

Quarterly Bulletin

2014 Q3 | Volume 54 No. 3



BANK OF ENGLAND





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Topical articles



Innovations in payment technologies and the emergence of digital currencies

By Robleh Ali of the Bank's Financial Market Infrastructure Directorate, John Barrdear of the Bank's Monetary Assessment and Strategy Division, and Roger Clews and James Southgate of the Bank's Markets Directorate.⁽¹⁾

- Modern electronic payment systems rely on trusted, central third parties to process payments securely. Recent developments have seen the creation of digital currencies like Bitcoin, which combine new currencies with decentralised payment systems.
- Although the monetary aspects of digital currencies have attracted considerable attention, the distributed ledger underlying their payment systems is a significant innovation.
- As with money held as bank deposits, most financial assets today exist as purely digital records. This opens up the possibility for distributed ledgers to transform the financial system more generally.

Overview

Money and payment systems are intrinsically linked. In order for an asset to function as a medium of exchange, there needs to be a secure way of transferring that asset — a payment system. And for any system other than the exchange of physical banknotes or coins, a means of recording the values stored is also needed — a ledger. Modern payment systems are computerised and most money exists only as digital records on commercial banks' accounts.

This article considers recent innovations in payments technology, focusing on the emergence of privately developed, internet-based digital currencies such as Bitcoin. Digital currency schemes combine both new payment systems and new currencies. Users can trade digital currencies with each other in exchange for traditional currency or goods and services without the need for any third party (like a bank). And their creation is not controlled by any central bank. Bitcoin — currently the largest digital currency — was set up in 2009 and several thousand businesses worldwide currently accept bitcoins in payment for anything from pizza to webhosting. Most digital currencies, including Bitcoin, incorporate predetermined supply paths leading to fixed eventual supplies. An overview of how digital currencies work, including the creation of new currency, is included in this article.

Much of the media focus to date has been on the new currencies themselves (such as 'bitcoins') and the large price swings that these have experienced.

This article argues, however, that the key innovation of digital currencies is the 'distributed ledger' which allows a payment system to operate in an entirely decentralised way, without intermediaries such as banks. This innovation draws on advances from a range of disciplines including cryptography (secure communication), game theory (strategic decision-making) and peer-to-peer networking (networks of connections formed without central co-ordination).

When payment systems were first computerised, the underlying processes were not significantly changed. Distributed ledger technology represents a fundamental change in how payment systems could work. And in principle, this decentralised approach is not limited to payments. For instance, the majority of financial assets such as shares or bonds already exist only as digital records, stored on centralised databases.

A **companion piece to this article** focuses in more detail on the economics of digital currencies. It considers the extent to which they serve the roles of money, the incentives embedded in the design of the schemes and touches on some of the risks they may pose to the monetary and financial stability of the United Kingdom if they reached significant scale.

[Click here for a short video that discusses some of the key topics from this article.](#)

(1) The authors would like to thank Victoria Cleland, Danny Eckloff and Tom Ludlow for their help in producing this article.

Money and payment systems are intrinsically linked. They evolved together and this connection remains evident in the responsibilities of many central banks, including the Bank of England’s role of ensuring both the stability of the currency and the payment systems which support the UK economy. Recent innovations in payment technologies have prompted great interest, particularly those that also incorporate ‘digital currencies’.

This article provides a brief overview of how payment technologies, and the principles that underpin secure and reliable payments, have evolved from the 16th century up to the present day. It considers the key risks that arise and need to be mitigated in modern payment systems. It then considers the motivation behind some of the more recent developments in payment systems and currencies, and to what extent these truly represent a new technological or economic model. In particular, it focuses on the key technological development that underpins digital currencies: the creation of a distributed ledger. It considers the extent to which this new technology eliminates some of the risks traditionally found in payment systems, as well as some of the new risks it poses. Finally, it considers to what extent this distributed ledger model could have other applications beyond payments. A short video explains some of the key topics covered in this article.⁽¹⁾

A companion piece to this article, ‘[The economics of digital currencies](#)’, considers the extent to which digital currencies may be considered money; some of the challenges the existing schemes could face over the longer term; and provides an initial assessment of the risks that digital currency schemes may, in time, pose to the Bank’s mission through their potential impact on UK monetary and financial stability.⁽²⁾ Other issues such as those concerning consumer protection, taxation and money laundering are beyond the scope of this article, but some publications from other institutions regarding some of these issues are cited in the companion article.

The evolution of payment technology

The payment technology used in most economies today evolved from the early banking system and still retains structural characteristics from those roots. Early payments were made by exchanging intrinsically valuable items such as gold coins. When goldsmith banks emerged in the 16th century they kept ledgers of their customers’ deposits which enabled payments to be made by making changes in the ledgers rather than physically exchanging the assets. This only worked for customers who shared the same bank. Over time, the need to make payments between banks led to the emergence of a central ‘clearing’ bank at which all the member banks could hold accounts, making interbank payments much simpler. The box on page 264 traces the evolution of payment systems in more detail.

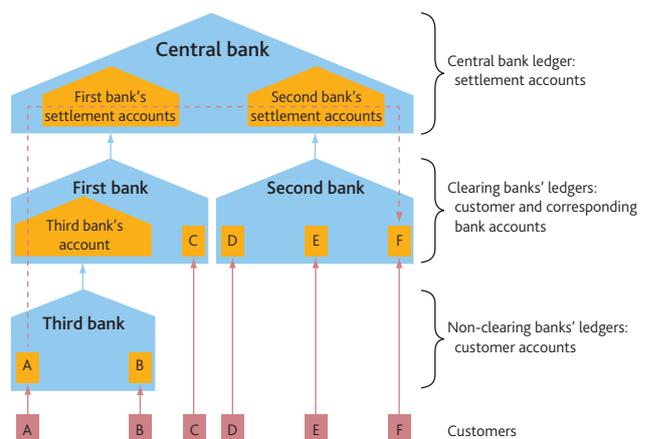
Modern payment systems

In modern payment systems, payments are made by reducing the balance in a customer’s account and increasing the balance in the recipient’s account by an equivalent amount — a process that has not changed since the 16th century. The difference lies in the technology employed to record the balances and transfer them between different banks.

Technological developments over the past 50 years have affected payment systems in two key ways. First, the records and ledgers have been converted from paper to electronic form, which has increased the speed of completing transactions and reduced operational risks. Second, the emergence of low-cost technology has allowed new payment schemes to emerge, such as mobile money schemes. These are discussed in [Figure 2](#) on page 265.

Despite the application of new technology, the basic structure of centralised payment systems has remained unchanged. At the heart lies a central ledger, with settlement taking place across the books of a central authority, acting as a clearing bank (a service usually undertaken by the central bank of a given economy).⁽³⁾ Each participant, typically a commercial financial institution, holds a balance at the central bank,⁽⁴⁾ recorded in the ledger, but also reflected in the participant bank’s own (internal) ledger. Individual customers, branches, or even other (typically smaller) banks would then hold balances at the participant bank, which would again be reflected in their own ledger. This ‘tiered’ arrangement is illustrated in [Figure 1](#). The example traces a payment being made from one person to another via their commercial banks and the central bank.

Figure 1 A tiered payment system



Note: A payment from A’s account to F’s account passes through a number of intermediaries, which verify each step of the process. Participants only have sight of their own assets and liabilities. The solid lines indicate deposits and the dashed line payments.

(1) http://youtu.be/CxDKE_gQX_M.
 (2) See Ali *et al* (2014).
 (3) For more discussion of the role of the central bank in payment systems see Manning, Nier and Schanz (2009) and Norman, Shaw and Speight (2011).
 (4) Settlement accounts may also serve as reserves accounts. And banks without settlement accounts may hold reserves accounts for other purposes. For the role of reserves see McLeay, Radia and Thomas (2014).

