and consists of a measure of world activity (world GDP, or a broader set of indicators), a measure of world prices, an indicator of financial market stress (the spread between the three-month dollar interbank lending rate and the three-month Treasury bill rate) and a financial market-based measure of uncertainty (the VIX index). All variants of the model are estimated on quarterly data spanning the period from 1987 Q1 to 2013 Q4. A more detailed description of the individual models is contained in the annex.

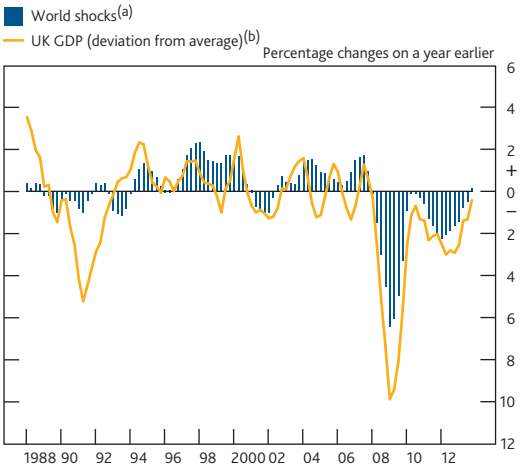
This approach means that UK monetary policy is endogenous to the models, with movements in Bank Rate largely being interpreted as responses to other shocks. Reductions in Bank Rate after 2007 can therefore be understood as a response to the global financial crisis, rather than as shocks in themselves. 'Unconventional' monetary policy, such as quantitative easing and the Funding for Lending Scheme, is not explicitly included in the model. But insofar as these policies affect UK GDP, their effects will be captured implicitly as positive UK-specific shocks.

Results of the VAR

To present the key results, it is useful to average across the four different model specifications. Averaging across the models yields a central estimate for the impact of world shocks on UK GDP growth over the past 25 years (**Chart 3**). The blue bars show the total impact of all world shocks (world demand, world supply/price and world financial) on annual GDP growth in the United Kingdom.(1)

This analysis suggests that the early 1990s UK downturn was mostly driven by domestic, rather than external factors.

Chart 3 Estimates of the historical impact of world shocks on UK activity



Sources: Bloomberg, Bureau for Economic Policy Analysis, IMF, OECD, ONS, Thomson Reuters Datastream and Bank calculations.

(a) Average estimates across the four variants of the structural vector autoregression model.
(b) Line shows UK GDP growth relative to the average over the period 1988–2007, which is 3.1%. The contributions of world shocks are relative to model-consistent trend growth rates.

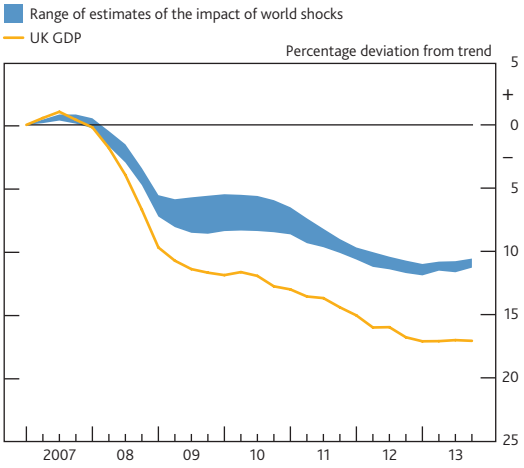
During the so-called 'Great Moderation' — the period of stable growth and inflation between the mid-1990s and 2007 — world shocks generally exerted a positive impact on the United Kingdom, possibly reflecting loose global credit conditions and a low perception of risk, as well as healthy growth in overseas demand.

Consistent with the narrative in the previous section, these results indicate that UK GDP growth since 2007 has largely been shaped by global developments. It is particularly striking that world shocks deducted over 6 percentage points from annual UK GDP growth at the height of the recession. The recovery was subsequently held back by world shocks too. This result is consistent with Hackworth, Radia and Roberts (2013), who find that disappointing global growth and high commodity prices accounted for a significant part of the unexpected weakness in UK GDP after mid-2010. Interestingly, a large part of the pickup in UK growth since 2012 appears to have been driven by a waning of the drag from world shocks.

The identified world shocks can account for the level of UK GDP at end-2013 being around 11% lower than a simple counterfactual of a continuation of the pre-crisis trend would have predicted (**Chart 4**). These results therefore suggest that around two thirds of the current shortfall in output in the United Kingdom relative to pre-crisis trend came about as a result of global developments.(2)

(1) The lines for UK GDP in **Charts 3**–**5** represent useful reference points to put estimates for the impact of world shocks into context.
(2) The difference in trends between the model-based estimates and UK GDP in **Charts 4** and **5** mean that the models provide a conservative estimate for the impact of world shocks on UK GDP. This is because the 1988–2013 average of UK GDP growth is lower than the 1988–2007 average, such that the deviation of UK GDP since 2007 from the longer 1988–2013 trend period would be lower than that shown here.

Chart 4 Estimates of the impact of world shocks on the level of UK GDP since 2007, relative to trend[a]



Sources: Bloomberg, Bureau for Economic Policy Analysis, IMF, OECD, ONS, Thomson Reuters Datastream and Bank calculations.

(a) The line shows the level of UK GDP relative to a continuation of the average four-quarter growth rate of 3.1% over the 1988–2007 period. Estimates in the blue swathe are relative to model-consistent trend rates.

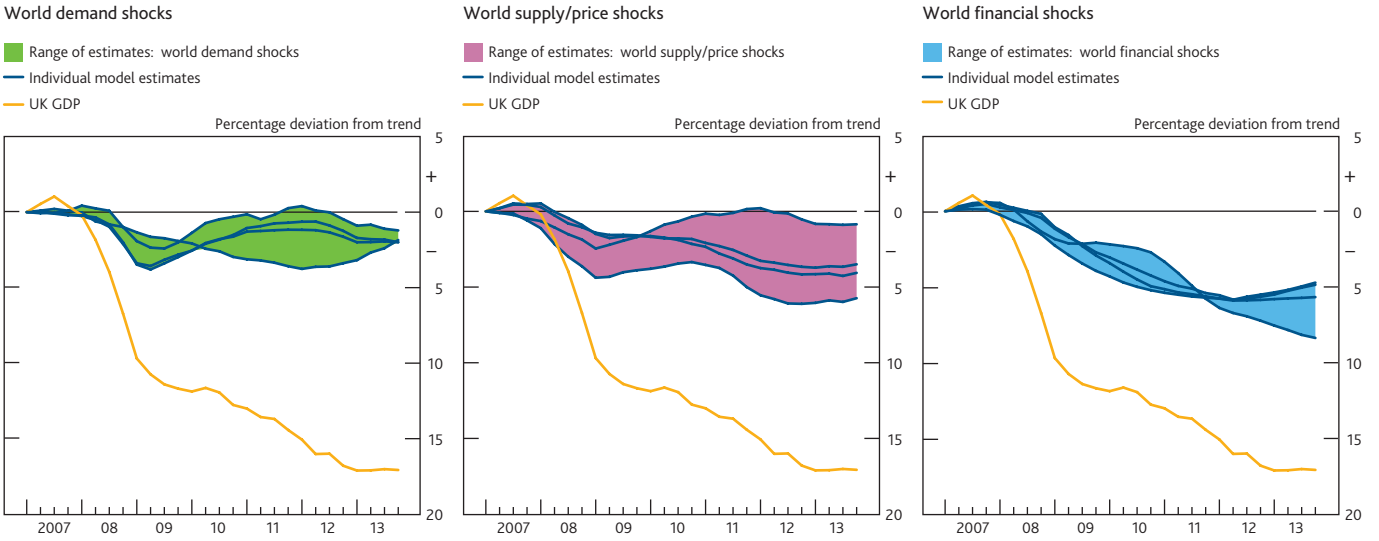
But which particular world shocks have been important since 2007? **Chart 5** sets out model estimates for the individual contribution of world demand, world supply/price and world financial shocks to the shortfall of UK GDP, relative to the same simple counterfactual of the pre-crisis trend. The models suggest that two shocks were particularly important: world supply/price shocks and world financial shocks. The world demand shocks played a role in the early stages of the financial crisis, but their impact has since diminished. As the width of these swathes illustrates, there is substantial uncertainty about the 'source' of the shocks: some models suggest that world financial shocks played a bigger role than world supply/price shocks, while others suggest that the two had a similar impact.

The results show that the key headline result — that world shocks in aggregate account for around two thirds of the weakness in UK output since 2007 — seems robust to several different VAR-modelling strategies. And despite identification of the impact of *specific* shocks being more uncertain, different specifications confirm that world shocks have been important for the United Kingdom.

While world shocks have been the dominant influence on UK activity in recent years, domestic factors have also been important over this period. UK productivity growth, for example, has been extremely weak over this period, both compared with past experience, as well as relative to other countries.(1) It is therefore likely that the UK economy's supply capacity has been adversely affected since the onset of the crisis.(2) That said, the poor recent performance of UK productivity may itself be symptomatic of world shocks. The impairment of the UK banking system associated with the global financial crisis, for instance, may have restricted the reallocation of resources from less to more productive uses. In addition, weak UK credit supply may also have slowed productivity growth. A further domestic shock that has detracted from UK growth since 2010 is fiscal consolidation, as reduced discretionary government spending and higher VAT dampened aggregate demand.(3)

(1) Hughes and Saleheen (2012) consider UK labour productivity since the financial crisis in an international and historical perspective.
(2) See Barnett *et al* (2014), in this edition of the *Bulletin*, for a detailed discussion of candidate explanations for the UK productivity puzzle.
(3) Hackworth, Radia and Roberts (2013) point out that fiscal consolidation has been broadly in line with the Government plans announced in 2010 and is, therefore, unlikely to explain the *unexpected* weakness of UK GDP from mid-2010 to mid-2013.

Chart 5 Estimates of the impact of three world shocks on the level of UK GDP since 2007, relative to trend[a]



Sources: Bloomberg, Bureau for Economic Policy Analysis, IMF, OECD, ONS, Thomson Reuters Datastream and Bank calculations.

(a) Charts show the estimated impact of the shock on the level of UK GDP, with separate lines for each of the four estimated models. The swathe illustrates the range of impacts across the models. Pre-crisis trend for four-quarter UK GDP growth calculated over the period 1988–2007 is 3.1%. The model estimates are relative to model-consistent trend rates.

All of the models in this article share the same broad characteristics, and, as is the case with every econometric modelling exercise, there is a degree of uncertainty around the results. Three of these characteristics merit discussion.

(1) **The models implicitly assume that there was no structural change in the UK or world economies over the past 25 years.** In practice, the structure of both the UK and global economies has of course changed. Financial openness, for example, has tended to increase over time. But the headline results are robust to varying the estimation period: for example, estimation only over the post-2000 period yields very similar results to those presented here.

(2) **The models do not distinguish between shocks which are genuinely external to the UK economy, and those which are common to most or all individual economies, including the United Kingdom.** This distinction may be straightforward at times. A fiscal expansion abroad, for example, is clearly external to the United Kingdom. An increase in oil prices, by contrast, is a common shock in the sense that all countries would experience the higher global oil price. But the distinction between external and common shocks is more blurred in other cases. Some shocks may have a specific geographical origin, but still transmit instantaneously to the wider global economy. Stresses in the US sub-prime sector in 2007, for instance, quickly increased households' and firms' uncertainty levels in many advanced economies. Given this conceptual difficulty, and as discussed in the introduction, the aim of this section is to assess the *total* impact of world shocks on the United Kingdom, rather than analyse the relative importance of external versus common shocks.

(3) **The modelling approach assumes that the United Kingdom is a small open economy, meaning that UK-specific developments have little to no impact on the world economy.** In particular, if truly domestic UK shocks happen to coincide with world shocks, the models could misinterpret those as world shocks. And given the relatively large size of the UK financial system, it is of course possible that the United Kingdom could be a source of financial shocks for the rest of the world. But over the long sample period considered it is sensible to assume that UK-specific shocks had little impact on the global economy at large.

Through which channels do world shocks affect the United Kingdom?

The previous section discussed estimates of the *impact* of world shocks on the UK macroeconomy. But those models did not identify the *channels* through which those shocks affected the United Kingdom.(1) Understanding channels of transmission is important because doing so can allow policymakers to attempt either to limit or to offset the impact of shocks. In practice, it is the United Kingdom's trade and financial linkages with the rest of the world that allow for the transmission of world shocks. This section provides a stylised explanation of the trade and financial channels of transmission, as well as a third channel that transmits world shocks via agents' economic uncertainty. It outlines how specific mechanisms operate, and also provides an indicative assessment of the importance of trade relative to other channels for the United Kingdom. While the focus is on the period since the onset of the financial crisis — when global events are estimated to have had a negative impact on UK GDP — it is important to bear in mind the fact that the UK economy benefitted from world shocks for much of the two decades prior to the financial crisis (**Chart 3**).

The trade channel

The trade channel captures changes to the cross-border flow of goods and services that result from world shocks. The impact of developments abroad will be felt in the United Kingdom through changes in the quantities and prices of UK exports and imports.

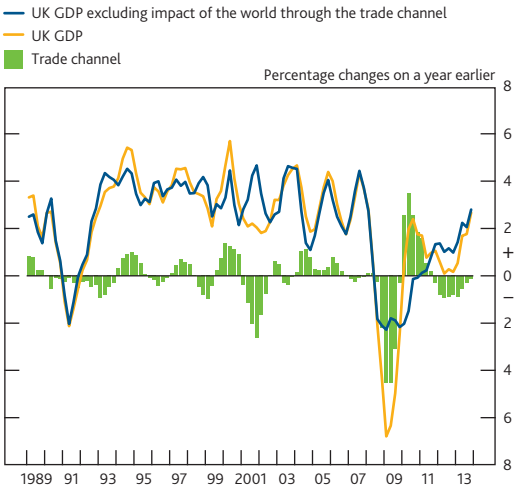
All the world shocks discussed in the previous section can propagate through the trade channel. A negative demand shock abroad will reduce demand for UK exports, lowering the price and quantity of UK goods and services exported. And insofar as it leads to a greater shortfall in UK output than the United Kingdom's trading partners, the negative demand shock may also cause sterling to depreciate in order to eliminate spare capacity in the UK economy. A foreign financial shock, such as a failure of a financial institution abroad, could also reduce demand for UK exports. Meanwhile, a world supply/price shock, for instance a natural disaster that leads to a fall in the production of oil and an increase in oil prices, would primarily transmit through increased UK import prices, which in turn would put upward pressure on firms' costs and squeeze households' incomes available for other purchases. Regardless of the source of the shock, lower demand for UK exports or higher import prices are likely to depress domestic output.

Indirect trade effects also matter because a shock in a country *without* sizable direct trade linkages with the United Kingdom could still affect UK GDP by transmitting through other countries which are close trading partners of the United Kingdom. This is particularly the case given the presence of long and complex global supply chains: for example, the floods in Thailand in 2011 resulted in disruption to the global supply chain of hard drives.

(1) 'Channels' here refers to both the mechanisms by which shocks originating in a foreign country transmit to the UK economy, but also the linkages that allow 'global' shocks common to a number of economies (including the United Kingdom) to have a direct impact on the UK economy.

The Bank's main forecasting model, COMPASS, can be used to estimate the extent to which world shocks transmitted to the United Kingdom through the trade channel (**Chart 6**).[1] While subject to uncertainty, the estimate from COMPASS suggests that, at its peak, the collapse in world trade detracted significantly from annual UK growth.[2] Around 2% of the total shortfall, relative to trend, in the level of UK GDP by end-2013 was due to world shocks being transmitted to the United Kingdom through the trade channel. While clearly significant, this represents only around one fifth of the total weakness in UK GDP allocated to world shocks in the previous section. Four fifths of world shocks since 2007 therefore appear to have affected the UK economy through other, 'non-trade' channels (**Table A**).

Chart 6 Estimated impact of world shocks on UK GDP through the trade channel[a]



Sources: IMF, OECD, ONS, Thomson Reuters Datastream and Bank calculations.

(a) Green bars are the difference between blue and orange lines and show estimates from COMPASS that capture the trade effects of shocks that originate outside the United Kingdom. And while they do not capture the *direct* effects on UK GDP of any shocks that are common to both the United Kingdom and other economies, they do include the 'second-round' trade spillover effects of those common shocks.

Table A Channels through which world shocks have impacted UK GDP

Total estimated impact of world shocks on the level of UK GDP relative to pre-crisis trend since 2007[a]	**Around -11%**
of which is estimated to have transmitted through:	
the trade channel	*Around -2%*
other (non-trade) channels	*Around -9%*

(a) Average of structural vector autoregression models discussed in the previous section of this article.

Financial channels

Financial channels operate in parallel to the trade channel described above. While the trade channel involves the exchange of goods and services across countries, the exchange of financial assets underlies financial channels. Financial integration can bring benefits to the world economy, for instance by increasing the flow of funding to globally productive projects. But in times of stress, those same financial linkages can allow shocks to spread from one country to another.[3]

Although the financial transmission of shocks is complex, a simple classification distinguishes between three types of channel: credit, funding and non-banking. Both credit and funding channels operate through the banking system and are associated with changes in UK credit conditions, via the availability or price of credit. Non-banking channels, by contrast, operate directly through households, firms and non-bank financial institutions, such as pension funds and hedge funds. These banking and non-banking channels can affect overall UK activity through their impact on household consumption and business investment.

(i) Credit channel

The credit channel works via banks operating in the United Kingdom, and in particular, how lending to UK households and companies may be affected by the crystallisation of risks associated with these banks' exposures abroad. Consider, for example, a weakening of demand conditions in a foreign country that led to an increase in non-performing loans there. If a UK bank suffered losses abroad as a result of this then its capital base would be reduced — as would its capital ratio, that is, capital as a share of total assets.[4] In response to this, if the bank attempted to rebuild its capital ratio then one way in which it might achieve this is via reducing the size of its balance sheet (that is, total assets) by restricting the amount of new loans it supplies to the UK real economy (which might be achieved by raising the interest rates the bank charges on new loans). Similarly, foreign banks operating in the United Kingdom may face losses on their lending in their home country or elsewhere. This too may result in a tightening of UK credit conditions.

(ii) Funding channel

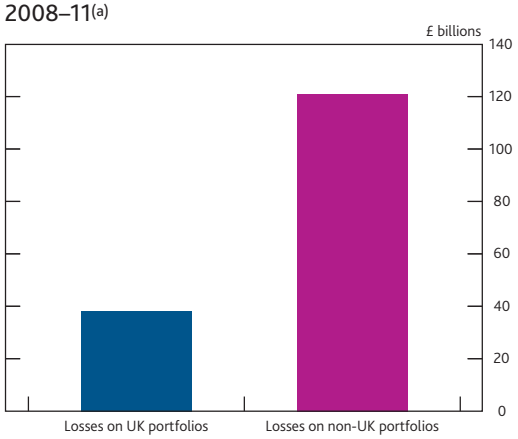
The funding channel reflects the reliance of UK financial institutions on foreign funding. To illustrate this channel, consider the case of a foreign bank short of liquidity. The cash-strapped foreign bank may withdraw funding that it supplies to UK banks. This might occur directly through international wholesale markets (where UK banks seek funds), or through a reduction of cross-border lending to the foreign bank's affiliates in the United Kingdom (if these affiliates in turn provide funds to UK banks). If UK banks cannot replace

(1) COMPASS includes trade linkages between the United Kingdom and the rest of the world. For more information on COMPASS see Burgess *et al* (2013).
(2) Domit and Shakir (2010) explain the collapse of world trade during the Great Recession in more detail, focusing on the fact that the decline in world demand was skewed toward tradable sectors.
(3) See, for example, Devereux and Yetman (2010) and Enders, Kollmann and Müller (2011). Lane and Milesi-Ferretti (2011) find that the importance of financial channels might have increased in recent years, particularly in the context of the financial crisis.
(4) For an explanation of bank capital, see Farag, Harland and Nixon (2013).

this lost funding, then they may be forced to cut back lending as set out under the credit channel.(1)

There is strong evidence that both the credit and funding channels played an important role for the transmission of world shocks to the UK economy in the global financial crisis. Broadbent (2012) points out that major UK banks' losses were, in large part, on their non-UK portfolios (**Chart 7**) which, in turn, is likely to have led them to restrict their lending to the UK economy. Furthermore, lending from non-resident UK banks to the United Kingdom weakened more sharply than credit from resident UK banks over 2007–09 (**Chart 8**).(2) And Aiyar (2011) argues that every 1% reduction in UK banks' external funding was associated with a 0.5%–0.6% contraction in the flow of domestic lending.(3) These results are all consistent with both credit and funding channels operating.

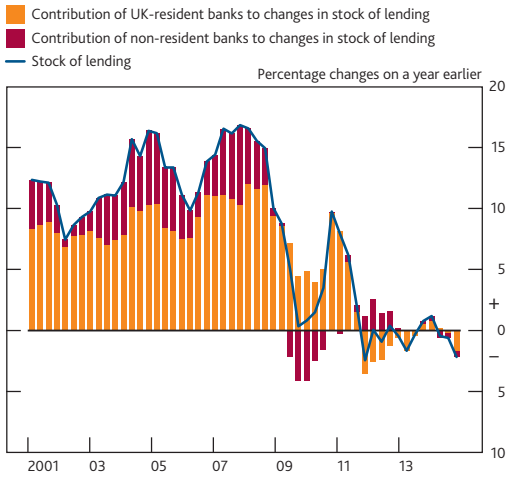
Chart 7 Losses of major UK-owned banks by portfolio, 2008–11(a)



Sources: FSA regulatory returns, published accounts and Bank calculations.

(a) Losses are defined as the sum of impairment, write-off, trading book and goodwill losses. Impairments and write-offs are taken from Financial Services Authority (FSA) regulatory returns. These data are indicative. Goodwill impairments are calculated on a *pro-forma* basis and may be subject to error. Non-UK entities include banks and other financial institutions. Due to sampling and definitional differences, these may not match those disclosed in published accounts or in the Bank of England's *Bankstats*. Banks covered in the chart are: Barclays, Co-operative Bank, HSBC, Lloyds, Nationwide, Royal Bank of Scotland and Santander.

Chart 8 Contribution of UK-resident and non-resident banks to UK credit growth(a)



Sources: BIS locational database and Bank calculations.

(a) UK credit growth defined as lending to the non-financial private sector, government and other financial companies.

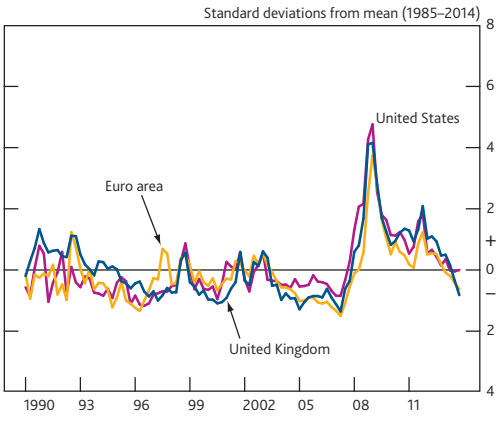
(iii) Non-banking channels

Around half of UK foreign assets and liabilities are held outside the banking system (for instance via portfolio and foreign direct investment) so world shocks can propagate to the UK economy through non-banking financial channels as well. For instance, there may be 'wealth effects' whereby UK households and firms cut back their spending if a shock abroad causes them to suffer losses on their foreign financial investments. And this could be exacerbated if the fall in the value of their assets also limits their ability to borrow. Alternatively, investment decisions by foreign agents might affect UK asset prices. A shock abroad, for example, could potentially cause UK asset prices to fall if foreign investors were to sell their UK holdings and repatriate capital. UK asset prices might rise, by contrast, if foreign investors view UK assets as a safe haven following a shock. While the empirical literature in this area is still at a relatively early stage, some recent research suggests that this channel could be significant for the transmission of shocks. Arslanalp and Poghosyan (2014), for example, estimate that international flows to the UK bond markets over 2008–12 reduced ten-year government bond yields by 20–30 basis points.

Uncertainty

Beyond the trade and financial channels, world shocks can also propagate to the UK economy by affecting the level of uncertainty. Macroeconomic uncertainty refers to how wide households and firms perceive the range of their possible future incomes to be. **Chart 9** shows summary measures of

Chart 9 Measures of uncertainty across countries(a)



Sources: Eurostat, ONS, Thomson Reuters Datastream and Bank calculations.

(a) Uncertainty indicators for the United Kingdom, euro area and United States include option-implied volatility of exchange rates and equity prices, survey measures of confidence and measures of the dispersion of earnings growth expectations over the next twelve months. The uncertainty indicator for the United Kingdom also includes: dispersion of annual GDP growth forecasts, measures obtained from press articles citing 'economic uncertainty' and measures from the Confederation of British Industry's *Quarterly Industrial Trends* and *Service Sector* surveys related to companies' capital expenditure.

(1) While bank lending creates deposits at the aggregate level, a given individual bank needs to make sure it is able to attract and retain some kind of funds in order to keep extending more loans. See McLeay, Radia and Thomas (2014).
(2) Hills and Hoggarth (2013) find evidence that lending from non-resident banks was more volatile than lending from resident banks in most advanced economies during the financial crisis.
(3) Barnett and Thomas (2013) find that credit supply shocks account for most of the weakness in UK bank lending since the financial crisis.

uncertainty for the United Kingdom, the euro area and the United States, each based on a number of underlying indicators.(1) While some of the changes in UK uncertainty may reflect domestic factors, the close correlation of uncertainty measures across countries since 2007 suggests that it may have been a channel for the transmission of world shocks to the United Kingdom. The start of the US sub-prime crisis in 2007 and euro-area crisis from 2010, for example, are likely to have increased the uncertainty of UK households and firms about the domestic economy and prospects for their own income and revenue. Consistent with events abroad generating increased uncertainty in the UK private sector, the Deloitte survey of UK chief financial officers in 2012 Q2 reported a fairly high probability — 36% — of a break-up of the euro area over the following year.

There are several ways in which elevated uncertainty can dampen demand. Bernanke (1983) and Bloom (2009), for example, suggest that households postpone spending when economic prospects become more uncertain because their incentive to 'wait and see' how the economy evolves increases. Firms reassess their prospects for demand, leading them to postpone investment. Finally, elevated uncertainty may push up borrowing costs for households and firms as investors demand greater compensation against future risks. Previous Bank analysis suggests that uncertainty shocks, including uncertainty driven by foreign factors, can have material impacts on UK GDP.(2)

Interaction of channels of transmission

It is important to note that the trade, financial and uncertainty channels described in this section rarely operate in isolation. Instead, they are active simultaneously, and feedback loops among channels can amplify the effect of shocks. To that extent, the estimates in **Table A** should be taken with a degree of caution.

The uncertainty channel, in particular, can amplify both trade and financial mechanisms. This is because it leads consumers and firms to be unsure about what the ultimate effect of world shocks will be. A financial shock, for example, such as an isolated failure of a financial institution abroad, might be transmitted through credit channels. But it could also affect households' and firms' sense of economic uncertainty. The academic literature suggests that if domestic agents become more uncertain in response to events abroad, this can amplify their response to shocks, via second-round effects through the trade and financial channels. Taglioni and Zavacka (2013), for instance, find that exporters' production plans are heavily affected by their uncertainty about the foreign trading environment.

Conclusions

The UK economy is highly exposed to foreign economic developments due to its trade and financial openness. And given the major world events that have occurred since 2007, the global economy has been an important influence on UK output and inflation over the recent past. These events include the global financial crisis in 2007–08, severe gyrations in global commodity prices over 2008–11 and, since 2010, the euro-area crisis.

Model-based estimates suggest that world shocks played a very important part in the 2008–09 downturn in the United Kingdom and account for around two thirds of the weakness in the level of UK GDP since 2007, relative to its pre-crisis trend. Transmission through the trade channel, however, can only account for around a fifth of the impact of these shocks on the United Kingdom. Financial channels and uncertainty are likely to have been more important.

An awareness of the impact of world shocks and the channels through which they transmit has been a key feature of UK monetary and financial policy, particularly since the crisis. The loosening in monetary policy by major central banks in late 2008, for instance, attempted to support economic activity at the height of the financial crisis while avoiding exchange rate volatility.(3)

The analysis in this article affirms the importance of understanding the international environment for policymakers. Doing so allows domestic monetary and financial policy to be set in a way which takes into account the impact that world shocks are expected to have going forward. And understanding the linkages between the United Kingdom and the rest of the world can help to assist the Bank in its aim to support the setting of policies in international fora.

(1) Each summary measure combines the underlying indicators into a single uncertainty index using a statistical technique called 'principal component analysis'. This method involves extracting from a set of related variables a smaller number of new variables, called principal components, which explain most of the variation in the original set.
(2) See Haddow *et al* (2013).
(3) In October 2008, the Bank of Canada, Bank of England, European Central Bank, Riksbank, Swiss National Bank and US Federal Reserve reduced their key policy rates by 50 basis points simultaneously.

Annex
Constructing VAR models to estimate the impact of world shocks on the United Kingdom

This annex sets out how the suite of vector autoregression (VAR) models used in this article to estimate the impact of world shocks on UK GDP were constructed. It starts with general modelling principles, and then briefly outlines the differences between the four modelling approaches.

Generally speaking, a VAR is a statistical model that allows for an examination of the linear interdependencies between the variables of interest. For example, this framework allows estimation of the relationship between key global variables and UK GDP.

The model used in the article can be thought of as consisting of two segments: the world block (modelled as a single economic entity) and the UK block. All variants of the model are estimated on quarterly data spanning the period from 1987 Q1 to 2013 Q4.(1)

In the baseline specification, the world block consists of:(2)(3)

- **A measure of world activity:** world GDP, weighted by countries' shares in UK exports.(4)
- **Measures of world prices:** world export prices excluding oil(5) and oil prices in US dollars.(6)
- **Measures of financial conditions:** the spread between the three-month US dollar interbank rate and the three-month US Treasury bill rate; and the VIX index (Chicago Board Options Exchange Market Volatility Index of the S&P 100).

The UK block consists of UK GDP, UK CPI (both in percentage changes on a quarter earlier) and Bank Rate (in per cent). The UK block is therefore relatively simple: this is because the modelling exercise concentrates on the impact of world shocks on the United Kingdom (separately identifying the impact of the UK-specific shocks is beyond the scope of this article).

The baseline specification is estimated using ordinary least squares (OLS), and the structural shocks are identified recursively (an identification technique often referred to as Cholesky identification). This means that the ordering of the variables in the VAR is significant, as shocks to variables ordered first affect all the variables that follow on impact, but not *vice versa*. As explained in the main text, the ordering reflects the assumption that the United Kingdom is a small open economy: shocks associated with world variables will have an impact on the United Kingdom instantaneously, but the UK-specific shocks will not impact on the world variables. So the world block is ordered first, and the UK block follows.(7)

The second approach is similar to the baseline specification, except that the measure of world activity is constructed by combining a large set of cross-country activity data, using principal component analysis.(8) The advantage of this method is that the principal component summarises the information content of a large number of indicators efficiently.(9)

The third variant of the model differs from the baseline in the way it is estimated: in this case, Bayesian techniques are employed to estimate the parameters. The Bayesian approach is useful relative to OLS, in this instance, given the relatively large number of parameters to be estimated.

The fourth specification is also estimated using Bayesian techniques, but introduces an alternative identification technique: the sign restrictions identification. In this approach, structural shocks are identified on the basis of the sign of responses of the variables to the shock.(10) These sign restrictions are intended to accord with economic intuition. For example, a positive world demand shock is assumed to raise both world output and inflation. Shocks to world prices and world financial shocks are assumed to have the characteristics of a supply shock, in that global output and prices respond in opposite directions (for example, an adverse shock to world prices depresses global output and raises global inflation). Finally, the shocks to world prices and the world financial shocks are differentiated through their impact on the financial variable, the VIX (which is assumed to rise in response to the adverse financial shock, but decline in response to the shock to world prices).(11) The responses of UK variables to any of the world shocks are unrestricted: this is because those responses are the key results of the article, and so it is important to allow the data and the model to determine those responses independently.

(1) All variants of the model are specified to be of order two; that is, each variable is regressed on the last two quarters' values of all variables (including itself).
(2) World activity and world price measures are in percentage changes on a quarter earlier. The spread is measured in percentage points, and the VIX is measured in index points.
(3) Inclusion of the exchange rate into these models does not change any of the headline results, so it is omitted from the models shown in this article for ease of exposition.
(4) World GDP is constructed using data for the real GDP growth rates of 143 countries weighted according to their shares in UK exports.
(5) World export prices are constructed using data for export prices of 52 countries, weighted according to their shares in UK imports. The sample does not include any major oil exporters. Prices are in foreign currency (from a UK perspective).
(6) In some specifications world export prices including oil are used instead.
(7) The ordering of the variables within each block follows standard principles of identification in these types of models. For example, it is assumed that fast-moving financial variables will react instantaneously to any shocks to activity, but the world financial shocks will only have an effect on world activity with a delay.
(8) In total, 56 seasonally adjusted quarterly growth rate series are used in the principal components analysis estimation.
(9) Specifically, the first principal component is the single indicator that explains most of the comovement of the wide range of data.
(10) In this specification only one measure of financial stress — the VIX index — is used.
(11) There are other ways in which these shocks could be identified, and the headline results are robust to alternative identification techniques.

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How has the Liquidity Saving Mechanism reduced banks' intraday liquidity costs in CHAPS?

By Nick Davey and Daniel Gray of the Bank's Market Services Division.[1]

- Banks require intraday liquidity to settle payments in CHAPS, the United Kingdom's high-value sterling payment system.
- In April 2013, the Bank of England introduced a Liquidity Saving Mechanism (LSM) into the infrastructure used to settle CHAPS payments. The LSM has reduced CHAPS banks' intraday liquidity requirements by around 20% (or £4 billion).
- The LSM has reduced incentives for banks to adopt adverse behaviours to economise on their intraday liquidity requirements, thus enhancing the resilience and efficiency of CHAPS.

Overview

CHAPS is the United Kingdom's high-value sterling payment system. On average £280 billion of CHAPS payments are made every business day. The Bank of England provides the infrastructure used by banks to settle CHAPS payments, called the Real-Time Gross Settlement (RTGS) infrastructure. All banks that settle CHAPS payments have an account in RTGS.

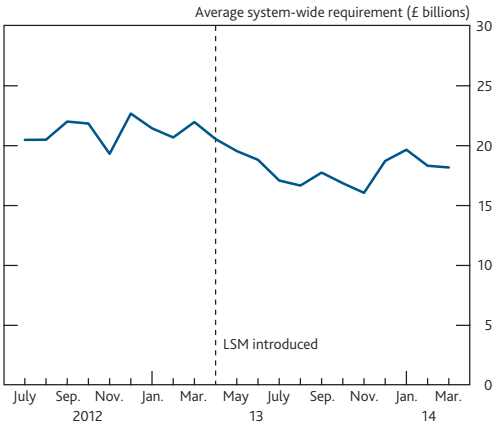
In order to settle a CHAPS payment, a bank must have sufficient funds in its RTGS account. Broadly speaking, a bank has two types of funds in its account. First, there are 'received funds' — that is, payments received from other banks throughout the day. Second, there are 'own funds' — these include sterling reserves held at the Bank, for example. A bank requires 'own funds' when, at any point during the day, it has sent more payments than it has received. This need is referred to as an 'intraday liquidity requirement'.

Following the recent financial crisis, the Financial Services Authority (the prudential banking regulator at the time) strengthened its liquidity regulations which, unavoidably, created incentives for banks to economise on their intraday liquidity requirements. Specifically, banks might have started to reduce the amount of their own funds that they used to settle CHAPS payments — relying more on received funds instead. This could have introduced additional operational and liquidity risks into CHAPS.

To minimise the likelihood of these risks materialising, the Bank sought to provide a technical means for banks to reduce their CHAPS intraday liquidity requirements. As a result, the Liquidity Saving Mechanism (LSM) was introduced into the Bank's RTGS infrastructure in April 2013.

The LSM, which uses algorithms to match up groups of broadly offsetting CHAPS payments and then settle them simultaneously, has reduced CHAPS banks' intraday liquidity requirements by around 20%, or £4 billion. This has reduced incentives for banks to adopt adverse behaviours to economise on their intraday liquidity requirements, enhancing the resilience of CHAPS. It is also now less likely that, under stressed conditions, banks will be unable to settle CHAPS payments due to liquidity shortfalls, enhancing UK financial stability.

Summary chart Average value of intraday liquidity required by CHAPS settlement banks for sterling payment systems



(1) The authors would like to thank Andrew Georgiou and Danielle Gontier for their help in producing this article.

Electronic payments are essential to the functioning of modern economies. They are used, for example, by individuals to purchase goods, by companies to pay salaries, and by the government to pay for public goods and services. For this reason, the infrastructure used to make sterling electronic payments is sometimes described as the financial plumbing that enables money to flow around the UK economy.

The Bank of England sits at the heart of this financial plumbing in the United Kingdom. As 'settlement agent' for the main sterling electronic payment systems, the Bank facilitates the transfer of electronic payments between the customers of different banks. To do so, it operates an accounting system called the Real-Time Gross Settlement (RTGS) infrastructure.