A brief history of money and payment systems

Throughout history there have been many different manifestations of money, both physical and electronic. Economists identify money through the roles that it serves in society. In particular, something may be considered money from the perspective of economic theory to the extent that it serves as a **medium of exchange** with which to make payments; a **store of value** with which to transfer 'purchasing power' (the ability to buy goods and services) from today to some future date; and a **unit of account** with which to measure the value of any particular item for sale.

In order for money to function as a medium of exchange, there needs to be a system to enable transfers of value — that is, a payment system — and for any system other than the exchange of physical banknotes or coins, a means of recording the values stored — a ledger.

Coins made of precious metals were one of the earliest methods of making payments in a number of regions of the world. Physical possession of the instrument denoted ownership, and the act of physical transfer acted as the payment system.

When goldsmith banks emerged in the 16th century, they issued notes — essentially IOUs — as receipts for gold deposits made with them. These IOUs could be transferred from one individual to another. Each bank kept its own ledger and in the earliest days there was no interbank settlement — that is, no

way in which the ledgers of individual banks and branches could be 'connected' — so the notes could only be redeemed at the bank and the branch where they were issued. This meant that any payment requiring the transfer of money to a different bank would require the bearer of a note to first convert it into gold and then to physically transport it to the new bank, a cumbersome process.

The pressure to reduce these transaction costs led to banks starting to accept claims on each other. This innovation made trading more convenient as merchants could now deposit notes from other banks directly into their own bank, eliminating the burden of converting paper money into gold in order to transfer the funds. In accepting the note from a different bank, though, the payee's bank faced a new problem in that it was now exposed to the payer's bank until settlement in gold could be arranged. Where note acceptance was limited to a small number of banks this could be handled bilaterally. But as the number of banks in the system increased, interbank payments became more cumbersome and the incentive for banks to create a more efficient system increased.

The solution that eventually emerged was for one 'clearing' bank to sit at the centre of the system, with all member banks holding accounts with the clearing bank. The system worked by requiring all the member banks to hold balances against the risks they brought to the system. The bank operating the clearing system was, in effect, taking on some of the functions of a central bank (Goodhart (1988)).

New developments in payment systems and alternative currencies

A variety of developments in payment technologies and alternative currencies have emerged in recent years. Some of these innovations focus on making payments more accessible to a wider range of users — such as mobile phone payments — while still relying on a trusted central entity. More recent innovations have introduced a fundamentally different, decentralised structure to payment systems by relying on cryptography rather than a central authority. **Figure 2** describes four categories of recent innovations and some of their characteristics. They are split according to whether they establish a new payment system, a new currency, neither, or both (summarised in **Table A**).

There are some caveats to this simple categorisation. For example, while local currencies technically represent new currencies, any such scheme operating at a one-to-one fixed exchange rate and backed by national currencies bears a close relationship with an existing currency. It is also important, in

Table A Types of innovation

Category	New payment system	New currency
I: Wrappers	No	No
II: Mobile money	Yes	No
III: Credits and local currencies	No	Yes
IV: Digital currencies	Yes	Yes

the final category, to distinguish between digital currencies as candidate payment systems and digital currencies as potential forms of money. Although Bitcoin introduced a new currency and a new payment technology together, the distributed ledger technology could, in theory, be used without the creation of a new currency. As emphasised by Haldane and Qvigstad (2014), it would technically be possible for an existing central bank to issue digital-only liabilities in a distributed-ledger payment system equivalent to those deployed by recent digital currencies.

Figure 2 Recent innovations in payment technologies

<p>Category I: Wrappers</p> 	<p>Category II: Mobile money</p> 
<p>The first category of innovation focuses on providing 'wrapper' services to improve the user interface and accessibility of existing payment systems architecture. These innovations therefore represent neither a new currency nor a new core payments system.</p> <p>The core motivation can be either new entrants seeking to capture a segment of the market, or incumbents seeking to improve market share and reduce consumer use of other, more expensive payment systems. Examples include Google Wallet, Apple Pay and Paym, which builds on the existing infrastructure to make payments by linking users' mobile phone numbers to their bank accounts.</p>	<p>These schemes represent new payment systems, with money stored as credits on a smart card or a system-provider's books, but continue to use national currencies. One example is M-Pesa, a popular service in Kenya that grants access to financial services, including payments, to anybody with a mobile phone.</p> <p>In areas where access to traditional banking infrastructure is limited, development and adoption of new payment systems serves to fulfil otherwise unmet demand. In more developed economies, new payment systems are probably developed in response to the high margins associated with incumbent systems and adopted on the basis of their ease of use.</p>
<p>Category III: Credits and local currencies</p> 	<p>Category IV: Digital currencies</p> 
<p>This category relies on users trusting a new currency as a unit of account and medium of exchange. Credits are schemes in which private companies accept money in exchange for an alternative unit of account which can be spent on a particular platform (such as within an online game). Nevertheless, they generally make use of existing payment systems, including use of 'wrapper' services, to make transfers. Local currencies are similar in that people exchange national currencies for a local equivalent which can be spent in a specific geographical area. UK local currencies such as the Bristol Pound are often backed by and remain on a fixed exchange rate with sterling. Naqvi and Southgate (2013) consider local currencies in more detail.</p> <p>A key motivation for both the development and the adoption of local currencies surrounds a desire to promote spending at, and between, participants of the scheme in order to boost economic activity in a specific region, support local sustainability and shorten supply chains.</p>	<p>A digital currency scheme incorporates both a new decentralised payment system and a new currency. All the schemes exhibit a publicly visible ledger which is shared across a computing network. A key defining feature of each digital currency scheme is the process by which its users come to agree on changes to its ledger (that is, on which transactions to accept as valid).</p> <p>Most digital currencies are 'cryptocurrencies', in that they seek consensus through means of techniques from the field of cryptography. There are also a small number of digital currencies, the most prominent of which is Ripple, that seek consensus through non-cryptographic means.⁽¹⁾</p> <hr/> <p><small>(1) It is possible to have a digital currency with a centralised ledger. This is not discussed in this article because there is no recent example of a digital currency operating in this way.</small></p>

The rest of this section provides an introduction to Bitcoin — currently the most prominent example of a digital currency — including a brief discussion of the motivation for setting up and using a digital currency.

What is Bitcoin?

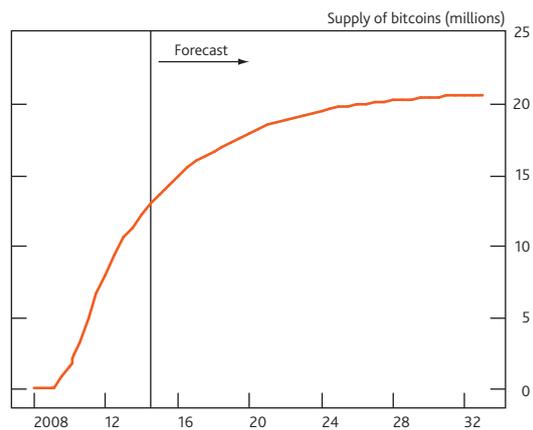
Bitcoin was the first, and remains the largest, functioning digital currency. It was launched in January 2009 and is a privately developed, internet-based currency and payment system that requires no intermediaries (like banks) for the processing of payments. Furthermore, the supply of bitcoins is not controlled by a central bank.⁽¹⁾ It is commonly referred to as a 'cryptocurrency' as it relies on techniques from the field of cryptography to ensure the secure validation of transactions. There are currently several hundred cryptocurrencies in existence, such as Litecoin and Peercoin. Most of these were inspired by, or explicitly based on, Bitcoin.

Bitcoin users do not have to disclose who they are. They maintain a digital 'wallet' on their computers and, by use of special software, trade the currency among each other in exchange for traditional currency or goods and services. Several thousand businesses worldwide currently accept bitcoins in payment for anything from pizza to webhosting. Payments can be made at any time and between any two users worldwide. Users may acquire bitcoins as a reward for verifying earlier transactions (explained more below), by purchasing them from other users (in exchange for traditional currencies) or in exchange for goods and services.

A key innovation of digital currency systems is the use of a 'distributed ledger' that allows payments to be made in a decentralised way. How this works — and how it marks a key innovation in payment technology — is explained in the subsequent section of this article, but the basic process is as follows. A user, wishing to make a payment, issues payment instructions that are disseminated across the network of other users. Standard cryptographic techniques make it possible for users to verify that the transaction is valid — that the would-be payer owns the currency in question. Special users in the network, known as 'miners', gather together blocks of transactions and compete to verify them. In return for this service, miners that successfully verify a block of transactions receive both an allocation of newly created currency and any transaction fees offered by parties to the transactions under question. The box on pages 268–69 provides a step-by-step overview of how a transaction works using this payment system.

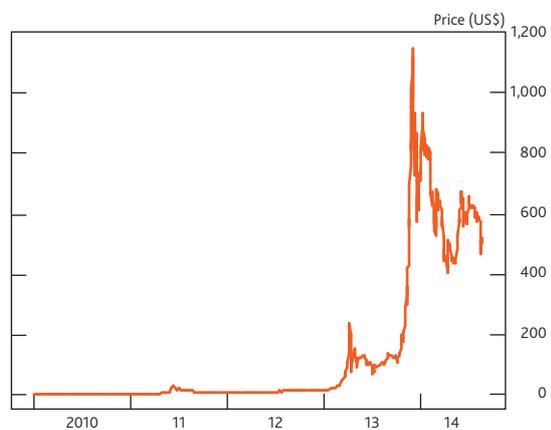
The candidate blocks were 'empty' in the sense that they had no transactions in them other than the allocation of new bitcoins as a reward for solving the puzzle. This effectively served to create the initial endowment of bitcoins. The first blocks created 50 new bitcoins per block and the Bitcoin protocol calls for this reward to be halved every 210,000 blocks (roughly every four years).⁽²⁾ The current

Chart 1 The projected supply of bitcoins in circulation



Source: <http://blockchain.info>.

Chart 2 The price of bitcoins (linear scale)



Source: <http://blockchain.info>.

Chart 3 The price of bitcoins (log scale)



Source: <http://blockchain.info>.

(1) Note that throughout this article, 'Bitcoin' is used to refer to the system as a whole and 'bitcoin' to refer to individual units of the currency.

(2) The Bitcoin protocol seeks to maintain a roughly constant time of ten minutes between each successfully verified block. See the box on pages 268–69 and the annex for more detail.

reward is 25 bitcoins per block, and this is likely to be reduced to 12.5 bitcoins per block in 2017. The planned eventual total number of bitcoins is therefore 21 million, which will be mostly reached by 2040. There are currently a little over thirteen million bitcoins in circulation (**Chart 1**), distributed over perhaps one or two million users worldwide.

The price of bitcoins has increased markedly since the scheme was launched, rising roughly 5,000% over the past two years (**Charts 2 and 3**). It has also exhibited significant volatility, which has led to considerable debate and media attention.

Motivation for the development and adoption of digital currencies

Beyond a general increase in public willingness to use and trust computing technology, interest in and the adoption of digital currencies appears to be driven by three key factors: ideology, financial return and the pursuit of lower transaction fees.

The foundational motivations for Bitcoin appear to have been largely **ideological**. The digital currency was expressly designed to avoid any centralised control (of either the money supply or the payment system) and to minimise the degree of trust that participants need to place in any third party. The first block in Bitcoin's block chain (the 'genesis block') includes the text:

The Times 03/Jan/2009 Chancellor on brink of second bailout for banks

in reference to a newspaper article from that day (Duncan and Elliott (2009)), presumably in order both to demonstrate that it could not have been created before that date and to highlight the conceptual distinction between Bitcoin and the structure of modern monetary economies. Complete adoption of Bitcoin by its users would allow them to exist economically almost entirely outside the prevailing monetary system, although this is not straightforward due to the relatively small number of businesses which accept it. In addition, some participants may be drawn to the near anonymity offered by such systems.

Second, digital currencies have come to be viewed by some as an **asset class** for financial investment, driven by an interaction between the schemes' planned fixed supplies and their increasing publicity. Since the future path of each such scheme's supply is predetermined and known with near certainty, movements in their price will essentially reflect only changes in demand.⁽¹⁾ Since digital currencies have no intrinsic demand (they are not used as a factor of production and are not sought out as a consumer good), expectations about medium and long-run future price growth will be predominantly driven by expectations relating to the future growth in the transactional use they support.

Advocates of digital currencies argue that they offer **lower transaction fees** on payments than existing electronic retail payment systems or international transfers. Based on this premise, a number of start-up businesses are seeking to offer payment facilities that use digital currencies as a bridge mechanism for settlement.⁽²⁾ The sustainability of low transaction fees from digital currencies is discussed in more detail in the companion piece to this article.

The distributed ledger as a key technological innovation

This section examines the concept of a distributed ledger — a key technical innovation of digital currencies — and how it is a feature that solves the problem of 'double spend' in a decentralised payment system. The distributed ledger (the 'block chain' in cryptocurrencies) was made possible by the emergence of several earlier innovations, including the internet. It rests on concepts from cryptography, game theory and peer-to-peer networking. Finally, this section also considers the risks in both centralised and decentralised payment systems.

The double-spend problem

A key problem for any electronic payment system is how to ensure that money cannot be 'double spent'. If Anne has a single £1 coin, it is not possible for her to give £1 to Bill and also £1 to Clare. The physical act of exchange prevents the payer from spending the same money twice. A payment system that relies on digital records must have a way of preventing double spending because it is simple to copy and edit digital records.

The approach used in the modern banking system, which emerged as a computerised replication of earlier paper-based records, is for specialised entities (usually banks) to maintain master ledgers that act as the definitive record of each individual's money holdings. In turn, they hold accounts recorded in the ledger of one central body (typically the central bank). Those holding the ledgers have the ability to prevent any transaction they deem to be invalid. In order to use the system, people must trust that these centralised ledgers will be maintained in a reliable, timely and honest manner.

An alternative approach is to implement a fully decentralised payment system, in which copies of the ledger are shared between all participants, and a process is established by which

(1) Markets that allow trading of digital currencies are also relatively illiquid, which may affect short-term price movements.

(2) For example, a payment provider might allow retailers to set their prices (and receive payment) in sterling, but allow consumers to pay with a digital currency. If consumers wished to pay with a different currency, such as the US dollar, then the payment provider might first convert the dollars to the digital currency before processing the payment.

Making payments securely with a distributed ledger

Any electronic payment system must have a reliable method of recording transactions that all participants can agree is accurate. For a decentralised system like Bitcoin this creates two challenges. The first is devising a secure and reliable method for updating a public ledger of which there are myriad copies distributed throughout the world. The second is, in the absence of a central authority to provide or co-ordinate resources, creating the necessary incentives for users to contribute resources to verifying transactions. This box describes how Bitcoin overcomes these challenges by explaining the main steps in a transaction. The key concepts were first outlined by Nakamoto (2008).

Step 1 — Agreeing the transaction

Anne is a Bitcoin miner who has previously verified a block of transactions successfully and received 25 new bitcoins as a reward. Bill is a carpenter who sells furniture online and accepts bitcoin. Anne decides to pay 1 bitcoin to Bill for a chest of drawers and is prepared to pay 0.01 bitcoins as a transaction fee.

Bitcoin users are under no formal requirement to pay transaction fees and if they offer one, the size of that fee is at their discretion. However, Bitcoin miners are able to choose which transactions they process, so a higher fee offered gives them a greater incentive to validate Anne's transaction.

Step 2 — Creating the transaction message

Anne creates a message with three basic elements: a reference to the previous transaction through which she acquired the bitcoins, the addresses to pay (including Bill's) and the amount to pay each one. The message also has other elements such as digital signatures and any conditions that Anne may place on the payment.