One of the electronic payment systems that uses the RTGS infrastructure is CHAPS, the United Kingdom's high-value sterling payment system. CHAPS is vital to the functioning of the UK economy: on average, £280 billion of CHAPS payments are made every business day. As part of its financial stability objective, the Bank therefore seeks to identify and mitigate any risks to the smooth functioning of CHAPS.

In 2009 and 2010, the Financial Services Authority (FSA) strengthened its liquidity regulations which, unavoidably, created incentives for banks to economise on the amount of liquid assets that they required to make CHAPS payments (referred to as their 'intraday liquidity requirement' for CHAPS).(1) This might, in turn, have incentivised banks to adopt adverse behaviours such as delaying the rate at which they settled CHAPS payments. To counter this potential risk, the Bank sought to reduce the likelihood that banks would delay their CHAPS payments by providing them with a technical means to reduce their intraday liquidity requirements. This technical means is referred to as the Liquidity Saving Mechanism (LSM). The LSM was introduced into the RTGS infrastructure in April 2013.

This article describes the motivations for introducing the LSM, its design, and its effect on banks' intraday liquidity requirements. It follows a series of publications by the Bank of England about liquidity saving mechanisms.(2)

Drawing on these previous Bank publications, the first section of this article describes CHAPS and the importance of the Bank's role in settling CHAPS payments. The second section details the rationale for providing banks with a technical means to reduce their intraday liquidity requirements for CHAPS. The article then outlines recent developments, by detailing how the Bank redesigned its RTGS infrastructure to incorporate the LSM and describing the outcomes, as of March 2014, of introducing the LSM.

The CHAPS payment system

CHAPS and the Bank of England's role

CHAPS is the electronic payment system designed for making real-time, high-value sterling payments, such as wholesale market transactions by financial institutions and corporate treasury transactions. CHAPS is also used to make other, lower-value but time-critical payments, such as house purchases.

Economic agents — such as individuals, companies, the government and financial institutions — are able to make CHAPS payments via a CHAPS settlement bank. There are currently 21 CHAPS settlement banks, which are the payment system's 'direct participants'.(3) When the customer of one settlement bank makes a CHAPS payment to the customer of another settlement bank, an interbank obligation arises as the paying bank needs to pay the receiving bank the value of that payment. In order to settle these interbank obligations, each CHAPS settlement bank has an account at the CHAPS system's settlement agent — the Bank of England. The Bank undertakes the role of settlement agent for CHAPS for financial stability reasons, as explained in Dent and Dison (2012).(4)

To fulfil its role as settlement agent, the Bank provides the RTGS infrastructure. The RTGS infrastructure allows banks and building societies to hold sterling balances, called reserves, at the Bank.(5) During the day, these reserves can be transferred between settlement banks to extinguish the interbank obligations arising from payments made by the banks and their customers. Interbank obligations arising from CHAPS payments are settled individually and in real time. Each time a CHAPS payment is settled, the paying bank's settlement account in RTGS is debited and the recipient bank's account credited immediately.

The real-time settlement of CHAPS payments means that payments are settled with finality. There is no gap between the settlement of a payment and the clearing of funds, hence no scope for credit exposures between settlement banks to build up within the settlement process. Recipient banks can

(1) The new regulatory framework was introduced by the FSA, the banking regulator at the time. Since April 2013, the microprudential regulation of deposit-takers, insurers and major investment firms has been performed by the Prudential Regulation Authority — see Murphy and Senior (2013) for more information.
(2) Norman (2010) summarises the empirical and theoretical evidence on the effectiveness of liquidity saving mechanisms. Ball *et al* (2011) describe why a change in intraday liquidity regulation in the United Kingdom may merit the introduction of an LSM. And Denbee and McLafferty (2013) present the results of a simulation study which predicted how an LSM would affect banks' intraday liquidity requirements in CHAPS.
(3) This figure is set to increase to 25 by 2015 following the Bank's 'de-tiering' initiative. See Finan, Lasaosa and Sunderland (2013).
(4) The Bank of England is also settlement agent for Bacs, Cheque & Credit Clearing (C&CC), the Faster Payments Service (FPS), LINK, Visa Europe and the interbank payments arising from securities transactions in CREST.
(5) Reserves held in RTGS are also a key component of the Sterling Monetary Framework (SMF). For an explanation of the SMF and how monetary policy is implemented, see Bank of England (2014).

credit customer accounts, or use incoming funds to pay other banks, in the knowledge that they have received the funds irrevocably and in real time.

Intraday liquidity requirements for CHAPS

While the real-time settlement of payments eliminates interbank credit risk in CHAPS, it also requires that banks have a relatively large value of funds (termed 'liquidity') on their settlement accounts. This is because when a CHAPS payment is settled, the paying bank's account is debited immediately. Therefore prior to settling a CHAPS payment, the paying bank must have sufficient funds in its account at the Bank to settle the gross value of that payment.

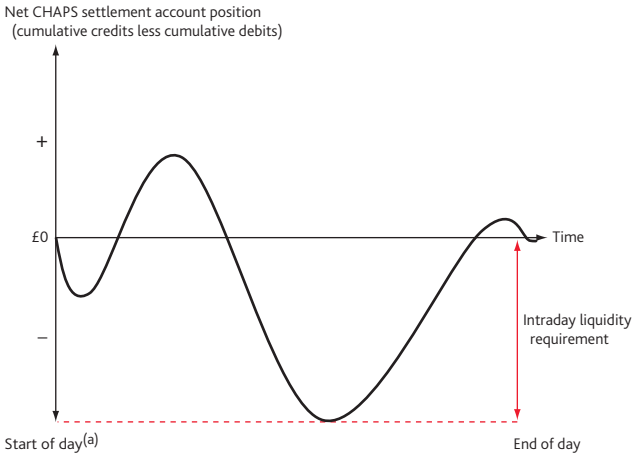
Broadly speaking, a settlement bank has two types of funds in its account which can be used to settle CHAPS payments. First, there are 'received funds'. Settlement banks receive CHAPS payments from other settlement banks throughout the day and are able to use these received payments to fund their outgoing payments. Second, there are 'own funds'. A settlement bank can supply own funds by holding reserves at the Bank, or borrowing intraday from the Bank on a secured basis.

The amount of its own funds that a settlement bank requires to settle payments is referred to as its intraday liquidity requirement. Such requirements exist because settlement banks are not always able to recycle received funds to settle outgoing payments: typically settlement banks will, at some point during the day (and possibly for only a very short period), have sent more payments than they have received. In other words, it is common for there to be a timing mismatch between a bank's debits and its credits.

A settlement bank's intraday liquidity requirement on any given day is the value by which its sent payments most exceed its received payments during that day. Or, equivalently, it is the largest net debit position the settlement bank incurs intraday — as illustrated in **Figure 1**. Prior to the introduction of the LSM in April 2013, the total daily value of intraday liquidity required by all the CHAPS settlement banks averaged £21.2 billion.

The total value of intraday liquidity that banks require is significant for two reasons. First, it is important that a settlement bank's intraday liquidity requirement does not exceed its supply of own funds, since insufficient funds would prevent it from being able to settle payments in a timely manner. This could have important financial stability implications: a lack of liquidity was one of the key elements that precipitated the collapse of Lehman Brothers on 14 September 2008 (Ball *et al* (2011)), for example. Second, the Prudential Regulation Authority (PRA) now monitors the total value of own funds that banks require for payment systems, as discussed in the next section.

Figure 1 Intraday liquidity requirements



(a) CHAPS is available on sterling business days between 06:00 and 16:20.

Regulatory changes

The new regulatory framework for liquidity risk management

In response to the recent financial crisis, the FSA — the prudential banking regulator at the time — strengthened its liquidity regulations so as to reduce the risk that banks experience liquidity shortfalls. As described in Ball *et al* (2011), the new regulations changed how the regulator considers a bank's intraday liquidity requirements for payment systems, including CHAPS, when determining the value of liquid assets that the bank is required to hold. Liquid assets include cash or assets that a bank can convert into cash in a timely manner and at little cost.(1)

A settlement bank holds a buffer of liquid assets for two purposes. First, to enable the bank to fund outflows at times of stress, ensuring balance sheet resilience. And second, to fund intraday liquidity requirements in payment systems. The minimum value of liquid assets a bank should hold is determined by the regulator and is referred to as a 'liquid asset buffer' requirement.

Under the pre-crisis regulatory framework, the only formal requirement was for banks to hold liquid assets for the first of these purposes: to ensure an adequate degree of balance sheet resilience to a stress scenario. During the day, their liquid asset buffers could be used to fund payment activity — a practice known as 'double duty'. The problem with this approach was that the same assets were charged with meeting two separate requirements: liquid asset buffer values were calibrated to fund outflows at times of stress, so may not always have been available to fund intraday payment activity.

(1) See Farag, Harland and Nixon (2013) for a description of bank liquidity.

Under the new regulatory framework banks must hold enough liquid assets to meet both prudential resilience needs *and* intraday payment requirements. This regulatory change has made intraday liquidity usage in payment systems potentially more costly. Previously, if a bank's intraday liquidity usage was less than the amount of liquid assets it was required to hold for prudential resilience needs, then intraday liquidity requirements for payments were essentially costless, since the bank could use its liquid asset buffer for intraday activity. But since the regulatory change came into force, there has been a direct opportunity cost to using liquidity in payment systems: the more liquidity a bank uses intraday to settle payments, the higher the level of liquid assets the bank will be required to hold, all else equal. The Bank fully supported the introduction of this new regulatory framework as it seeks to ensure that banks have sufficient liquid assets available to meet their intraday payment requirements, even in stressed financial circumstances.

Implications of the new regulatory framework

This regulatory change has made it less likely that banks will experience intraday liquidity shortfalls. Banks will now have a greater resilience to stressed conditions than under the pre-crisis regulatory framework. However, the regulatory change has also had the unavoidable effect of incentivising banks to economise on their intraday liquidity requirements for payment systems (so that they can reduce the size of their liquid asset buffer requirement). As discussed above, a CHAPS settlement bank uses its own funds when, at any point during the day, it has sent more payments than it has received. To reduce its liquidity requirement (that is, its need for own funds), a CHAPS settlement bank can therefore simply wait to receive payments from others *before* it sends payments. This behaviour is referred to as being 'receipt-reactive'.

However, by waiting to receive liquidity first, receipt-reactive behaviour can result in individual banks sending payments later in the day — a practice that increases that bank's vulnerability to operational problems. For example, consider a bank that suffers a system failure so that it is unable to make payments for the rest of the day. The impact of this operational issue will depend upon the value and volume of payments that are unsettled at the time of the failure, which is likely to be higher if a bank has deliberately delayed its payments. Ten unsettled house purchase payments would inevitably cause more disruption than one unsettled house purchase payment. The impact of operational stress is therefore greater if banks act receipt-reactively.

Receipt-reactive behaviour can also increase the intraday liquidity requirements of other banks. If a bank delays its payments, all the other banks will receive payments from that bank later in the day. This means it is less likely that the other banks will be able to recycle those funds, and may therefore have to use more of their own funds to settle outgoing payments.

Perhaps most importantly, however, receipt-reactive behaviour could turn out to be self-defeating. If all banks delay their payments, then no bank would receive payments early in the day (or succeed in reducing its intraday liquidity requirements). Instead, system-wide receipt-reactive behaviour might simply lead to all payments being settled significantly later in the day, increasing vulnerability to the operational risks discussed above. Commentators such as Bech (2008) have likened this scenario to the mutually adverse outcome in the 'prisoner's dilemma' game.

To discourage CHAPS settlement banks from adopting receipt-reactive behaviours, the operators of the CHAPS system, CHAPS Clearing Company Limited (CHAPS Co) enforce 'throughput' rules. These are intraday deadlines by which banks are required to send a proportion of the value of their day's payments.(1) However, recognising that regulatory change may create renewed incentives for settlement banks to reduce their intraday liquidity requirements through adopting receipt-reactive behaviours, the Bank, CHAPS Co and the settlement banks agreed to design a technical means to reduce the settlement banks' intraday liquidity requirements in CHAPS. This technical solution, referred to as the Liquidity Saving Mechanism, incentivises banks to bring forward, rather than delay, the submission of their payments. The LSM was therefore designed to operate in conjunction with the CHAPS Co throughput rules and reduce operational and liquidity risks in the CHAPS payment system.

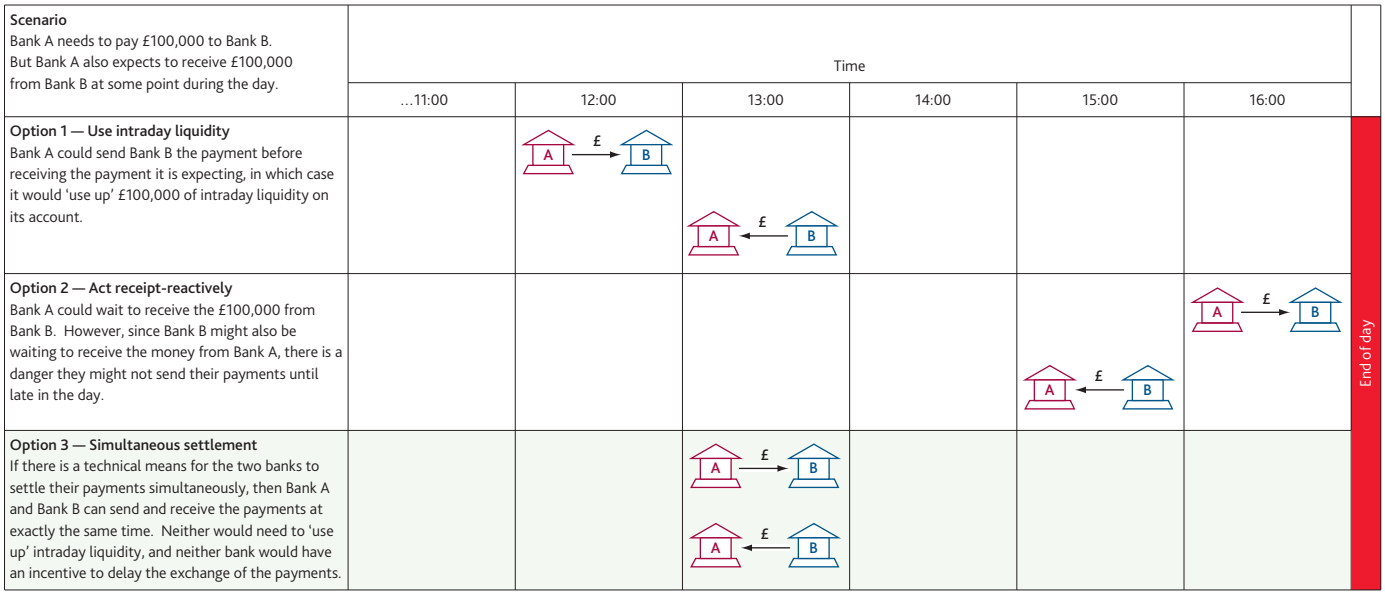
The Liquidity Saving Mechanism

The introduction of the LSM formed part of a programme of changes, led by the Bank, to increase the resilience of both the RTGS infrastructure and the payment systems that settle across it. In addition to the LSM, recent examples of risk-reduction measures include: first, the Bank's initiative to increase the number of CHAPS settlement banks, reducing the operational, credit and liquidity risks arising from a more 'tiered' payments system (Finan, Lasaosa and Sunderland (2013)). And second, the implementation of the Market Infrastructure Resiliency Service — a generic RTGS infrastructure, developed and hosted by SWIFT offsite, that would be used by the Bank should the RTGS infrastructure ever fail simultaneously at both its principal and standby sites.(2)

(1) In CHAPS, two throughput rules have been set: banks need to have settled 50% of their CHAPS payments (by value) by 12 pm and 85% (by value) by 3 pm. CHAPS banks are required to meet these targets over the course of a month. Where a settlement bank considers that there are mitigating circumstances that prevent them from meeting these criteria, it can apply for a Throughput Adjustment Waiver. If successful, the Adjustment Waiver amends the throughput target required to be met by that bank for a defined period. For more information see CHAPS Clearing Company Limited (2013).

(2) SWIFT supplies secure messaging services and interface software to wholesale financial entities.

Figure 2 Example to illustrate the advantages of simultaneous settlement



Because of its critical role in the settlement of sterling electronic payments, the Bank maintains RTGS to extremely high standards of operational reliability, service and resilience. Any business case for a change to the design of RTGS is subject to thorough analysis, where the benefits of change are weighed against the risks and the costs associated with modifying the RTGS infrastructure. In order to assess the potential benefits of introducing an LSM into the RTGS infrastructure, the Bank undertook a comparative analysis of other RTGS systems that had implemented an LSM.

Internationally, a number of different solutions have been implemented to reduce intraday liquidity requirements in high-value payment systems. Some of these solutions are set out in the box on page 185. The most common approach has been to enable payments to 'queue' temporarily in the RTGS infrastructure and introduce an algorithm that matches up groups of queued, offsetting payments and settles them simultaneously.

By identifying broadly offsetting payments from different banks and settling them simultaneously, these algorithms mean that banks no longer have to choose between using 'own funds' (by sending payments before they receive payments) or being receipt-reactive (by waiting to receive payments before sending payments). Rather, settlement banks can send and receive payments at precisely the same time.

Figure 2 demonstrates with a simple example how this can reduce a bank's intraday liquidity requirements, without introducing additional operational and liquidity risk into the settlement process. It shows that Option 3 — simultaneous settlement using offsetting algorithms — acts to reduce the intraday liquidity requirements associated with Option 1, without introducing the delay associated with acting receipt-reactively, Option 2.

Empirical research to date has concluded that introducing such measures delivers liquidity savings. For example, Norman (2010) cites estimated savings of 15% and 20% in the Japanese and Korean RTGS systems, respectively, following the introduction of offsetting algorithms.

The Bank undertook a series of simulation studies to estimate the potential liquidity savings that could be realised by introducing offsetting algorithms into CHAPS.[1] These simulation studies used a subset of CHAPS payments from the period from 12 July 2010 to 3 September 2010 and information from a survey of the CHAPS settlement banks to make assumptions about how banks would use CHAPS with an LSM. A range of different algorithms were tested and assessed based upon measures of liquidity saving and payment delay. Results suggested that, under some assumptions, offsetting algorithms could lead to aggregate liquidity savings of around 30%.

Recognising the potential benefits of offsetting payments in CHAPS, the Bank, CHAPS Co and the settlement banks agreed to redesign how CHAPS settled across the RTGS system. Input from the settlement banks was essential: they are the users of the RTGS system, and the success of offsetting algorithms would hinge on the settlement banks adopting new liquidity management techniques. The settlement banks also bear the costs that the Bank incurs by supplying the RTGS infrastructure, and so would be funding the redesign of the CHAPS settlement process.

(1) See Denbee and McLafferty (2013) for more details.

International examples of liquidity saving mechanisms

Internationally there have been various solutions employed to reduce liquidity requirements in high-value payment systems (Norman (2010)). These solutions typically seek to limit the potential differences in value between what any one bank has sent and received in the high-value payment system at any point during the day. This has been achieved, for example, by:

(a) Incentivising all participants to submit the bulk of their payments at approximately the same time. This increases the likelihood that most participants' payments and receipts will be broadly co-timed so that the potential difference between any one participant's payments and receipts is reduced. For example, SIC, the Swiss RTGS system, has a tariff structure which means that payments made early in the day incur a lower fee than those made towards the end of the day. Participants do not necessarily have to be incentivised through pricing to submit payments at roughly the same time. For example, in the Norwegian RTGS payment system, NBO, participants have agreed to submit the majority of their payments at around 13:00 (Berge and Christophersen (2012)).

(b) Splitting high-value payments so that they can be settled piecemeal over time. This minimises the potential liquidity impact of settling a large payment. For example, participants in the Swiss RTGS system are encouraged to split payments larger than CHF100 million.

(c) Introducing a technical means for participants to settle payments simultaneously. This means that banks can send and receive payments at precisely the same time, extinguishing timing mismatches between payments and receipts. This has been a particularly common solution internationally — adopted in Canada, the euro area and Japan, for instance — and is the solution that the Bank of England has implemented.

The design of the UK LSM

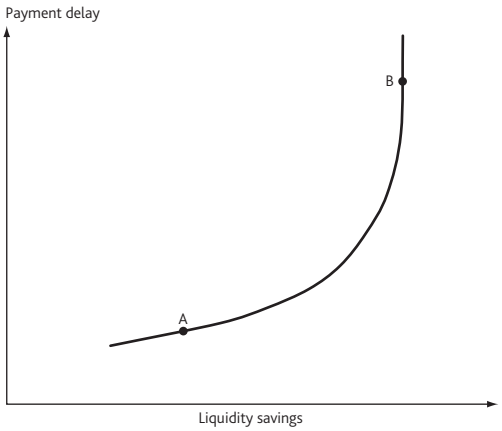
To facilitate the simultaneous settlement of CHAPS payments, using offsetting algorithms, banks are now able to submit their payments into the RTGS system without settling them immediately. Payments which have been submitted but not yet settled are referred to as 'queued'.

Once payments are queued in the RTGS system, settlement banks are able to use a queue management program, called the 'central scheduler', to control when payments are settled. Some of the features of the central scheduler are described in the box on page 186. The longer a payment queues in the central scheduler, the more time there is for another bank to submit an offsetting payment, and thus the less intraday liquidity a bank is likely to use. However, queuing a payment for longer means settling a payment later, introducing delay into the settlement process.

There is therefore a trade-off between liquidity savings and payment delay. This is illustrated in **Figure 3**: a bank that wishes to minimise the delay to its payments at the expense of liquidity savings (perhaps because it must settle certain payments by a specific intraday deadline), might be represented by point A on the curve. Conversely, a bank facing less time pressure to settle payments might choose point B, thereby achieving greater liquidity savings.

If a settlement bank wants to settle a payment immediately, it can submit the payment to RTGS as 'urgent'. Urgent payments can settle with minimal delay. This functionality is useful for banks that need to prioritise payments which must settle within a specific time frame, for example margin payments to central counterparties,(1) and pay-ins to the Continuous Linked Settlement (CLS) system.(2)

Figure 3 The trade-off between payment delay and liquidity savings(a)



(a) The shape of this trade-off curve is derived from data produced during simulation testing, see Denbee and McLafferty (2013).

RTGS is available to immediately settle CHAPS payments classified as urgent for 85% of the settlement day. For the remaining 15% of the day, RTGS briefly suspends the immediate processing of urgent payments in order to settle payments classified as 'non-urgent'. These payments are settled in 'matching cycles' that last just over 20 seconds. At the start of a matching cycle, an algorithm attempts to find

(1) For an introduction to central clearing, see Nixon and Rehlon (2013).
(2) The international CLS system settles foreign exchange transactions on a so-called 'payment versus payment' basis. See Sawyer (2004) for more details.

Tools available to the banks in the central scheduler

As part of the LSM changes, the Bank of England built a queue management program called the 'central scheduler'. The design of the central scheduler was heavily based on the design of the settlement banks' internal payment schedulers. Banks use the central scheduler to control when payments they have submitted to RTGS settle. For example, banks have tools that allow them to:

(a) Limit the amount of funds they are willing to contribute to any one matching cycle. Banks are able to use the central scheduler to cap the size of the net difference between payments sent and received in a matching cycle.

(b) Limit the value of payments they are willing to send to another CHAPS settlement bank in excess of the value they have received from that settlement bank. This enables banks to ensure that they do not use too much liquidity settling payments to any one counterparty.

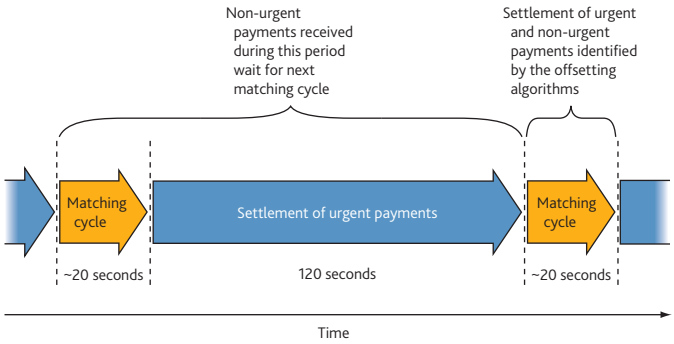
(c) Limit the value of payments they are willing to send to all other settlement banks in excess of the value they have received from all other settlement banks at any point during the day. This gives the settlement banks a means to limit the overall amount of 'own funds' they require for CHAPS on any one day.

(d) Change the priority of a payment from non-urgent to urgent after it has been submitted to RTGS. This gives banks a means to 'promote' a payment to urgent after it has been queuing for a certain length of time.

(e) Prevent a payment from settling without the bank's specific authorisation if it breaches a certain value or is destined to a particular settlement bank. This enables banks to prevent a certain type of payment from settling in the next matching cycle.

groups of broadly offsetting payments from different banks.(1) At the end of the matching cycle, all payments identified as eligible by the algorithm settle at precisely the same time. Any non-urgent payments not settled by the end of a matching cycle will remain in the queue until the start of the subsequent cycle. This settlement model is illustrated in **Figure 4**.

Figure 4 The matching cycle process



There is a two-minute period between matching cycles that enables non-urgent payments to accumulate in queues while the system is only available for the settlement of urgent payments. This has two advantages. First, it ensures that banks can, for the majority of the settlement day, settle high-priority payments immediately, if they wish to. Second, it enables non-urgent payments to queue between matching cycles, increasing the likelihood that two offsetting payments will be considered in the same matching cycle, thereby driving down settlement banks' intraday liquidity requirements.

The matching cycle process reduces settlement banks' intraday liquidity requirements in CHAPS because successfully matched payments are settled at precisely the same time. A bank therefore only needs liquidity to fund the net difference between the payments it has sent and received in that cycle. Without the matching cycle process, the bank's liquidity requirement could have been as high as the gross value of its sent payments.

Crucially, all CHAPS payments, irrespective of whether they settle inside or outside of matching cycles, still settle gross and individually. The fundamental attributes of CHAPS remain the same: the CHAPS settlement banks are able to receive money into, and send money from, their settlement accounts continuously throughout the day. In line with the set-up prior to the introduction of the LSM, all payments are debited from the banks' settlement accounts individually, hence there continues to be no credit exposures between settlement banks within the settlement process.

The results of implementing the Liquidity Saving Mechanism

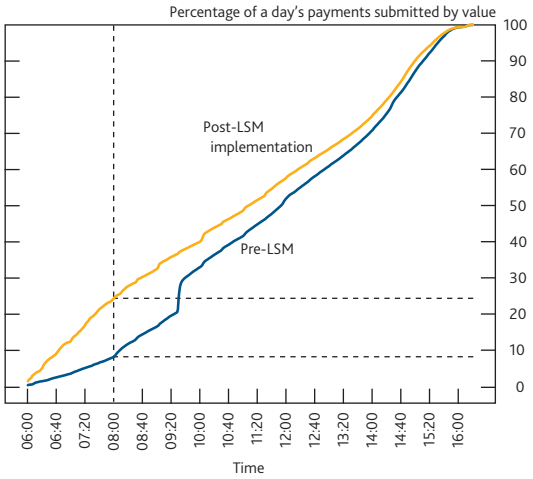
The LSM was introduced into RTGS on 15 April 2013. The Bank and the settlement banks thereafter began a six-month

(1) The LSM switches between bilateral and multilateral offsetting algorithms, and uses three different sorting modes for selecting which payments (out of those that are queuing upon entering a matching cycle) are considered in each cycle. The multilateral algorithm is able to identify 'circles' of offsetting payments between two or more settlement banks. A maximum of 500 payments for each CHAPS settlement bank are considered in each matching cycle.

'optimisation' period where queue management best practice was discussed at industry fora and in bilateral meetings. This collaboration was a fundamental driver of the liquidity savings achieved under the LSM. The optimisation period aimed to assist settlement banks in two respects: first, to establish which of their payments were likely to receive an offset within a reasonable time frame (essentially, choosing an optimal position on the savings-delay curve shown in **Figure 3**); and second, to determine how to use the central scheduler tools to manage that trade-off.

In principle, enabling payments to queue centrally and be considered by an offsetting algorithm should encourage early submission of payment instructions: if banks submit payments early, there is a greater likelihood that the algorithm will identify offsetting payments (Ball *et al* (2011)). The implementation of the LSM did indeed lead to the earlier submission of CHAPS payments into RTGS, as shown in **Chart 1**. For example, prior to the implementation of the LSM, on average only about 8% of payments (by value) had been submitted to RTGS by 08:00. Since the implementation of the LSM, about 24% of payments have been submitted by 08:00 on an average day.

Chart 1 Submission of CHAPS payments before and after the introduction of the LSM(a)

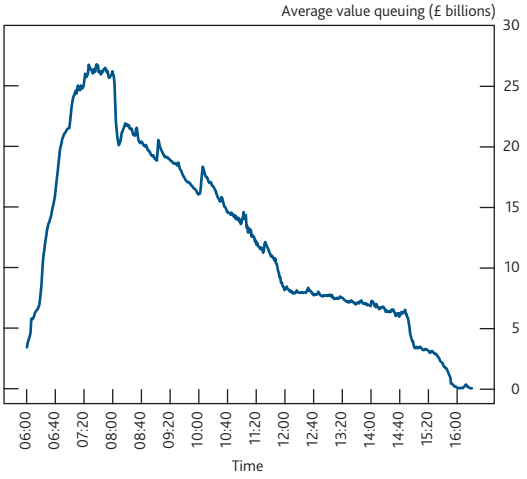


(a) Pre-LSM is defined as July 2012 to March 2013. Post-LSM is defined as July 2013 to March 2014.

As anticipated, settlement banks are using the central scheduler to queue their CHAPS payments. On average, payments queue for approximately seven and a half minutes. **Chart 2** shows the total value of payments that the banks have typically been queuing throughout the day, with around £26 billion of payments — equivalent to just under 10% of an entire day's payments — queued at 07:30.

Combined, these two developments mean that the implementation of the LSM has had a broadly neutral effect on the rate of CHAPS payment settlement, or 'throughput': the earlier submission of payments to RTGS has been broadly

Chart 2 The average value of payments queuing during the day



offset by banks queuing their payments. Consequently, the median time of settlement — or the point during the day at which half of all payments (by value) have settled — has remained broadly the same: 12:11 before the implementation of the LSM, compared with 12:00 since.

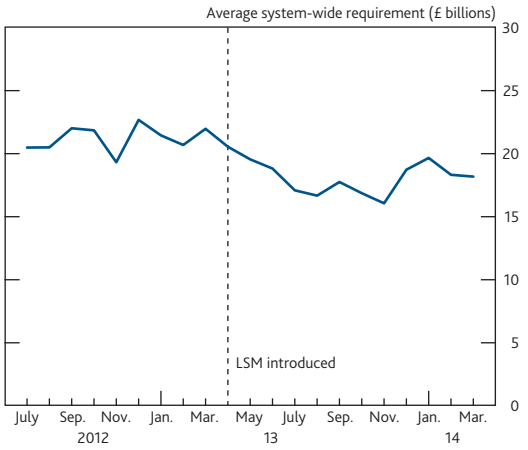
The fact that the settlement banks are queuing a significant value of payments in the central scheduler means that the offsetting algorithms, run during matching cycles, have been successful in finding broadly offsetting payments between banks. The simultaneous settlement of these payments has reduced the CHAPS settlement banks' intraday liquidity requirements. Prior to the implementation of the LSM, the combined intraday liquidity requirements of all the settlement banks averaged £21.2 billion.(1) Since the implementation of the LSM, the monthly average of combined intraday liquidity requirements has been in the range of £16 billion to £20 billion, as shown in **Chart 3**.

Regression analysis suggests that the combined intraday liquidity requirements of all the settlement banks would have remained approximately £21.2 billion between July 2013 and November 2013 if the LSM had not been introduced.(2) Given that actual intraday liquidity requirements averaged £16.9 billion during this period, this would imply aggregate intraday liquidity savings for the CHAPS banks of around £4 billion — equivalent to a 20% reduction in intraday

(1) This figure refers to the liquidity required by CHAPS settlement banks for the following payment systems between July 2012 and March 2013: Bacs, CHAPS, C&CC, FPS, LINK and Visa Europe (from 23 October 2013). All payment systems were included, even though the LSM could only make savings in CHAPS, because the liquidity requirements in CHAPS cannot easily be disentangled from liquidity requirements in the other payment systems. Bank of England has been excluded because, given its unique ability to create sterling central bank money, it has no incentive to minimise its liquidity usage via offsetting. CLS has also been excluded as it cannot manage payments to minimise intraday liquidity usage. This is consistent with the methodology used during simulation testing.

(2) The daily aggregate liquidity requirements were regressed on: (i) the daily aggregate sum of all funds that individual banks sent in excess of what they received; and (ii) the total value of payments that individual banks sent. The estimation period was October 2012 to April 2013.

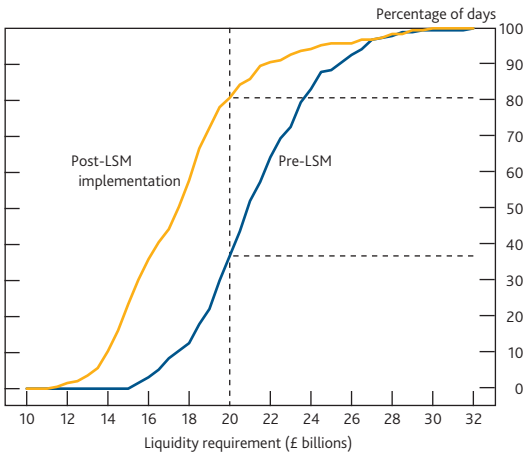
Chart 3 Average value of intraday liquidity required by CHAPS settlement banks for sterling payment systems



liquidity costs. The regression analysis also suggests that the average combined intraday liquidity requirements would have averaged around £22.5 billion between December 2013 and March 2014, partially due to a shift in some settlement banks' payment profiles. Given that actual intraday liquidity requirements averaged £18.7 billion in this period, this implies that the LSM led to aggregate intraday liquidity savings of around £4 billion in this period too.

Chart 4 provides further evidence of the liquidity savings achieved under the LSM. It shows the percentage of days on which the CHAPS banks' intraday liquidity requirements were below a given value. Before the implementation of the LSM, the banks needed less than £20 billion of intraday liquidity on approximately 35% of days; since the implementation of the LSM, this has risen to 80%.

Chart 4 The percentage of days on which CHAPS settlement banks' intraday liquidity requirements were below a given value[a]



(a) Pre-LSM is defined as July 2012 to March 2013. Post-LSM is defined as July 2013 to March 2014.

Aggregate intraday liquidity requirements have varied since the implementation of the LSM (**Chart 3**). This variation has been partly driven by changes in settlement banks' queue management practices. For example, over certain periods some settlement banks have queued particular payments for longer. This has increased the likelihood of these particular payments offsetting against incoming payments, therefore reducing the intraday liquidity required. The variation in aggregate intraday liquidity requirements has also been partly driven by changes in settlement banks' payment profiles. For example, over certain periods some settlement banks have borrowed more from the overnight sterling money markets. As settlement banks typically repay such overnight loans (that is, send a CHAPS payment) before taking out a new loan (that is, receive a CHAPS payment), borrowing from the overnight sterling money markets tends to drive up a settlement bank's intraday liquidity requirement in CHAPS.

Aggregate intraday liquidity requirements have not fallen by the 30% suggested as possible in the simulation study (discussed in the previous section of this article). This is likely to stem from the assumptions that the simulation study made about settlement bank practices, such as how they would manage their liquidity, as well as features of the CHAPS payment system. For example, the simulation study was undertaken when there were only 17 CHAPS settlement banks, whereas on implementation this figure had risen to 19 and has since risen to 21. Finan, Lasaosa and Sunderland (2013) describe some of the benefits of having a less concentrated payment system, but in the context of implementing the LSM, a less concentrated membership might reduce the potential for liquidity savings since there are likely to be proportionately fewer pairs or chains of offsetting payments present.[1]

Nevertheless, the objective of the LSM changes was to give CHAPS participants a means to reduce their liquidity requirements without slowing the rate at which they settled payments. The evidence suggests that the LSM has reduced the settlement banks' average liquidity requirements by some 20%, without reducing their throughput. This is broadly in line with the savings achieved by introducing similar mechanisms into other RTGS systems internationally.

Conclusion

This article has discussed the motivations for introducing the LSM, its design, implementation and its effect on settlement banks' intraday liquidity requirements. Close collaboration between the infrastructure provider (the Bank), the operator of the payment system (CHAPS Co) and the users of that payment system (the settlement banks) has been important for the success of the LSM.

The implementation of the LSM, and the consequent reduction of settlement banks' intraday liquidity requirements, has had two clear benefits. First, it has reduced incentives for

(1) See Norman (2010).

CHAPS settlement banks to adopt adverse behaviours to economise on their intraday liquidity requirements, thus enhancing the resilience of the CHAPS payment system. And second, it has reduced the likelihood that a bank's intraday liquidity requirement will outstrip its supply of own funds, and so it is now less likely that banks will be unable to settle payments due to liquidity shortfalls, enhancing UK financial stability.

The LSM therefore operates in conjunction with the PRA's liquidity regulations to enhance the resilience of CHAPS. The regulatory framework ensures that the settlement banks have sufficient liquid assets to support their payment system liquidity requirements, and the LSM enables CHAPS settlement banks to manage those liquidity requirements more efficiently.