The number of bitcoins at any address is derived from the output of earlier transactions that are all publicly available on the block chain for inspection. In this example there is a previous output of 25 bitcoins from Anne's mining activity which forms the input to the new transaction. Bitcoin transactions may have any number of inputs or outputs. The 'change' due to Anne is paid as an output of the transaction and any credit included in the input which is not accounted for in the output is accepted as a transaction fee.

Inputs:

- 25 bitcoins from Anne (the output from her previous transaction).

Outputs:

- 1 bitcoin to Bill.
- 23.99 bitcoins to Anne (her 'change' from the transaction).

- 0.01 bitcoins as a transaction fee to whichever miner successfully verifies the transaction.⁽¹⁾

It is also possible for Anne to place some conditions on the payment, so that Bill cannot spend his proceeds unless they are met. Most payments do not impose any conditions, but more complex transactions may require multiple conditions to be met before any funds are released. This capability allows the technology to be expanded to support more complex transactions.

Step 3 — Signing the transaction message

Once the message has been created, Anne digitally signs it to prove that she controls the payer address.

Similar to real signatures, digital signatures provide proof that the transaction message was created by the person who wants to make the payment.

Digital signatures are a form of public-key cryptography. They work by creating 'public' keys which can be used to decrypt messages encoded by a corresponding 'private' key. To create a digital signature, Anne encrypts the message she wishes to sign with her private key. This message can then only be decoded with the corresponding public key, which she also broadcasts in order that her transactions can be verified. Further information on public-key cryptography is contained in the technical annex.

Step 4 — Broadcasting the transaction message

Anne broadcasts the signed message to the network for verification.

Bitcoin miners are arranged in a 'peer-to-peer network' — a network of connections that are formed informally with no central co-ordination. Although miners are under no obligation to do so, the Bitcoin protocol calls for all messages to be transmitted across the network on a 'best-efforts' basis, sharing the message with one's immediate peers. This means that Anne's transaction is not broadcast to the entire network at once, but instead goes to a random subset of her peers first, then to their peers and so on.

Peer-to-peer networks are commonly used to quickly and effectively share data between users in a number of other settings. Some video-streaming services, for example, make use of the technology.

Step 5 — Transaction verification ('mining')

Miners gather Anne's new transaction and combine it with others into new candidate 'blocks'. They then compete to verify them in a way that other miners will accept.

Verification of a transaction block has two elements: validation and achieving consensus. Validating a block of transactions — which includes checking that the digital signatures are correct — takes a very short amount of time. Establishing consensus is purposefully more difficult and requires each miner to demonstrate the investment of computing resources known as a 'proof of work'. The proof of work scheme used by Bitcoin is explained in detail in the annex.

Proof of work schemes need to be difficult to achieve but simple to check. This allows the incentives of the system to be balanced in favour of transaction verification by making it very easy to spot a fraudulent transaction. The only way the system can be attacked is by assembling sufficient computing power on the network to 'verify' fraudulent transactions. This would undermine trust in the system as a whole and the value of any bitcoins the attacker could steal. It therefore makes more sense for anyone capable of assembling the necessary computing power to contribute to the continuation of the system, rather than attacking it.

The proof of work scheme used by Bitcoin means that the time taken for a miner to successfully verify a block of transactions is random. But as new miners join the network, or existing miners invest in faster computers, the time taken for a successful verification can fall. In order to allow time for news of each success to pass across the entire network, the difficulty of the proof of work problem is periodically adjusted so that the average time between blocks remains broadly constant at ten minutes for Bitcoin, meaning that payments are not instantaneous.

Step 6 — Success

Clare is a miner and successful at verifying a block with Anne's transaction in it, so she will receive both a reward of new bitcoins, as well as the transaction fee from Anne's transaction. Clare broadcasts this result and other miners add the block to the end of their copies of the block chain and return to step 5. Bill receives the 1 bitcoin sent to him and delivers the chest of drawers to Anne.

Coinbase transactions

The first transaction in each block is a special 'coinbase' transaction which (i) grants the miner new bitcoins as a reward and (ii) pays the miner any transaction fees offered by transactions within the block.⁽²⁾ The allocation of new bitcoins to each coinbase transaction is halved every 210,000 blocks (which, at ten minutes per block on average, equates to roughly once every four years). The current allocation is 25 bitcoins per block, which should halve to 12.5 bitcoins per block in 2017. The motivation behind such a money supply rule — and some issues associated with it — are discussed further in the companion article.

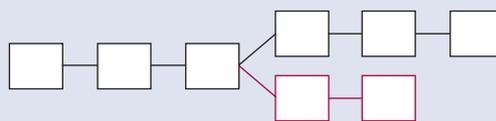
Orphaned blocks

The nature of a distributed system means that it is possible — albeit fairly infrequently — for two miners to successfully verify two different candidates for the next block at essentially the same time. When this happens, both copies are initially retained by the network as branches of the main chain, but miners will proceed to work on candidate blocks that follow on from whichever one they first receive.

The chain of blocks representing the greatest sum of work done is the accepted truth within the Bitcoin network (sometimes referred to as the 'longest chain'). Whichever branch is received by the majority of the network will initially be selected. However the branch with the most computation resources should ultimately take the lead. This branch will be most likely to have a subsequent block built on top of it and is therefore more likely to eventually 'win' the race. Miners that were working off blocks in the 'shorter' branch (that is, the branch with less demonstrated work done) then have a significant incentive to switch to the longer branch, as any work they contribute to the shorter branch will never be accepted by the majority of the network.

In this scenario, blocks within the abandoned shorter branch are referred to as 'orphans', such as the blocks in red shown in **Figure A**. Any transactions listed in an orphan block will need to be verified again. No reward a miner claims from an orphan block is recognised, as it is not part of the longest block chain.

Figure A Orphaned blocks



The rule that the chain with the greatest sum of work done wins is an important element in combating fraud in the Bitcoin network. Any attacker attempting to modify earlier blocks (so that bitcoins could be spent twice) would have to control enough computing power for them to both catch up with and then overtake the genuine block chain as the 'longest'. To be assured of success, the would-be attacker would need to obtain, and retain, a majority of all computing resources on the network. For this reason, the attack is known as a '50%+1' attack.

(1) Strictly, transaction fees are defined implicitly as the difference between the inputs and the explicitly listed outputs for each transaction. They are paid to miners as part of the 'coinbase' transaction in each block — see below for more detail.
 (2) For example, in block number 310,000, the coinbase transaction was for a total of 25.15638661 bitcoins, comprising 25 new bitcoins and 0.15638661 bitcoins that were offered as transaction fees from the other 711 transactions in that block.

users agree on changes to the ledger (that is, on which transactions are valid). Since anybody can check any proposed transaction against the ledger, this approach removes the need for a central authority and thus for participants to have confidence in the integrity of any single entity.

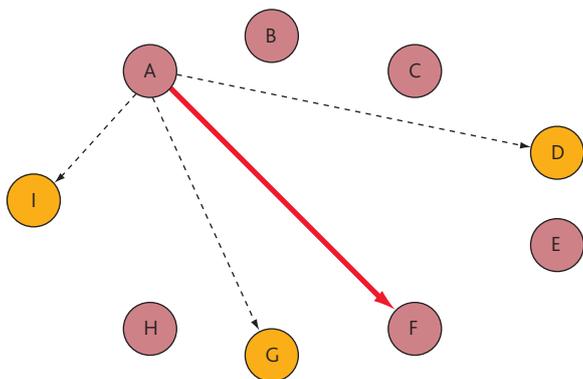
Achieving consensus

The defining feature of a distributed payment system is the manner by which consensus is reached about any proposed changes to the ledger. How to achieve consensus between people in a network when nobody can be completely sure who can be trusted has long been recognised as a problem in the field of computer science.⁽¹⁾ It is not sufficient to offer blanket acceptance to all statements, for example, because this creates an incentive to lie in order to gain an advantage.