Importantly, the implementation of the LSM has not compromised the ability of settlement banks to settle CHAPS payments in real time: payments classified as urgent can settle immediately. The Bank will periodically review the potential for changes or enhancements to the LSM to maintain its position as a key risk-reducing feature of the CHAPS system.

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Risk managing loan collateral at the Bank of England

By Alice Alphandary of the Bank's Risk Management Division.[1]

- The Bank stands ready to lend to its counterparties against eligible collateral, which includes a wide range of securities and portfolios of loans that can be adequately risk-managed through a combination of prudent eligibility criteria, valuations and haircuts.
- When accepting portfolios of loans as collateral, the Bank undertakes an extensive due diligence process to understand and mitigate the legal and financial risks associated with these loans and the level of uncertainty surrounding these risks.
- Residential mortgages now represent the majority of collateral pre-positioned and the Bank's Risk Management Division uses loan-level data as an input to its credit stress and cash-flow models to calculate the stressed value of these loans in extreme, but plausible, scenarios.

Overview

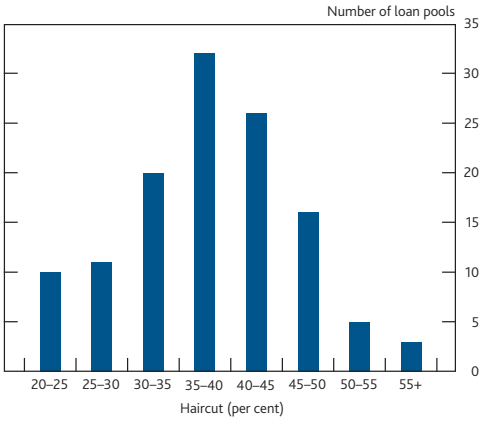
In pursuit of its objective of maintaining financial stability, the Bank stands ready to provide a wide range of banks and building societies (hereafter 'participants') with liquidity at a range of maturities against a broad set of collateral. In addition to securities, this includes portfolios of loans ('loan pools'), which must be 'pre-positioned' with the Bank before counterparties can draw liquidity against the collateral.

The Bank undertakes an in-depth review of potential loan collateral to ensure that it is protected against risks in the loan pool. It ensures that it can obtain legal ownership of the collateral and any associated cash flows in the event that the Bank's counterparty defaults. And it ensures that it is protected against financial risks associated with the collateral, and, importantly, understands the extent of the uncertainty around the level of these financial risks.

The Bank's Risk Management Division applies prudent eligibility criteria and valuations, along with conservative, through-the-cycle haircuts. The Bank uses credit stress and cash-flow models to determine the haircuts on pools of residential mortgages, which represent the majority of collateral pre-positioned. But the Bank does not set haircuts mechanistically and undertakes a thorough due diligence to consider qualitative risk factors before accepting a loan pool and setting the final haircut on it.

As shown in the **summary chart**, the modal haircut on residential mortgage loan pools is between 35%–40%, meaning that a participant can borrow 60%–65% of the value of the loans' outstanding principal balance.

Summary chart The distribution of haircuts applied to residential mortgage loan pools[a]



Sources: Bank of England and Bank calculations.

(a) Data as at 31 December 2013.

The Bank also accepts pools of other loans, including loans to small and medium-sized enterprises, corporates and registered social landlords and personal loans. Due to the less homogeneous nature of these asset classes, the Bank's framework for setting haircuts on them is necessarily more bespoke.

Once pre-positioned, the Bank monitors pools of loans to assess emerging risks. This is increasingly important given that the Bank had £352 billion loans pre-positioned at the end of 2013.

(1) The author would like to thank Clare Rogowski for her help in producing this article.

While at the aggregate level, lending creates deposits, at the level of individual institutions, banks and building societies (collectively referred to as 'participants' in this article) need to consider their sources and costs of funding in order to finance lending to households and businesses. They can attract funding from a range of sources: taking deposits from individual household and corporate savers; issuing debt or equity that is purchased by investors; or obtaining funding from other financial institutions. When counterparties, including the Bank of England, lend to each other they may take collateral — in which case the lending is said to be 'secured' — to guard against the risk of losses in the event that their counterparty defaults. In the case of the Bank of England, HM Treasury is its sole shareholder and so by adopting prudent risk management practices, the Bank seeks to minimise risks to public funds. In market-based transactions, this collateral normally takes the form of securities, which can include bonds, equities and asset-backed securities (ABS). But because of the Bank's special position in the markets where it may become the lender of last resort, it may need to lend to a given participant on a much greater scale than the amount which that participant would be able to borrow from any other single financial market participant.

Given the potential scale of lending that the Bank may be required to undertake and that all of it is done on a secured basis, the Bank needs to accept a wide range of collateral. So in April 2011, it began to accept portfolios of loans that participants had on their balance sheets. In addition, an independent review, completed in 2012 by Bill Winters[1] into the Bank of England's framework for providing liquidity to the UK banking system, recommended that 'the Bank should continue to broaden the range of eligible collateral for its Discount Window Facility (DWF) and other facilities beyond the substantial portion of bank assets already allowed…and, as such, might include allowing drawn revolving credit facilities as eligible collateral'.

This article explains the process for using loan collateral to raise funding with the Bank of England and is divided into two sections. The first section discusses the ways in which counterparties are able to borrow from the Bank of England in times of stress against a range of securities and loan collateral. The second section discusses how the Bank risk manages loan collateral through its eligibility criteria and loan valuations and haircuts. It sets out the approach used by the Bank's Risk Management Division to determine haircuts on loan pools in a prudent and conservative way, based on adverse hypothetical scenarios for credit losses. The range of haircuts that have been applied on loan collateral is discussed alongside some of the idiosyncratic factors that can influence the size of these haircuts.

Pre-positioning loans and securities with the Bank as collateral

The Bank's response to the Winters Review

Governor Carney's October 2013 speech, and the accompanying document outlined the changes to the Bank's Sterling Monetary Framework (SMF) in light of recommendations made in Bill Winters' review, together with the changing regulatory and financial market landscape.[2] In particular, they clarified that the Bank of England is 'open for business', that is, the Bank stands ready to provide liquidity to the UK banking sector when needed, by providing liquidity at longer maturities, against a wider range of collateral, at a lower cost and with greater predictability of access.[3]

In response to the Winters Review, the Bank of England established three criteria that an asset class must meet to be eligible as collateral:

(a) **Quantity**. It must be held in sufficient quantity by a range of SMF-eligible participants to support the Bank's lender of last resort function.

(b) **Risk management**. The Bank should be able to risk manage eligible assets using existing resources or with additional resources obtained at a proportionate cost. This risk management should mitigate the financial and operational risks associated with holding the collateral.

(c) **Avoidance of any unsecured exposures to other SMF participants**. Unsecured assets issued by an institution that participates in the SMF would not provide the Bank with robust risk mitigation benefits if accepted by the Bank as collateral. For example, unsecured bank debt would expose the Bank to high and uncertain amount of 'wrong-way' risk, since the value of unsecured bank debt is likely to decrease substantially at the time that banks are looking to collateralise borrowing from the Bank.

As part of this follow-up work, the Bank announced in October 2013 that the drawn portion of corporate revolving credit facilities would become eligible collateral, representing a further expansion to this collateral set. Following this announcement, and other changes made during the financial crisis, the Bank has one of the widest lists of eligible collateral among central banks.[4]

Providing liquidity insurance facilities

In order to access these SMF facilities, banks and building societies must apply to the Bank to become SMF participants. There is a presumption that all banks and building societies

(1) See Winters (2012).
(2) See Carney (2013) and Bank of England (2013).
(3) Other changes to the SMF are discussed in greater detail in the 'Sterling Monetary Framework Annual Report 2013–14' on pages 218–225 of this *Quarterly Bulletin*.
(4) See Bank for International Settlements Markets Committee (2013).

that have been authorised by the Prudential Regulation Authority (PRA) may sign up for the SMF and have full access to borrow in SMF facilities against eligible collateral.(1) Participation in the SMF is subject to the Bank being satisfied that the legal and operational requirements of the bank or building society in question are met, and may be subject to the provision of a guarantee from another group entity.

At present, only banks and building societies have access to the Bank's SMF facilities. In his review, however, Winters recommended that the Bank consider making certain liquidity facilities in the SMF available to non-banks, such as broker-dealers and central counterparties. As mentioned in the 'Sterling Monetary Framework Annual Report 2013–14' in this edition of the *Quarterly Bulletin*, the Bank is investigating whether to expand SMF access to reflect the increasingly important role of non-banks and capital markets. If any non-banks were granted access to some or all of the Bank's liquidity insurance facilities, lending would be collateralised and the Bank would manage this collateral in a manner consistent with the processes described in this article.

In the first instance, participants should insure themselves against liquidity risk — the risk that they become unable to fund their activities in the market. They may do this by holding portfolios of high-quality, highly liquid assets, which can be easily turned into cash in order to meet their liquidity needs as they come due, such as if depositors wanted to withdraw some or all of their funds. Liquid assets generally mean debt issued by the most creditworthy sovereigns or cash held on account at central banks.(2)

But it is sub-optimal for the banking sector as a whole and the UK real economy if participants insure themselves to too high levels, since this would divert cash away from productive lending to agents in the real economy.(3) In order to prevent this from happening, central banks can play a role by providing liquidity insurance facilities — facilities that solvent commercial banks and building societies can use to finance their assets if they are unable to access market funding. Such facilities should only be used significantly in stressed environments, whether these be stressed conditions in the market as a whole, or idiosyncratic factors affecting a specific participant. There is, however, a balance to be struck: through provision of these facilities by the central bank, participants may not elect to insure themselves against liquidity risk to a prudent level (so-called 'moral hazard'). In order to guard against moral hazard, international regulatory authorities such as the Basel Committee on Banking Supervision and national prudential supervisors, such as the PRA, require banks and building societies to hold an appropriate stock of liquid assets relative to their funding profiles.(4)

Eligible collateral

When the Bank lends funds in its operations, it accepts participants' assets as collateral so that it is protected against credit risk — the risk of the participant defaulting before it has repaid the funds that the Bank has advanced. This is because the Bank needs to protect taxpayers as far as possible from any unnecessary risk of loss incurred through its operations that help to deliver its policy goals of ensuring monetary and financial stability.(5) A significant financial loss could harm the Bank's credibility, threaten central bank independence and impair its ability to discharge its statutory responsibilities.

The types of collateral accepted by the Bank are broad and are split into three categories:

- Level A — high-quality sovereign debt that is liquid in almost all market conditions;
- Level B — high-quality sovereign, supranational and private sector debt and highest-quality ABS that are normally liquid in the market; and
- Level C — less liquid securitisations, own-name securities and portfolios of loans, including mortgages that are not normally liquid in private markets.(6)

The differing credit quality and liquidity of these types of collateral means that not all collateral can be used in all facilities, as shown in **Table A**. The price of the funding also varies with the degree of liquidity enhancement (where less liquid collateral is swapped for gilts or cash, which are more liquid), so it is most expensive to use Level C collateral. The facilities that only accept Level A collateral are for implementing monetary policy, whereas the facilities that accept all levels of collateral are liquidity insurance facilities.

Table A Collateral eligibility by SMF facility(a)

Facility	Level A	Level B	Level C
Operational Standing Facility	✓	✗	✗
Short-Term Repo	✓	✗	✗
Indexed Long-Term Repo	✓	✓	✓
Contingent Term Repo Facility	✓	✓	✓
Discount Window Facility	✓	✓	✓

(a) Note that the Funding for Lending Scheme and Emergency Liquidity Assistance are not part of the SMF.

(1) See Bank of England (2014).
(2) For an introduction to funding and liquidity risk for banks, see Farag, Harland and Nixon (2013).
(3) This risk was noted by the Financial Policy Committee in its June 2012 and June 2013 statements (www.bankofengland.co.uk/publications/Documents/records/fpc/pdf/2012/record1207.pdf and www.bankofengland.co.uk/publications/Documents/records/fpc/pdf/2013/record1307.pdf).
(4) See Bailey, Breeden and Stevens (2012).
(5) The Bank's sole shareholder is HM Treasury, so in turn, taxpayers would be liable if the Bank needed new capital.
(6) For a full list of assets in each category, see www.bankofengland.co.uk/markets/Documents/money/publications/summary_collateral.pdf.

Pre-positioning collateral

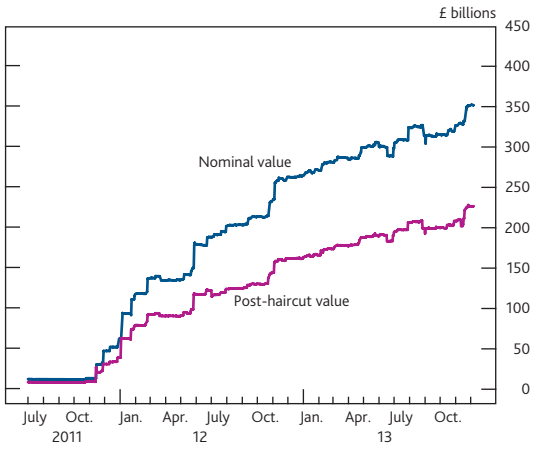
The Bank strongly encourages SMF participants to 'pre-position' a proportion of their total assets with the Bank of England to improve their ability to access central bank liquidity at short notice. Pre-positioning means delivering collateral to the Bank, but not using it straight away — it is contingency planning for a future need. In practice, this means that participants submit relevant signed documentation to the Bank's back office. The Bank then confirms when the loans have been pre-positioned. While the formal pre-positioning can take place intraday, the checking processes relating to the eligibility of portfolios of loans (collectively referred to as 'loan pools') that is required in advance of this can take several months to complete. By contrast, securities may be eligibility checked and pre-positioned within a day. This should be in advance of drawing down on a lending facility, as discussed in the box on page 194. So it is particularly beneficial to pre-position loan pools before a participant enters a period of stress.(1) It also provides both the Bank and the participant with certainty about the value that can be advanced against the collateral and allows the Bank to inform the participant of any preferences as to the order of delivery of different collateral.

Since April 2011, the Bank has accepted loan pools as collateral. Over time, the amount of loan pools pledged as collateral has increased substantially, as shown in **Chart 1**. This, in turn, has seen the total value of collateral pre-positioned with the Bank increase substantially. In part, this reflects the fact that participants no longer need to securitise their assets in order to access funding from the Bank — the securitisation process can be both costly and take several months to complete.(2) The smallest securitisations tend to be a few hundred million pounds in size, meaning that until loans were accepted by the Bank, only larger participants (who had these amounts of loans to securitise) were able to mobilise their loans to collateralise funding from the Bank.

The Bank encourages participants to shape their collateral into sufficient pools so that their funding needs can be collateralised by different tranches according to their liquidity needs and without excessive encumbrance. When an asset becomes encumbered, usually because it is collateralising an exposure, it cannot be withdrawn to raise funding elsewhere. So if a participant wants to draw down £500 million funding, but only has a loan pool after haircuts of £1 billion pre-positioned, the full £1 billion will become encumbered at the point of drawdown. It would be more efficient if that participant had, instead, pre-positioned two loan pools, each of £500 million, meaning that it would only need to encumber one of the £500 million loan pools to access the £500 million funding.(3)

Pre-positioning is a particularly beneficial form of preparation for a liquidity stress because unless a loan pool is drawn against lending from the Bank, it does not encumber a participant's balance sheet. For example, some participants may gradually increase the value of loans pre-positioned until they have a pool of a sufficient size to withdraw and use to launch a securitisation. If a large number of participants pre-position a proportion of their balance sheet, this has the potential to increase financial stability by improving their ability to withstand liquidity shocks.

Chart 1 The nominal and post-haircut value of pre-positioned loans over time(a)(b)



Sources: Bank of England and Bank calculations.

(a) Note that although loan pools became eligible in April 2011, the first pool was not pre-positioned until July 2011.
(b) Post-haircut values exclude the 5 percentage point DWF haircut for lending against gilts.

Pre-positioning delivers a number of additional benefits to participants. It allows them to access the Funding for Lending Scheme (FLS),(4) which was launched by the Bank and HM Treasury in July 2012 and is designed to incentivise banks and building societies to increase their lending to the UK real economy by providing them with a cheaper source of funding. In addition, in advance of implementation of the Basel III Liquidity Coverage Ratio, which will require banks to hold a stock of highly liquid assets to meet their needs in a 30-day liquidity stress scenario, the PRA currently allows banks and building societies to count the drawing capacity from the Bank's Discount Window Facility for up to 40% of their required holdings of liquid assets (subject to their meeting certain conditions).(5)(6) Finally, a recent change to the Bank's operations means that participants are now able to use pre-positioned Level C collateral in Indexed Long-Term Repo (ILTR) operations.

Loan collateral now makes up the majority of all pre-positioned collateral, as shown in **Chart 2**.

(1) See Fisher (2012).
(2) For a recent discussion on securitisation, see Bank of England and European Central Bank (2014).
(3) In practice, because the post-haircut value of loan pools fluctuates and participants have to meet margin calls whenever the value decreases by more than £25,000, many participants will leave excess collateral with the Bank to reduce the number of potential margin calls.
(4) For more information on the FLS, see Churm *et al* (2012).
(5) See Basel Committee on Banking Supervision (2013).
(6) See www.bankofengland.co.uk/publications/Pages/news/2013/099.aspx.

Pre-positioning securities collateral

In order to borrow from the Bank, participants must be able to provide the Bank with securities or loans to collateralise the borrowing. As outlined in this article, when participants pre-position loan pools, they become aware of how much they can borrow against the collateral. However, because participants may deliver securities on the day of borrowing, they may not always know how much they can borrow in total from the Bank unless they have already eligibility checked their entire portfolio.

The Bank of England will check the eligibility of any security submitted to it by an SMF participant. This helps with the participant's liquidity planning by letting them know which securities in their portfolio they can use to raise funds at the Bank.(1) The Bank is looking at ways to provide all participants with a list of securities that have been checked and deemed eligible.

This will not, however, be a complete list of all the securities that the Bank of England would be prepared to take: it only reviews securities that participants submit for review. So if a security is not on this list, it does not mean that it is ineligible; it may be that the Bank has yet to review its eligibility. In this case, a participant wishing to pre-position this security should first check the security against the Bank's guidance for eligibility prior to submitting it to the Bank for eligibility checking.(2)

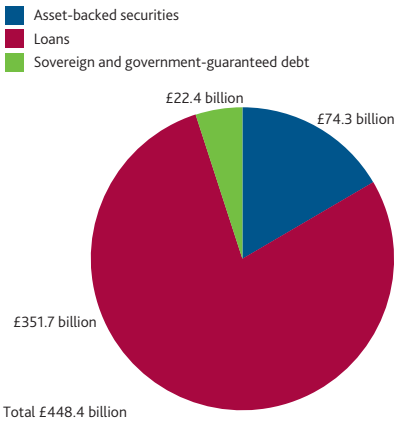
The Bank has decided not to publish a complete securities eligibility list for Level B and C assets. Reviewing the complete universe of these securities would create a big operational burden, for potentially little benefit. In addition, the Bank knows from its discussions with market participants that a fully public list of which securities do and do not meet central bank eligibility criteria can create a sharp division in market liquidity and pricing of central bank eligible, versus ineligible securities. So an approach that saw the Bank publishing a complete list of eligible securities could lead to market participants relying on the central bank to make decisions on creditworthiness. For this reason, this eligibility information is restricted to SMF participants only.

In common with loan pools, where the Bank does not believe that it can manage the risks of the collateral through appropriate valuation and haircuts, it will not make that security eligible. At present, failing to meet the Bank's transparency criteria is the most common reason for a security to be deemed ineligible. Since end-November 2011, to be eligible, any ABS must have publicly available loan-level information; transaction documentation; a transaction overview; standardised monthly investor reports; and a cash-flow model that shows the order in which cash is distributed to the different ABS note holders. The Bank introduced these requirements to improve transparency in the market, thus enabling potential investors in ABS to undertake their own credit analysis of these assets, instead of relying solely on marketing materials and ratings agency reports.

The Bank updates the value of securities on a daily basis, based — where possible — on the most recent market prices. This means that the value of the drawing capacity can change over time.

(1) Note that the Bank has ultimate discretion in how much to lend to a participant and so even if a participant has a certain amount of collateral pre-positioned with the Bank, there is no guarantee that the Bank will lend against that full value.
(2) More information on the Bank's collateral eligibility criteria can be found at www.bankofengland.co.uk/markets/Pages/money/eligiblecollateral.aspx.

Chart 2 Breakdown of all collateral pre-positioned at the Bank(a)



Sources: Bank of England and Bank calculations.

(a) Data as at 31 December 2013.

Risk managing loan pools

This section discusses in more detail the three ways that the Bank manages the financial risks associated with the loan collateral that it takes:

- Eligibility — whether or not it accepts a participant and/or an asset as collateral;
- Valuation — what level it prices an asset at; and
- Haircuts — what proportion of the Bank's valuation of an asset the Bank will lend against.

This section also shows the range of haircuts that the Bank has applied to different loan pools pre-positioned with it.

These risk management tools are designed to identify financial risks in the collateral and the level of uncertainty inherent in the assessment of these risks. In addition, this process is designed to eliminate 'binary' risks that are all or nothing in their nature, meaning that if they crystallise, they could prevent the Bank from realising any value from part or all of the loan pool. Throughout this review process, the Bank liaises closely with both the participants in question and their supervisors at the PRA, with the aim of minimising risks to the Bank's balance sheet.

Eligibility of participants and residential mortgage loan pools

Before a participant can pre-position collateral with the Bank for use in the ILTR, Contingent Term Repo Facility and/or DWF, it must be a member of the SMF, and have signed up to the DWF (that is, become a DWF participant). This entails the participant meeting the Bank's operational and legal requirements for participating in the DWF. The participant seeking to pre-position a loan pool — and the loans in that pool — are analysed using the Bank's internal credit assessment framework. The Bank has internal committees comprised of staff from different areas of the Bank with different areas of expertise that review participant and loan pool eligibility. This process includes seeking the views of relevant experts at the PRA.

When a participant wishes to be able to access funding from the Bank against loan collateral, it must first pre-position the collateral with the Bank. Before a participant pre-positions a loan pool, the Bank will undertake an extensive due diligence process, which includes an in-depth review of the participant and the loans in question in order to understand and mitigate the risks and uncertainties associated with accepting these loans as collateral. A key part of this is a site visit by staff from the Risk Management Division to the participant in order to meet members of the participant's management team and to build a qualitative understanding of its business.

To be eligible, loans must be governed by the laws of England and Wales, Scotland or Northern Ireland. However, its 'centre of main interest' (COMI) does not need to lie in the United Kingdom.(1) In cases where the COMI lies overseas, the loans in question would require participants to provide local legal counsel on the enforceability of the loans in that jurisdiction. Put simply, this means that the Bank does not only lend against loans to UK corporate borrowers located in the United Kingdom.

The collateral eligibility assessment element of the pre-positioning process comprises four parts, which can take place concurrently, and the Markets area of the Bank liaises closely with relevant supervisors at the PRA throughout this review process. First, the Bank reviews the participant's lending practices, encompassing their internal policies, controls around underwriting and servicing arrangements, as well as an overall assessment of the business as a whole. Second, the Bank compiles statistics on the major risk characteristics of a proposed loan pool — including the borrower, the purpose of the loan, the value of the loan and its repayment characteristics.(2) Third, the participant's legal advisers undertake a review of the legal terms that the loans in the proposed loan pool have been written under to ensure that the collateral can legally be transferred to the Bank and that once this is done, the Bank is able to enforce the terms. This legal review is in turn analysed by the Bank's legal advisers. Finally, a data audit carried out by an external firm is used to verify the existence, ownership and quality of loans, and to offer assurance on the quality of the participant's systems and processes. This is important because the Bank relies on the participant's data in order to accurately assess and monitor the loan collateral — any errors or omissions in the data could impair the Bank's ability to risk manage the loan pool.

In some cases where the loans in a pool have been written under highly standardised terms and conditions and so the legal risks associated with the loan pool are assessed to be very low ('vanilla' pools), the Bank modifies some of the four tests outlined above. A loan pool must meet certain criteria in order to be considered 'vanilla'. For instance, it must contain only owner-occupied loans that have been written under a limited number of standard mortgage terms, and must have been originated by the participant and not contain any unusual features (which could include equity release or flexible loan features).

Once all four of these reviews of a loan pool have been completed, the Bank's collateral committee will review the information and take a view on (i) participant eligibility (for the asset class in question); (ii) loan pool eligibility; and (iii) the haircut to be applied. If the Bank does not believe that the risks identified in its review process can be adequately captured by a haircut, it may reject the participant and/or the loan pool.

Reasons for ineligibility of loan pools

The Bank works with participants to help them to shape loan pools such that any risk management concerns the Bank may have can be addressed in a way that allows the participant to access the funding it requires. As such, it is rare for the Bank to reject a loan pool, although it may request the removal of certain loans from a loan pool if it does not think they can be

(1) A person or company's 'centre of main interests' or 'COMI' describes the jurisdiction with which that person or company is most closely associated. Often a company's COMI is the same as its jurisdiction of incorporation, but a number of additional factors are relevant, including, among others: (i) the location of the bodies responsible for the management and supervision of the company; (ii) the location of the registered office; and (iii) the location from which the management decisions of the company are taken.

(2) Borrower details are suitably anonymised so that the participant and the Bank comply with the Data Protection Act 1998. The Bank also exercises its usual obligations of handling sensitive data.

adequately risk-managed. In cases where a loan pool has not been accepted, there is usually a number of contributing factors that have led to the judgement that the pool cannot be effectively risk-managed. Such factors have included:

- Excessive uncertainty around the quality of the collateral, such as when a participant has insufficient management information meaning that the Bank is unable to monitor the ongoing performance of the loans to its satisfaction or there are serious doubts about the accuracy of the data that a bank has provided;
- excessive 'wrong-way' risk; and
- 'binary' risks, for example if the underlying loans had not been written under robust legal agreements, then if a risk should crystallise, the Bank may be unable to take possession of the entire value of all of the loans in the pool if the SMF participant were to default.

Valuation of residential mortgage loan pools

Valuation is an important risk management and policy tool. If the valuation is set too high, there is the risk that the Bank will lend more against the asset than — in the event of a participant's default — it could achieve by either selling the asset or holding it to maturity. But if the valuation is set too low, the Bank will limit the amount of funding it provides to a participant, potentially hampering its policy goals of monetary and financial stability.

There are a number of different valuations that can be applied to an asset. These include:

- **Market value** — the value that an asset is trading at in a liquid market. But when risk managing loan collateral, the Bank does not consider the market value, since loans are not normally liquid in private markets.
- **Nominal value, or the 'face value' of the loans** — that is, the outstanding principal amount left to repay.
- **Stressed value of the loans** — the estimated fundamental value of loans in the event of a severe real economy and/or financial market downturn taking into account factors such as declining house prices.

As described in the rest of this section, the Bank uses both nominal and stressed values as part of its risk management process for loan pools. By comparison, the Bank's preferred method for valuing securities is to use market value (subject to a haircut) where possible.

Haircuts on residential mortgage loan pools

The Bank does not lend an amount equal to the full value of the collateral that it takes, but instead sets a 'haircut' on the collateral. In the case of loan collateral, the haircut is the difference between the nominal and (lowest) stressed value of the loans. If a participant defaulted, the Bank would need to sell this collateral to make good any potential loss (or be prepared to hold this collateral to maturity). The value of the collateral could decrease in between the time that the Bank accepts it and when the participant defaults or, alternatively, the collateral could have been overvalued to begin with. So the haircut is designed to mitigate the risk of loss arising from the value of the collateral declining in the market, or due to the credit fundamentals of mortgages in the pool significantly deteriorating over the time that the Bank holds them on its balance sheet. Together, the product of the valuation and (1-the haircut on collateral) make up the amount that the Bank will lend against a loan pool.

The Bank is conservative in its lending in order to avoid any unnecessary risk to public funds in pursuit of its monetary and financial stability objectives. As such, it takes a prudent approach to valuing and setting haircuts on loan collateral, driven in part by the wrong-way risk associated with taking these assets, as participants are more likely to want to access funding from the Bank at times of market stress. **The approach outlined below is designed solely for the purpose of determining haircuts in a prudent and conservative way on existing loan pools offered as collateral, based on adverse scenarios for credit losses.**

This conservative approach allows the Bank to set 'through-the-cycle' haircuts, meaning that they will not increase systematically in the downswing of the business cycle. Therefore, when participants are informed of the post-haircut value of the collateral, they will know how much funding they can draw against that loan pool even in times of severe stress, which helps with their liquidity planning.

Use of models in setting haircuts on residential mortgage loan pools

The haircut on a loan pool typically consists of the credit loss haircut, which is designed to cover the credit risk associated with the loan pool, alongside additional haircuts to mitigate risks that are not captured by the Bank's models. For residential mortgages, the Bank sets a base level for the credit loss haircut using its credit stress model and its cash-flow model. The methodology is a two-stage process: the first stage assesses the quality of the loan pool and forecasts losses using the credit model; the second stage runs a number of stress scenarios to estimate the behaviour of (and cash flows associated with) the loans in the pool, using the cash-flow model to calculate a net present value of cash received over the lifetime of each loan.

In the first step, the credit model is used to forecast borrowers' ability and willingness to service their mortgages, and based on these, derive a probability of default (PD). The credit model uses the loan-level information provided by the participant to

estimate the borrower's PD. In the model, a key determinant of the PD is the loan to value (LTV) ratio: the greater the equity a borrower has in a property, the greater the likelihood of them continuing to repay the loan. Another key factor that is assumed to impact the PD is the affordability of the loan. Taking loan repayments relative to the borrower's income as one such metric of affordability, the model assumes that the higher this metric is, the higher the probability of a borrower being unable to meet their repayment obligations over the lifetime of the loan. The PDs used in the credit model are calibrated by Bank staff using these measures of ability and willingness to make mortgage payments.

This model-derived PD can be overridden (typically increased) if the loan demonstrates certain other risk characteristics such as if the borrower has an adverse credit history and/or the loan in question is interest-only. The credit model calculates a PD for every loan in the pool and uses these results to estimate a weighted average PD for the whole loan pool.

The credit model also calculates estimates of the losses on each loan in the event that they default — the 'loss given default' (LGD).(1) This calculation takes the outstanding balance on the loan and an up-to-date valuation of the property and then applies a significant fall in this valuation in order to replicate a stressed economic scenario. The calculation also considers other risk factors, such as whether a loan is interest-only or the borrower is in arrears on the loan, as well as the costs associated with selling the property. The recovery value for each loan is then used in the cash-flow model to forecast recoveries in the event that a loan defaults.

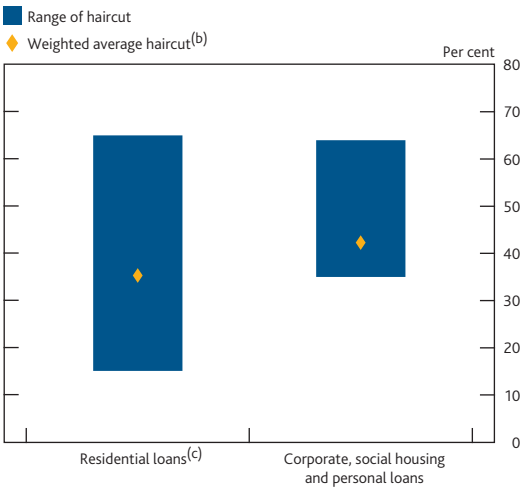
In the second step, the cash-flow model takes outputs from the credit model and uses them to forecast the different repayment profiles on every mortgage in a loan pool under a range of hypothetical economic stresses, recognising that the capital and interest repayments made by borrowers on their mortgages will vary depending on the nature of the stress. The Bank then discounts the value of these cash flows back to their present value. Taken together these give a stressed value of the entire loan pool: the difference between the face value of the underlying loans and this stressed value is the base haircut on the pool, as implied by the credit and cash-flow models.

Additional determinants of the haircut

As discussed above, LTV ratios and the affordability of loans are two key determinants of the haircut on a loan pool. But due to the Bank's non-mechanistic approach to setting haircuts, loan pools with similar quantitative characteristics may have very different haircuts. The Bank also applies additional haircuts (not derived from its credit and cash-flow models) where it thinks that the models have not adequately captured the risks owing to specific factors affecting a particular loan pool. Reasons for applying additional haircuts could include concentration risk, where a small number of loans account for the majority of the value of a loan pool.

Average haircuts on residential mortgage loan pools are lower than on pools of corporate, social housing and personal loans as shown in **Chart 3**. At present, only secured corporate loans have been pre-positioned(2) and, the assets that they are secured against — such as commercial property — have greater uncertainty over their value than the assets securing residential mortgages, and therefore a potentially lower recovery value in the event of a counterparty default. That said, some corporate entities may have a lower probability of default than certain classes of residential mortgage borrowers, leading to a lower haircut on selected commercial pools. This is particularly true of loans to registered social landlords, which are regulated entities and are eligible to receive grants and so are more likely to be able to service their debt in an economic downturn.

Chart 3 Haircuts applied to pre-positioned loan portfolios(a)



Sources: Bank of England and Bank calculations.

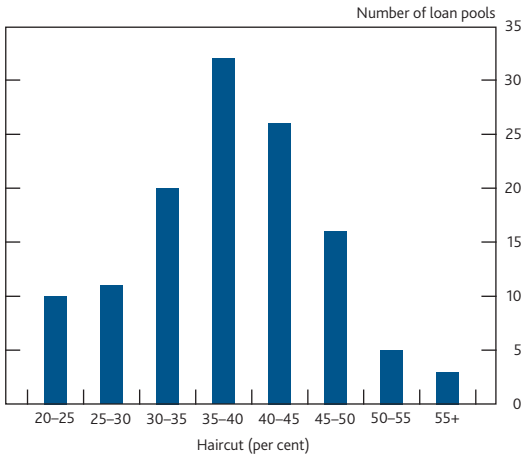
(a) Data as at 31 December 2013.
(b) Weighted by nominal value of loan portfolios, before haircuts are applied.
(c) Excludes social housing loans.

The modal haircut on residential mortgage loan pools is between 35%–40%, as illustrated by **Chart 4**. This means that for these loan pools, the participants will be able to borrow 60%–65% of the value of the loan pool.

At first glance, this may appear higher than the haircuts on an equivalent residential mortgage-backed security (RMBS), the base haircuts for which lie between 12%–24%.(3) But it is worth noting that a number of additional haircuts apply on RMBS collateral delivered to the Bank: a 5 percentage point

(1) Together, the PD and LGD can be multiplied together to calculate an expected loss. Expected losses are discussed in the article 'Credit spreads: capturing credit conditions facing households and firms' in this edition of the *Quarterly Bulletin* and in Button, Pezzini and Rossiter (2010).
(2) Although unsecured commercial loans are also eligible.
(3) See www.bankofengland.co.uk/markets/Documents/money/publications/summary_haircuts.pdf.

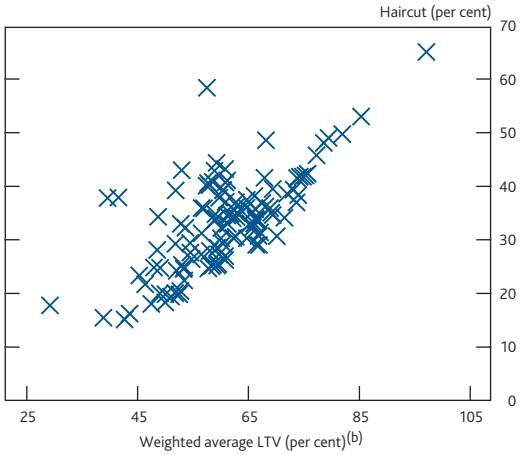
Chart 4 The distribution of haircuts applied to residential mortgage loan pools[a]



Sources: Bank of England and Bank calculations.

(a) Data as at 31 December 2013.

Chart 5 Weighted average LTV ratios and haircuts on residential mortgage loan pools[a]



Sources: Bank of England and Bank calculations.

(a) Weighted average across loans in a given loan pool, by value.
(b) Data as at 31 December 2013.

haircut if the security is model-priced, a 5 percentage point haircut if the security is issued by the SMF participant that is also delivering it to the Bank (akin to a bank delivering a pool of loans it originated) and wrong-way risk haircuts if the bank delivering the RMBS plays additional roles in the deal, such as providing the swap. In addition, RMBS will incorporate credit enhancement, which is additional protection for the RMBS note holders if some or all of the borrowers of the underlying mortgages were to default.(1) One example of credit enhancement is overcollateralisation, where there is more collateral backing the RMBS than the value of notes in issue. This generates greater cash flows than are needed to service the coupon payments on the debt. This is something that a portfolio of unsecuritised loans does not benefit from.

Given the calibration of the Bank's risk models, it is unsurprising that in general, the lower the LTV, the lower the haircut. This can be seen in **Chart 5**, although this is not a perfect relationship, as mentioned, for a number of reasons. It is more difficult to observe a strong relationship between affordability metrics and haircuts, since the majority of loan pools demonstrate similar affordability metrics. This largely reflects the fact that most pools comprise a large number of loans that vary by affordability, but this variation typically averages out across pools of loans.