It is also not sufficient to have users vote on whether to accept a proposed change. This is because it is generally very easy for a single person to create many nodes on a computer network in order to distort the vote. Instead, digital currencies make use of game theory and recognise that, on its own, any proposed change to the ledger is 'cheap talk' — a statement that, since it was effectively free to issue, should receive very little weight. In order for a proposed change to the ledger to be accepted by others as true, those proposing the change — the 'miners' that serve as transaction verifiers — must demonstrate that it was costly for them to issue the proposal.

Cryptocurrencies require that users contributing to the verification process must demonstrate a cryptographic 'proof of work' to show that they have paid a cost in computation time before their proposals are accepted. The box on pages 268–69 and the technical annex describe a proof of work scheme in more detail. Some other digital currencies impose a cost in the form of a small amount of currency that is destroyed as part of the transaction.⁽²⁾ Figure 3 shows an example of a distributed payment system.

Figure 3 A distributed payment system



Note: All participants have sight of all accounts (and their entire history). Payments pass directly between users — shown here by the red arrow from A to F — but are verified by other users: in particular, new transactions are broadcast to 'miners' (shown here as participants D, G and I). When verified, the transactions are added to the history of the ledger.

Risks in payment systems

Centralised systems

There are certain risks that are common to all existing tiered payment systems. Finan, Lasaosa and Sunderland (2013) identify the three greatest risks as:

- **Credit risk**, in that a paying bank may become insolvent with a large amount of money owed to other members of the system.
- **Liquidity risk**, in that a member bank that is fundamentally solvent may not have the funds to settle a required payment at a particular moment in time.
- **Operational risk**, in that one of the banks involved in a payment transaction may cease to function (either temporarily or permanently) because of some event, such as an IT failure.

These risks are inherent to any intermediated banking system. As discussed in the box on page 264, this structure evolved in response to the need to make payments more efficiently and when payment systems were computerised, this intermediated structure remained — along with the main credit and liquidity risks present in those original systems. Prudential regulation of systemically important payment systems has led to the introduction of several measures which significantly reduce or remove these systemic risks.⁽³⁾ When making these decisions regulators face a trade-off: on the one hand, prudential regulation of systemically important payment systems contributes to stable and efficient payments which promotes economic activity by reducing risk and uncertainty in the economy; but, on the other hand, some of the measures needed to reduce systemic risks in payment systems require participants to contribute money up front to cover these risks. Economic theory would suggest that such 'barriers to entry' may serve to weaken competition between existing members which may, in turn, lead to increased transaction fees and reduced levels of economic activity. But when constrained to the existing payment system architecture, these requirements are necessary in order to protect the broader financial stability of the United Kingdom.

(1) This is known as the 'Byzantine Generals Problem'. See Lamport, Shostak and Pease (1982).

(2) For example, Peercoin imposes that transaction fees paid by parties to the transaction (which are mandatory and set by the Peercoin protocol) are destroyed, rather than paid to transaction verifiers (miners). To ensure that this does not lead to an overall reduction in the supply of the currency, Peercoin also implements a 1% per annum increase in the supply that is paid to miners in a 'proof of stake' system broadly analogous to the payment of interest.

(3) For example CHAPS de-tiering referred to in Finan, Lasaosa and Sunderland (2013) and Bacs (the United Kingdom's automated clearing house, through which Direct Debits are processed) Liquidity Funding and Collateralisation Agreement in order to reduce credit risk in that system. Other examples can be found in *The Bank of England's supervision of financial market infrastructures — Annual Report*, formerly the *Payment Systems Oversight Report*.

Another important but generally non-systemic risk is **fraud**. For example a credit card user wishing to make a purchase over the internet must disclose their card details to the retailer. If these card details are stolen, the thief is then able to fraudulently make payments from the account of the card holder.

Decentralised systems

Existing distributed payment systems remove the credit and liquidity risks discussed above by eliminating intermediaries: payments are made directly between payer and payee. To be sure of this, users need to have confidence that for any distributed system they use, the cryptography employed has been implemented correctly.

In general, distributed systems designed in this way should also be more resilient to systemic operational risk because the whole system is not dependent on a centralised third party. A distributed system effectively has as many redundant backups as there are contributors to the network (which can easily number in the thousands, many more than centralised payment systems typically operate).

The nature of fraud risk — and other ways that customers may be susceptible to lose money — changes significantly between centralised and decentralised payment systems. In a decentralised system there is no need for users to disclose their complete payment details when making a payment, thus removing the risk of payment details being stolen from a retailer. However, the risk of direct loss of digital currencies is higher than that for deposits held (electronically) with commercial banks: if a user's private key is lost — because of a corrupted hard drive, say — then their digital currency will not be recoverable. This contrasts to a lost password used for internet banking with a commercial bank, say, which could be recovered or reset by contacting the bank in question. In this sense, a digital wallet is more analogous to a physical wallet containing physical currency than a bank account accessed online.

More substantially, distributed systems are subject to a risk of **system-wide fraud** if the process of achieving consensus is compromised. Cryptocurrency schemes, for example, are currently designed such that a would-be attacker would require sustained control of a majority of the total computer power across the entire network of miners. Some loosely co-ordinated pools of miners have, on occasion, represented a majority of computing power in the Bitcoin network.⁽¹⁾ Some researchers have also suggested that the necessary threshold for a successful attack may be less than 50%. This issue is examined in more depth in the annex.

Applications of the distributed ledger beyond payment systems

The introduction of any new technology enables the rethinking of business processes associated with the former technology. In the case of payments, when paper ledgers were first computerised, the underlying processes were not significantly changed.

It is often the case that the bulk of the gains from the introduction of a new technology do not arise immediately because processes that make use of the technology also need to be rethought. For example, Brynjolfsson and McAfee (2014) observe that when the electric motor was first introduced to factories, the productivity improvements it enabled only emerged after a lag of 30 years. This was approximately the time it took for a new cohort of factory managers to emerge who realised that instead of merely electrifying the single steam engine powering all the machinery in a factory, small electric motors could be fitted to each machine. While the initial installation did reduce costs, the authors argue that the greatest gains came from factories being rearranged according to the most efficient flow of materials, rather than the limitations of the machinery. It was not the electrification itself which produced the gains but the changes in processes which it made possible.

In a similar way, the potential impact of the distributed ledger may be much broader than on payment systems alone. The majority of financial assets — such as loans, bonds, stocks and derivatives — now exist only in electronic form, meaning that the financial system itself is already simply a set of digital records. These records are currently held in a tiered structure (that is, with records of individuals' accounts stored centrally at their bank, and banks' reserves accounts held centrally at the central bank), but it may be possible in the future — in theory, at least — for the existing infrastructure of the financial system to be gradually replaced by a variety of distributed systems (although this article makes no prediction in this regard). Some developers have already implemented so-called 'coloured coins' which means using digital currencies as tokens for other assets by attaching additional information. This development could allow any type of financial asset, for example shares in a company, to be recorded on a distributed ledger. Distributed ledger technology could also be applied to physical assets where no centralised register exists, such as gold or silver.⁽²⁾

(1) The proof of work scheme used by Bitcoin means that the time taken for any given miner to successfully verify a block of transactions is random. In order to smooth out the consequent volatility of earnings, miners often pool their resources and agree to share their earnings in proportion to the computing resources contributed.

(2) For an asset such as gold there is a necessary link to physical custody which is different for most financial assets which are already purely digital.

Some commentators (Wenger (2013)) have suggested that the key to understanding Bitcoin is to think of it as a protocol, akin to those that underpin the internet. Others have extended this analogy further, suggesting that digital currencies may be thought of as an 'internet of money'. But since the potential applications are, in principle, broader than just payments, the distributed ledger technology may perhaps be better described as a first attempt at an 'internet of finance'.