Setting haircuts on other loan pools (including commercial loans)

Due to the less standardised nature of commercial loans, the Bank uses a different approach to set haircuts. The Bank does not, in general, have a preference for residential mortgage assets over other assets, but its due diligence of the latter is necessarily more onerous because the uncertainty around these risks is greater due to the more bespoke nature of the terms commercial loans are written under, as discussed later in this section.

For these asset classes, the Bank has calculated a range of expected losses to determine a haircut on the loan pool. As shown in **Table B**, different asset classes are assumed to have different PDs and LGDs, which in turn will affect the size of the haircut. Broadly speaking, private finance initiative and social housing loan pools have the lowest average base haircuts, while commercial real estate, auto loans (for car purchases) and personal loans have some of the highest average base haircuts. While for residential mortgage loan pools, PDs and a range of different LGDs are important inputs into the cash-flow model, the expected loss output for other loan pools is not a straightforward multiplication of the PD with the LGD.

Table B Relative PDs and LGDs for different asset classes[a]

Asset class	Probability of default	Loss given default
Private finance initiative loans	Low	Low
Social housing loans	Low	Low
Loans to large corporate entities	Low	Medium
Auto loans	Medium	High
Personal loans	Medium	High
Loans to small and medium-sized enterprises	High	Medium
Commercial real estate loans	High	Medium

(a) Based on conservative Bank estimates.

Bank staff reviewed a range of data sources and studies to set PDs and LGDs for the different asset classes, placing most weight on UK-specific data and studies with a long-run history covering several business cycles.(2) Information from counterparties on their own default history was also input into Bank staff's judgement on where to estimate LGDs. The Bank then sets haircuts designed to cover these ranges of expected losses. However, while the Bank's modelling of residential

(1) For more information on credit enhancement, see Breeden and Whisker (2010).
(2) These included default and recoveries data from the ratings agencies as well as academic and industry research and empirical evidence.

mortgages calculates PDs and LGDs resulting in a range of estimates given the fundamental characteristics of the pool, for commercial loan pools the Bank uses conservative point estimates for LGDs and PDs within pre-agreed ranges.

Many of the factors that the Bank considers when assessing commercial loans are the same as for residential mortgage ones, although some are more significant when assessing commercial loan pools. For example, exposures to a single borrower tend to be much greater in a commercial loan pool than a residential mortgage one. This is because while a residential loan pool may consist of tens of thousands of loans, a commercial loan pool tends to consist of a smaller number of loans, each of a higher value. So the impact of one loan defaulting in a commercial pool is likely to be much greater than in a residential loan pool. This risk is offset to some extent if there is collateral backing the loan, especially since the collateral will typically be more diversified than the (individual) borrower.

In addition, underwriting may also be performed on a more individual basis for corporate loans than for residential mortgages. Many participants make use of models to mass underwrite residential mortgage and personal loans under their standard lending policy. By contrast, commercial lending may be done by teams with specialist knowledge in a particular sector. They can use this expertise, alongside building strong relationships with their borrowers, to structure facilities in a way that attempts to manage the risks appropriately.

Where appropriate, the Bank's risk management staff also review the cumulative default performance for loans of different vintages within pools. This can be a useful indicator of whether underwriting standards have changed — a trend of progressively higher cumulative default rates, for example, could suggest a relaxation in underwriting standards. However, where a long back-history of these data is not available — because a participant is newly established or has only recently started to conduct a certain type of lending, say — Bank staff will seek alternative evidence of the likely performance of these loans and the uncertainty around their performance, so that in most cases participants are still able to use this collateral to raise funding from the Bank.

As discussed in the section on residential mortgages, Bank staff then use judgement to determine whether to apply additional haircuts to capture risks that are not accounted for in the base haircut. The Bank reaches a decision about the eligibility of a loan pool, and if accepted, communicates its haircut to the participant and works with them to formally pre-position the loan pool.

Ongoing monitoring of loan pools and participants

Once a participant has pre-positioned loan collateral, the Bank undertakes a range of ongoing monitoring, designed to identify changes in loan pool composition, origination standards and other factors with a bearing on the performance of current and future loans. The Bank undertakes this monitoring of both loan pools that have and have not been drawn against, in the latter case to ensure that participants can draw against loan pools at any time. This is becoming an increasingly important part of the Bank's work on collateral given the value of loans that are now pre-positioned; this figure stood at £351.7 billion at the end of 2013.

The Bank regularly checks that the post-haircut value of collateral pre-positioned exceeds the amount of any funding advanced by the Bank. As loans mature, the value of collateral held by the Bank decreases as household and corporate borrowers repay their loans — this cash is held by the SMF participant that wrote the loan and is not passed on to the Bank. If the haircut value of the collateral no longer exceeds the value advanced by the Bank, it will make a margin call for the participant to post more collateral with the Bank. However, such occurrences are rare with respect to loan pools as participants tend to have a number of loan pools of different sizes pre-positioned with the Bank. Participants can therefore notify the Bank to use a larger loan pool to collateralise their borrowing, thus meeting the margin call and unencumbering the smaller loan pool. In addition, the Bank frequently re-runs its credit and cash-flow models to update its valuations and haircuts of the evolving loan pools. The Bank reviews its haircut methodology regularly to ensure that it remains fit for purpose.

The Bank also conducts periodic reviews of the lending and risk management policies and practices employed by participants. This involves, at a minimum, requiring participants to re-submit their due diligence questionnaire, highlighting changes to existing policies. The Bank will also conduct additional site visits, and apply additional monitoring where required for prudent risk management.

The Bank monitors data for trends across participants in order to identify any emerging risks common to some or all pre-positioned loan pools. An example of such monitoring is reviewing the cost of borrowing for different asset classes, as an increased cost of borrowing can signal increased credit risk in that sector. This monitoring allows the Bank to perform useful peer analysis by identifying any deterioration that suggests a participant is weakening, such as a marked rise in the number of loans in a pool entering arrears. As part of this process, staff review changes in haircuts as a result of monthly data sent in by participants. This allows the Bank to monitor changes to the loan pool and changes to key risk indicators in the pool, such as changes in concentration in the loan pool and an update of the LTV ratio.

Conclusion

The Bank stands ready to provide liquidity to a wide range of banks and building societies, for a variety of maturities against a wide range of collateral. But in providing this important liquidity insurance, the Bank must limit the financial risks to its balance sheet in order to protect public funds. It does this by assessing collateral for eligibility and, when accepted, the Bank applies conservative valuations and haircuts to this collateral. But it is also important that the Bank behaves predictably and so by pre-positioning collateral with the Bank, participants become aware of their drawing capacity for times of stress and can incorporate the use of Bank of England facilities into their contingency planning.

The Bank's due diligence process for residential mortgage loan pools uses credit and cash-flow modelling, alongside qualitative analysis. The non-mechanistic nature of this work, in particular the key role played by an analysis of the uncertainty surrounding collateral valuation, means that haircuts on loan pools with similar LTV and affordability metrics can have markedly different valuations and haircuts. The review process for loans to businesses covers similar issues to those for loans to households, but because the former are written under more bespoke terms, the Bank's due diligence of these loans is necessarily higher due to the greater uncertainty of these risks.

The Bank works to ensure that its liquidity insurance facilities offer wide access, while balancing that with the need for prudent risk management. As such, the Bank periodically reviews the case for, say, expanding its list of eligible collateral to include a new asset class.

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Recent economic and financial developments

Markets and operations

- UK and US short-term interest rates rose a little during the review period. Euro-area short-term interest rates declined in response to growing expectations among market participants that the European Central Bank (ECB) would loosen monetary policy at its June meeting (after the end of the review period). In the event, the ECB announced a number of easing measures.
- The volatility of financial markets implied by derivatives prices remained low. Some contacts suggested that this reflected reduced uncertainty around the path of monetary policy and output growth.
- UK and US ten-year government bond yields were largely unchanged over the review period, as rises in short-term interest rates were broadly offset by lower forward rates.
- The majority of advanced-economy risky asset prices increased over the review period and were broadly unaffected by tensions between Ukraine and Russia or other global events.

Overview

UK and US short-term interest rates rose in line with the path implied by forward rates at the start of the review period. In contrast, euro-area short-term interest rates declined, reflecting market participants' growing expectation that the European Central Bank (ECB) would loosen monetary policy at its June meeting. After the end of the review period, the ECB did indeed announce cuts to its main refinancing rate and the rate on its marginal deposit facility. The ECB also announced that it would stop draining liquidity to offset purchases made under its Securities Market Programme, and that it would undertake a number of targeted long-term refinancing operations later in the year.

Sterling appreciated against a broad range of currencies, albeit less so than over the previous review period. Contacts continued to attribute sterling's strength to improvements in the United Kingdom's economic outlook relative to that of other countries, and rising interest rate differentials with the euro area.

The option-implied volatility of interest rates at short horizons increased a little, but remained low by historical standards. Some contacts suggested that the level of implied volatility reflected low realised volatility, as well as reduced uncertainty around both the path of monetary policy and near-term output growth. But there were also reports of some investors selling interest rate options in order to increase the return on their portfolios as part of a broader search for yield. Some contacts were concerned that a rapid exit of those positions could amplify any future increase in market interest rates (see the box on pages 208–10 for further discussion).

UK and US ten-year government bond yields were largely unchanged over the review period, as rises in short-term interest rates were broadly offset by lower forward rates. Euro-area sovereign bond yields continued to decline, despite a short period of limited market turbulence that saw sharp increases in the government bond yields of some periphery countries. Contacts struggled to attribute the sell-off to any specific factor, and market prices retraced those moves in the days that followed. Greece re-entered the sovereign bond market during April, having been absent from the market since March 2010, and there was successful issuance from Ireland, Portugal and Spain.

Most advanced-economy risky asset prices rose over the review period and were broadly unaffected by tensions between Ukraine and Russia or other global events. There was some volatility in US equities around the start of the review period, with a brief sell-off in technology and biotech stocks in particular. But the S&P 500 index subsequently resumed its upward trend, reaching a new all-time high.

In discharging its responsibilities to ensure monetary and financial stability, the Bank gathers information from contacts across a range of financial markets. Regular dialogue with market contacts provides valuable insights into how markets function, and provides context for the formulation of policy, including the design and evaluation of the Bank's own market operations. The Bank also conducts occasional surveys of market participants in order to gather additional information on certain markets.

The first section of this article reviews developments in financial markets between the 2014 Q1 *Quarterly Bulletin* and 29 May 2014 and includes a box that discusses the recent low levels of implied volatilities across a range of asset classes. The second section goes on to describe the Bank's own operations within the Sterling Monetary Framework.

Financial markets

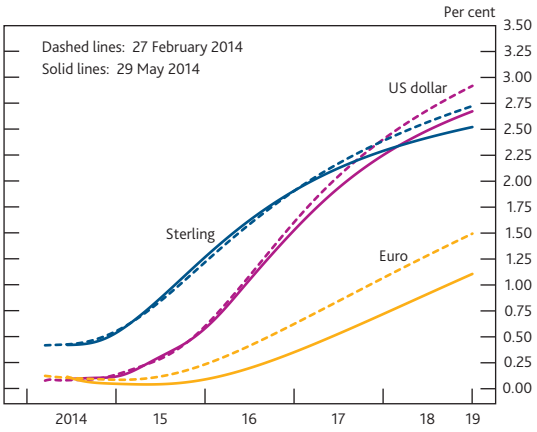
Monetary policy and interest rates

Throughout the review period, the Bank of England's Monetary Policy Committee (MPC) maintained Bank Rate at 0.5% and the stock of asset purchases financed by the issuance of central bank reserves at £375 billion. In the minutes of its May meeting, the MPC reaffirmed the guidance provided in its February *Inflation Report* that when Bank Rate did rise, it was expected to do so only gradually and to a level materially below its pre-crisis average of 5%. The MPC also used the May *Inflation Report* to clarify that it would defer sales of assets held in the Asset Purchase Facility (APF) until Bank Rate had reached a level from which it could be cut materially, were further stimulus to be required. And in line with the guidance regarding the future path of monetary policy provided by the MPC on 7 August 2013, £8.1 billion of cash flows associated with the redemption of the March 2014 gilt owned by the APF were reinvested.

During the review period the Federal Open Market Committee (FOMC) announced that it would continue to reduce — or 'taper' — the pace of its asset purchases, from US$65 billion per month in February, to US$55 billion in April and then to US$45 billion per month in May. UK forward interest rates remained higher than those of the United States over a two to three-year horizon (**Chart 1**), but US forward rates rise more steeply thereafter, reaching the same level as UK rates in the first half of 2018.

April saw some volatility in sterling overnight secured money market interest rates, with the repurchase overnight index average (RONIA) trading in the range of 31–36 basis points and reaching a level of only 10 basis points on 30 April — a record low for a day that was not a year end (**Chart 2**). Contacts pointed to the increased cost to banks of accepting customer deposits at month end, due to both their increased regulatory capital requirements and efforts to deleverage.

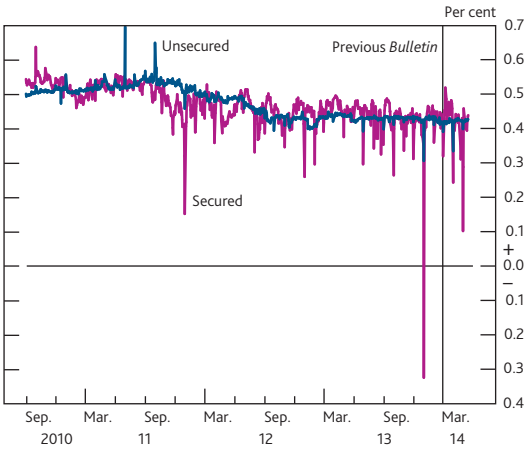
Chart 1 Instantaneous forward interest rates derived from overnight index swap (OIS) contracts[a]



Sources: Bloomberg and Bank calculations.

(a) Instantaneous forward interest rates derived from the Bank's OIS curves.

Chart 2 Weighted average sterling overnight interest rates[a]



Sources: Bloomberg and Bank calculations.

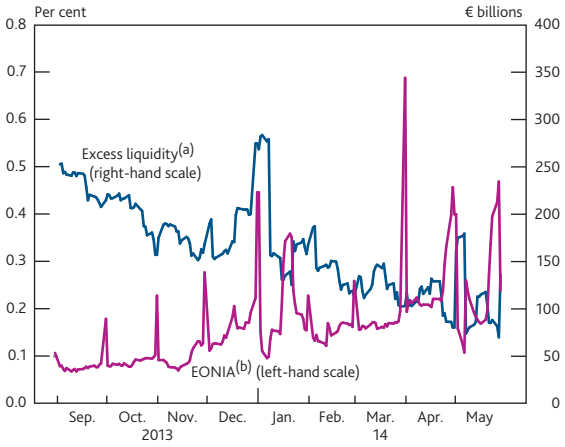
(a) The unsecured overnight interest rate is measured by the sterling overnight index average (SONIA). The secured overnight interest rate is measured by the RONIA. Both indices are provided by the Wholesale Markets Brokers' Association. For further details, see www.wmba.org.uk.

Contacts also cited a rise in demand for collateral due to a seasonal increase in equity lending at around the time of dividend payments, which may help to explain why overnight unsecured interest rates did not fall to the same extent.

There was also volatility in overnight euro-area money markets. The euro overnight index average rate (EONIA) reached 69 basis points on 31 March, the quarter end, and exhibited high levels of volatility during April (**Chart 3**). Contacts attributed this to falling excess liquidity in the euro area, reflecting ongoing repayments of funds borrowed under the European Central Bank's (ECB's) longer-term refinancing operations, as well as unanticipated changes in levels of money market liquidity stemming from 'autonomous' factors[1] such as seasonal tax payments.

(1) Autonomous factors affect the liquidity needs of the banking system but are out of the control of the ECB, and include items such as banknotes in circulation and deposits by national governments.

Chart 3 EONIA and excess liquidity in the Eurosystem

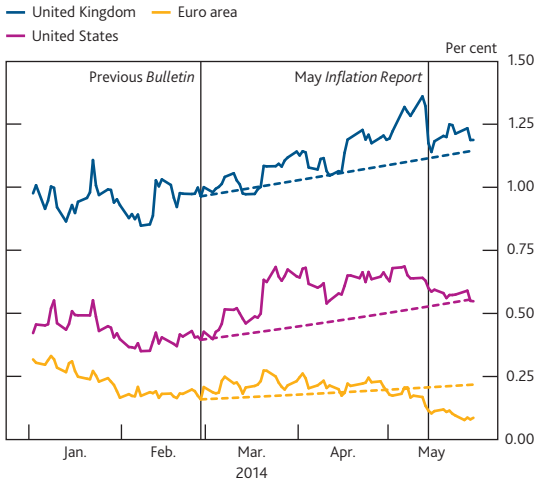


Source: Bloomberg.

(a) Excess liquidity is defined as the total amount of reserves held in Eurosystem current accounts and the deposit facility, minus average reserves requirements and use of the marginal lending facility.
(b) EONIA is the weighted average of overnight unsecured lending transactions in the interbank market undertaken in the European Union and European Free Trade Association countries.

The sterling one-year OIS rate, one year ahead, rose during the review period, but remained roughly in line with the path implied by forward rates at the time of the previous *Bulletin* (**Chart 4**). In the run-up to the publication of the May *Inflation Report*, short-term interest rates increased particularly strongly; contacts attributed this to the possibility that better-than-expected data might cause the MPC to signal a possible tightening in policy.

Chart 4 One-year OIS rates, one year ahead(a)(b)



Sources: Bloomberg and Bank calculations.

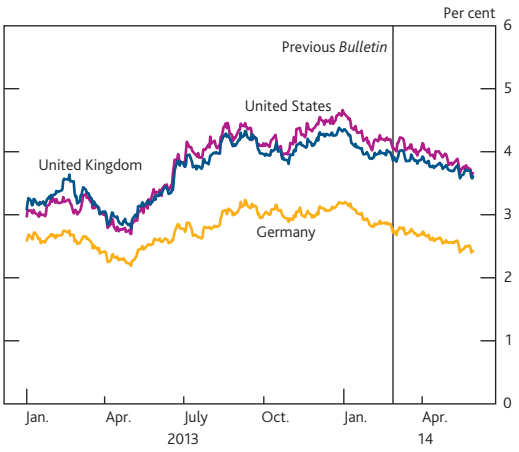
(a) Forward rates derived from the Bank's OIS curves.
(b) Dashed lines show the expected path of the one-year OIS rate, one year ahead, implied by the OIS forward curve at the start of the review period.

In the event, on the publication day of the May *Inflation Report*, sterling short-term interest rates fell sharply. Contacts pointed to weaker-than-expected labour market data released on the same day as the *Report*, and also to the MPC's forecast for the level of spare capacity in the economy (which remained around 1%–1.5% of GDP), which was slightly higher than some had expected. Contacts also noted increased interest in how steps taken by the Financial Policy Committee to counteract the risks of rising house prices might interact with the MPC's policy stance.

US and UK short-term interest rates continued to move fairly closely together for most of the review period. But the anticipated pace of recovery in the euro area continued to diverge from that of the United States and the United Kingdom. The euro-area one-year OIS rate, one year ahead, fell during the review period, which was attributed to low inflation outturns and expectations of further monetary easing by the ECB at its June meeting. In the event (and shortly after the end of the review period), the ECB announced cuts to its main refinancing rate and the rate on its marginal deposit facility. It also announced that it would stop draining liquidity to offset purchases made under its Securities Market Programme, and that it would undertake a number of targeted long-term refinancing operations later in the year.

US and UK medium-term forward interest rates fell, continuing the decline that began around the start of the year (**Chart 5**). Contacts attributed this to lower terminal policy rate expectations, a fall in risk premia due to a reduction in uncertainty around the path of future policy rates, and lower inflation expectations. Short-term interest rates increased over the review period, such that ten-year US and UK government bond yields remained largely unchanged.

Chart 5 Selected five-year government bond yields, five years forward(a)

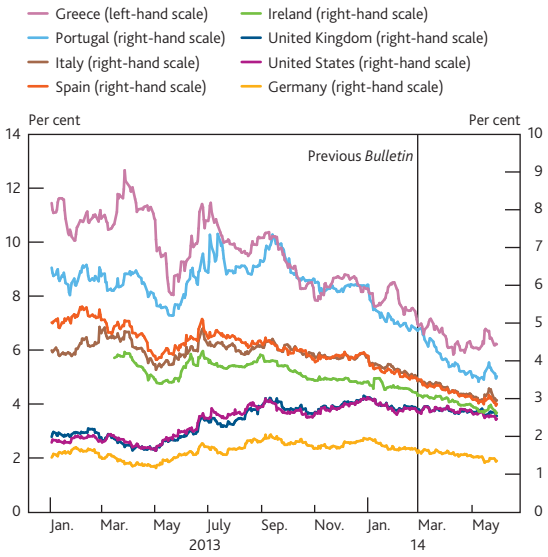


Sources: Bloomberg and Bank calculations.

(a) Yields to maturity derived from the Bank's government liability curves.

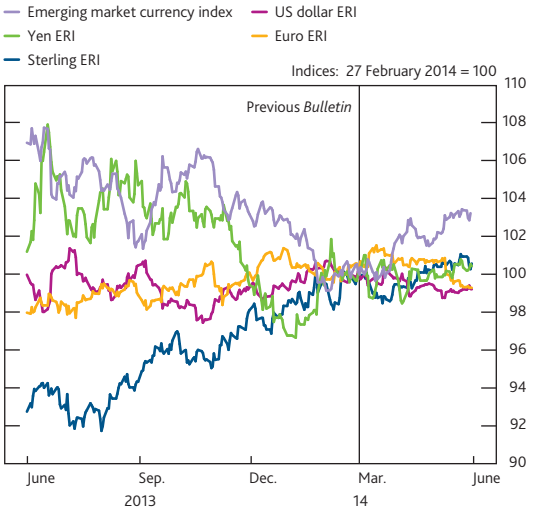
Bond yields in the euro-area periphery continued to decline relative to bunds (**Chart 6**). The Greek government re-entered the bond market for the first time since its Economic Adjustment Programme was agreed with the European Union (EU), ECB and International Monetary Fund in May 2010, and Ireland, Portugal and Spain also issued bonds. There was a temporary reversal of some of the fall in periphery government

Chart 6 Selected ten-year government bond yields



Source: Bloomberg.

Chart 7 Selected exchange rate indices



Sources: Bloomberg, European Central Bank, JPMorgan Chase & Co. and Bank calculations.

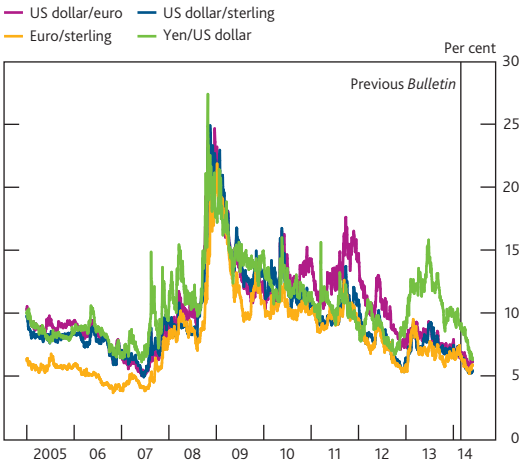
bond yields on 15 May, with spreads to bunds rising sharply — by up to around 30 basis points. Contacts struggled to attribute these moves to a specific factor. Some thought that they reflected concerns about political risk in parts of the euro-area periphery. Others suggested that a large number of investors had bought euro-area periphery sovereign debt as part of a broader 'search for yield' in response to the low level of nominal interest rates, leaving prices particularly vulnerable to a correction. A reduction in the willingness of dealers to provide liquidity — perhaps reflecting diminished appetite to offer market-making services during periods of stress — was also said to have contributed to the rapid market movement. Contagion to other markets was limited, however, and the moves largely reversed over the days that followed.

Foreign exchange

The sterling effective exchange rate index (ERI) appreciated a little over the review period, albeit by less than over the previous review period (**Chart 7**). The majority of the rise in sterling was driven by an appreciation against the euro, although the pound also appreciated against a broad basket of currencies. Contacts continued to attribute the ongoing rise in sterling to improvement in the UK economic outlook, relative to that of other countries, as well as the widening difference in interest rates in the United Kingdom versus the euro area. But some foreign exchange strategists felt that recent good news about the UK economy was now fully incorporated in the level of the exchange rate, and suggested that the risks to sterling were mainly to the downside. In particular, they thought that disappointing macroeconomic news had the potential to push down on the currency, and some also suggested that the sizable UK current account deficit would tend to cause sterling to depreciate over the medium term.

Some commentators suggested that there had been a return of emerging market 'carry trades', whereby investors borrow in low-yielding advanced-economy currencies in order to invest in higher-yielding assets in developing markets. This had been encouraged by low levels of exchange rate volatility (**Chart 8**), which served to reduce the perceived riskiness of such investment strategies (for a general discussion of recent developments in asset price volatility see the box on pages 208–10). Such carry trades were thought to have contributed to the appreciation of some emerging market currencies, with the JPMorgan emerging market currency index rising by 3% over the review period.

Chart 8 Three-month option-implied volatility of foreign exchange rates



Source: Bloomberg.

Implied volatility

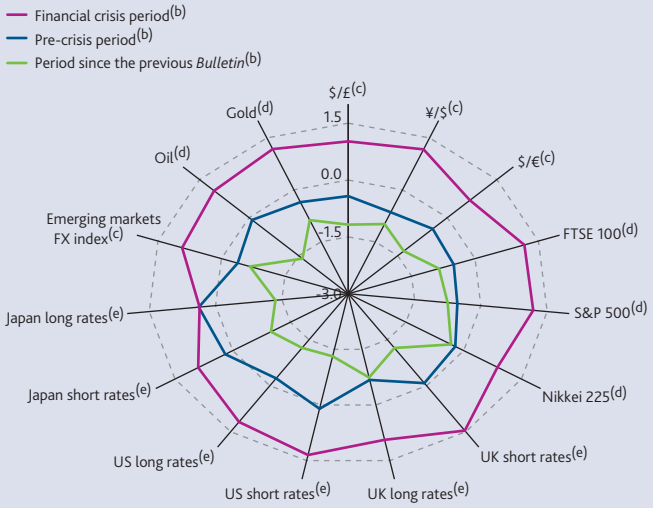
What is implied volatility?

Options are contracts that give investors the right to buy or sell an asset at a specified price — or 'strike price' — on (or before) a specified future date. An option's price therefore reflects investors' views as to the likelihood that the option will expire with positive value, and so offers an indication of the probability investors attach to the underlying asset price reaching the option strike price. This, in turn, implies something about the variability investors expect the price of the underlying asset to exhibit over the lifetime of the option. This is known as 'implied volatility'.

Recent trends in implied volatility

Short-term implied volatilities (derived from options with a three-month maturity) are currently low relative to their historical levels across a range of asset classes, including equities, interest rates, currencies and commodities. **Chart A** shows that implied volatilities derived from options with a three-month maturity are, on average, at or below pre-crisis levels across various asset classes.

Chart A Implied volatilities at the three-month horizon for international interest rates, equities, exchange rates and commodities(a)

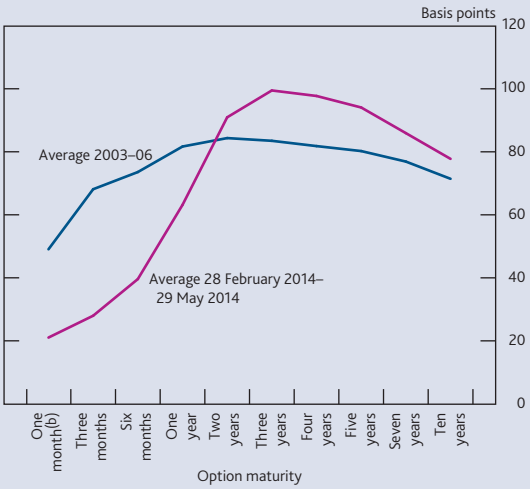


Sources: Bank of England, Barclays Live, Bloomberg and Bank calculations.

(a) The chart shows differences, in number of standard deviations, between the values of these indicators and their averages between 2 January 2003 and 29 May 2014, averaged over three different time periods. The averages are based on daily data.
(b) Pre-crisis period refers to 2 January 2003 to 8 August 2007. Financial crisis period refers to 9 August 2007 to 31 December 2009. The period since the previous *Bulletin* refers to 28 February 2014 to 29 May 2014.
(c) $/£, ¥/$ and $/€ refer to implied volatilities from three-month options on the respective exchange rates. Emerging markets FX index refers to the JPMorgan implied volatility index.
(d) Implied volatilities from three-month options on the FTSE 100, S&P 500, Nikkei 225, oil and gold.
(e) Implied volatilities from three-month options on one-year and ten-year interest rate swaps.

Implied volatilities are, however, somewhat higher at longer horizons. **Chart B** shows that, based on options of different maturities on a one-year interest rate swap, UK short-term interest rate implied volatility is well below average at a six-month horizon, but at a two-year horizon is closer to the average. The same is true of implied volatilities on US short-term interest rates. This might suggest that financial market participants expect interest rate volatility to pick up in future — perhaps due to anticipated central bank policy tightening.

Chart B Term structure of implied volatility from options of differing maturities on sterling one-year interest rate swaps(a)



Sources: Barclays Live and Bank calculations.

(a) Normalised implied volatilities of options of varying maturities on one-year sterling interest rate swaps.
(b) Data for the one-month option is only available from 30 November 2004 onwards.

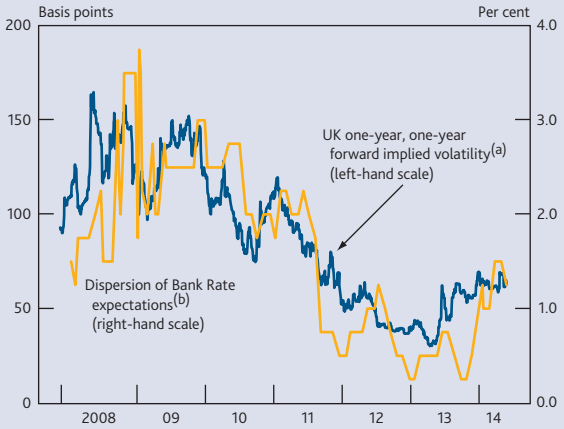
Short-maturity implied volatilities for both equities and foreign exchange are also currently at very low levels, and, as with interest rates, the term structure of implied volatility is upward sloping. Since exchange rates and equity prices are, in part, a reflection of interest rates and the differentials in interest rates between countries, it might therefore be expected that anticipated increases in the implied volatility of interest rates would be reflected in that of foreign exchange and equities.

There may, of course, be other factors serving to lower volatility in equities and exchange rates. In the foreign exchange market, for example, contacts suggest that the growth of machine-to-machine trading has served to dampen small fluctuations in prices. Contacts also note that some institutional investors and corporate end-users perceive there to be less need for active management of foreign exchange exposures in the current low-volatility environment than in the past. This will tend to have reduced implied volatility. That said, a rise in volatility may lead such market participants to reappraise the need for hedging.

What explains the low level of interest rate implied volatility?

There are a number of factors that might help explain the current low implied volatilities of interest rates at short horizons. Policy rates in the United Kingdom, the United States and the euro area have been constrained by the zero lower bound. By limiting the scope for interest rates to fall further, contacts point out that this dampens volatility. The Bank of England, Federal Reserve and ECB have also provided considerable information on their reaction functions through forward guidance, reducing uncertainty about the path of policy in the future. In the United Kingdom, for example, there does appear to be broad correlation between the dispersion of survey-based expectations of the future level of Bank Rate and implied volatility from one-year options on the one-year swap rate (**Chart C**). A reduction in the uncertainty that investors ascribe to the future path of monetary policy may therefore have helped to lower implied volatility at short horizons.

Chart C Implied volatility from a one-year option on a one-year interest rate swap versus dispersion of survey expectations for Bank Rate



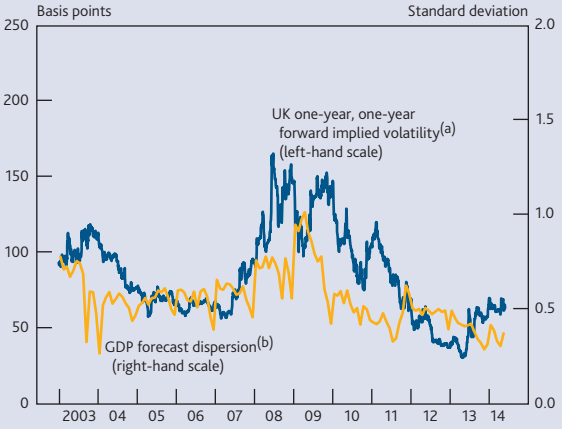
Sources: Barclays Live, Reuters and Bank calculations.

(a) Normalised implied volatility from one-year options on one-year interest rate swaps.
(b) Range of Bank Rate expectations six quarters ahead.

The low level of short-term implied volatilities might also reflect reduced uncertainty about the near-term macroeconomic outlook. But while there is some correlation between the dispersion of Consensus forecasts for GDP growth and implied volatility, both in the United Kingdom (**Chart D**) and the United States, it is not particularly strong.

Market participants may have become accustomed to the low level of observed, or 'realised', volatility in financial asset prices in the recent past, and expect it to persist. If implied volatility is largely a backward-looking measure of variability in asset prices, however, it might not be a useful predictor of future volatility at the current point in the interest rate cycle. And contacts suggest that some market participants may have

Chart D Implied volatility from a one-year option on a one-year interest rate swap versus dispersion of forecasts for annual growth in real UK GDP



Sources: Barclays Live, Consensus Economics Inc., Thomson Reuters Datastream and Bank calculations.

(a) Normalised implied volatility from one-year options on one-year interest rate swaps.
(b) Standard deviation of Consensus Economics survey of forecasters' projections for next-year real GDP growth.

underpriced the likelihood that volatility will rise. They note that there has been some sizable selling of options in the belief that interest rates and volatility would remain low for a long time and suggest that it could be difficult for option sellers to exit these positions without adding to upward pressure on options prices and causing volatility to rise further.

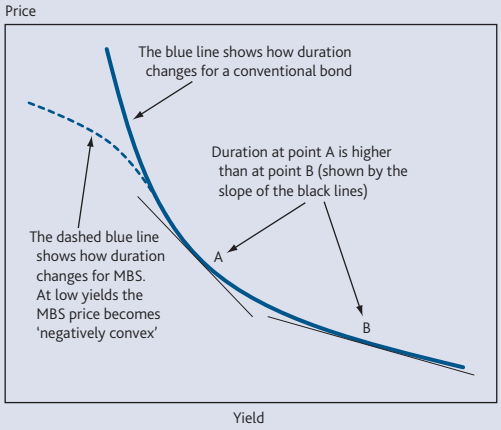
Structural changes to the US interest rate volatility market

In addition to the factors mentioned above, there may also have been a reduction in demand for protection against a rise in volatility due to changes to the US mortgage-backed securities (MBS) market. This will tend to have lowered option prices and reduced the implied volatility of long-term US interest rates.

Other things being equal, MBS prices vary inversely with financial market interest rates, or yields. A fall in the market interest rate increases the current value to the MBS holder of all of the future coupon payments accruing to the instrument. A fall in interest rates will therefore increase the current value of an MBS, pushing up its price (see **Chart E** for a simple illustration). The sensitivity of the price of an instrument to changes in interest rates is referred to as 'duration'.

Duration is a function of the level of yields. For a conventional bond, duration rises as the yield falls (see the difference in the slope of the blue line in **Chart E** at points A and B). But in the case of an MBS, duration is also affected by the fact that a decline in interest rates will induce some borrows to repay their mortgages early (by re-mortgaging). If interest rates fall materially, the loss of future income resulting from early repayments will begin to offset the effect of decreasing market

Chart E Illustrative diagram of the relationship between bond and MBS prices and yields



rates on the current value of the remaining coupons. And, at a certain point, the price of the MBS will become less, rather than more, sensitive to further declines in rates. Duration will then fall as the yield falls (the dashed blue line in **Chart E**).

This feature of the duration of MBS is referred to as 'negative convexity' and has implications for the hedging of interest rate risk associated with holding MBS. The risk of small changes in interest rates can be hedged by, for example, entering into an interest rate swap to receive floating interest rates and pay fixed. Then, if rates fall, income from the floating-rate leg of the swap will fall, offsetting the increase in the value of the MBS. As a result, the duration of the portfolio overall is held broadly constant.

However, because of negative convexity, once rates have fallen sufficiently far from where they began, the duration of the MBS will also begin to fall. To maintain the hedge, the MBS holder will then need to increase the duration of the portfolio, perhaps by receiving fixed and paying floating in swaps (putting downward pressure on swap rates), or buying US Treasuries (putting downward pressure on yields).

So, convexity hedging will tend to reinforce the initial decline in the market interest rate. But, once rehedged, as rates begin to rise, and the MBS duration begins to rise, convexity hedging will then induce the MBS holder to enter into swap agreements to receive floating and pay fixed, or to sell assets that are long duration. Thus, in a rising rate environment, convexity hedging will tend to amplify the impact of the initial movement in market interest rates — resulting in sharper rises in interest rates and volatility than would have occurred otherwise.