Conclusion

Digital currencies, as presently designed, carry both risks and benefits. As explained in the companion piece to this article, digital currencies do not currently pose a material risk to monetary or financial stability in the United Kingdom, but it is conceivable that potential risks could develop over time. The distributed ledger is a genuine technological innovation which demonstrates that digital records can be held securely without any central authority.

The total stock of digital currencies is at present too small to pose a threat to financial stability, but further increases cannot

be ruled out and it is conceivable in time that there could be an asset price crash among free-floating digital currencies that had the potential to affect financial stability. Potential risks to monetary stability would only be likely to emerge once digital currencies had achieved substantial usage across the economy. If a subset of people transacted exclusively in a digital currency, then the Bank's ability to influence demand for this group may potentially be impaired. The incentives of existing digital currency schemes pose considerable obstacles to their widespread adoption, however. This is discussed in more detail in the companion article.

Ultimately every transaction involving a financial asset must be recorded and most of these records are digital. The structure of the broader financial system is similar to payments in that these records are held by centralised third parties. The application of decentralised technology to this platform of digital information could have far-reaching implications, other industries whose products were digitised have been reshaped by new technology. The impact of the distributed ledger on the financial industry could be much wider than payments.

Annex Technical issues

This technical annex provides further details on digital signatures and cryptographic hash functions. It also discusses whether digital currencies are fraud-proof.

Digital signatures and public-key cryptography

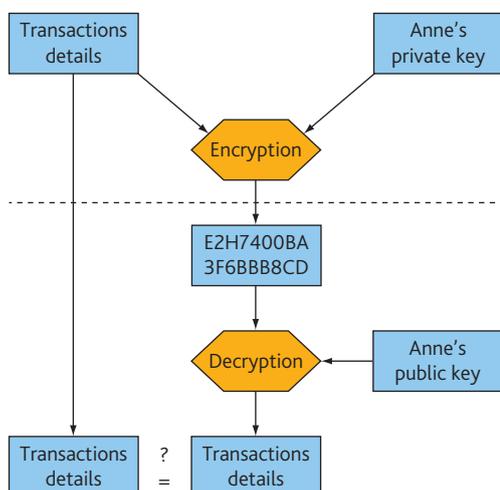
Digital signatures provide a mathematical proof that a particular message was approved by a particular person. They are an application of public-key cryptography, which relies on two separate, but mathematically interrelated keys: one private and one public.

Bitcoin addresses are a version of the public key, which can be made widely available and published. Addresses and their private keys are random strings of alphanumeric characters. An address is typically 34 characters long (for example 1FfmbHfnpaZjKFvyi1okTjJusN455paPH), while a private key is typically 51 characters long.

Each Bitcoin address is paired with a corresponding private key, which is kept secret by the owner of the address, and needed to sign transactions from — and, hence, prove ownership of — the address. It is also possible to create addresses that are linked to multiple private keys. These may be set up such that any of the private keys may be used to sign a transaction, or all of them must be used together.

Figure A depicts the process of signing a transaction in Bitcoin. Anne encrypts a copy of the transaction with her private key and then broadcasts both the plain and the encrypted versions of the transaction details. Anybody can combine the encrypted version with Anne’s public key to obtain another plain version. If it is the same as the plain version that Anne broadcast, then it proves that Anne’s private key must have been used.

Figure A Digital signatures



Cryptographic hash functions and Bitcoin’s proof of work scheme

As discussed in the main text, Bitcoin miners must demonstrate a proof of work before their proposed block of transactions is accepted by the network. Given that typically, all users need to know all previous transactions to figure out account balances, it becomes important that all users agree on which transactions have actually happened and in which order. If two users observe different transaction histories, they will be unable to come to the same conclusion regarding balances and double spends. The block chain serves as a way for all users to come to a consensus regarding which transactions have already happened and in which order. In Bitcoin, the way in which users agree on a set history of transactions is to pick the history which users have put the most work into creating. **The ‘work’ must be a task that is hard for a computer to complete, but easy for other computers to verify.**

A simple example would be a requirement that people repeatedly roll three six-sided dice until they roll three ones. When somebody does this, everybody accepts their message as true and moves on to the next message. This is a time-consuming exercise in trial and error, but one where success is immediately visible to everyone. The time taken for somebody to successfully roll three ones is random, but the expected number of attempts is known. The more people that take part, or the faster that each person makes each attempt, the shorter the time until somebody succeeds. To offset this, each person might be required to roll four dice and to get four ones. With careful calibration, by making the problem harder as more people join, the average time taken for somebody to succeed can be made to stay roughly constant.

The proof of work scheme used by Bitcoin makes use of a special algorithm called a ‘cryptographic hash function’, which takes any amount of information as an input and creates an output of a standard length (the ‘hash value’). The function is cryptographic because the hash value produced is different for any change in the input (even of a single character), and it is almost impossible to know in advance what hash value will be produced for a given input. For example, the hash function used by Bitcoin (called ‘SHA-256’) generates the following:

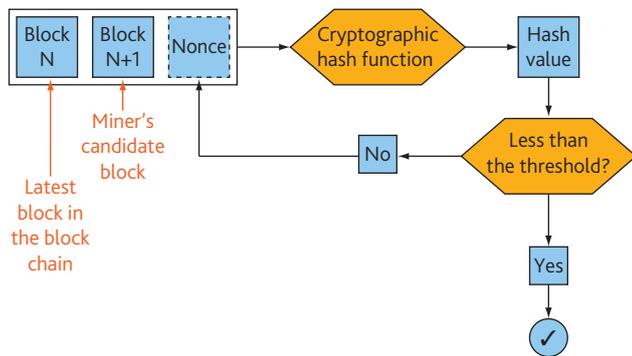
Input (case sensitive)	Output (the ‘hash value’)
Bank of England	6b31489400146361800f1f67cfb003f6ba5734b645c30a68d1888b4a19c9d64c
Bank of England1	38f0f960648853c9675951b10cf55acb3f5696bfb183d398782d4f32e99905fe
Bank of England2	ba9745451de288a04fcbf08fbd43fa429e9c5f7d6ce436e5adf97f10dd22836
Bank of England3	028aa80090f374aaed153ac5b3ab199f3cd663b1e409f55be777c1189dd4b23f1

The Bitcoin protocol requires that miners combine three inputs and feed them into a SHA-256 hash function:

- A reference to the previous block.
- Details of their candidate block of transactions.
- A special number called a 'nonce'.

If the hash value produced is below a certain threshold, the proof of work is complete. If it is not, the miner must try again with another value for the nonce. Because there is no way to tell what value of the nonce, when combined with the other two inputs, will produce a satisfactory hash value, miners are forced to simply cycle through nonce values in trial and error (Figure B).

Figure B Bitcoin's proof of work scheme



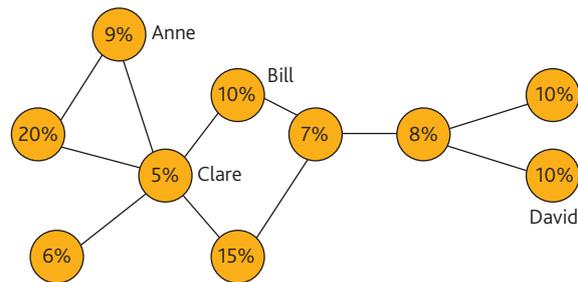
Are digital currencies fraud-proof?

The current design of digital currencies is predicated on the assumption that fraud — the creation of false transactions — can only be achieved by an agent, or coalition of agents, controlling a majority of computing resources on the mining network over a sustained period of time (a '50%+1 attack'). However, a number of researchers have suggested that it may be possible to defraud such schemes while possessing less than a strict majority of computing power. Potential weaknesses have been identified in two key areas: (i) the position of an attacker in the network; and (ii) the strategic timing of when an attacker chooses to release messages to the rest of the network.

To appreciate these weaknesses, it may be helpful to consider a simple example of a verification network. Figure C provides one such example. Individual miners are arranged in a peer-to-peer network, with each of them controlling a different share of the total computing power. Note that although Clare controls the smallest share of the network's computing resources, she is quite 'central' to the network in that she is immediately connected to other nodes that together represent a majority.

An attacker's **position in the network** is important because the longer it takes for messages to propagate across a digital currency's network, the greater the probability that a fork in the block chain (with two candidates for the next block being successfully verified at similar times) will emerge. A hypothetical attacker that is centrally located in the network

Figure C An illustrative digital currency verification network



Note: Percentages indicate the share of total computing resources controlled by each node. For simplicity, links are assumed to be undirected (eg if Bill is connected to Clare, then Clare is also connected to Bill), although this may not be true in practice.

(such as Clare) will be able to communicate to most of the network very quickly, and so may not strictly require a majority if other users (such as David) are, relatively speaking, quite distant.⁽¹⁾ More generally, even honest users in central positions will, for the same reason, be expected, over time, to earn shares of total payments (by successfully adding blocks to the chain) that exceed their shares of computing power on the network.

An incentive also exists for miners to **strategically choose the time** when they broadcast their success at verifying transaction blocks. For example, suppose that when Bill successfully verifies a candidate block N, he does not reveal his success immediately. Instead, he starts work verifying block N+1 and only discloses his success to the rest of the network after a short delay. Bill's strategy will force other miners to waste extra time attempting to verify their own candidates for block N and grant Bill a head start in trying to verify the next block. Over time, Bill's share of total payments will, on average, exceed his share of total computing power.⁽²⁾

Since mining is a zero-sum game — extra earnings for one miner must come at the expense of another — then it is sometimes argued that when one miner receives outsized returns, this creates an incentive for other miners to either drop out or to join the first in a pool, eventually leading to the pool controlling a majority of the network's computing resources (and so expose the system to the risk of fraud). Complete analysis of these settings is not yet complete,⁽³⁾ but research done to date does suffice to illustrate that the incentives surrounding fraud prevention in digital currency networks have not been fully explored.

- (1) Decker and Wattenhofer (2013) examine propagation times for the Bitcoin network and conclude that a perfectly centrally located attacker would indeed require less than a strict majority of the total computing resources.
- (2) Eyal and Sirer (2013) discuss a variant of this strategy in which a single 'selfish' miner seeks to establish and maintain an undisclosed lead of at least two in the number of blocks verified over the other, honest miners in the network. In their model, they show that even if the selfish miner is only distantly connected to the rest of the network, their share of total earnings will exceed their share of computing resources when controlling only one third of the network's computing power.
- (3) For example, the Bank is not aware at the current time of any research that has (i) derived the optimal (that is, profit maximising) strategy for each self-interested miner; (ii) established a Nash equilibrium when all agents are individually self-interested and profit-maximising; or (iii) considered the problem of non co-operative bargaining between multiple self-interested miners that seek to pool their resources.

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The economics of digital currencies

By Robleh Ali of the Bank's Financial Market Infrastructure Directorate, John Barrdear of the Bank's Monetary Assessment and Strategy Division, and Roger Clews and James Southgate of the Bank's Markets Directorate.⁽¹⁾

- Although digital currencies could, in theory, serve as money for anybody with an internet-enabled device, at present they act as money only to a limited extent and only for relatively few people.
- The economics of the schemes as currently designed, both in terms of individuals' incentives and at a macroeconomic level, pose significant challenges to their widespread adoption.
- Digital currencies do not currently pose a material risk to monetary or financial stability in the United Kingdom. The Bank continues to monitor developments in this area.

Overview

Digital currencies represent both innovations in payment systems and a new form of currency. This article examines the economics of digital currencies and presents an initial assessment of the risks that they may, in time, pose to the Bank of England's objectives for monetary and financial stability. A [companion piece provides an introduction to digital currency schemes](#), including some historical context for their development and an outline of how they work.

From the perspective of economic theory, whether a digital currency may be considered to be money depends on the extent to which it acts as a **store of value**, a **medium of exchange** and a **unit of account**. How far an asset serves these roles can differ, both from person to person and over time. And meeting these economic definitions does not necessarily imply that an asset will be regarded as money for legal or regulatory purposes. At present, digital currencies are used by relatively few people. For these people, data suggest that digital currencies are primarily viewed as stores of value — albeit with significant volatility in their valuations (see [summary chart](#)) — and are not typically used as media of exchange. At present, there is little evidence of digital currencies being used as units of account.

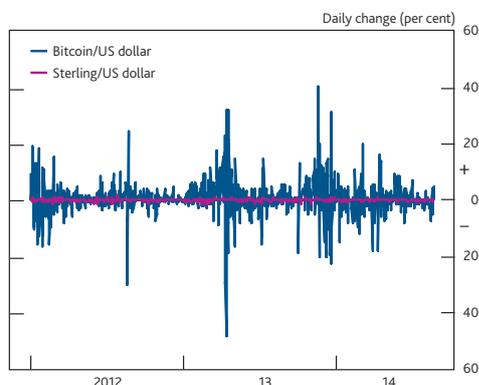
This article argues that the incentives embedded in the current design of digital currencies pose impediments to their widespread usage. A key attraction of such schemes at present is their low transaction fees. But these fees may need to rise as usage grows and may eventually be higher than those charged by incumbent payment systems.

Most digital currencies incorporate a pre-determined path towards a fixed eventual supply. In addition to making it

extremely unlikely that a digital currency, as currently designed, will achieve widespread usage in the long run, a fixed money supply may also harm the macroeconomy: it could contribute to deflation in the prices of goods and services, and in wages. And importantly, the inability of the money supply to vary in response to demand would likely cause greater volatility in prices and real activity. It is important to note, however, that a fixed eventual supply is not an inherent requirement of digital currency schemes.

Digital currencies do not currently pose a material risk to monetary or financial stability in the United Kingdom, given the small size of such schemes. This could conceivably change, but only if they were to grow significantly. The Bank continues to monitor digital currencies and the risks they pose to its mission.

Summary chart Bitcoin price volatility



Sources: Bank of England and the BitStamp exchange, via <http://bitcoincharts.com>.

[Click here for a short video that discusses some of the key topics from this article.](#)

(1) The authors would like to thank Victoria Cleland, Will Abel and Danny Eckloff for their help in producing this article.

This article explores the economics of digital currencies — schemes that combine new payment systems with new currencies — and provides an initial view on the consequent implications for the Bank of England's objectives to maintain monetary and financial stability in the United Kingdom. Any potential risks to monetary or financial stability posed by digital currencies will depend on how widely they are used, both today and in the future. The article therefore begins by examining the extent to which digital currencies are currently used as a form of money. As part of evaluating the likely growth in digital currencies' usage over time, it next examines the sustainability of the low transaction fees offered by digital currencies at present.

In order to explore the macroeconomic implications of digital currencies, the article also considers a hypothetical — and extremely unlikely — scenario in which a digital currency with a fixed eventual money supply were to achieve dominant usage in an economy, supplanting the existing monetary system. The consequences of such an arrangement are examined, together with some possible responses. Finally, this article provides an initial view on current and possible future risks to monetary and financial stability that might be posed by digital currencies.⁽¹⁾ A short video explains some of the key topics covered in this article.⁽²⁾

Setting the context: the emergence of digital currencies

A companion piece to this article, '[Innovations in payment technologies and the emergence of digital currencies](#)', provides an introduction to these schemes.⁽³⁾ It details the historical development of modern monetary payment systems; how digital currencies differ from these; and potential benefits of the technology underlying digital currencies beyond use as a payment system. This section offers some context by giving a brief summary of the key points from the companion piece to this article.