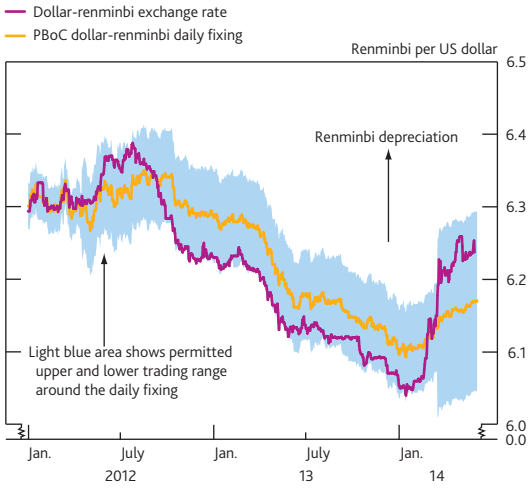
Contacts suggest that this amplification mechanism has exacerbated increases in volatility during past tightening cycles. However, they also report that the effects of convexity hedging might be less potent than in previous rate-rising cycles. In large part, that is because asset purchases by the US Federal Reserve have significantly reduced the amount of MBS held by private investors. While MBS investors, such as government-sponsored enterprises, typically hedge at least some of their exposure to changes in duration, the Federal Reserve does not. Bank holding companies also now hold more MBS in their hold-to-maturity portfolios than was previously the case, and do not need to hedge these exposures against convexity risk.

Separately, changes to mortgage-servicing practices are thought to have significantly reduced interest rate hedging activity. Contacts note that a large amount of mortgage-servicing activity has migrated to non-bank mortgage originators, adding that these institutions tend to rely on revenue from new mortgage origination to offset the effect of pre-payments on revenues from mortgage servicing. Indeed, contacts suggest that mortgage servicing-related hedging flows are now a fraction of what they were a few years ago.

The shift in the structure of the US MBS market described above — and associated changes in interest rate hedging behaviour — may have lowered option prices and implied volatilities. And, while it remains to be seen, it might also have reduced the extent to which a rise in volatility will become self-reinforcing in the future. Given the high degree of substitutability of US and UK government bonds, there may be material spillovers to UK rates as well.

One notable exception to this was the Chinese renminbi, which declined fairly steadily over the course of the review period. In February, the People's Bank of China (PBoC) began to lower the value of the renminbi versus the US dollar, by raising the daily dollar-renminbi fixing. This introduced more 'two-way risk' into the currency, following a prolonged period of steady appreciation. Commentators suggested at the time that this might presage a move towards a widening of the daily trading band versus the US dollar, in an effort to introduce a greater role for market forces in determining the exchange rate. During the current review period, the PBoC did indeed widen the daily trading band from ±1% to ±2%. Having typically traded towards the bottom of the band during the period of renminbi appreciation, the dollar-renminbi exchange rate has traded towards the upper end of that range since the PBoC's actions in February (**Chart 9**).

Chart 9 Chinese renminbi per US dollar and daily renminbi trading bands



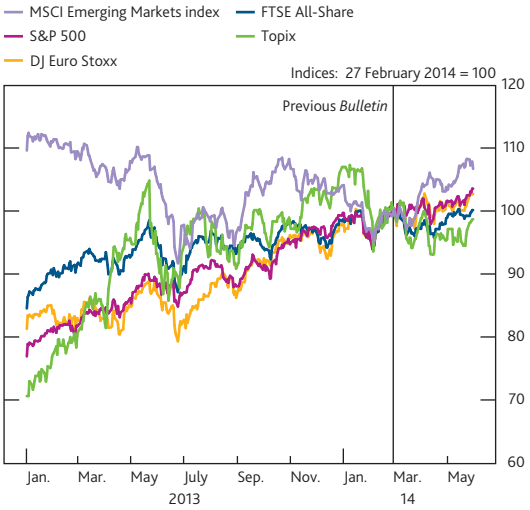
Source: Thomson Reuters Datastream.

Corporate capital markets

The majority of advanced-economy equity indices rose over the review period as a whole (**Chart 10**), with limited reaction to tensions in Ukraine or political developments in other parts of the world. That said, around the start of the review period, there was a reappraisal of the value of US stocks, with technology, homebuilder and biotech shares particularly affected. Contacts thought that these stocks had become expensive-looking and prone to repricing. Nevertheless, US equities subsequently resumed their upward trend, with the S&P 500 reaching an all-time high during the review period.

The UK initial public offering (IPO) market remained buoyant, with the review period seeing the flotation of 35 companies in deals worth a total of US$8.6 billion. There was, however, a slowing of this market compared with the end of 2013 and Q1 of this year (**Chart 11**). There were also some signs of a diminishing investor appetite for new issues, with contacts pointing to underperformance of some recently listed shares. In particular, contacts noted that retail stocks may have become harder to list relative to those of other sectors, given the large number of recent flotations of retailers.

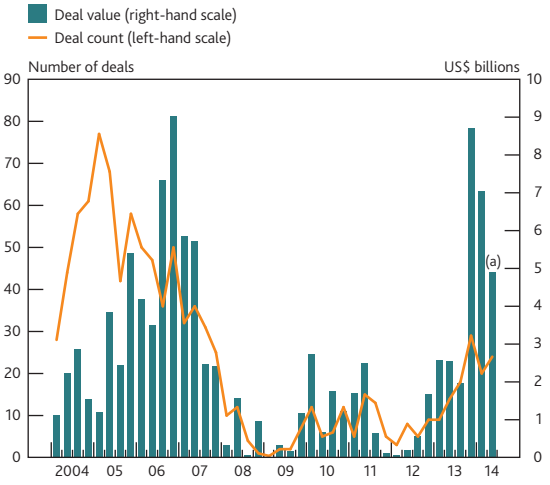
Chart 10 International equity indices[a][b]



Sources: Bloomberg and Bank calculations.

(a) Indices are quoted in domestic currency terms, except for the MSCI Emerging Markets index, which is quoted in US dollar terms.
(b) The MSCI Emerging Markets index is a free-float weighted index that monitors the performance of stocks in global emerging markets.

Chart 11 Total value and number of IPOs by UK firms

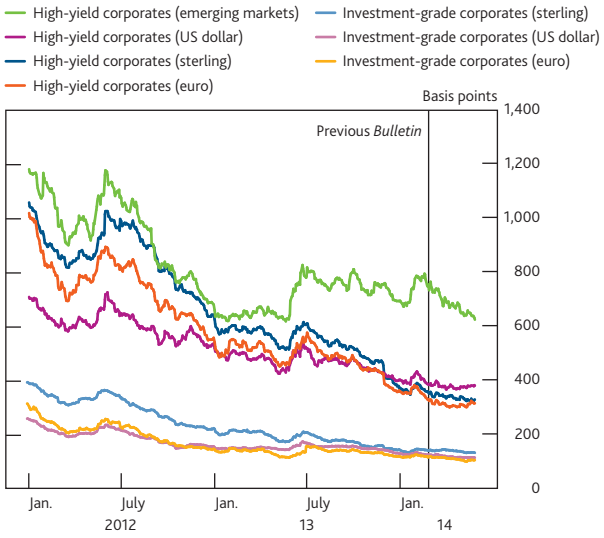


Source: Dealogic.

(a) Data to 29 May 2014.

In corporate bond markets, advanced-economy investment grade and high-yield credit spreads continued to fall (**Chart 12**). As with equities, events in Ukraine and elsewhere did little to interrupt the broad trend in credit spreads, suggesting that markets perceived there to be limited spillover from political tensions to corporate credit risk in developed markets. Demand for euro-denominated high-yield debt was particularly strong, reflecting investor appetite for assets offering high returns. Some corporates based in euro-area periphery countries were able to return to the bond market.

Chart 12 International corporate bond option-adjusted spreads

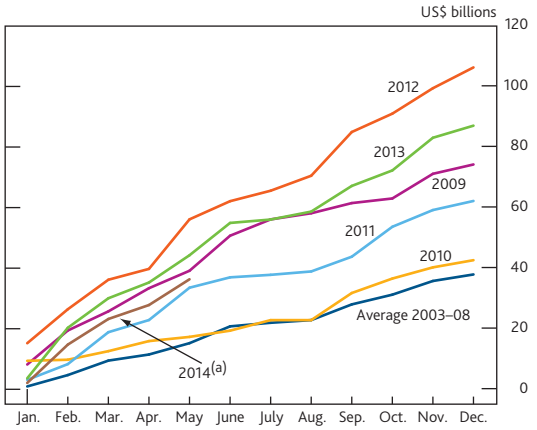


Sources: BofA Merrill Lynch Global Research and Bank calculations.

As well as tightening spreads, there had been a loosening in some non-price terms, such as loan covenants.

Bond issuance by UK private non-financial corporations (PNFCs) since the start of the year was broadly in line with the same period in 2013 (**Chart 13**). Contacts expected the current pace of issuance to continue into the summer, as issuers sought to take advantage of current favourable pricing conditions.

Chart 13 Cumulative gross bond issuance by UK PNFCs



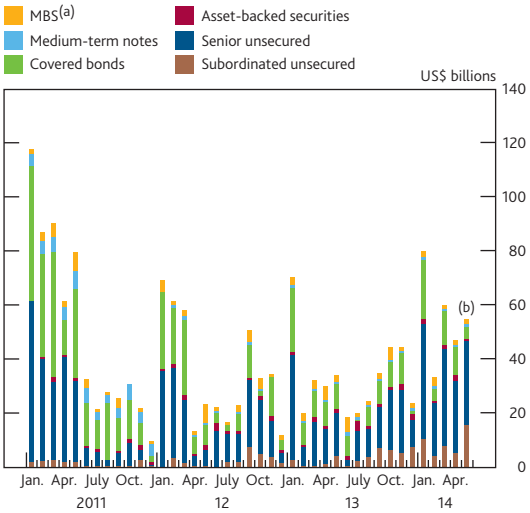
Sources: Dealogic and Bank calculations.

(a) Data to 29 May 2014.

Bank funding markets

There was a marked rise in issuance by European banks compared with the same period in 2013 (**Chart 14**). Among the issuers were several banks from periphery euro-area countries. Sterling-denominated issuance also rose compared with the same period last year.

Chart 14 Term issuance by European (excluding UK) lenders in public markets



Sources: Dealogic and Bank calculations.

(a) Commercial and residential mortgage-backed securities.
(b) Data to 29 May 2014.

There continued to be strong demand for contingent convertible capital instruments. Issuance of additional Tier 1 (AT1) capital instruments since the start of the year overtook the total for the whole of 2013, and March saw the largest single week of contingent convertible capital issuance to date. Some contacts suggested that the prices paid for AT1 instruments looked high; others felt that yields were still attractive relative to those on other assets. Contacts also expressed concern that some investors might be buying AT1 instruments on the basis of the strength of the issuer, with little attention paid to the structure of the instruments themselves.

In the secondary market, the gap between senior unsecured bank bond spreads for UK, US and European banks narrowed, as European spreads continued to fall more quickly than those for the United Kingdom and the United States (**Chart 15**). For the first time since April 2012 an indicative measure of European senior unsecured bank bond spreads dipped below that of the United States.

On 29 April the Bank announced details of the scenario for the stress tests proposed in October 2013 to assess the capital adequacy of the UK banking system.(1) The Bank of England will add a number of additional UK layers to the EU-wide stress test, the details of which were announced by the European Banking Authority in January 2014,(2) in order to explore particular vulnerabilities facing the UK banking system. Overall, contacts felt that both of the stress tests, and the ECB's asset quality review, would help to increase transparency and capital resiliency in the banking sector.

(1) www.bankofengland.co.uk/publications/Pages/news/2014/071.aspx.
(2) www.eba.europa.eu/-/eba-announces-key-features-of-the-2014-eu-wide-stress-test.

Chart 15 Indicative senior unsecured bank bond spreads[a]

Sources: Bloomberg, Markit Group Limited and Bank calculations.

(a) Constant-maturity unweighted average of secondary market spreads to mid-swaps of banks' five-year senior unsecured bonds, where available. Where a five-year bond is unavailable, a proxy has been constructed based on the nearest maturity of bond available for a given institution and the historical relationship of that bond with the corresponding five-year bond.
(b) Average of Bank of America, Citi, Goldman Sachs, JPMorgan Chase & Co., Morgan Stanley and Wells Fargo.
(c) Average of Banco Santander, BBVA, BNP Paribas, Crédit Agricole, Credit Suisse, Deutsche Bank, ING, Intesa, Société Générale, UBS and UniCredit.
(d) Average of Barclays, HSBC, Lloyds Banking Group, Nationwide, Royal Bank of Scotland and Santander UK.

Operations

Operations within the Sterling Monetary Framework and other market operations

This section describes the Bank's operations within the Sterling Monetary Framework (SMF) over the review period, and other market operations. The level of central bank reserves is determined by (i) the stock of reserves injected via the Asset Purchase Facility (APF); (ii) the level of reserves supplied by operations under the SMF; and (iii) the net impact of other sterling ('autonomous factor') flows across the Bank's balance sheet.

Operational Standing Facilities

Since 5 March 2009, the rate paid on the Operational Standing Deposit Facility has been zero, while all reserves account balances have been remunerated at Bank Rate. As a consequence, average use of the deposit facility was £0 million in each of the February, March and April maintenance periods. Average use of the lending facility was also £0 million.

Indexed Long-Term Repo open market operations

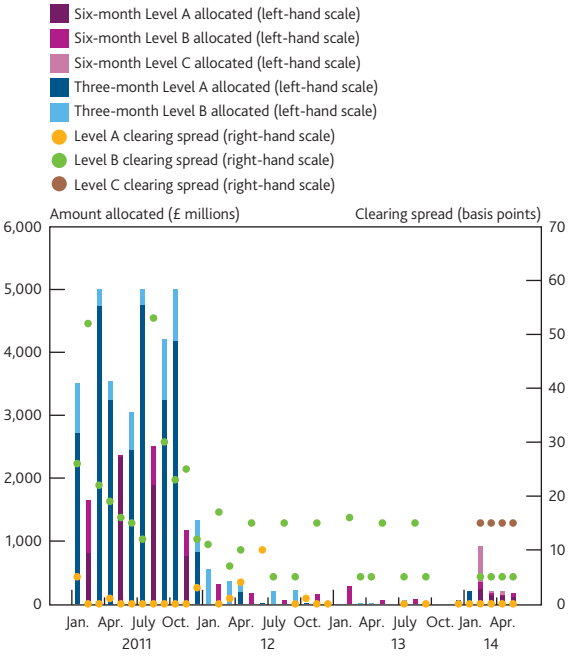
The Bank conducts Indexed Long-Term Repo (ILTR) operations as part of its provision of liquidity insurance to the banking system. These typically occur once every calendar month. During the review period, the Bank offered a minimum of £5 billion via six-month ILTR operations on 11 March, 8 April and 13 May 2014 (**Table A**).

Over the quarter, and in line with recent quarters, the aggregate level of reserves supplied by the Bank through quantitative easing (QE), remained in excess of the level that would otherwise be demanded by market participants. Usage of the facility therefore remained limited, though the launch of the revised operations in February 2014 prompted some additional interest (**Chart 16**).

Table A Indexed Long-Term Repo operations

	Total	Collateral set summary		
		Set A	Set B	Set C
11 March 2014 (six-month maturity)				
Minimum on offer (£ millions)	5,000			
Total bids received (£ millions)	203	148	25	30
Amount allocated (£ millions)	203	148	25	30
Clearing spread (basis points)		0	5	15
8 April 2014 (six-month maturity)				
Minimum on offer (£ millions)	5,000			
Total bids received (£ millions)	200	125	20	55
Amount allocated (£ millions)	200	125	20	55
Clearing spread (basis points)		0	5	15
13 May 2014 (six-month maturity)				
Minimum on offer (£ millions)	5,000			
Total bids received (£ millions)	160	110	50	0
Amount allocated (£ millions)	160	110	50	0
Clearing spread (basis points)		0	5	15

Chart 16 ILTR reserves allocation and clearing spreads[a]



(a) Where there has not been any allocation to a collateral set, no clearing spread is marked.

Contingent Term Repo Facility

The Contingent Term Repo Facility (CTRF) is a contingent liquidity facility, designed to mitigate risks to financial stability arising from a market-wide shortage of sterling liquidity.[1] The Bank judged that in light of market conditions, CTRF auctions were not required during the review period.

(1) Further details are available at www.bankofengland.co.uk/markets/Pages/money/ctrf/default.aspx.

Discount Window Facility

The bilateral on-demand Discount Window Facility (DWF) is aimed at banks experiencing a firm-specific or market-wide shock. It allows participants to borrow highly liquid assets in exchange for less liquid collateral in potentially large size and for a variable term. The average daily amount outstanding in the DWF in the three months to 31 December 2012, lent with a maturity of more than 30 days was £0 million.

Other operations

Funding for Lending Scheme

The Funding for Lending Scheme (FLS) was launched by the Bank and HM Treasury on 13 July 2012. The initial drawdown period for the FLS ran from 1 August 2012 until 31 January 2014, and the drawdown period for the FLS extension opened on 3 February 2014 and will run until 30 January 2015. The quantity each participant can borrow in the FLS extension is linked to its performance in lending to the UK real economy, with the incentives skewed towards supporting small business lending.(1)

The Bank publishes quarterly data showing, for each group participating in the FLS extension, the amount borrowed from the Bank and the net quarterly flows of lending. In the first two months of the second part of the Scheme ending 31 March 2014, four of the 36 groups participating in the FLS extension made drawdowns totalling £2 billion. Participants also repaid £0.6 billion from the first stage of the FLS. This took outstanding aggregate drawings under the Scheme to £43.3 billion.(2)

US dollar repo operations

Since 11 May 2010, in co-ordination with other central banks, the Bank has offered weekly fixed-rate tenders with a seven-day maturity to offer US dollar liquidity. From 12 October 2011 to 23 April 2014 the Bank also offered US dollar tenders with a maturity of 84 days.

On 24 January 2014 the Bank, in co-ordination with other central banks, announced that in view of the improvement in US dollar funding conditions and the low demand for US dollar liquidity-providing operations, the current US dollar repo operations would be phased out. Consistent with this, monthly 84-day operations ceased on 23 April 2014. The network of bilateral central bank liquidity swap arrangements provides a framework for the reintroduction of US liquidity operations if warranted by market conditions.(3) There was no use of the Bank's US dollar facilities during the review period.

Bank of England balance sheet: capital portfolio

The Bank holds an investment portfolio that is approximately the same size as its capital and reserves (net of equity holdings, for example in the Bank for International Settlements, and the Bank's physical assets) and aggregate cash ratio deposits. The portfolio consists of sterling-denominated securities. Securities purchased by the Bank for this portfolio are normally held to maturity, though sales may be made from time to time, reflecting, for example, risk or liquidity management needs or changes in investment policy. The portfolio currently includes around £5.0 billion of gilts and £0.3 billion of other debt securities.

Asset purchases

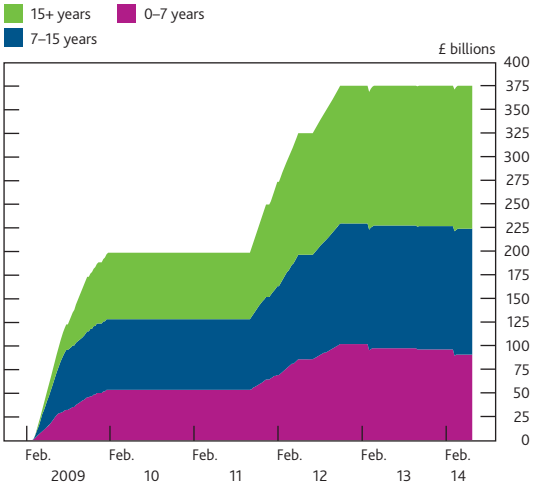
As of 31 May 2014, outstanding asset purchases financed by the issuance of central bank reserves under the APF were £375 billion, in terms of the amount paid to sellers.

Gilts

Alongside the publication of the *Inflation Report* on 12 February 2014, the MPC announced that it intends to maintain the stock of purchased assets, including reinvesting the cash flows associated with all maturing gilts held in the APF, at least until Bank Rate has been raised from its current level of 0.5%.(4) In line with this, the cash flows associated with the redemption of the March 2014 gilt owned by the APF were reinvested. Reinvestment operations took place over the three-week period after the gilt matured on 7 March.

The total stock of gilts outstanding, in terms of the amount paid to sellers, was £375 billion, of which £90.5 billion of purchases were made in the 3–7 years residual maturity range, £133.2 billion in the 7–15 years residual maturity range and £151.3 billion with a residual maturity of greater than 15 years (**Chart 17**).

Chart 17 Cumulative gilt purchases by maturity(a)(b)



(a) Proceeds paid to counterparties on a settled basis.
(b) Residual maturity as at the date of purchase.

(1) Further details are available at www.bankofengland.co.uk/markets/Pages/FLS/default.aspx.
(2) Further details are available at www.bankofengland.co.uk/markets/Pages/FLS/extensiondata.aspx.
(3) Further details are available at www.bankofengland.co.uk/markets/Documents/marketnotice140124.pdf.
(4) Further details are available at www.bankofengland.co.uk/publications/Documents/inflationreport/2014/ir14febo.pdf.

Gilt lending facility[1]

The Bank continued to offer to lend some of its gilt holdings via the Debt Management Office in return for other UK government collateral. In the three months to 31 March 2014, a daily average of £385 million of gilts was lent as part of the gilt lending facility. Average daily lending in the previous quarter was £225 million.

Corporate bonds

There were no purchases of corporate bonds during the review period and future purchase or sale operations will be dependent on market demand, which the Bank will keep under review in consultation with its counterparties in the Corporate Bond Scheme.[2] The Scheme currently holds no bonds.

Secured commercial paper facility

The Bank continued to offer to purchase secured commercial paper (SCP) backed by underlying assets that are short term and provide credit to companies or consumers that support economic activity in the United Kingdom.[3] The facility remained open during the review period but no purchases were made.

(1) For more details on the gilt lending facility see the box 'Gilt lending facility' on page 253 of the *Bank of England Quarterly Bulletin*, Vol. 50, No. 4.
(2) More information can be found in the Market Notice at www.bankofengland.co.uk/markets/Documents/marketnotice130627.pdf.
(3) The SCP facility is described in more detail in the Market Notice available at www.bankofengland.co.uk/markets/Documents/marketnotice120801.pdf.

Reports

Sterling Monetary Framework Annual Report 2013–14

Overview

This is the first in a new series of annual reports, designed to throw light on the operation of the Bank's published framework for implementing monetary policy and providing liquidity to the banking system, known as the Sterling Monetary Framework (SMF). As recommended by Bill Winters' review of the SMF, the Report draws on the views of a wide range of internal and external stakeholders to identify areas where the SMF works well, and areas where it might be improved. The Bank's Court has reviewed this Report and has endorsed its publication. The key findings are as follows:

Access to the SMF

Membership of the SMF has broadened considerably, from 70 participants in January 2007 to 139 at the end of the 2013/14 financial year. Most of this increase comes from smaller or 'challenger' banks and building societies. SMF members now account for 98% of sterling deposits, and there is a presumption that other banks or building societies meeting the Prudential Regulation Authority's Threshold Conditions are eligible to become SMF members. The Bank is assessing the scope for extending SMF membership to some non-bank financial institutions.

Implementing monetary policy

Overnight market interest rates remained close to Bank Rate — a primary objective of the SMF — throughout 2013/14. But the broader functioning of sterling money markets remained impaired. This reflected the large quantity of excess liquidity injected through quantitative easing, persistent counterparty credit concerns and the impact of regulatory change. Managing down the size of the Bank's balance sheet when the time comes to normalise monetary policy will present a number of practical challenges. In due course, when market expectations point to a near-term rise in Bank Rate, the Bank will review the approach it intends to take to deliver monetary control. Assessing this will require consideration of a number of complex issues, including the functioning of money markets and the future composition of the Bank's balance sheet. The process will take account of the views of SMF participants and other key stakeholders.

Providing liquidity insurance

As the Governor explained when launching the Bank's response to the Winters Review in October 2013, in providing liquidity insurance, the Bank is 'open for business'. Reforms to SMF liquidity insurance facilities announced alongside the Governor's speech — aimed at providing more liquidity at longer terms and cheaper rates — have been widely welcomed. But, as expected, use of the SMF facilities remained low in 2013/14, reflecting the large stock of central bank reserves in the system and banks' improving financial positions. In view of the recent changes to the Bank's facilities, no immediate changes to the SMF are proposed in this Annual Report, but the Bank will remain alert to signs that its facilities are inappropriately stigmatised.

Risk management

The amount of collateral delivered to the Bank for actual or potential use in its facilities (such as the Funding for Lending Scheme and those within the SMF) has increased substantially, and stood at almost £450 billion at the end of February 2014, consisting mainly of portfolios of residential mortgage loans. After valuation and haircuts, this provided banks and building societies with a total drawable value of around £280 billion in the Bank's facilities. In recent years, the range of eligible collateral has been broadened to include portfolios of corporate loans, social housing loans, unsecured personal loans, and revolving credit facilities.

The Bank is conscious of the operational costs of pre-positioning collateral, particularly for smaller firms. It continues to seek ways to reduce these costs where possible without risking public money. The Bank also seeks to set haircuts efficiently. As more accurate information about the risks in pre-positioned collateral becomes available, this may result in some reductions of haircuts from current levels.

Governance

Changes to the internal governance of the SMF were announced in October 2013. First, a new Operations Committee has reviewed the operation of the SMF, and helped develop the changes introduced in 2013/14. This process was overseen by the Oversight Committee of the Bank's Court. Second, the Monetary and Financial Policy Committees have agreed new Concordats setting out the arrangements for consultation and information sharing on SMF issues. Third, there has been more active engagement with internal and external stakeholders. And fourthly, this Report represents the conclusion of a new annual review process.

Introduction

The Sterling Monetary Framework (SMF) sets out the published operational framework under which the Bank uses its balance sheet to implement the monetary policy decisions of the Monetary Policy Committee (MPC) and provide liquidity to the banking system, during periods of both normal and abnormal market conditions. A brief outline of the SMF is provided in the box opposite.(1)

The SMF has been extensively reformed since the peak of the financial crisis. It now contains a much broader and more flexible range of tools for responding to developments than in the pre-crisis era, and is designed to provide a sound basis for supporting monetary and financial stability as the economic recovery progresses. At the same time, a key lesson of the crisis was that central banks must keep their operational frameworks under active review as the markets in which they operate evolve, and as they learn from experience about the efficacy of their tools. This process of review, if managed successfully, should help ensure that the SMF evolves more continuously, reducing the need for further wholesale reform in the future. To assist with that process, the Bank decided, following a review of the SMF commissioned by the Court of the Bank of England(2) and conducted by Bill Winters in 2012,(3) to carry out annual reviews of the SMF. These will draw on the staff's own experience of operating the SMF, together with the views of a wide range of other stakeholders both inside and outside the Bank. This Report sets out the outcome of that review for the Bank's 2013/14 financial year.(4)

The context in which this first Report is published is unusual in a number of respects. First, with Bank Rate at the effective lower bound and with banks and building societies holding a large stock of central bank reserves as a result of the MPC's programme of asset purchases (often referred to as quantitative easing, or 'QE'), some parts of the SMF are either temporarily suspended or have not been used in size for some time. Second, market participants are still working through the implications of the major package of post-crisis regulatory reforms, some of which may affect the way in which they use the SMF. And third, many of the reforms made to the SMF in response to the Winters Review — which itself involved extensive consultation with a wide range of stakeholders — have only recently been introduced, or remain work in progress. Against that backdrop, and looking backwards, the Report perhaps unsurprisingly identifies no other major deficiencies in the current framework. The main challenges to the SMF, however, lie ahead — in particular as monetary policy eventually begins to normalise. The specific areas in which these challenges arise are highlighted later in this Report.

The process of reform triggered by the Winters Review has been a positive development, which the Bank is keen to maintain in the years ahead. The Bank welcomes thoughts or comments from interested parties on this Report or the SMF more broadly. Details of how to submit views are provided at the end of the Report.

The objectives of the Sterling Monetary Framework

The Bank of England's mission is to promote the good of the people of the United Kingdom by maintaining monetary and financial stability. The Bank's operations in the sterling money markets — set out in the Sterling Monetary Framework — directly support this mission by:

(i) **Implementing the Monetary Policy Committee's decisions in order to meet the inflation target.** This is usually achieved by paying interest at Bank Rate on the reserves balances held at the Bank of England by commercial banks and building societies. It currently also involves undertaking any asset purchases — financed by the creation of central bank reserves — and sales mandated by the MPC.

(ii) **Reducing the cost of disruption to the liquidity and payment services supplied by banks and building societies to the UK economy.** The Bank does this by standing ready to provide liquidity in the event of unexpected developments by offering to swap high-quality but less liquid collateral for liquid assets (a so-called 'liquidity upgrade'). When the Bank lends in its operations, it does so against collateral of sufficient quality and quantity to protect itself from counterparty credit risk.

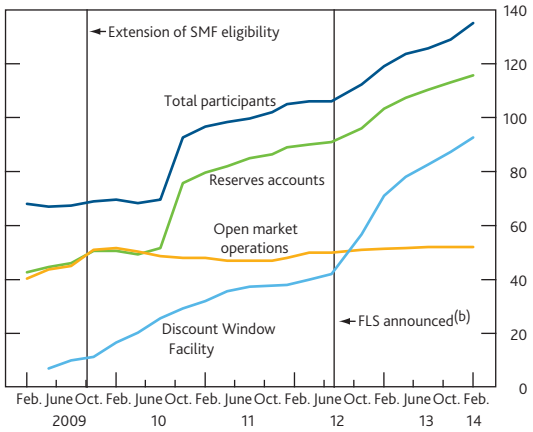
SMF membership

The Bank has broadened access to SMF facilities considerably in recent years. Since October 2013, there has been a presumption that any bank or building society meeting the Prudential Regulation Authority's (PRA's) Threshold Conditions for authorisation is eligible to become an SMF member, subject to the SMF eligibility criteria.(5)

(1) Details of the SMF are in the 'Red Book': www.bankofengland.co.uk/markets/Documents/money/publications/redbook.pdf.
(2) The Court is the Bank of England's Board of Directors. For more information about the Court, see Lees, D and Footman, J (2014), 'The Court of the Bank of England', *Bank of England Quarterly Bulletin*, Vol. 54, No. 1, pages 28–35, available at www.bankofengland.co.uk/publications/Documents/quarterlybulletin/2014/qb14q103.pdf.
(3) The Winters Review is available at www.bankofengland.co.uk/publications/Documents/news/2012/cr2winters.pdf. The Bank's response to the Review is available at www.bankofengland.co.uk/publications/Pages/news/2013/124.aspx.
(4) This covers the period from 1 March 2013 to 28 February 2014.
(5) Eligibility criteria are set out in the SMF documentation at www.bankofengland.co.uk/markets/Pages/money/documentation.aspx.

At the end of February 2014, 139 institutions were signed up to the SMF (**Chart 1**), up from 117 at the end of 2012 and 70 in January 2007. The operational requirements associated with SMF membership and pre-positioning collateral can initially be a challenge for smaller firms but, through working closely with the Bank, a large number have now signed up. Indeed, banks and building societies accounting for 98% of sterling deposits are now SMF members.

Chart 1 Number of institutions with access to the SMF(a)



(a) Quarterly averages.
(b) FLS is the Funding for Lending Scheme, launched on 13 July 2012.

Two main factors have encouraged increased SMF membership in recent years:

- The eligibility to apply for a reserves account at the Bank (part of the SMF) was widened to smaller institutions in October 2009 to give them a flexible way to hold the sterling portion of their liquid asset buffer. This led to an increase in the number of institutions with SMF access from 2010, after the submission and processing of applications.

- The launch of the Funding for Lending Scheme (FLS)(1) in July 2012 required banks and building societies who wanted access to the scheme to sign up for the Discount Window Facility (DWF), which is part of the SMF.

The Bank maintains close dialogue with all SMF participants, through regular contacts with the Bank's sterling dealing desk and by assigning a dedicated relationship manager to each firm. Relationship managers are responsible for understanding the business models of their firms in order to help support SMF participation, to ensure that the Bank is aware of developments in key sterling markets, and to support the Bank's wider policy goals and market intelligence efforts. The Bank also engages with SMF stakeholders through the Money Market Liaison Group (MMLG) and other fora.

As part of the reforms to the SMF announced in October 2013, the Bank is investigating the scope for expanding SMF access further to reflect the increasing role of non-banks and capital markets. Work on developing a possible framework for implementing this reform is currently under way.

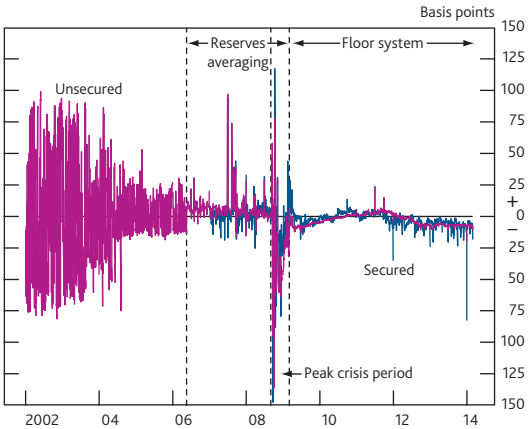
As part of its response to the Winters Review, the Bank has relaxed its previous rule allowing only one legal entity per banking group to have a reserves account. Groups facing regulatory or legal barriers to the movement of liquidity or collateral intragroup (including, in due course, those required by the ring-fencing rules in the Banking Reform Act) may now be able to hold more than one reserves account. The Bank is currently implementing this new policy.

Implementing monetary policy

The first purpose of the Sterling Monetary Framework is to implement decisions made by the MPC. Since March 2009, when QE was initiated, this has involved maintaining overnight market rates in line with Bank Rate and undertaking asset purchases financed by the creation of central bank reserves. Bank Rate was maintained at 0.5% throughout the 2013/14 financial year.

The Bank currently keeps overnight market rates in line with Bank Rate by paying Bank Rate on all cash held in reserves accounts. This 'floor' system remained effective in keeping market rates close to Bank Rate during 2013/14 (**Chart 2** and **Table A**). Indeed, throughout most of 2013/14, volatility of overnight interest rates remained at historically low levels. Secured overnight interest rates remained slightly more volatile than unsecured rates, in part reflecting fluctuations in the availability of collateral in the market.

Chart 2 Spread of sterling overnight interest rates to Bank Rate(a)



Sources: Wholesale Markets Brokers' Association (WMBA) and Bank calculations.

(a) In the brokered secured market, interest rates are represented by the repurchase overnight index average (RONIA), the daily weighted average interest rate of transactions secured against UK government debt, brokered by members of the WMBA. Interest rates in the brokered unsecured market are represented by the sterling overnight index average (SONIA), which is the daily weighted average interest rate of unsecured overnight transactions brokered by WMBA members. For further details on RONIA and SONIA, see www.wmba.org.uk.

(1) For more details on the FLS, see www.bankofengland.co.uk/markets/Pages/FLS/default.aspx.

Table A Deviation of sterling overnight interest rates from Bank Rate[a]

Basis points	Mean		Standard deviation	
	Unsecured	Secured	Unsecured	Secured
Pre-reserves averaging[b]	-4	–	37	–
Reserves averaging:				
to August 2008[c]	6	3	9	11
peak crisis[d]	-27	-19	29	34
Floor system:				
to February 2013[e]	-2	-1	4	5
in 2013/14[f]	-7	-7	1	6

Sources: WMBA and Bank calculations.

(a) The secured and unsecured rates are RONIA and SONIA respectively, as defined in **Chart 2**. (RONIA data not available before January 2007.)
(b) January 2002–May 2006.
(c) May 2006–August 2008.
(d) September 2008–March 2009.
(e) March 2009–February 2013.
(f) March 2013–February 2014.

The tendency for unsecured interest rates to trade slightly below Bank Rate throughout 2013/14 reflected the fact that some lenders without reserves accounts at the Bank were willing to lend cash overnight at below Bank Rate. Reserves account holders chose not to arbitrage away all of this difference — by accepting deposits at below Bank Rate and placing them in their reserves accounts at Bank Rate — in part because doing so would increase gross balance sheet metrics, including reported leverage ratios.

Secured overnight interest rates fell sharply on the last day of 2013, with RONIA (the brokered, secured overnight interest rate average) falling to -0.32%, compared with +0.35% the previous day. SONIA (the brokered, unsecured overnight interest rate average), fell by somewhat less, from +0.42% to +0.31%. According to market contacts, this reflected the reluctance of financial institutions to borrow cash over year end, as this was a key reporting date for balance sheets, including for published leverage ratios. As a result, non-bank market participants without access to a reserves account at the Bank were able to lend only at reduced rates. Market rates recovered the next business day. Contacts reported that the majority of investors were well prepared for year end, having discussed in advance with counterparties how much cash they would be able to place.

The Bank pays close attention to the money markets because they are intimately linked with the SMF: interbank transactions are settled directly or indirectly by transfers between banks' reserves accounts at the Bank and so the sterling interbank market is also a market for sterling reserves balances. In the presence of a floor system with a large-scale injection of reserves, however, there is less need for banks to manage their liquidity actively among themselves and so there is much less activity in money markets at present. Overseas money markets, including in the United States[1] and euro area,[2] have also seen declines in activity.

According to market participants responding to the most recent MMLG Sterling Money Market Survey,[3] functioning in the sterling unsecured market — and the interbank market in particular — remained impaired. Incentives for banks to trade on an unsecured basis were low, with many instead allowing their reserves balances at the Bank to fluctuate in response to daily payment needs. As a result, estimated activity in the unsecured overnight money market has fallen since 2007–08, but has been stable at around £40 billion since 2012.[4]

A range of factors are bearing down on money market activity at present, some temporary — most importantly, the impact of QE — but others with potentially more lasting effects. For example, global liquidity standards will be introduced for the first time through the Basel III framework, which includes the Liquidity Coverage Ratio (LCR). The LCR will require banks and building societies to hold a stock of high-quality liquid assets against net wholesale outflows during a 30-day stress scenario. Many MMLG survey respondents felt that, in addition to credit risk concerns, existing and prospective liquidity regulations had limited their appetite to transact in the unsecured market.

By contrast, the secured money market continued to function well during most of 2013/14. Secured trades make up around two thirds of the money market turnover reported in the MMLG survey. Market contacts suggested that the preference for secured trading reflected liquidity regulations and a continued aversion to lending unsecured to other banks. That said, secured trading volumes declined by 15% in the six months to November 2013. Contacts suggested that a contributory factor could have been an increased focus on leverage and other metrics of balance sheet usage in anticipation of regulatory requirements.

Some of the temporary factors bearing down on money market activity may abate. One key influence will be the system of monetary control that the Bank will choose to operate as monetary policy normalises. Some possible frameworks — including in particular the pre-crisis system of 'reserves averaging' (see the box on page 222) — require banks and building societies to manage their liquidity actively and so are likely to result in some recovery in money market activity, perhaps especially in the secured market. Other frameworks imply less active use of short-term money markets. As recommended in the Winters Review, the Bank will review its presumption of returning to reserves averaging (as opposed to retaining the floor system or adopting some other approach)

(1) See www.newyorkfed.org/markets/omo/omo2013.pdf.
(2) See www.ecb.europa.eu/pub/pdf/other/euromoneymarketsurvey201311en.pdf??e34259b291b21d9dee4bc45bcc611b95.
(3) Available at www.bankofengland.co.uk/publications/Documents/other/markets/mmlg/smms2013h2.pdf.
(4) The MMLG survey accounts for all interbank and non-interbank activity in the sterling money market. This is in contrast to SONIA, which covers brokered transactions only.

Reserves averaging

Before the start of the financial crisis, the Bank used a 'reserves averaging' system for implementing monetary policy.

In the reserves averaging scheme, for each reserves maintenance period (running from the date of one MPC policy decision to the next) the MPC set the reserves remuneration rate (Bank Rate) and each scheme participant set a target for the average amount of reserves they would hold, taking into account their own liquidity management needs. They could adjust their targets from maintenance period to maintenance period if those needs changed. And within each maintenance period, a bank could vary its reserves holdings from day to day. Those holdings were remunerated at Bank Rate so long as they were, on average over the maintenance period, within a small range around the target.

Average reserves outside the target range attracted a charge. But a bank could avoid that charge by making use of the Bank's Operational Standing Facilities (OSFs). These bilateral facilities allow banks to borrow overnight from the Bank (against high-quality collateral) at a rate above Bank Rate or to deposit reserves overnight with the Bank at a rate below Bank Rate. Commercial banks will typically be unwilling to deal in the market on worse terms than those available at the Bank. So these facility rates acted as a ceiling and floor in rate setting, forming an interest rate corridor around the rates at which banks were willing to deal in the market.

The Bank undertook to supply, in aggregate, the reserves that banks needed to meet their collective targets. It used its open market operations (OMOs) to achieve that, settled by movements on and off banks' reserves accounts. But the supply of reserves was affected not only by OMOs but also by other transactions undertaken by the Bank. For example, when demand for banknotes increased, banks paid for the additional notes with reserves from their accounts at the Bank. The net amount of reserves which the Bank aimed to supply in its OMOs therefore reflected not only the banks' demand for reserves, expressed in their reserves targets, but also the predicted impact of these other factors.

For more details see 'The Bank's money market framework', at www.bankofengland.co.uk/publications/Documents/quarterlybulletin/qb100404.pdf.

when market prices suggest a near-term increase in Bank Rate. Assessing this will involve considering a number of complex issues such as the functioning of money markets, and interacts with wider considerations on the future composition of the Bank's balance sheet. This work will take account of the Bank's policy objectives and the views of SMF participants and other key stakeholders.

Providing liquidity insurance

The second purpose of the SMF is to provide liquidity insurance to banks and building societies, by offering to swap high-quality but less liquid collateral for liquid assets. The objective is to reduce the cost of disruption to the liquidity and payment services supplied by banks and building societies to the UK economy. The Court of the Bank commissioned a review into the operation of the SMF by Bill Winters in 2012. As the Governor explained when launching the Bank's response to the Winters Review in October 2013, in providing liquidity insurance, the Bank is 'open for business'.(1) The SMF operates according to four main principles:

- **Availability.** The Bank stands ready to provide solvent participants with highly liquid assets in exchange for a wide range of collateral assets of good credit quality but lower market liquidity in sufficient size and at an appropriate maturity.

- **Appropriate terms.** The terms of the Bank's liquidity insurance facilities are set so as to ensure that SMF participants have the incentive to manage their liquidity primarily through markets in normal times.

- **Clarity.** The Bank aims to give SMF participants as much certainty as possible about the circumstances in which they can expect to borrow from SMF facilities, so they can plan ahead.

- **Flexibility.** Given the difficulty of knowing where future liquidity risks will emerge, the Bank maintains a range of liquidity insurance facilities capable of tackling a wide variety of eventualities.

Although the liquidity insurance facilities provided by the Bank were used extensively during the financial crisis, lending via these facilities has been lower in recent years. This reflects a number of factors, including the improving financial positions of banks and building societies, and the greater liquidity provided by the Bank through QE and, more recently, the FLS. As a result, the Bank's liquidity insurance facilities saw relatively modest use in 2013/14 (**Chart 3**).

Significant changes were announced to the Bank's liquidity insurance facilities in October 2013 in response to the Winters Review. These included changes to the three main liquidity insurance facilities — the Indexed Long-Term Repo (ILTR) facility, Discount Window Facility (DWF) and Contingent Term Repo Facility (CTRF). These are summarised in the box on page 223.

(1) See www.bankofengland.co.uk/publications/Pages/speeches/2013/690.aspx.

Key changes announced in October 2013

The Bank introduced a number of significant changes to the SMF in late 2013 and early 2014, designed to reduce stigma and increase the flexibility of the Bank's ability to provide liquidity insurance:

- The monthly market-wide ILTR auctions were expanded in February 2014, with reduced prices, a longer maturity and a wider range of eligible collateral. An important innovation in the design of the new ILTR auctions is that they are responsive to market conditions, with the amount of liquidity available rising automatically if there is greater demand, in contrast to the fixed-size auctions used previously.

- The bilateral DWF was repriced, introducing significantly lower, flat-rate 'entry fees', and smoothing the increase in fees for higher usage. The Bank sought to reduce the financial stability risks posed by premature disclosure of DWF drawings, by extending its own disclosure lag and ensuring that firms have the capacity to turn over their liquid assets in repo markets regularly. The Bank continues to argue the case for ensuring that new national and international liquidity disclosure regimes do not increase that risk through other channels.

- The market-wide CTRF was retained, allowing the Bank to provide whatever liquidity is required in conditions of actual or prospective market-wide stress, against the widest range of collateral, and at a price it chooses.

- The Bank's list of eligible collateral, which had already expanded significantly in recent years, was extended even further to include the drawn portions of corporate revolving credit facilities.

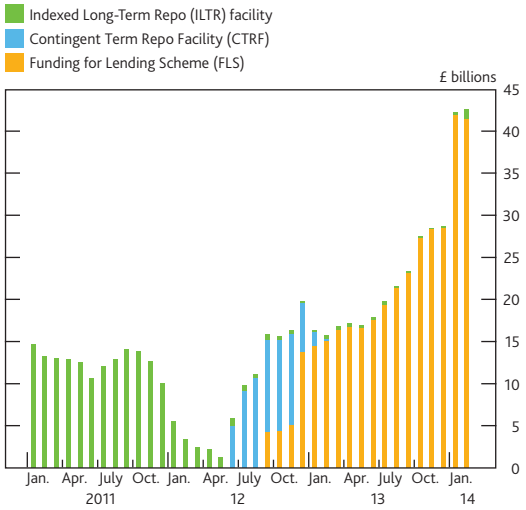
- The certainty with which banks and building societies can expect to be able to borrow from the Bank was reinforced through a presumption that all banks and building societies that meet the PRA's Threshold Conditions may sign up for the SMF and have full access to borrow in its facilities.

- The Bank announced its intention to use the new opportunities made available by the creation of the PRA to ensure that banks and building societies better integrate the availability of liquidity insurance into their liquidity planning and use the Bank's facilities at the appropriate time.

- The Bank's rule limiting banking groups to a single reserves account was relaxed.

Further details are available in 'Developments in the Bank of England's approach to liquidity insurance', available at www.bankofengland.co.uk/markets/Documents/money/publications/liquidityinsurance.pdf.

Chart 3 Outstanding amounts lent in SMF liquidity facilities and the FLS[a]



(a) Prior to January 2014, the CTRF was called the Extended Collateral Term Repo facility. The FLS (including the FLS Extension) lies outside the SMF and is not a liquidity insurance facility, but has the result of providing liquidity to the banking sector. There has been no Discount Window Facility usage up to the most recent disclosure point (as specified in the Bank's 'Red Book').

In general, the updates to the SMF have been well received by market participants and other commentators. Many market participants reported that they appreciated the increased clarity around the circumstances under which they could expect to borrow from the SMF, and thought that the changes would have the intended, positive impact of reducing stigma during times of stress. The changes have also been noted by ratings agencies, some of which have issued guidance suggesting there would be no negative ratings penalty for banks and building societies running down excessive liquid asset buffers as a result of increased funding routinely available through the ILTR. The Bank welcomes feedback on these or any other aspects of the SMF at any time (see the end of this Report for further details).

Banks and building societies have begun to work through the implications of the changes for their liquidity planning, with the active assistance of the Bank's supervisory and markets teams.

The changes to the SMF liquidity facilities provide the Bank with a much more flexible range of tools to deal with a variety of liquidity scenarios. But whether in practice this translates to more regular business-as-usual usage of the SMF facilities,

or earlier approach to the Bank for liquidity support in times of stress, is something that will need to be monitored carefully throughout 2014 and beyond. In view of the very recent updates to the Bank's facilities, no further changes to the SMF are proposed in this Report, but the Bank will remain alert to any signs that its facilities are inappropriately stigmatised.

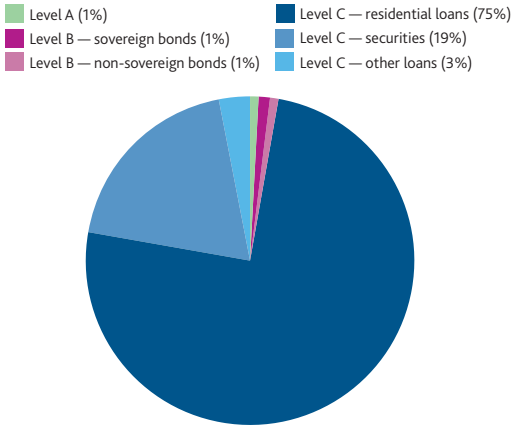
Risk management

The design of the SMF reflects the Bank's objective of achieving its broader policy aims while minimising the risk to public money on its balance sheet. In SMF facilities, the Bank is not generally exposed to market risk — exchange rate or interest rate risk — as lending is in sterling and is typically indexed to Bank Rate. So the main financial risk to which the Bank is exposed is counterparty credit risk. As noted above, the Bank now has a presumption that all banks and building societies that meet the PRA's Threshold Conditions for authorisation may sign up for the SMF and have access to borrow in SMF facilities against eligible collateral. Due diligence is undertaken on all prospective SMF participants and risk protection is further enhanced by the fact that all lending by the Bank is against collateral of sufficient quality and quantity. Collateralised lending is subject to suitably conservative 'haircuts' (that is, the Bank lends an amount less than the market value of the collateral it takes). If a counterparty fails to repay when due, the Bank can sell or retain the collateral to make good any loss it may face.(1)

The amount of collateral delivered to the Bank for actual or potential use in its facilities (such as the FLS and those within the SMF) has increased substantially over recent years, and stood at almost £450 billion at the end of February 2014. After valuation and haircuts, this provided banks and building societies with a total drawable value of around £280 billion in the Bank's facilities. Part of the collateral pre-positioned at the Bank comprises securities, such as residential mortgage-backed securities, but around three quarters is in the form of portfolios of loans (**Chart 4**). In total, at the end of February 2014, 40 banks and building societies had loans placed at the Bank as collateral, involving around 150 loan portfolios. The ability to use less liquid collateral such as loans in various SMF facilities has made these facilities a more efficient source of liquidity for banks and building societies. The Bank has responded to increased demand from SMF participants to pre-position such collateral by allocating additional internal resources to this function.

The bulk of loans currently pre-positioned are residential mortgage loans, reflecting their prevalence on SMF members' balance sheets. But the Bank has actively sought to extend the range of eligible collateral. For example, in recent years the Bank has accepted pre-positioning of other asset classes including portfolios of corporate loans (mainly loans to small and medium-sized enterprises), social housing loans, unsecured personal loans, and revolving credit facilities. Although the Bank's collateral list is already very broad, the Bank has made it clear that the list extends in principle to any asset that the Bank judges it can effectively and efficiently risk manage. The Bank will therefore keep under review the case for any further widening of the range of eligible collateral.

Chart 4 Collateral pre-positioned by asset class(a)



(a) As at 28 February 2014. Level A comprises highly liquid, high-quality sovereign debt; Level B comprises other high-quality sovereign bonds, supranational bonds, covered bonds and liquid securitisations and corporate bonds; and Level C comprises own-named securities, portfolios of loans and less liquid securitisations and corporate bonds. Further detail is available at www.bankofengland.co.uk/markets/Pages/money/eligiblecollateral.aspx.

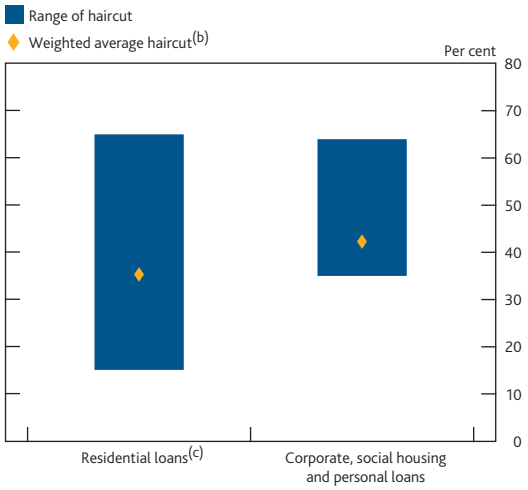
When valuing collateral, the Bank applies haircuts, which are designed to protect the Bank against possible further falls in the value of collateral in the period between the default of a counterparty and the realisation of collateral, including in times of illiquid markets or severe economic stress. The Bank publishes 'base haircuts' that it applies to different classes of securities.(2) Base haircuts are not applied to portfolios of loan collateral. Instead, haircuts applied to loans reflect the particular characteristics of individual portfolios and so vary according to the composition of each pool of loans (**Chart 5**).

The Bank is conscious of the operational costs associated with pre-positioning assets, particularly for smaller banks and building societies, and continues to seek ways to reduce them where it can do so without putting public money at risk. For example, the Bank is providing more information on the process for assessing collateral and determining haircuts, including providing an early indication of likely eligibility where possible.

The Bank seeks to set haircuts efficiently. As more accurate information about the risks in pre-positioned collateral becomes available, this may result in some reductions of haircuts from current levels.

(1) For further details, see 'Risk managing loan collateral at the Bank of England', available at www.bankofengland.co.uk/publications/Documents/quarterlybulletin/2014/qb14q208.pdf.
(2) See www.bankofengland.co.uk/markets/Documents/money/publications/summary_haircuts.pdf.

Chart 5 Haircuts applied to pre-positioned loan portfolios[a]



(a) As at 31 December 2013.
(b) Weighted by nominal value of loan portfolios, before haircuts are applied.
(c) Excludes social housing loans.

Governance

As the Bank announced in October 2013, a number of important changes have been made to the governance of policy formulation and decision-making around the SMF. These ensure that the SMF benefits from a broader range of input and challenge from inside and outside the Bank, and is subject to periodic scrutiny by the Bank's Court and the public. First, a new Operations Committee — an executive-level committee of the Bank chaired by a Deputy Governor — has discussed SMF-related issues regularly and played an integral role in developing the significant changes to the SMF introduced in late 2013 and early 2014. This process is overseen by the Oversight Committee of Court, which has full access to the minutes and papers of the Operations Committee. Second, a number of discussions have taken place with the Monetary and Financial Policy Committees under the aegis of the new Concordats setting out arrangements for consultation and information sharing on SMF issues relevant to those Committees' remits. Third, there has been more active engagement on SMF-related issues, both internally with Bank staff and externally with key stakeholders. And, fourth, this Report itself represents the conclusion of a new annual review process, drawing on the staff's own experience of operating the framework and on the views of a wide range of other stakeholders from inside and outside the Bank.

Conclusions

The process of reform triggered by the Winters Review has been a positive development, which the Bank is keen to maintain in the years ahead.

The Bank's Court has reviewed this Report — welcoming in particular improvements to the governance of the SMF — and endorsed its publication.

The Bank would welcome thoughts or comments from interested parties on anything in this Report or relating to the SMF more broadly. All comments should be sent to:

Head of Sterling Markets Division
Bank of England
Threadneedle Street
London, EC2R 8AH

or by email to: SMFfeedback@bankofengland.co.uk.

A review of the work of the London Foreign Exchange Joint Standing Committee in 2013

This article reviews the work undertaken by the London Foreign Exchange Joint Standing Committee during 2013.

Introduction

The London Foreign Exchange Joint Standing Committee (FXJSC — hereon, 'the Committee') was established in 1973, under the auspices of the Bank of England, as a forum for banks and brokers to discuss broad market issues. The Committee comprises senior staff from many of the major banks operating in the wholesale foreign exchange market in London, representatives from brokers, trade associations including the Wholesale Market Brokers' Association, the Association of Corporate Treasurers (ACT) — representing corporate users of the foreign exchange market, the British Bankers' Association and the Financial Conduct Authority (FCA). A list of the members of the Committee as at end-2013 can be found at the end of this article. The Committee held six meetings during 2013.

The implementation of over-the-counter derivatives regulation internationally, and the possible implications for the structure of foreign exchange (FX) markets, remained a key theme for the FXJSC in 2013. A guest speaker from Millennium Global discussed the impact of the proposed regulatory changes on investment management firms, while EBS and Thomson Reuters discussed how trading venues were adapting to the new regulatory landscape. The Global Financial Markets Association's Global FX Division and the ACT gave presentations on their work programme. The Committee also discussed the results of the 2013 Bank for International Settlements triennial turnover survey, focusing on the evolution in trade execution methods and market participants since the previous survey in 2010.

Non-Investment Products (NIPs) Code

The NIPs Code is a voluntary code of good market practice drawn up by market practitioners covering the FX market in the United Kingdom as well as the markets for wholesale bullion and wholesale deposits. The Code is published by the FXJSC, with contributions from the FXJSC operations and legal subgroups, the Sterling Money Markets Liaison Group and the Management Committee of the London Bullion Market Association for the relevant sections. The current version of the Code was published in November 2011.(1) The FXJSC is awaiting clarity on how the European Market Infrastructure Regulation (EMIR) and the Market in Financial Infrastructure Directive will impact the FX market before considering publishing an update to the NIPs Code.

Work of the FXJSC operations subgroup

The operations subgroup was established in 2002. Its members are operations managers from many major banks active in the London wholesale FX market, as well as representatives from service providers and trade associations. The group met six times in 2013.

In 2013, the operations subgroup sponsored workstreams including continued work to improve its own understanding of the details of FX settlement processes.

Over the course of the year, the subgroup received presentations on themes relating to regulatory developments in the FX market, changes in Russian rouble settlement processes, how broader macroeconomic conditions impact the FX market and developments in FX market infrastructure. CLS gave a presentation on FX transaction settlement methods and SWIFT discussed its work in relation to the EMIR implementation.

Work of the FXJSC legal subgroup

The legal subgroup was established in 2004 and comprises fourteen professionals providing in-house legal counsel for many of the major institutions involved in the wholesale FX market in London. The group met three times in 2013. It continued to make an important contribution through its provision of legal support to the work of the FXJSC main

(1) The NIPs Code can be accessed at: www.bankofengland.co.uk/markets/Documents/forex/fxjsc/nipscode1111.pdf.

Committee and its subgroups. During 2013, the legal subgroup welcomed guest speakers from the Federal Reserve Bank of New York and Allen & Overy, as well as speakers from member firms to discuss how regulatory change affects the FX market. The group also discussed developments in the global FX market as well as the new prudential supervision framework in the United Kingdom.

The legal subgroup continued to liaise with a range of other domestic and foreign legal committees to keep abreast of developments in FX markets.

Work of the FXJSC chief dealers' subgroup

The chief dealers' subgroup was established in July 2005. Its membership in February 2013 comprised fourteen chief dealers active in the London FX market.

The subgroup met once during 2013 to discuss conjunctural and structural developments in the FX market. Topics of discussion included market liquidity, developments in Japan and their impact on yen markets and the impact of regulatory developments impacting on FX markets globally. No further meetings are scheduled, and the future of the subgroup is under review.

Work of the FXJSC buy-side subgroup

The buy-side subgroup held its inaugural meeting in November following its reconstitution. Its membership comprises ten buy-side institutions active in wholesale FX markets as well as the Chair of the main Committee.

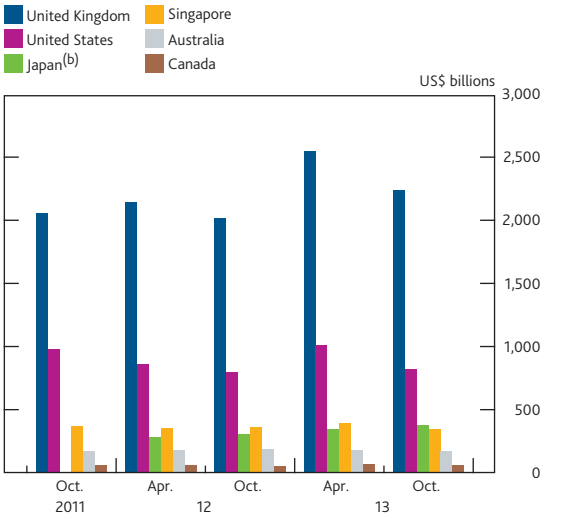
The subgroup discussed how regulatory initiatives in Europe and abroad, including the introduction of mandatory trade reporting requirements in the United States, were likely to impact their operations and market liquidity more broadly.

International survey results overview

Thirty banks representing the most active participants in the UK FX market contributed to the 18th and 19th FXJSC semi-annual surveys of UK FX turnover in April and October 2013. Total turnover rose 11% in the year to October 2013, although it was 12% below the April 2013 survey high (**Chart 1**).

This trend was broadly consistent with other global centres: total turnover across the six reporting centres rose 8% year-on-year in October 2013. In particular, Tokyo registered the largest increase in turnover (up 24%), followed by the United Kingdom (up 11%), Canada (up 4%) and United States (up 3%). In contrast, turnover in Australia and Singapore fell by 9% and 5% respectively.

Chart 1 Global FX[(a)] daily average turnover



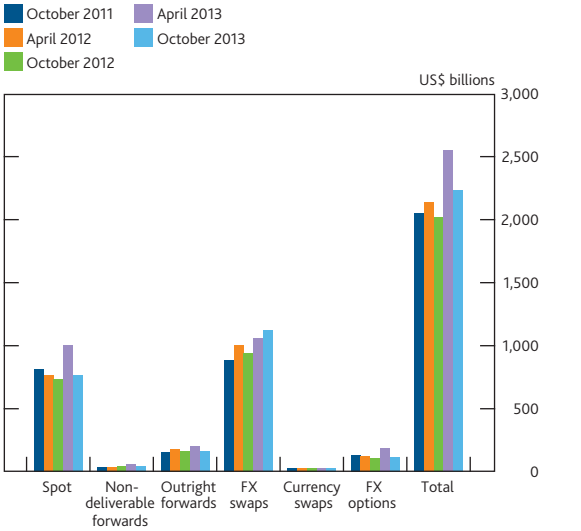
Sources: Australian Foreign Exchange Committee, Canadian Foreign Exchange Committee, London Foreign Exchange Joint Standing Committee, New York Foreign Exchange Committee, Singapore Foreign Exchange Market Committee and Tokyo Foreign Exchange Market Committee.

(a) This includes spot, non-deliverable forwards, outright forwards, FX swaps, currency swaps and FX options.
(b) The Tokyo Foreign Exchange Market Committee began reporting turnover data on a semi-annual basis from October 2012. Previously they collected data annually in April.

The April 2013 surveys recorded a marked increase in global FX turnover. In the United Kingdom, turnover rose 26% from October 2012 to fresh survey highs, the second largest six-monthly rise in the survey's history. This was consistent with growth in other international centres: for example activity in the United States rose 27%, and in Tokyo by 16%. But the October 2013 surveys showed that turnover had fallen across all centres, retracing around two thirds of the April 2013 increase. Tokyo was a notable exception, with total FX turnover rising by 7%, largely driven by increased FX swap volumes.

By instrument, average daily spot turnover in the United Kingdom rose to US$767 billion in October 2013, 5% higher than the previous year (**Chart 2**). While this was

Chart 2 UK daily average turnover by product



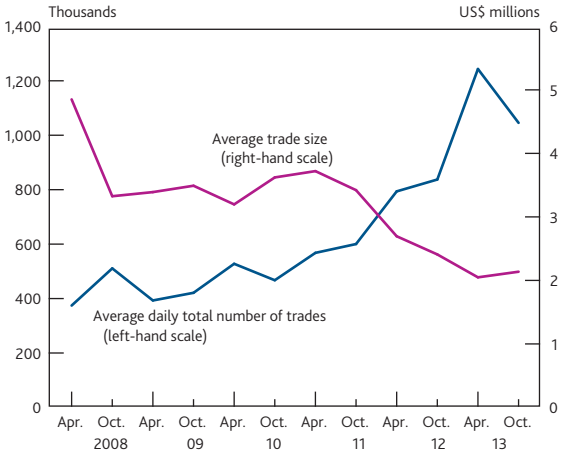
Source: London Foreign Exchange Joint Standing Committee.

consistent with the broader global trend, there was significant variation across the major global centres in spot FX turnover: Tokyo saw a 39% rise in FX spot turnover while Australia reported a fall of 8%. In terms of counterparty types, turnover with reporting dealers (major banks) fell in the year to October 2013. Consequently, the proportion of deals accounted for by this group of market participants fell to a record survey low of 36% (down from 43% in October 2012). Conversely, FX spot deals with 'other financial institutions' (such as hedge funds, central banks and sovereign wealth funds) and 'other banks' (smaller non-reporting banks) rose, accounting for 36% and 24% of October 2013 spot turnover respectively. Over the year, prime brokerage turnover was little changed accounting for around 15% of total turnover and a third of all spot trades in October 2013.

Similar to the headline figures, turnover in most products rose markedly in April 2013, before retracing at least some of the gains in October 2013. The exception was FX swaps where turnover rose to new survey highs in October 2013, at US$1,125 billion per day.

The average FX trade size continued to fall in the year to October 2013 to US$2.1 million (**Chart 3**). This was reflected by an increase in the number of spot trades, with the average spot trade size falling to US$0.8 million in October 2013 (from US$1.0 million a year earlier).

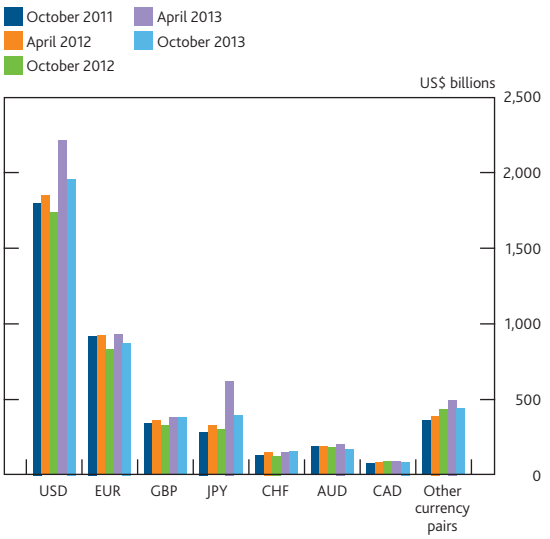
Chart 3 Average daily number of trades and average trade size (all products)



Source: London Foreign Exchange Joint Standing Committee.

In terms of currencies, the rise in activity in USD/JPY (particularly during the October 2012 to April 2013 period) was most noticeable. Turnover in the pair rose by 46% in October 2013 from a year earlier. This was mainly accounted for by an increase in spot transactions (up by 71%). Indeed, turnover in both US dollars and Japanese yen rose (**Chart 4**), with the proportion of all deals involving the US dollar growing to 87.7% from 86.0% in October 2012. The proportion of turnover in euros fell to 39.1%, down 2.1 percentage points from a year earlier, while turnover in sterling rose slightly to 17.1%. Average daily turnover in some emerging market currencies continued to rise, with particularly strong growth in the Chinese renminbi (up 57% from a year earlier) and Turkish lira (up 36%). But turnover in other emerging market currencies fell. Examples include the Indian rupee (-35%), South Korean won (-26%), and Polish zloty (-22%).

Chart 4 UK daily average turnover by currency



Source: London Foreign Exchange Joint Standing Committee.

Overall turnover concentration for the survey was slightly higher than recorded in October 2012; the top three banks participating in the survey accounted for 44% of total turnover.

The forthcoming FXJSC survey results for April 2014 will be published in Summer 2014.

Tables of membership at end-2013

Members of the London Foreign Exchange Joint Standing Committee as at December 2013

Name	Firm/organisation
Brian Welch	Association of Corporate Treasurers
Christopher Bae	Bank of America Merrill Lynch
Rob Loewy	Bank of China
Richard Gill	Bank of New York Mellon
Mike Bagguley	Barclays
Eric Auld	BNP Paribas
Andrew Rogan	British Bankers' Association
James Bindler	Citigroup
Vincent Leclercq	Crédit Agricole CIB
Kevin Rodgers	Deutsche Bank
Heather Pilley	Financial Conduct Authority
Paddy Boyle	Goldman Sachs
Frederic Boillereau	HSBC
Gil Mandelzis	ICAP
Troy Rohrbaugh	JPMorgan Chase
Darren Coote	Lloyds Banking Group
Tim Carrington	Royal Bank of Scotland
Phil Weisberg	Thomson Reuters
James Potter	Tullett Prebon
George Athanasopoulos	UBS
Alex McDonald	Wholesale Markets Brokers' Association
Chris Allen	Barclays, Chair, legal subgroup
Jacqueline Joyston-Bechal	Bank of England, Secretariat, legal subgroup
Graeme Munro	JPMorgan Chase, Chair, operations subgroup
Lisa Scott-Smith	Millennium Global, Chair, buy-side subgroup
Michael Cross (Chair)	Bank of England
Grigoria Christodoulou and Sumita Ghosh (Secretariat)	Bank of England

Members of the London Foreign Exchange Joint Standing Committee operations subgroup as at December 2013

Name	Firm/organisation
Nigel Brigden	Association of Foreign Banks
Sarah Mullen	Bank of America Merrill Lynch
Louise Lee	Bank of England
Pamela Bald	Bank of New York Mellon
Duncan Lord	Barclays
Andrew Rogan	British Bankers' Association
Leigh Meyer	Citigroup
John Hagon	CLS Services
Nick Doddy	Deutsche Bank
John Blythe	Goldman Sachs
Trevor Evans	HSBC
Tony Platt	Morgan Stanley
Stephen Nankivell	Nomura
Richard Norman	Royal Bank of Scotland
Ian Cowell	State Street
Joe Halberstadt	SWIFT
Daniel Haid	UBS
Graeme Munro (Chair)	JPMorgan Chase
Jacqueline Joyston-Bechal	Bank of England, Secretariat, legal subgroup
Grigoria Christodoulou, Andrew Forrest, Jack Garrett-Jones and Sumita Ghosh (Secretariat)	Bank of England

Members of the London Foreign Exchange Joint Standing Committee chief dealers' subgroup as at February 2013[a]

Name	Firm/organisation
Kazuyuki Takami	Bank of Tokyo-Mitsubishi UFJ
Bob De Groot	BNP Paribas
Rohan Ramchandani	Citigroup
Danny Wise	Credit Suisse
Jon Pierce	Goldman Sachs
Stuart Scott	HSBC
Richard Usher	JPMorgan Chase
David Jones	National Australia Bank
Ed Monaghan	Royal Bank of Canada
James Pearson	Royal Bank of Scotland
Chris Freeman	State Street
Niall O'Riordan	UBS
Martin Mallett (Chair)	Bank of England
James O'Connor	Bank of England

(a) No further meetings of the chief dealers' subgroup are currently scheduled pending completion of the FCA's investigation into the FX markets (see FCA press release dated 16 October 2013; www.fca.org.uk/news/forex-investigation-statement).

Members of the London Foreign Exchange Joint Standing Committee buy-side subgroup as at December 2013

Name	Firm/organisation
Murray Steel	AHL
Alexis Blair	Aspect Capital
Jatin Vara	BlackRock
Marcus Browning	Bluecrest Capital
David Bowen	Goldman Sachs
Eric Dannheim	Moorecap
Peter Maltz	Rubicon—UK
Aadarsh Malde	Tudor
John Dacosta	Wellington
Lisa Scott-Smith (Chair)	Millennium Global
Michael Cross	Bank of England
Grigoria Christodoulou and Jack Garrett-Jones (Secretariat)	Bank of England
Jacqueline Joyston-Bechal	Bank of England, Secretariat, legal subgroup

Members of the London Foreign Exchange Joint Standing Committee legal subgroup as at December 2013

Name	Firm/organisation
Janet Wood	Bank of America Merrill Lynch
Helen Oldfield/Alan Brewer	Barclays
Richard Haynes/Sharon Blackman	Citigroup
Gaynor Wood	CLS Services
Simon Goldsworthy/Charlotte Hannavy	Deutsche Bank
Paul Dodd	Financial Conduct Authority
Dan Parker	Goldman Sachs
Christian Bettley	HSBC
Patrick Palmer	JPMorgan Chase
Barra Little	Morgan Stanley
Joanna Wormell	Royal Bank of Scotland
Alistair Cleverly/Kate Binions	Standard Chartered
Richard Lamb/Sergey Likhosherstov	UBS
Chris Allen (Chair)	Barclays
Jacqueline Joyston-Bechal (Secretariat)	Bank of England

Summaries of speeches and working papers

Bank of England speeches

A short summary of speeches and *ad hoc* papers made by Bank personnel since 1 March 2014 are listed below.

Unfair shares

Andrew Haldane, Executive Director for Financial Stability, May 2014.

www.bankofengland.co.uk/publications/Documents/speeches/2014/speech732.pdf

In this speech, Andrew Haldane discussed the issue of inequality. Some have argued that central bank policies of extraordinary monetary accommodation have, by boosting asset prices and wealth, exacerbated inequalities.

But extraordinary monetary measures will not last forever. And nor will any distributional effects. Moreover, inequality can have an important adverse effect on the stability of the financial system and growth in the economy. So central banks do have a vested interest.

He pointed to evidence from psychologists that financial scarcity creates a 'myopia trap' that can reduce (human) capital accumulation, lowering growth and productivity. And he made the case for a reform of corporate governance to address short-termism and rebalance the scales towards investing profits rather than distributing them.

Inclusive capitalism: creating a sense of the systemic

Mark Carney, Governor, May 2014.

www.bankofengland.co.uk/publications/Documents/speeches/2014/speech731.pdf

In his speech, the Governor set out his views on how to rebuild social capital, return to true markets and make capitalism more inclusive.

The combination of unbridled faith in financial markets prior to the crisis and the recent demonstrations of corruption in some of these markets had eroded social capital. When combined with the longer-term pressures of globalisation and technology on the basic social contract, an unstable dynamic of declining trust in the financial system and growing exclusivity of capitalism threatened.

To counter this, rebuilding social capital was paramount. Financial reform was now helping. Globally systemic banks were simplifying and downsizing. Some were de-emphasising high-profile but risky businesses that benefited employees more than shareholders and society. Authorities were working feverishly to end 'too big to fail'. The structure of compensation was being reformed so that horizons were longer and rewards matched risk. Regulation was hard-wiring the responsibilities of senior management. And new codes were seeking to re-establish finance as a true profession, with broader societal obligations.

The Governor noted that a welcome addition to these initiatives would be changes to the hard and soft infrastructure of financial markets to make them dynamic and fair. Through all of these measures, finance could help to deliver a more trustworthy, inclusive capitalism — one which embedded a sense of the systemic and in which individual virtue and collective prosperity could flourish.

The future of monetary policy

Charlie Bean, Deputy Governor, May 2014.

www.bankofengland.co.uk/publications/Documents/speeches/2014/speech729.pdf

Speaking at the London School of Economics, Deputy Governor Charlie Bean described the measures taken by the Bank of England to moderate the impact of the financial crisis. While he did not expect that central banks' collective management of the exit from the exceptionally stimulatory monetary stance would be easy, he noted that the risk of major financial problems crystallising in the advanced economies should be lower given improvements in banks' balance sheets and the resolution framework. He then examined the interaction between monetary and macroprudential policies and observed that a good macroprudential tool would be one well targeted at dealing with a particular financial market failure. He concluded by describing a framework for how monetary policy and macroprudential policy might be best combined, noting that while they could superficially appear to be at odds with each other, such a balance of the policies might be entirely appropriate.

Ending 'too big to fail' — progress to date and remaining issues

Sir Jon Cunliffe, Deputy Governor, May 2014.

www.bankofengland.co.uk/publications/Documents/speeches/2014/speech727.pdf

Jon Cunliffe reviewed the progress made by regulators in addressing the issue of 'too big to fail' and set out some remaining issues. Two key elements of prudential standards were still in the design stage: the leverage ratio and the net stable funding ratio. Though tighter regulation was likely to

impact on market liquidity, it needed to be acknowledged that liquidity risks were probably underpriced before the crisis. Reforms were also under way to allow even the largest firms to fail and be resolved in a safe way without recourse to taxpayer funds. While the required legal framework was now in place, banks also need to hold sufficient debt that can be quickly bailed in if needed, also known as 'gone concern' loss-absorbing capacity (GLAC). There was now agreement on the broad objective for an international GLAC standard: it must allow for an orderly wind down of large, complex cross-border groups, while protecting its critical economic functions. Derivatives contracts also needed to be amended to prevent a disorderly close out of contracts during a resolution. Regulators were working with the International Swaps and Derivatives Association to develop a revised protocol which put in place a stay on close-out rights to permit the orderly use of resolution powers. The way forward would likely entail the major dealers moving to a revised set of contracts first.

Institutions for macroprudential regulation: the United Kingdom and the United States

Donald Kohn, Financial Policy Committee member, May 2014.

www.bankofengland.co.uk/publications/Documents/speeches/2014/speech726.pdf

Comparing UK and US macroprudential systems: lessons for China

Donald Kohn, Financial Policy Committee member, May 2014.

www.bankofengland.co.uk/publications/Documents/speeches/2014/speech728.pdf

Donald Kohn delivered the first of these speeches at the Kennedy School of Government, Harvard University where he compared the macroprudential institutions of the United Kingdom and the United States. In his second speech, given at the Global Financial Forum, PBC School of Finance, Tsinghua University, Beijing, Kohn contrasted the macroprudential systems in the United Kingdom, the United States and China.

Kohn reflected that one of the many causes of the financial crisis was that no entity had a clear mandate to look at the financial system as a whole and the authority to act to mitigate the risks it saw developing. He argued that the world's regulatory agencies were lured into complacency by a relatively tranquil economic and financial environment and relied too much on the private sector to police itself.

Kohn set out what the world should expect macroprudential authorities to do:

- Identify legitimate risks to financial stability.
- Be willing and able to act on the risks they identify in a timely way.
- Be able to interact productively with the microprudential and monetary policy authorities.
- Weigh the costs and benefits of proposed actions appropriately.

Kohn described the UK macroprudential system and discussed some of its benefits. In particular he highlighted the composition of the Financial Policy Committee which benefits from having microprudential regulators, external members and members of the Monetary Policy Committee among its members. However, Kohn did not hold up the UK institutional arrangement as ideal for all countries in all circumstances.

In drawing contrasts with the US system, Kohn drew out the value of giving agencies an explicit financial stability objective, ensuring that there are data-sharing agreements, putting in place a mechanism to review the regulatory perimeter and ensuring that the regulators have enough independence so that they can take the necessary action, even if this may be unpopular in some quarters. As a particular lesson for China, Kohn noted that deregulation and liberalisation will heighten the need for strong macroprudential oversight.

Momentum in the housing market: affordability, indebtedness and risks

Sir Jon Cunliffe, Deputy Governor, May 2014.

www.bankofengland.co.uk/publications/Documents/speeches/2014/speech725.pdf

Speaking to the Worshipful Company of International Bankers, Sir Jon Cunliffe considered recent developments in the UK housing market. Growing momentum likely reflected a pickup in confidence and more readily available mortgage credit including through the Government's Help to Buy scheme. Together these factors had unleashed pent-up demand. With supply inelastic, when demand grows strongly, house prices can keep rising quickly for a long time. The extent to which that jeopardises financial stability depends on whether pressure results in more transactions at higher prices and whether that in turn leads to an increase in household indebtedness and where that debt is concentrated. The Bank and Treasury had already taken some action in response to the growing momentum in the housing market by withdrawing the cheap funding and favourable capital treatment of mortgage lending from the Funding for Lending Scheme. Whether and how to act further would be the most challenging judgement that the Financial Policy Committee (FPC) will have to take in the coming months. The FPC's response would depend on the nature of the risks to stability: its powers of direction on bank capital bear most directly on lenders' ability to weather a downturn and a housing bust once it has emerged; while powers to make recommendations to the Financial Conduct

Authority and Prudential Regulation Authority could bear more directly on underwriting standards and affordability constraints like debt to income, loan to income and loan to value ratios.

Slack, pricing pressures and the outlook for policy

Ian McCafferty, Monetary Policy Committee member, April 2014.

www.bankofengland.co.uk/publications/Documents/speeches/2014/speech724.pdf

In this speech, Ian McCafferty argued that quantitative estimates of the amount of economic slack are highly uncertain, making it important to monitor directly the inflationary pressures they give rise to. Estimates of labour market slack — how much average hours worked are below 'desired' hours or how far unemployment is above its medium-term equilibrium level — pointed to slack in the economy equivalent to 1%–1½% of GDP in early 2014, suggesting there remained some room for demand to recover further without pushing up on inflation. Companies' output prices and prices early in the supply chain have so far been muted. But the pickup of some wage settlements suggests that nominal pay may recover strongly as slack is absorbed. The timing of the first increase in Bank Rate depends not only on these considerations, but also on the need for rate rises thereafter to be gradual. While a relatively low end-point for Bank Rate might make the first rise appear less pressing, a gradual pace of tightening means it cannot be held back too far.

The age of asset management?

Andrew Haldane, Executive Director for Financial Stability, April 2014.

www.bankofengland.co.uk/publications/Documents/speeches/2014/speech723.pdf

In this speech, Andrew Haldane discussed the links between asset management and financial stability. He explored the risks to the financial system and the opportunities that asset management offers.

The industry's assets under management (AUM) are currently estimated at around US$87 trillion globally. They have grown rapidly as the pool of prospective global savers has become larger, older and richer. The United Kingdom has seen a five-fold increase in AUM since around 1980.

Given its increasing size and importance, he asked whether the asset management industry has spawned institutions that are 'too big to fail' and whether the industry contributes to procyclicality in the financial system. He pointed out that pension funds, as long-term investors, could play a stabilising, countercyclical role.

In practice, there is some evidence of institutional investors acting procyclically and investment decisions being short-termist. Public policy might consider these market failures.

Why there is life after death: four myths about the future of securities financing markets

Andrew Hauser, Head of Sterling Markets Division, April 2014.

www.bankofengland.co.uk/publications/Documents/speeches/2014/speech721.pdf

In a speech to JPMorgan's Collateral Management and Securities Financing Forum, Andrew Hauser argued that it was time for a more rational debate about the role of securities lending and repo markets, avoiding both the extremes of those who asserted that the markets had single-handedly caused the financial crisis, and those who abhorred the post-crisis regulatory response as excessively heavy-handed. In doing so, he argued against four commonly heard myths. First, regulators and central banks did not want to kill off repo and securities lending — they wanted to see a thriving, but safer, market. Second, a global 'collateral crunch' was highly unlikely, with the amount of extra high-quality issuance far outweighing the projected increase in demand. Third, barriers to collateral fluidity were not primarily for the public authorities to remove, but would mostly come from the private sector responding to changing price incentives. And, fourth, there would be ways to make an economic return on securities financing business, as demand recovered. But the nature of that business would inevitably change, perhaps quite radically. It was essential that central banks stayed abreast of these changes, as the Bank was doing through its Securities Lending and Repo Committee.

City Week 2014

Andrew Bailey, Deputy Governor, March 2014.

www.bankofengland.co.uk/publications/Documents/speeches/2014/speech719.pdf

Andrew highlighted the importance of achieving a stable institutional structure of financial regulation in the United Kingdom. Consistency and clarity in the objective of regulation were necessary pre-conditions for delivering this. While it had been possible to coalesce around a view on the institutional structure for monetary policy it had been less easy to describe simply what constituted financial stability — this explained why it had taken longer to arrive at a stable institutional structure for achieving it. Andrew observed that a stable financial system was necessary for realising stable economic growth and other economic welfare benefits. An important example was the UK housing market where there was evidence of increased momentum. Andrew concluded by highlighting seven important messages for the future,

including that policymaking tools at the Bank of England would be joined up, consistent with the recently announced single mission to promote the good of the people of the United Kingdom by maintaining monetary and financial stability.

Taking the long view: how market-based finance can support stability

Dame Clara Furse, Financial Policy Committee member, March 2014.

www.bankofengland.co.uk/publications/Documents/speeches/2014/speech718.pdf

In a speech to the Chartered Institute for Securities and Investment in March, Dame Clara Furse talked about the importance of the FPC's forward agenda for the next 12–18 months and, in particular, its focus on working to improve the diversity of market-based financing in the United Kingdom.

Dame Clara explained that the FPC's work so far had, rightly, focused on mitigating systemic risks to the UK financial system by improving the resilience of banks, but also noted that some market segments, including small and medium-sized enterprises, had continued to face tight credit conditions. Improving the availability of non-bank and market-based finance could help to broaden the type of funding available to companies.

Dame Clara stated that the FPC would work with the wider Bank to examine the impediments to the development of market-based finance in the United Kingdom. As part of this work, the Bank would assess and, where necessary, act to: promote a better-functioning securitisation market in the United Kingdom; consider whether a credit register might support financial stability; enhance the resilience of liquidity in those financial markets important to the United Kingdom's financial resilience; and reduce the risks to the system arising from procyclicality in the availability of finance, including via collateral markets. Dame Clara also noted that the ability of the financial system to provide credible long-term equity capital to promising companies to support innovation and future growth was of particular importance to her.

Dame Clara also pointed out that regulation is vital in promoting confidence by building a framework with predictable and proportionate rules, standards and reactions, but that businesses and investors must also play a part in developing high standards of corporate governance and building trust.

Global systemically important insurers: issues, policies and challenges after designation

Julian Adams, Deputy Head of the Prudential Regulation Authority and Executive Director of Insurance, March 2014.

www.bankofengland.co.uk/publications/Documents/speeches/2014/speech717.pdf

In a speech at the Geneva Association's 30th PROGRES Seminar, Julian Adams focused on the policy measures currently being developed by the International Association of Insurance Supervisors (IAIS) for global systemically important insurers (G-SIIs), following the designation of nine insurers as G-SIIs by the Financial Stability Board in July 2014. As Chair of the IAIS Financial Stability Committee which leads on development of these policies, Julian was invited to discuss this programme of work.

Key themes emerging from the panel discussion and Q&A session included whether insurers and their activities should be considered systemic; the importance of, but also the difficulties associated with, developing international capital standards in the absence of a globally comparable valuation framework; and the extent to which any standards developed by the IAIS can be implemented consistently given existing jurisdictional arrangements.

Slack and the labour market

Martin Weale, Monetary Policy Committee member, March 2014.

www.bankofengland.co.uk/publications/Documents/speeches/2014/speech716.pdf

In this speech, Martin Weale set out his thoughts on the recent behaviour of the labour market. He asked how far the economy can continue to recover before wage pressures build up and risk pushing inflation above the Bank's 2% target.

Drawing on survey data on the labour market, Martin found that workers who succeeded in finding a job between 2012 and 2013 were paid less than two thirds as much per hour than those who were already employed. They also worked fewer hours per week. In part this is because many of those taking up work were young, and young workers tend to be paid much less than the average of the population. But it might also imply that new workers — at least in the short run — contribute less to production than those already in work.

Martin then considered the difference between how many hours people would like to work and their actual working week. Using data from the same survey, he found that on average, people would like to work more hours than they currently do. This was especially true for young workers. But comparing how much longer people said they would like to work, to how

much longer they actually succeeded in working, Martin found that many were satisfied with smaller increases than they said they wanted. Those who wanted to work more hours also tended to be paid less per hour than the average.

Drawing this evidence together, Martin concluded that there was still some way for unemployment to fall before wage pressure started to push price inflation above target. But although the unemployment rate was much higher than it was before the crisis, the margin of spare capacity in the labour market may be smaller than this headline number would imply.

One Mission. One Bank. Promoting the good of the people of the United Kingdom

Mark Carney, Governor, March 2014.

www.bankofengland.co.uk/publications/Documents/speeches/2014/speech715.pdf

Delivering the 30th Mais Lecture, the Governor described the way in which the Bank was reshaping itself into a central bank for the 21st century, combining the finest aspects of its history and traditions with the best of the modern and the new, in order to fulfil its single, timeless mission: promoting the good of the people of the United Kingdom.

The Governor began by noting that while the adoption of inflation targeting had helped secure fifteen years of price stability and sustained economic growth, the recent crisis was a powerful reminder that price stability was not sufficient to maintain macroeconomic stability. Following the return of prudential supervision and the introduction of macroprudential policy to the Bank of England, the challenge was to create a macroeconomic environment that provided the basis for strong, sustainable and balanced growth.

The Governor described how, through the co-ordinated use of its tools, risks to monetary and financial stability could be mitigated. The Monetary Policy Committee's forward guidance policy had reduced uncertainty about how monetary policy would be set as the recovery gained pace. Microprudential supervision and macroprudential management would help in preventing the build-up of vulnerabilities that could arise from excessive financial and household risk-taking. Through changes to the hard and soft infrastructure of markets, fair, open and competitive markets could be rebuilt. Through ideas and engagement, the global financial system could be reformed to secure an open, resilient system in which all countries would have confidence and in which British businesses could thrive.

Is the world financial system safer now?

Sir Jon Cunliffe, Deputy Governor, March 2014.

www.bankofengland.co.uk/publications/Documents/speeches/2014/speech714.pdf

Giving the keynote address at a Chatham House conference, Jon surveyed the progress made by international standard setters since 2008 to make the financial system safer and set out the further steps that need to be taken. Considerable progress, through the development of new resolution powers, had been made to address the problem of 'too big to fail'. Jon did not think, however, that the authorities could say with confidence that they could resolve a failing global giant. Systemic cross-border banks needed to be restructured so that resolution powers could be used effectively and safely. That required a new international standard. In addition to the completion of standards, the international community needed to work together to ensure the reform programme was coherent and that there was mutual trust between different jurisdictions. Without mutual trust, it was not possible to maintain a global financial sector that was resilient to destabilising crises.

Ambidexterity

Andrew Haldane, Executive Director for Financial Stability, March 2014.

www.bankofengland.co.uk/publications/Documents/speeches/2014/speech713.pdf

In this speech, Andrew Haldane described the emergence of macroprudential policy — 'using prudential means to meet macroeconomic ends' — from the depths of the financial crisis. The credit cycle differs from the business cycle. It is twice as long and twice as big. In the language of Tinbergen, two cycles and two objectives call for two instruments. This is where macroprudential policy comes in.

He considered three case studies to illustrate the role that a countercyclical capital buffer (CCB) could have played in tempering the credit cycle and stabilising the financial system and macroeconomy. He described how a CCB might have been able to counteract loose monetary policy after the US dotcom bubble and prevent the rapid accumulation of credit in the run-up to the eurozone crisis. He also described how macroprudential policy is being used to temper risk-taking currently.

In short, the advent of macroprudential policy has given policymakers a second arm with which to manage the financial system and the macroeconomy. It is still early days. Macroprudential policy today resembles monetary policy perhaps a generation ago.

Sustaining the recovery

Charlie Bean, Deputy Governor, March 2014.

www.bankofengland.co.uk/publications/Documents/speeches/2014/speech710.pdf

Speaking at the North East Chamber of Commerce President's Club, Deputy Governor Charlie Bean summarised the key issues facing the economy. He discussed three things that were required for the recovery to be both sustained and sustainable: a pickup in business investment; a revival in productivity growth; and an expansion in net exports. He noted that business investment had already started to pick up, while productivity growth ought eventually to return to something approaching pre-crisis average rates. He discussed the need to reduce the UK trade deficit in due course, noting that any further appreciation of sterling would not be particularly helpful in terms of facilitating a rebalancing towards net exports. He repeated the Monetary Policy Committee's latest policy guidance, namely that when Bank Rate does rise, it should do so only gradually and to a level materially below its pre-crisis average of 5%.

Shadow banks and macroeconomic instability

Summary of Working Paper No. 487 Roland Meeks, Benjamin D Nelson and Piergiorgio Alessandri

Between the early 1990s and the onset of the 2007–09 sub-prime crisis, the financial system in the United States and elsewhere underwent a remarkable period of growth and evolution. Banking underwent a shift away from the traditional 'commercial' activities of loan origination and deposit issuing towards a 'securitised banking' business model, in which loans were distributed to entities that came to be known as 'shadow' banks. As shadow banks came to replicate core functions of the traditional banking system, in particular those of credit and maturity transformation, they took on many of the same risks but with far less capital. An overreliance on securitisation, and the increased leverage of the financial system as a whole, ultimately contributed to financial instability, recession, and a substantial contraction in shadow banking activity.

The aggravating role played by flaws in the securitised banking model have been rightly emphasised in many accounts of the sub-prime crisis and ensuing 'Great Recession'. But there is also a need to understand the increasingly central role played by securitisation in credit provision over the decades prior to the crisis. To illustrate why, we show that in the US data from 1984 to 2011 periods when traditional bank credit underwent cyclical contraction were often periods when shadow bank credit expanded. Similarly, other authors have documented that over the post-1984 period, consumer credit and mortgage assets held by commercial banks were positively correlated with GDP, while holdings outside the banking system were negatively correlated with GDP.

These observations suggest that a macroeconomic model which seeks to account for the behaviour of intermediated credit should be able to account for the differences in credit supply across institutions, as well as the collapse in shadow banking during the crisis. To that end we develop a dynamic general equilibrium model featuring securitisation and shadow banking, which aside from its treatment of the financial sector, closely resembles a standard macroeconomic model.

In our model we show that the ability of commercial banks to securitise can stabilise the overall supply of credit in the face of aggregate disturbances, but that risk-taking by the shadow banking system leads to an increase in macroeconomic volatility. We then give conditions under which the negative correlation between traditional and shadow bank credit observed in the US data come about, and quantify the credit dynamics resulting from the interaction between banks and shadow banks. Finally, we argue that in a securitisation crisis government policies targeted at the shadow banking system, such as purchases of asset-backed securities, can have spillover effects on the rest of the financial system which weaken the effectiveness of interventions. Taken together, these points constitute a first step towards addressing what are widely thought to be some important shortcomings of the generation of dynamic general equilibrium models used for research and policy analysis prior to the recent crisis.

Our model does not attempt to capture the full complexity of shadow banking activities, however, and leaves room for future research. First, we do not attempt to model the process of financial innovation and regulatory change which lay behind the rapid expansion of shadow banking. Second, the crisis highlighted shortcomings in the workings of key asset markets, which we ignore. For example, we do not model complex financial instruments based on securitised assets, such as collateralised debt obligations, which the market badly mispriced. Last, we do not deal with issues of prudential regulation, or with policies relating to financial system structure. An important contributory factor behind the creation of some shadow banking entities, in particular structured investment vehicles, was a desire by banks to reduce the amount of regulatory capital they held against credit exposures. In our model there is no explicit regulatory motive behind the existence of shadow banks or the market for securitised assets, although we proxy the advantage that shadow banks enjoy from being unregulated by allowing them to carry higher leverage than commercial banks. Relaxing some of these strong assumptions is a topic ripe for future work.

News and labour market dynamics in the data and in matching models

Summary of Working Paper No. 488 Konstantinos Theodoridis and Francesco Zanetti

A number of studies establish that anticipated changes in future productivity, referred to as news shocks, represent an important source of business cycle fluctuations. Many authors have focused on the effect of news on economic activity, but none so far have investigated the effect on labour market variables. This paper fills this gap. It develops a multivariate statistical model that identifies the effect of anticipated productivity shocks on unemployment, wages and the job finding probability, and it then investigates to what extent a simple theoretical model with real frictions on the labour market is able to replicate the empirical impact of news shocks on labour market variables and macroeconomic aggregates.

In the aftermath of a positive news shock, unemployment falls, whereas wages and the job finding probability increase. The inclusion of labour market variables does not alter the response of macroeconomic aggregates to the news shock, since output and investment modestly fall and consumption increases, in line with recent studies that abstract from labour market variables. We establish, using US data, that news shocks explain 30% of unemployment fluctuations and approximately 20% of the job finding rate, whereas their contribution to output and consumption is more limited to around 15% in the long run. We also illustrate that most of the historical fluctuations in the job finding rate and unemployment are explained by news shocks, whereas news shocks play a limited role in explaining wages and output fluctuations.

We next set up a simple theoretical model with real (search and matching) distortions in the labour market. We find that this basic framework replicates the news shocks identified in the data relatively well. The theoretical model shows that in response to a positive news shock the firm anticipates that the surplus from establishing a match increases, thereby leading to an increase in vacancy posting that generates a decrease in unemployment. High vacancy posting and low unemployment raise labour market tightness, which increases the job finding rate. In general, the qualitative responses are similar to those from the time-series model. However, the responses of unemployment and wages to a news shock are not in line with those predicted by the empirical model. Hence, we investigate to what extent refinements to the basic framework improve the model's performance. We establish that the job destruction rate and real wage rigidities are important for the response of unemployment and wages to the news shock and for the overall variables' responses.

Expectations, risk premia and information spanning in dynamic term structure model estimation

Summary of Working Paper No. 489 Rodrigo Guimarães

Market interest rates are of great interest to policymakers, not least because they play a crucial role in the monetary transmission mechanism. Moreover, financial market measures of future interest rates and inflation rates can also provide useful and timely information when making policy decisions.

This information complements and extends other sources monitored by policymakers, such as surveys of private forecasters and macroeconomic forecasting models. Market rates are available at a much higher frequency and for longer forward horizons than other data, as well as being available in a long time series. This can prove crucial in answering questions that involve the reaction to policy (such as announcements), comparisons over long periods (the effect of institutional changes, such as independence of the central bank), or effects that are expected to have distinct effects over different horizons (such as forward guidance).

In order to extract policy-relevant information from yields, it is important to understand what has driven these rates lower. Decompositions can be carried out along a number of dimensions to shed light on the drivers. First, movements in interest rates can be split into movements at different forward horizons to assess whether the changes are mainly at shorter or longer horizons. Second, movements in nominal rates can be decomposed into changes in real interest rates and changes in implied inflation rates.

And third, movements in market rates can be decomposed into two parts; one that reflects changes in expectations of future short-term rates, and another associated with changes in their required compensation for risk ('risk premia'). Disentangling both is important for policymakers because influencing the expected path of the policy rate plays an important role in the transmission mechanism of monetary policy. And estimating risk premia can give policymakers an indication of market participants' assessments of the perceived risks. In addition, some measures are designed to reduce the compensation for risk (such as quantitative easing).

While the first two decompositions — time horizon and the real versus inflation split — can be done using available data, the distinction between expectation and risk compensation components is more complicated. Extracting this information requires complicated theoretical models and statistical techniques, which raises the question of reliable decompositions. Unfortunately, the most popular class of models, both within academia and with major policy institutions, are known to be subject to instability problems that would hamper their use for policy. This paper focuses on how to obtain robust estimates from these models for the quantities of interest for policymakers: the expected path of future interest and inflation rates as well as real and inflation risk premia.

We analyse the robustness of the decomposition obtained from the workhorse model in previous work, the family of Gaussian affine dynamic term structure models. The great advantage of this type of model, which assumes linearity and a relatively straightforward probability distribution of shocks to returns, is its tractability. At the same time their flexibility is a great asset, necessary to accommodate the rich behaviour of bond yields observed over time and across maturities. But without enough restrictions or information to pin down the model parameters, this flexibility can become a liability, resulting in instability in the implied decomposition into risk and expectations.

Exploring recent advances in yield curve modelling this paper compares alternative methods proposed in previous work to ensure sensible decompositions. These include using survey forecasts from professional forecasters, restricting the way risk premia are allowed to vary or purely statistical techniques. This paper finds that using surveys of private professional forecasters to help anchor the model dynamics is the most reliable way to obtain robust decompositions.

In addition, the use of surveys automatically delivers 'sensible' decompositions because these survey forecasts (i) have been shown to provide good proxies for expected future rates (good forecasting properties); (ii) are true real-time measures (not subject to look-ahead or overfitting biases); (iii) can incorporate information that is readily available to practitioners (political events, changes in policy or policy frameworks) hard to obtain from past data.

The outputs of the models with surveys have been used to analyse the evolution of UK government bond yields in a 2012 Q3 *Quarterly Bulletin* article. The model decomposition of nominal, real and market inflation rates provided valuable insight about the behaviour of yields. It proved particularly useful in understanding the recent period of the financial crises and how it impacted market rates.

In a more technical contribution, the paper also links the ability of surveys to stabilise the decomposition of yields to new developments in term structure modelling related to spanning of information. A Monte Carlo study (based on random simulations of a theoretical model) confirms the importance of having additional information about future dynamics to reliably estimate these models. It suggests that the introduction of surveys delivers gains in precision equivalent to observing at least twice as long a sample — in other words we would need double the amount of information available (wait another 40 years) to obtain measures as reliable as those we can obtain by adding surveys.

Adaptive forecasting in the presence of recent and ongoing structural change

Summary of Working Paper No. 490 Liudas Giraitis, George Kapetanios and Simon Price

Forecasting is an important activity for central banks, not least because policy takes effect with a lag. Inevitably, policy is forward looking. Thus in many central banks, including the Bank of England, the published forecast is a key tool in communicating judgements about monetary policy and the economy. The Bank's forecast, published in the *Inflation Report*, represents the judgements of the Monetary Policy Committee and is not mechanically produced by a single model. However, many forecasting models — a 'suite' of models — help the Committee determine its judgement, including simple largely atheoretical models of the type considered in this paper.

One common cause of forecast failure is that structural changes or 'breaks' keep on occurring in the underlying relationships in the economy, and this paper addresses that problem, building on previous work undertaken in the Bank. The problem, almost by definition, is that we do not know what form the structural break took. If we did, we could model it: but then it would not be a structural break, but a known data-generation process. What we need are methods that are useful where there is the possibility of a wide range of types of structural change. The earlier work showed that a robust way of forecasting in such an environment is to discount past data so that more recent data is given more weight. This helps avoid forecast errors, as if there have been structural breaks in the past, the data pertaining to that period is given less weight compared to recent data where there may have been no or fewer breaks. This can be done in many ways. These include 'rolling windows' where all data before a cut-off date is excluded, exponentially declining weights smoothly lowering the weight for distant data (often implemented as an exponentially weighted moving average), and other methods. But this raises the practical question of exactly how rapidly to downweight. The innovation of the paper is to choose this by using in-sample forecast performance.

The paper shows that in a wide variety of situations the method will have good statistical properties. What is more, it can handle any degree of persistence. Speaking somewhat loosely, 'persistence' is the tendency for a series to be affected by its past behaviour. For example, a series that is simply a constant with some random white noise has no persistence. (In this case, the best forecast is to use all the data to calculate the mean as precisely as possible.) By contrast, in the classic random walk a series is equal to what it was last period plus a random white noise error, and so there is a high degree of persistence. (In that case, the best forecast ignores all except the last observation.) These examples show that the optimal rate of discounting past data is likely to depend upon persistence. We are also able to demonstrate that the method is very flexible. There are ways of including dynamics, similar to the widely used autoregressive (AR) method, known to produce good forecasts, where the series is solely related to a few of its own lags. We can also allow the weights to vary very flexibly using a non-parametric method which does not tie down the model to a specific form, and allow for other explanatory variables. The theory is for large samples, but we show using simulation ('Monte Carlo') methods that the methods work for short samples as well.

The proof of the forecast pudding is in the testing, so we apply the methods to a large number of economic variables from the United States using a sample from 1960 to 2008, comparing root mean square forecast errors, which is a standard criteria that penalises large forecast errors. Not all the series exhibit breaks, but in the typical (median) case the methods do better than an AR benchmark. The methods that work best are ones that allow for some dynamics. For some variables, such as financial spreads and some inflation series, they do spectacularly better. Moreover, in many cases the methods are significantly better (in the statistical sense) than the benchmark, meaning that they do better much more often than would be expected by chance.

We conclude that the proposed technique of downweighting past data in a way determined by past forecast performance is likely to be a useful item in the forecaster's toolkit.

Household debt and the dynamic effects of income tax changes

Summary of Working Paper No. 491 James Cloyne and Paolo Surico

The persistent rise in mortgage debt across many industrialised economies prior to the recent financial crisis has drawn considerable attention to the role of private indebtedness in the transmission of macroeconomic shocks.

A common presumption behind many existing studies on the relationship between debt and consumer behaviour is that debtors are more likely to face liquidity constraints and thus adjust their consumption significantly in response to conditions that unexpectedly change their income. An important implication is that it is not wealth *per se* that determines the consumption reaction to income changes; households who made a large durable purchase — such as housing — may well be wealthy and liquidity constrained at the same time, depending on their level of indebtedness as well as their mortgage repayments relative to earnings.

Despite the clear relevance of this transmission channel, little is known about whether household consumption behaviour varies with their debt position and whether the mortgagors' reaction to income changes is larger or smaller than outright homeowners'. At least three considerations make this task particularly challenging. First, survey data with good expenditure coverage typically lack equally detailed and reliable information on the household finance position over a sufficiently long period of time. Furthermore, whether a household holds mortgage debt or not is partly a choice. Last but not least, consumption and income changes are jointly determined so that one ideally needs to isolate a surprise movement in income.

To address the endogeneity of income changes, we exploit variation in aggregate income taxes. The United Kingdom is a natural choice for our purposes because there have been a large number of income tax changes in the past 40 years. Furthermore, detailed information from official documents allows us to identify individual tax measures and their motivation. Tax changes that were introduced for reasons unrelated to the business cycle can then be used to identify exogenous variation in household income.

To elicit individual debt positions, we group households by their housing tenure, which allows us to distinguish between homeowners with a mortgage and homeowners without. A further advantage of looking at heterogeneity in consumption through housing tenure is that we can investigate the dynamic effects of tax changes on another interesting group of British households, namely those renting from local authorities or housing associations: 'social renters'. A typical household in this group is characterised by little (if any) net wealth, low income and only compulsory education. These features fit well the traditional stereotype of liquidity-constrained households in one-asset models.

Using a long span of household survey data from the Family Expenditure Survey and a new narrative measure of tax shocks, our disaggregated approach allows us to identify the expenditure response of different groups of households to an income change. We find that the estimated dynamic effects are highly heterogeneous across housing tenures, in a way that is understated — if not missed — when households are grouped by age and/or education.

We establish a number of specific results. First, mortgagors exhibit the largest and most significant response. In contrast, outright homeowners hardly adjust their expenditure, with effects that are never statistically different from zero. Second, the response of social renters is significant but smaller than (though rarely statistically different from) the mortgagors'. Third, the composition of mortgagors' net wealth is significantly different from those of outright owners and social renters. More specifically, we show that a typical household with mortgage debt holds very little *liquid* net wealth despite owning sizable illiquid assets.

Liquidity constraints for lower income/less educated households is an often cited explanation for the aggregate effects of tax changes on GDP and consumption that are typically reported in the empirical macro literature. On one hand, we show that social renters do respond to these changes in their income. This type of (arguably) liquidity-constrained household, however, accounts for only around 20% of our sample and therefore appears to constitute too small a share to drive the aggregate results. On the other hand, mortgagors — who tend to hold little liquid wealth despite owning sizable housing equity — account for about half of the British population, thereby providing a novel interpretation for the aggregate effects of tax changes on the economy.

Generalised density forecast combinations

Summary of Working Paper No. 492 Nicholas Fawcett, George Kapetanios, James Mitchell and Simon Price

Forecasts have become central to monetary policy making. The Bank of England has for many years published forecasts of inflation and growth conditional on particular paths of the policy rate as a central element of the discussion of policy in the quarterly *Inflation Report*. For almost as long, the Bank has explicitly quantified the uncertainty surrounding the central forecast by publishing a forecast distribution or density around that path, in the famous 'fan charts'. The Bank uses these as part of its communication strategy that help to explain the MPC's thinking. This process is influenced by many inputs, including various forecasts, and knowing how well those input forecasts perform is potentially helpful. More recently, the Bank has published probabilistic descriptions of other events, for example the probability of exceeding particular inflation rates or unemployment falling below a threshold specified under the Forward Guidance framework introduced in August 2013. In the area of financial stability, the probabilities of bank failure or financial crises occurring are of obvious interest. Clearly, forecast densities are key to the Bank's activities.

Recent research has revealed that some form of forecast combination is a very powerful method of improving forecast density accuracy, and this is the focus of the paper. One promising method is to choose fixed (linear) combination weights to maximise the log score of the combination. This object gives a high weight to forecast densities that assign a high probability to the events that actually occur. The difference between two average log scores is a measure of 'distance' between two sets of density forecast, so we can compare densities. We generalise the simple linear approach by letting the combination weights follow general schemes. Specifically, we let the combination weights depend on the variable one is trying to forecast, by allowing the weights to depend on which specific interval the forecast lies in. This allows for the possibility that while one model may be particularly useful (and receive a high weight in the combination) when the economy or market is in recession or a bear market, for example, another model may be more informative when output growth is positive or there is a bull market. It also allows some time variation in the weights as forecast outcomes move into different regions of the forecast density.

We show that these generalised density combinations or pools have good theoretical properties. There are practical issues to be resolved. The number of intervals has to be decided: we determine this by a 'grid' search over a range of possibilities, choosing the one that maximises the log score in a part of the data sample held back for this purpose (a method known as cross-validation). Similarly, the specific values delimiting the intervals must also be estimated.

Theoretical properties are good, but in practice data are limited and not well behaved. So we try a range of 'Monte Carlo' simulations where we simulate different processes and sample sizes to see how the method might work in practice. These show that the generalised combinations are more flexible than their linear counterparts and in general can better mimic a range of true but unknown densities, irrespective of their forms. Although this additional flexibility does come at the expense of the introduction of additional (interval) parameters, the simulations indicate that the benefits of generalised combinations mostly survive the extra parameter estimation uncertainty; and increasingly so for larger sample sizes and more distinct component densities. As a practical matter, the number of intervals chosen is generally quite small. One experiment uses densities known to work well for inflation. Here too the generalised method outperforms the linear one, showing that the method is likely to be useful in macroeconomic applications. We also show how the generalised combinations can work better in practice, finding that they deliver much more accurate density forecasts of the S&P 500 daily returns than optimal linear combinations of the sort used in earlier work by researchers on this topic. Not only are the gains large in absolute terms, but they are extremely significant in the statistical sense.

In summary, forecast densities are important, and a good way to generate them is by combining individual densities. We generalise a method known to work well, and we find that in theory and in practice the gains are very large. Although we only apply the method to stock market returns where there are many thousands of observations, the Monte Carlo experiments suggest it will be effective in macroeconomic cases too.

The macroeconomic effects of monetary policy: a new measure for the United Kingdom

Summary of Working Paper No. 493 James Cloyne and Patrick Hürtgen

The precise impact of monetary policy on the macroeconomy is of obvious interest to central bank policymakers. Yet despite considerable research in the academic literature, there remains disagreement about the effects. A range of empirical estimates have emerged in the literature, and the effects on prices and output of a 1 percentage point innovation to the policy rate tend to be between 0.5% and 1%. But a notable exception is the so-called narrative method pioneered by Christina and David Romer in 2004, which found considerably larger effects. To our knowledge, and despite the attention given to these results, there are no other applications of this methodology to isolate interest rate changes that can be used to estimate the effects of policy. In addition, much of the empirical research on monetary policy has focused on the United States and there are far fewer results for other countries such as the United Kingdom. This paper fills both these gaps, providing new narrative-based estimates of the effect of monetary policy in the United Kingdom.

We focus on the effect of changes in the central bank's policy interest rate rather than on unconventional policy measures such as quantitative easing. While the effect of unconventional measures is clearly an important topic in its own right, interest rates still remain a key policy instrument. Furthermore, looking at changes in policy interest rates is important for understanding the effects of monetary policy in the past and to be comparable with the existing literature. The effect of interest rates on the macroeconomy therefore remains of considerable interest, both to macroeconomists and policymakers.

Identifying the effects of changes in monetary policy requires confronting at least three technical challenges. First, monetary policy instruments, interest rates, and other macroeconomic variables are determined simultaneously as policymakers both respond to macroeconomic fluctuations and intend their decisions to affect the economy. Second, policymakers are likely to react to expected future economic conditions as well as current and past information. Third, policymakers base their decisions on 'real-time' data (that available at the time), not the *ex-post* (revised) data often used in empirical studies.

A major advantage of the Romer and Romer approach is that we can directly tackle all three of these empirical challenges. First, we need to disentangle cyclical movements in short-term market interest rates from policymakers' intended changes in the policy target rate. A particular advantage of studying the United Kingdom is that the Bank of England's policy rate, Bank Rate, is the intended policy target rate. We therefore do not need to construct the implied policy target rate from central bank minutes as Romer and Romer did. As a second step, the target rate series is purged of discretionary policy changes that were responding to information about changes in the macroeconomy. This may include real-time data and forecasts that determine the policy reaction to anticipated economic conditions. We use historical sources to reconstruct a proxy for the information available to policymakers at the time. Specifically we construct an extensive new data set of historical Bank of England forecasts, private sector forecasts from the National Institute of Economic and Social Research and real-time data, for the sample from 1975 to 2007. (We hope that our detailed new data set and policy change series will provide a useful resource in itself.)

We perform a first-stage estimation to purge the intended policy target rate of systematic policy changes, producing a new series of policy changes that can be used to estimate the effects on the economy. Armed with our new measure of monetary policy changes we estimate the effects of monetary policy on the macroeconomy. In our baseline empirical specification, a 100 basis point tightening leads to a maximum decline in output of 0.6% and a fall in inflation of 1.0 percentage points after two to three years. Monetary policy changes have a protracted effect on the economy. Our results also suggest that GDP responds by a comparable magnitude to industrial production — around 0.5% at the peak.

The narrative results for the United States generated considerable discussion given the large effects found. Also employing this narrative approach, we find similar effects of monetary policy for the United Kingdom and the United States. Furthermore, we show that differences across empirical methods used in the literature, at least for the United Kingdom, largely result from differences in the implied paths for policy. Once we control for these effects we find our estimates are in line with the magnitudes reported elsewhere in the wider literature.

However, unlike many studies in the literature, and in keeping with Romer and Romer for the United States, we find a negative, significant and theoretically plausible response for inflation and prices. Our approach therefore solves the so-called 'price puzzle' — first documented by Christopher Sims in 1992 — for the United Kingdom, where prices and inflation puzzlingly increase following a monetary contraction. Investigating the issue further, we find that use of our new forecast data set is crucial for this result.

The effect of changes in monetary policy continues to be keenly debated, both in academic and policy circles. Furthermore, it seems likely that interest rates will remain a key tool in the future. Our estimates therefore contribute new evidence to the empirical literature. In doing so, we provide a rich new data set which we hope will provide exciting scope for future research.

Estimating the impact of changes in aggregate bank capital requirements during an upswing

Summary of Working Paper No. 494 Joseph Noss and Priscilla Toffano

This paper estimates the effect of changes in capital requirements applied to all UK-resident banks' aggregate capital requirements on lending during a credit boom. It is a 'top-down' study that investigates the joint dynamics of the aggregate capital ratio of UK-resident banks and a set of macrofinancial variables, including lending growth. Its results may be useful to policymakers given the growing international consensus on the need to apply time-varying macroprudential bank capital requirements on top of existing microprudential requirements. An example is the countercyclical capital buffer that comprises part of the toolkit of the Bank of England's Financial Policy Committee.

Estimating the effect of an increase in aggregate bank capital requirements on the macroeconomy is complicated by how such a policy tool has never before been used. There are, moreover, very few changes to aggregate regulatory capital requirements observable in past data. And for those changes in regulatory capital requirements that have occurred, it is difficult to isolate how much of the change in bank lending behaviour was as a result of those changes, rather than broader macroeconomic developments affecting banks. The approach offered here surmounts this problem by identifying shocks in past data that match a set of assumed directional responses of other variables to future changes in banks' aggregate capital requirements.

This analysis estimates how an increase in macroprudential capital requirements might affect banks' lending in the face a credit boom. In doing so, it assumes that an increase in banks' capital requirements have a negative effect on the supply of bank lending, at least in the short run. It is also important to note, however, that this assumption is likely to hold true only during a boom in the extension of credit, such as that witnessed before the recent financial crisis. It may not match the response of banks to regulation after the crisis, when, for example, an increase in macroprudential capital levels could improve investor confidence in the health of banks, allowing their cost of funding to fall, and thus enabling them to increase their level of capital without decreasing their lending.

The estimates of the impact of aggregate capital requirements on lending may — in certain states of the economic cycle — provide policymakers with a plausible 'upper bound' on the short-term effects of future increases in macroprudential capital requirements. This analysis concludes that an increase of 15 basis points (one standard deviation) in the aggregate capital ratio of the UK banking system is associated with a median reduction of around 1.4 percentage points in the level of lending after 16 quarters. The effect is found to be larger on total bank lending to corporates, and less on that to households, perhaps reflecting differences in capital requirements on lending to each sector. The impact on GDP growth is statistically insignificant.

The productivity puzzle: a firm-level investigation into employment behaviour and resource allocation over the crisis

Summary of Working Paper No. 495 Alina Barnett, Adrian Chiu, Jeremy Franklin and María Sebastiá-Barriel

Labour productivity growth in the United Kingdom has been exceptionally weak since the 2007/08 financial crisis and currently lies around 14 percentage points below the level implied by its pre-crisis trend growth rate. This phenomenon is commonly referred to as the UK 'productivity puzzle'. Such a prolonged period of weakness in labour productivity stands out from historical and international experiences.

This paper uses firm-level data collected by the Office for National Statistics (ONS) to improve our understanding about the drivers of the weakness in UK labour productivity. This analysis only covers the period to 2011, so cannot shed light on the strength in UK employment in 2012 and 2013.

There are two main objectives. First, to set out some stylised facts about productivity across both time and firm dimensions. Within this part we also discuss how representative our results are for the UK economy as a whole by comparing employment and gross value added in our sample of firms to ONS aggregate statistics. We observe that the productivity experience across firms of different sizes has been varied. Labour productivity fell more sharply for small and medium-sized enterprises (SMEs) at the onset of the crisis than for large firms, but by 2011 the weakness in productivity relative to its pre-crisis trend appears relatively evenly distributed across SMEs and large firms. Second, we examine the changing role of resource reallocation on UK productivity growth before and after the financial crisis.

There are two key findings that stand out. First, we find that a large part of the persistent weakness in productivity can be accounted for by the fact that the proportion of firms with shrinking output and flat employment doubled from 11% in 2005–07 to 22% in 2011. At any point in the economic cycle we see some firms who are growing and hiring more workers, while other firms are shrinking and reducing employment. At the onset of the financial crisis there was a significant decline in the proportion of firms that were growing and hiring, and a rise in the number of firms that were shrinking and firing. But by 2011, a large concentration of firms emerged that had shrinking output but no change in employment. This suggests that firms were able to respond flexibly to weak demand conditions by retaining staff at the expense of measured productivity, suggestive of an opening up of spare capacity within firms. This result implies a more temporary or cyclical explanation of the productivity slowdown in the United Kingdom, as these firms may have been well placed to increase production quickly without hiring when demand conditions started to strengthen. However, the strength of recent hiring behaviour since 2012 implies that this may now be less of a factor.

The second key finding relates to the role resource allocation played in the slowdown of labour productivity growth. Reallocation is the process through which factors of production move from lower to higher productivity firms, helping to take advantage of market expansion opportunities and generate aggregate increases in productivity. We find that labour reallocation, which includes movements in labour brought about by company formation and dissolution, and within-firm productivity improvements were equally important in driving productivity growth between 2002 and 2007. However since the crisis, the role of reallocation fell significantly while the contribution of within-firm productivity to aggregate productivity growth turned negative. Taken together, we find that a third of the shortfall in labour productivity since the crisis can be attributed to slower resource allocation across firms. The rest is due to productivity weakness within firms. This result is indicative of a more persistent interpretation of the UK productivity slowdown. There may be a number of factors that have slowed the reallocation process; for example a disrupted financial sector or heightened uncertainty about the economic environment. Since our data are at the firm and not plant level, these within-firm changes will not include any reallocation effects across individual plants that sit within particular firm entities and may, therefore, underestimate the scale of these reallocation effects.

We believe that the effect of reallocation on measured productivity may have been low in part because a greater proportion of firms facing difficulties have managed to survive the latest recession compared to previous ones. As discussed in the Bank of England's August 2013 *Inflation Report*, the number of company liquidations has remained unusually low this recession given developments in output. There may be several factors that may have helped firms survive, for example the low level of Bank Rate, weak real wage growth and any forms of loan forbearance (the extent of SME forbearance is discussed in the 2013 Q4 *Quarterly Bulletin*). To try to understand the likely magnitude of this effect, we develop a scenario to examine what might have happened to measured labour productivity should firm deaths have increased to a level more consistent with the 1990s recession. Because our data set only goes back to 1997, and therefore does not include previous recessions, we use ONS aggregate statistics to inform our counterfactual exercise. We find that the unusually low level of business failure is likely to have materially lowered measured labour productivity. Nonetheless, lower business failure, and the resultant lower unemployment, probably meant that the loss to GDP and general welfare associated with the financial crisis was smaller than it otherwise would have been.

Overall, our key findings suggest that the slowdown in UK productivity is likely to have coincided with an opening of spare capacity at the onset of the recession, as firms reacted flexibly to the weakness in demand by retaining staff. However, the strength in aggregate employment since 2012 implies that this may now be less of a factor. We also find that reallocation between firms (in terms of both the movement of labour and firm entry and exit) contributed significantly to aggregate productivity growth before the crisis, but its contribution fell substantially after. The speed at which labour productivity is able to grow in the short to medium term may be limited by the extent to which impaired allocation of resources across the economy continues to be a binding constraint. But exactly how companies and resources will respond as demand recovers remain key questions for the economic outlook.

Uncertainty in a model with credit frictions

Summary of Working Paper No. 496 Ambrogio Cesa-Bianchi and Emilio Fernandez-Corugedo

At around the time of Lehman Brothers' collapse, the world economy experienced a large contraction in economic activity. This was followed by an anaemic recovery and high levels of economic uncertainty by many measures. In the past few years, policymakers have often cited elevated uncertainty as a key reason why GDP growth in the United Kingdom and elsewhere has been sluggish. Despite this widely held belief that it has been important, the exact role that uncertainty plays in economic agents' decisions is hard to gauge. This makes it important to understand what the mechanisms may be, not least to be able to better offset any negative effects.

One long-held notion is that, when uncertainty about their future stream of income rises, households increase their savings and decrease their consumption. This is known as precautionary savings. But departures from the paradigm of frictionless financial markets can create additional channels through which uncertainty can affect macroeconomic outcomes. For example, when the relation between lender and borrower is subject to incomplete information, an increase in uncertainty will in general raise the cost of external finance.

This paper investigates the relationship between uncertainty and economic activity in a model that embodies both the precautionary savings and the cost of external finance channels. But what do we mean by uncertainty? There are many different notions and many different ways to model it. Economic theory generally hinges on the idea that macroeconomic fluctuations are the result of exogenous shocks to some key variables (for example to the level of productivity). In this paper we analyse the impact of uncertainty shocks, ie shocks to the variance rather than the level of those variables. For example, an uncertainty shock to productivity would increase its volatility without affecting its average level.

In our model, households consume, invest their savings in safe bank deposits, and supply labour to firms. In turn, firms produce goods with a technology whose productivity is subject to economy-wide shocks. Households' income depends on this aggregate productivity. Therefore, we define an increase in the volatility of aggregate productivity as a macro uncertainty shock.

Our model also has entrepreneurs who transform unfinished capital into finished capital with a technology that is subject to idiosyncratic (ie not aggregate but specific to the firm) productivity shocks. Entrepreneurs are heterogeneous, since their productivity will differ depending on the realisation of the idiosyncratic shock. And they need to borrow from banks to finance unfinished capital purchases. We assume that there are informational discrepancies between the lender and borrower which create a credit friction. We also assume that adverse shocks to idiosyncratic productivity may induce entrepreneurs to default on their debt. As a result, banks optimally charge a lending rate higher than the rate of return of a safe asset, thereby creating a spread between the two rates. An increase in the dispersion of entrepreneurs' productivity (or a micro uncertainty shock) induces banks to charge a higher spread, therefore reducing their demand for capital.

Our model simulations show that micro uncertainty shocks have a bigger impact on growth than macro uncertainty shocks. Specifically, we set the time-series properties of micro and macro uncertainty to match US data. We find that a two standard deviation increase in micro uncertainty generates a fall in GDP of 1.4 percentage points, relative to a fall of less than 0.1 in response to a two standard deviation shock to macro uncertainty.

Intuitively, while macro uncertainty operates primarily through the precautionary savings channel, micro uncertainty acts through the cost of external debt and capital demand and, therefore, it is greatly magnified by the credit friction.

Our results have important implications. Uncertainty shocks seem to have a first-order impact only when 'directly' interacted with credit market imperfections. We do not interpret this evidence as suggesting that uncertainty affects the economy mainly through investment and only to a lesser extent through consumption. Indeed, if households were to borrow in imperfect credit markets, the same amplification mechanism observed for entrepreneurs would be at work. Instead, our results suggest that uncertainty shocks can generate sizable impact on economic activity only when transmitted through a credit channel. It may be that when financial markets are performing better, the impact of uncertainty may diminish.

The international transmission of bank capital requirements: evidence from the United Kingdom

Summary of Working Paper No. 497 Shekhar Aiyar, Charles W Calomiris, John Hooley, Yevgeniya Korniyenko and Tomasz Wieladek

The global financial crisis of 2008 has led to an increasing focus on macroprudential regulation. An important element of macroprudential regimes going forward will be time-varying minimum capital requirements on banks. Higher capital requirements could make banks more resilient to adverse shocks. But as part of their adjustment to higher capital requirements, banks may cut back lending, especially if capital requirements are binding and bank equity is more costly to raise than bank debt. In light of these theoretical predictions, previous work has examined the impact of changes in capital requirements on the domestic loan supply.

But there is little reason to think that the response to capital requirement changes would be restricted to the country in which the regulatory change originates. In this paper we examine whether a rise in microprudential minimum capital requirements on UK banks is transmitted to foreign economies through a change in the supply of cross-border credit for the period 1999 Q1–2006 Q4. The United Kingdom provides an ideal testing ground for this analysis, for at least two reasons. First, UK-resident banks tend to be very globalised, not just through affiliated banks abroad, but also through cross-border lending and liabilities. Second, during the 1990s and 2000s the UK microprudential regulator, the Financial Services Authority, imposed bank-specific, time-varying minimum capital requirements on the banks under its purview. Merging these regulatory data with detailed data on each bank's cross-border lending creates a unique database that is well suited to identifying the cross-border credit supply impact of minimum capital requirements. In particular, we can observe quarterly cross-border lending by each bank to up to 145 countries. The detailed recipient country-level data allow us to control for demand with fixed effects and therefore give a loan supply interpretation to our estimates.

We find that a change in minimum capital requirements indeed elicits a robust cross-border supply response by affected banks: a 100 basis point increase in the capital requirement is associated with a reduction in the growth rate of cross-border credit of 5.5 percentage points. Overall, this is broadly similar to the effects of between 5.7% and 7.6% reported in studies that focus on the transmission to the domestic credit supply. Banks also tend to favour their most important country relationships, so that the cross-border credit supply response in 'core' countries — defined as countries that tend to be important destinations for cross-border lending from the perspective of the individual bank — is significantly less than in others. Furthermore, we find that banks tend to cut back cross-border credit to other banks (including foreign affiliates) rather than to firms and households. That observation is consistent with a greater willingness, or ability, to cut back on shorter maturity, wholesale lending. This implies that an important part of the cross-border transmission of capital requirements occurs through a liquidity shock to foreign banking systems. We do not find a significant impact on direct cross-border credit to non-banks (ie firms and households).

The two faces of cross-border banking flows: an investigation into the links between global risk, arms-length funding and internal capital markets

Summary of Working Paper No. 498 Dennis Reinhardt and Steven J Riddiough

Cross-border funding between banks is an economically important source of finance. It is comprised of two distinctive forms of funding. First, there is *arms-length* (interbank) funding, that takes place between unrelated banks. Second, there is related (intragroup) funding that takes place between global banks and their foreign affiliates within an *internal capital market*. It has been documented how there is a risk that both forms of funding are withdrawn during periods of heightened risk in the global financial system, and economic theory predicts that the two forms should behave in the same way during a financial crisis.

Yet, the two forms of funding have key differences, which may mean they behave differently during a crisis. Within an internal capital market, a global parent bank has the power to shift liquidity from one part of its group to another. Additionally, a bank lending internally has more information about their counterparties' overall riskiness, relative to banks lending at arms-length. The differences could influence the way the two flows behave in response to fluctuations in risk in the global financial system. It is therefore possible that some countries' banking systems could be more insulated from heightened global risk than others, depending on their mix of interbank and intragroup funding and the share of intragroup funding held by global parent banks relative to foreign affiliates.

In this paper, we empirically study the behaviour of *disaggregated* cross-border bank-to-bank funding — disaggregated into interbank and intragroup funding — in relation to swings in risk in the global financial system. We do so by sequentially decomposing aggregate cross-border funding between banks, across 25 advanced and emerging market economies, using data on cross-border banking flows from the Bank for International Settlements. First, we split funding to banks in a particular country into two baskets (i) funding between *arms-length* counterparties (interbank flows) and (ii) funding between banks within the same banking group (intragroup flows). Next, to paint a more detailed picture, we further disaggregate intragroup funding between flows to parent banks and flows to foreign affiliate banks.

We find that a period of high and rising global risk aversion, such as that witnessed following the collapse of Lehman Brothers, results in markedly different behaviour in interbank and intragroup flows. Intragroup funding, which makes up around half of all cross-border funding between banks, *rises* when global risk increases and is invariant to periods of high global risk. Interbank funding displays the opposite behaviour — it is withdrawn during periods of high global risk, with emerging economies particularly vulnerable. These findings contradict the theoretical prediction that both interbank and intragroup flows will contract during periods of heightened global risk. In fact, each country's mix of interbank and intragroup funding alone, can explain up to 45% of the change in cross-border bank-to-bank funding across countries, following the collapse of Lehman Brothers. We also reveal further information about the behaviour of cross-border banking flows. For example, the decision to withdraw interbank funding during the financial crisis is found to have been closely related to whether a country was experiencing a systemic banking crisis.

We show that higher intragroup funding during periods of heightened risk is principally driven by global banks headquartered in advanced economies, receiving funding from their foreign affiliates. We find that banking systems with a high share of global banks were relatively well insulated against funding withdrawals during the global financial crisis. But we do not find evidence of significantly reduced intragroup funding to foreign affiliates in either advanced or emerging economies during periods of high global risk. In fact, we find that foreign affiliates resident in emerging economies experience an *increase* in intragroup funding, when the average profitability of banks in the local economy is low. This result is found to hold even during the financial crisis, indicative of the beneficial role financial globalisation can play for emerging economies with resident foreign banks.

Overall, the results call for policymakers and academics to focus attention on the disaggregation of cross-border bank-to-bank flows, as the contrasting behaviour of interbank and intragroup funding in response to fluctuations in global risk has implications for a banking system's financial stability.

Sectoral shocks and monetary policy in the United Kingdom

Summary of Working Paper No. 499 Huw Dixon, Jeremy Franklin and Stephen Millard

A key question for monetary policy makers is how to deal with 'relative price' shocks; that is, movements in individual prices that do not reflect aggregate inflationary pressure but that can, as a result of nominal rigidities, lead to temporary changes in inflation. This question has gained in importance in recent years as the United Kingdom has been affected by shocks to the price of food and energy, which fall into the category of relative price shocks. In order to get at this question, this paper develops a framework within which we can examine sectoral shocks, their effects on the UK economy and how monetary policy makers should respond to them. More specifically, our framework links together news in the consumer prices index (CPI) data at the sectoral level and the behaviour of the economy at the aggregate level. Such a framework can be used to address several questions about the links between prices at the aggregate and sectoral levels as well as the particular issue of how monetary policy should respond to movements in sectoral prices.

Before constructing our model, we first investigate the empirical properties of quarterly sectoral inflation rates in the United Kingdom over the period 1988–2011. The idea is to generate some stylised facts with which we would like our model to be consistent. We find that the sectoral rates have much bigger variances than aggregate CPI inflation and that there is little cross-correlation of inflation across sectors. We also find that the persistence we observe in aggregate inflation comes mainly from the effect of the aggregate factors with sectoral shocks being white noise. Leaving aside food and energy, we find that sectoral shocks explain the majority of the variance of sectoral inflation rates, but explain little of the variance of aggregate inflation, which is mostly explained by macroeconomic factors.

We then use the UK CPI microdata for the period 1996–2006 to calibrate a 'Generalized Taylor Economy' (GTE) for each of the twelve Classification Of Individual Consumption by Purpose (COICOP) sectors. The idea of a GTE is that price changes are staggered with some firms in the sector changing their prices every quarter, some changing their prices every two quarters, and so on up to some who only change their price every twelve quarters. To calibrate the proportion of firms who change their prices every so many quarters, we estimate the cross-sectional distribution of firms whose prices have different durations within each COICOP sector. We can then use our model to trace out the effects of a productivity increase or decrease affecting a particular COICOP sector. The GTE model of pricing is then embedded into an open-economy macroeconomic model of the United Kingdom in which we separate food and energy out of the CPI sectors, giving them an independent role. We do this because these are both sectors where prices are largely determined outside the United Kingdom and have had a significant impact on inflation in specific periods. Doing so, in turn, enables us to examine the issue of the extent to which monetary policy should or should not respond to movements in food and energy prices.

The policy issue on which we focus is how monetary policy should respond to sectoral shocks, or whether it should concentrate instead on some measure of underlying inflation. In this paper, we look at two such measures: one that strips out the most volatile components of CPI inflation from the index and a second that strips out that part of CPI inflation that can be thought of as being 'external' to the United Kingdom, leaving only 'domestically generated' inflation.

In our model, we look at simple rules in which the central bank alters interest rates in response to movements in aggregate and sectoral inflation rates and output relative to trend. We find that the optimal rule in which interest rates respond to sectoral inflation rates leads to a small improvement over a rule in which interest rates only respond to aggregate inflation. However, this gain comes from partially looking through movements in aggregate inflation driven by movements in petrol price inflation, which is volatile and tends not to reflect underlying inflationary pressure.

Modelling the service sector

Summary of Working Paper No. 500 Philip King and Stephen Millard

In this paper, we try to understand better how service sector companies operate and to incorporate some of these features into an otherwise standard macroeconomic model so as to examine their implications. We have two motivations for doing this. First, in the wake of the financial crisis output fell dramatically while inflation remained above its target and productivity collapsed relative to its previous trend. The fall in productivity relative to trend was pronounced within the service sector, and then most particularly in certain subsectors such as 'Professional, Scientific and Technical Activities'. At the same time, CPI services inflation has remained in the 3% to 5% corridor it has occupied since at least 2000. Given the weight of services in the economy — 75% in GDP and 50% in the CPI — it would seem that understanding how this sector works is crucial if we are to understand how the economy as a whole responds to shocks. Second, most standard macroeconomic models assume that 'value added' is produced using capital and labour and raw materials and imports are combined with 'value added' to produce final output. Unfortunately, this model is not particularly representative of what happens in the service sector. For example, how do we measure the real output of, say, a firm of consultants, architects or estate agents? And what are the inputs of such firms? It is clear, for instance, that human capital and other forms of intangible capital such as goodwill, firm-specific knowledge and ways of doing things, and client bases, to name but a few, will be extremely important in enabling service companies to produce output. And these factors are also likely to affect price and wage-setting in the service sector. For example, given the difficulty in measuring output and hence productivity, together with the importance of individual-specific human capital, how do you determine wages in a service company?

In order to get a better idea of how service sector firms actually operate in practice, we first embarked on a series of structured visits to a set of firms that span the service sector. More specifically, we visited around 30 private sector service providers, with a roughly even spread across Standard Industrial Classification sectors. In each case, we asked the firm what they considered to be their outputs and inputs and how they went about measuring them; we asked them what they considered to be full capacity and how they might respond to increases in demand; and we asked them about the form that their investment undertook and, more generally, about how they were able to achieve improvements in productivity. Our visits suggested two important features of service sector firms: the need to spend time on 'marketing' given the search and matching frictions present in the market for, in particular, business services, and the high degree of 'scalability' of many services.

Armed with these insights about how the services sector works, we wanted to understand the macroeconomic implications. We therefore incorporated these features into an otherwise standard macroeconomic model and examined the response of output, inflation and sectoral and aggregate productivity to sector-specific productivity shocks and aggregate demand shocks. Our results suggest that, in sectors where these features were important, productivity should respond negatively to negative demand shocks. This contrasts with the positive response of productivity to negative demand shocks in standard models. In that case, the capital stock takes time to adjust, so when demand declines, employment declines more than output and productivity goes up.

We then used the model to examine the effect of a negative demand shock caused by a rise in spreads in line with that seen during the financial crisis. We find that the model can explain a small but important part of the observed fall in business services productivity, and a small but less significant part of the fall in productivity in 'scalable' services. We feel that our approach to modelling services has been successful given that we have matched qualitatively the fact that business services productivity has performed particularly badly since 2007 and the anecdotal evidence that this has been associated with an increased proportion of the workforce in these companies used in tasks such as winning and maintaining contracts and trying to build up customer relationships more broadly. We conclude that it is important to incorporate these features into our macroeconomic models if we are to understand the evolution of economies in which the service sector is so important, such as the United Kingdom.

Appendices

Contents of recent Quarterly Bulletins

The articles that have been published recently in the *Quarterly Bulletin* are listed below. Articles from December 1960 to Winter 2003 are available on the Bank's website at:

www.bankofengland.co.uk/archive/Pages/digitalcontent/historicpubs/quarterlybulletins.aspx.

Articles from Spring 2004 onwards are available at:

www.bankofengland.co.uk/publications/Pages/quarterlybulletin/default.aspx.

Articles

- Considering the continuity of payments for customers in a bank's recovery or resolution
- A review of the work of the London Foreign Exchange Joint Standing Committee in 2011

2012 Q3
- RAMSI: a top-down stress-testing model developed at the Bank of England
- What accounts for the fall in UK ten-year government bond yields?
- Option-implied probability distributions for future inflation
- The Bank of England's Real-Time Gross Settlement infrastructure
- The distributional effects of asset purchases
- Monetary Policy Roundtable

2012 Q4
- The Funding for Lending Scheme
- What can the money data tell us about the impact of QE?
- Influences on household spending: evidence from the 2012 NMG Consulting survey
- The role of designated market makers in the new trading landscape
- The Prudential Regulation Authority

2013 Q1
- Changes to the Bank of England
- The profile of cash transfers between the Asset Purchase Facility and Her Majesty's Treasury
- Private equity and financial stability
- Commercial property and financial stability
- The Agents' company visit scores
- The Bank of England *Bank Liabilities Survey*
- Monetary Policy Roundtable

2013 Q2
- Macroeconomic uncertainty: what is it, how can we measure it and why does it matter?
- Do inflation expectations currently pose a risk to the economy?
- Public attitudes to monetary policy
- Cross-border bank credit and global financial stability
- The Old Lady of Threadneedle Street
- Central counterparties: what are they, why do they matter and how does the Bank supervise them?
- A review of the work of the London Foreign Exchange Joint Standing Committee in 2012

2013 Q3
- Macroprudential policy at the Bank of England
- Bank capital and liquidity
- The rationale for the prudential regulation and supervision of insurers
- Recent developments in the sterling overnight money market
- Nowcasting world GDP and trade using global indicators
- The Natural Rate Hypothesis: an idea past its sell-by date
- Monetary Policy Roundtable

2013 Q4
- SME forbearance and its implications for monetary and financial stability
- Bringing down the Great Wall? Global implications of capital account liberalisation in China
- Banknotes, local currencies and central bank objectives
- Banks' disclosure and financial stability
- Understanding the MPC's forecast performance since mid-2010
- The financial position of British households: evidence from the 2013 NMG Consulting survey
- What can company data tell us about financing and investment decisions?
- Tiering in CHAPS
- The foreign exchange and over-the-counter interest rate derivatives market in the United Kingdom
- Qualitative easing: a new tool for the stabilisation of financial markets

2014 Q1
- Money in the modern economy: an introduction
- Money creation in the modern economy
- The Court of the Bank of England
- Dealing with a banking crisis: what lessons can be learned from Japan's experience?
- The role of business model analysis in the supervision of insurers
- Nowcasting UK GDP growth
- Curiosities from the vaults: a Bank miscellany
- Monetary Policy Roundtable

2014 Q2
- The UK productivity puzzle
- The Bank of England as a bank
- Credit spreads: capturing credit conditions facing households and firms
- Assessing the risk to inflation from inflation expectations
- Public attitudes to monetary policy
- How have world shocks affected the UK economy?
- How has the Liquidity Saving Mechanism reduced banks' intraday liquidity costs in CHAPS?
- Risk managing loan collateral at the Bank of England
- Sterling Monetary Framework Annual Report 2013–14
- A review of the work of the London Foreign Exchange Joint Standing Committee in 2013

Bank of England publications

The Bank of England publishes information on all aspects of its work in many formats. Listed below are some of the main Bank of England publications. For a full list, please refer to our website:

www.bankofengland.co.uk/publications/Pages/default.aspx.

Working papers

An up-to-date list of working papers is maintained on the Bank of England's website at:

www.bankofengland.co.uk/research/Pages/workingpapers/default.aspx

where abstracts of all papers may be found. Papers published since January 1997 are available in full, in portable document format (PDF).

No. 490 Adaptive forecasting in the presence of recent and ongoing structural change (March 2014)
Liudas Giraitis, George Kapetanios and Simon Price

No. 491 Household debt and the dynamic effects of income tax changes (March 2014)
James Cloyne and Paolo Surico

No. 492 Generalised density forecast combinations (March 2014)
Nicholas Fawcett, George Kapetanios, James Mitchell and Simon Price

No. 493 The macroeconomic effects of monetary policy: a new measure for the United Kingdom (March 2014)
James Cloyne and Patrick Hürtgen

No. 494 Estimating the impact of changes in aggregate bank capital requirements during an upswing (March 2014)
Joseph Noss and Priscilla Toffano

No. 495 The productivity puzzle: a firm-level investigation into employment behaviour and resource allocation over the crisis (April 2014)
Alina Barnett, Adrian Chiu, Jeremy Franklin and María Sebastiá-Barriel

No. 496 Uncertainty in a model with credit frictions (April 2014)
Ambrogio Cesa-Bianchi and Emilio Fernandez-Corugedo

No. 497 The international transmission of bank capital requirements: evidence from the United Kingdom (April 2014)
Shekhar Aiyar, Charles W Calomiris, John Hooley, Yevgeniya Korniyenko and Tomasz Wieladek

No. 498 The two faces of cross-border banking flows: an investigation into the links between global risk, arms-length funding and internal capital markets (April 2014)
Dennis Reinhardt and Steven J Riddiough

No. 499 Sectoral shocks and monetary policy in the United Kingdom (April 2014)
Huw Dixon, Jeremy Franklin and Stephen Millard

No. 500 Modelling the service sector (May 2014)
Philip King and Stephen Millard

External MPC Unit discussion papers

The MPC Unit discussion paper series reports on research carried out by, or under supervision of, the external members of the Monetary Policy Committee. Papers are available from the Bank's website at:

www.bankofengland.co.uk/research/Pages/externalmpcpapers/default.aspx.

The following papers have been published recently:

No. 41 The relevance or otherwise of the central bank's balance sheet (January 2014)
David Miles and Jochen Schanz

No. 42 What are the macroeconomic effects of asset purchases? (April 2014)
Martin Weale and Tomasz Wieladek

Monetary and Financial Statistics

Monetary and Financial Statistics (*Bankstats*) contains detailed information on money and lending, monetary and financial institutions' balance sheets, banks' income and expenditure, analyses of bank deposits and lending, external business of banks, public sector debt, money markets, issues of securities, financial derivatives, interest and exchange rates, explanatory notes to tables and occasional related articles.

Bankstats is published on a monthly basis, free of charge, on the Bank's website at:

www.bankofengland.co.uk/statistics/Pages/bankstats/default.aspx.

Further details are available from: Leslie Lambert, Statistics and Regulatory Data Division, Bank of England: telephone 020 7601 4544; fax 020 7601 5395; email leslie.lambert@bankofengland.co.uk.

Articles that have been published in recent issues of *Monetary and Financial Statistics* can also be found on the Bank's website at:

www.bankofengland.co.uk/statistics/Pages/ms/articles.aspx.

Financial Stability Report

The *Financial Stability Report* is published twice a year under the guidance of the Financial Policy Committee (FPC). It covers the Committee's assessment of the outlook for the stability and resilience of the financial sector at the time of preparation of the *Report*, and the policy actions it advises to reduce and mitigate risks to stability. The Bank of England intends this publication to be read by those who are responsible for, or have interest in, maintaining and promoting financial stability at a national or international level. It is of especial interest to policymakers in the United Kingdom and abroad; international financial institutions; academics; journalists; market infrastructure providers; and financial market participants. The *Financial Stability Report* is available at:

www.bankofengland.co.uk/publications/Pages/fsr/default.aspx.

Handbooks in central banking

The series of *Handbooks in central banking* provide concise, balanced and accessible overviews of key central banking topics. The *Handbooks* have been developed from study materials, research and training carried out by the Bank's Centre for Central Banking Studies (CCBS). The *Handbooks* are therefore targeted primarily at central bankers, but are likely to be of interest to all those interested in the various technical and analytical aspects of central banking. The *Handbook* series also includes '*Technical Handbooks*' which are aimed more at specialist readers and often contain more methodological material than the *Handbooks*, incorporating the experiences and expertise of the author(s) on topics that address the problems encountered by central bankers in their day-to-day work. All the *Handbooks* are available via the Bank's website at:

www.bankofengland.co.uk/education/Pages/ccbs/handbooks/default.aspx.

The framework for the Bank of England's operations in the sterling money markets (the 'Red Book')

The 'Red Book' describes the Bank of England's framework for its operations in the sterling money markets, which is designed to implement the interest rate decisions of the Monetary Policy Committee while meeting the liquidity needs, and so contributing to the stability of, the banking system as a whole. It also sets out the Bank's specific objectives for the framework, and how it delivers those objectives. The framework was introduced in May 2006. The 'Red Book' is available at:

www.bankofengland.co.uk/markets/Documents/money/publications/redbook.pdf.

Cost-benefit analysis of monetary and financial statistics

The handbook describes a cost-benefit analysis (CBA) framework that has been developed within the Bank to ensure a fair balance between the benefits derived from good-quality statistics and the costs that are borne by reporting banks. Although CBA is a well-established approach in other contexts, it has not often been applied to statistical provision, so techniques have had to be adapted for application to the Bank's monetary and financial statistics. The handbook also discusses how the application of CBA has enabled cuts in both the amount and the complexity of information that is required from reporting banks.

www.bankofengland.co.uk/statistics/Pages/about/cba.aspx.

Credit Conditions Survey

As part of its mission to maintain monetary stability and financial stability, the Bank needs to understand trends and developments in credit conditions. This survey for bank and non-bank lenders is an input to this work. Lenders are asked about the past three months and the coming three months. The survey covers secured and unsecured lending to households and small businesses; and lending to non-financial

corporations, and to non-bank financial firms. Copies are available on the Bank's website at:

www.bankofengland.co.uk/publications/Pages/other/monetary/creditconditions.aspx.

Trends in Lending

This quarterly publication presents the Bank's assessment of the latest trends in lending to the UK economy. This report draws mainly on long-established official data sources, such as the existing monetary and financial statistics collected by the Bank that cover all monetary financial institutions, and other data collections established since the start of the financial crisis. These data are supplemented by discussions between the major UK lenders and Bank staff, giving staff a better understanding of the business developments driving the figures and this intelligence is reflected in the report. The report also draws on intelligence gathered by the Bank's network of Agents and from market contacts, as well as the results of other surveys. Copies are available on the Bank's website at:

www.bankofengland.co.uk/publications/Pages/other/monetary/trendsinlending.aspx.

Quarterly Bulletin

The *Quarterly Bulletin* explores topical issues relating to the Bank's core purposes of monetary and financial stability. Some articles present analysis on current economic and financial issues, and policy implications. Other articles enhance the Bank's public accountability by explaining the institutional structure of the Bank and the various policy instruments that are used to meet its objectives. The *Quarterly Bulletin* is available at:

www.bankofengland.co.uk/publications/Pages/quarterlybulletin/default.aspx.

Inflation Report

The Bank's quarterly *Inflation Report* sets out the detailed economic analysis and inflation projections on which the Bank's Monetary Policy Committee bases its interest rate decisions, and presents an assessment of the prospects for UK inflation. The *Inflation Report* is available at:

www.bankofengland.co.uk/publications/Pages/inflationreport/default.aspx.

The *Report* starts with an overview of economic developments; this is followed by five sections:

- analysis of money and asset prices;
- analysis of demand;
- analysis of output and supply;
- analysis of costs and prices; and
- assessment of the medium-term inflation prospects and risks.

Publication dates

Publication dates for 2014 are as follows:

Quarterly Bulletin		*Inflation Report*	
Q1	14 March	February	12 February
Q2	16 June	May	14 May
Q3	16 September	August	13 August
Q4	8 December	November	12 November

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