Evolution in payment systems and money

Money is essential to a modern economy, since it is used in virtually all the transactions that underlie economic activity. But what is accepted in payment has changed over time, and so have the ways in which payments are made. The exchange of coins made of precious metals was one early method of making payments in a number of economies, including the United Kingdom. The use of precious metals as money was gradually superseded: first by receipts for gold lodged with goldsmiths, then by banknotes redeemable in precious metals, and nowadays by banknotes whose value depends not on gold but on the monetary policy of the issuing central bank. Most money now takes the form of bank deposits, originally recorded in physical ledgers but now entered electronically onto banks' books. Payments between customers of the same bank can be settled by entries in that bank's accounts. But

payments between customers of different banks are put into a central clearing system, with balances between banks settled by transferring claims on that central entity — a role typically played by the central bank of a given economy.

More recently, new schemes — 'cryptocurrencies' or 'digital currencies'⁽⁴⁾ — have emerged that combine both new decentralised payment systems and new currencies. The first of these schemes, and still the most prominent at the time of writing, is Bitcoin. In some ways, digital currencies resemble — and are intended to resemble — earlier forms of money and of payment systems. Their creation is not controlled by central banks and they allow payments to be made directly between payer and payee without the use of any intermediaries (such as commercial banks). They do not require users to disclose which holdings of digital currency they control, thereby approaching the anonymity of banknotes for electronic payments.

The key innovation: the distributed ledger

The key innovation in this regard is the introduction of a 'distributed ledger', which allows a digital currency to be used in a decentralised payment system. Any digital record of currency opens up the possibility that it may be copied and spent more than once. With conventional bank deposits, banks hold the digital record and are trusted to ensure its validity. With digital currencies, by contrast, the ledger containing the record of all transactions by all users is publicly available to all. Rather than requiring users to have trust in special institutions, reliance is placed on the network and the rules established to reliably change the ledger.

The way in which consensus is reached regarding additions to the ledger — that is, which transactions are accepted as valid — is addressed in the companion article, but the basic process for cryptocurrencies is as follows. A user, wishing to make a payment, issues payment instructions which are disseminated across the network of other users. Standard cryptographic techniques make it possible for users to verify that the transaction is valid — that the would-be payer owns the currency in question. Special users in the network, known as 'miners', gather together blocks of transactions and compete to verify them. In return for this service, miners that successfully verify a block of transactions receive both an allocation of newly created currency and any transaction fees offered voluntarily by parties to the transactions under question.

When blocks of transactions are verified, they are added to the ledger (the 'block chain'). A key design goal of digital

(1) Other issues, such as those concerning consumer protection, taxation and money laundering, are beyond the scope of this article. Some publications from other institutions regarding some of these issues are cited at the end of the article.

(2) <http://youtu.be/rGNNiTaC2xs>.

(3) See Ali *et al* (2014).

(4) The two concepts are not strictly identical. There currently exist some digital currencies that do not rely on cryptographic techniques to achieve consensus (such as Ripple), but all cryptocurrencies are digital currencies.

currencies is to balance incentives carefully in order to make it more profitable to participate in the network honestly than to try to get fraudulent transactions accepted. To this end, a cost is imposed on making changes to the ledger: more concretely, miners must devote computing resources to mathematical puzzles that are hard to solve, but the answers to which are easy to check. Those contributing greater computing power will, on average (but not always), solve the puzzle first and reap the reward. So long as no one miner, or pool of miners, attains a sustained majority of computing power, those transactions that have been verified will continue to be accepted as valid.

Digital currencies as money

This section examines the extent to which digital currencies may be thought of as money. It first describes a key distinction between fiat money and digital currencies in the manner of their creation. It then considers the main functions of money and provides some analysis of the extent to which digital currencies currently serve these functions.

Digital currencies versus fiat money: how are they created?

As explained by McLeay, Radia and Thomas (2014), money in the modern economy may be thought of as a series of claims, or 'IOUs'. Deposits held at commercial banks are an IOU, being a liability for the bank and an asset for the account holder. Most money is held as bank deposits and the principal way that new money is created is through the creation of loans. Whenever a bank makes a loan, it simultaneously creates a matching deposit in the borrower's bank account, thereby creating new money.⁽¹⁾ Banknotes issued by a central bank are also a special form of non-convertible claim, of the physical bearer on the central bank — and are liabilities of the central bank and assets to the noteholder.

In contrast to commonly used forms of money such as banknotes or bank deposits, digital currencies are not a claim on anybody. In this respect, they can therefore be thought of as a type of commodity. But unlike physical commodities such as gold, they are also intangible assets, or digital commodities. Digital currencies have meaning only to the extent that participants agree that they have meaning. That agreement takes the form of a public ledger and a process for how changes to it are made, including the creation of new currency. Not being an IOU or liability of the central bank (or the state) does not prevent digital currencies from being used as money (see below), but it does mark an important difference between them and national currencies.

Most existing digital currencies incorporate strict rules that govern their creation, following a pre-determined path to a fixed eventual total supply.⁽²⁾ For example, there are currently

a little over 13 million bitcoins in circulation and that system's protocol dictates that there will be an eventual total of 21 million, which should be largely reached by around 2040.

Among most digital currencies, new currency is allocated to users that contribute computing resources to the verification of transactions on the network. In some ways — and to the extent that digital currencies serve as money — this allocation is similar to *seigniorage* (the creation of monetary value minus the cost of its creation).⁽³⁾ But it differs from seigniorage in the classic sense as, rather than accruing to the government, it is an explicit payment of new currency to the private sector in return for the verification of earlier transactions.

The three functions of money

Throughout history there have been many different manifestations of money, both physical and electronic. Economic theory identifies money through the role that it plays in society, and, in particular, the extent to which it serves the following purposes:

- **A store of value** with which to transfer 'purchasing power' (the ability to buy goods and services) from today to some future date.
- **A medium of exchange** with which to make payments.
- **A unit of account** with which to measure the value of any particular item that is for sale.

It is not always the case that a given asset serves, or categorically does not serve, these functions. Different assets may, at various times, play some or all of these roles. And they may offer them for some people, but not for others. For example, Radford (1945) documents that cigarettes served all three of these roles within prisoner of war camps during the Second World War. Furthermore, meeting these economic definitions does not necessarily imply that an asset will be regarded as money for legal or regulatory purposes.

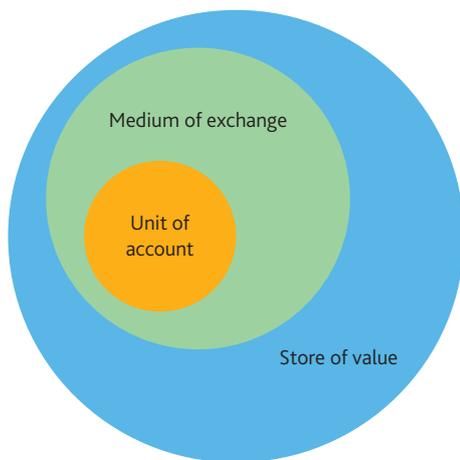
The functions of money may be considered to operate in a hierarchy, as depicted in **Figure 1**. There are many assets that people view as stores of value — houses, for instance — that are not used as media of exchange. By comparison, an asset can only act as a medium of exchange if at least two people (as parties to a transaction) are prepared to treat it as a store

(1) McLeay, Radia and Thomas (2014) also explain that money creation is constrained by banks' own internal risk appetite, regulatory restrictions, the demand for credit by households and businesses, and — most importantly — the application of monetary policy by the central bank to adjust interest rates in order to achieve a specific inflation target.

(2) Some digital currencies are created entirely at their inception (such as Ripple), while a small number of existing cryptocurrency schemes, particularly among those making use of 'proof of stake' systems, may allow for permanent growth in the money supply.

(3) Note that for digital currencies the cost of having the new allocation accepted by the rest of the network (which is significant) is distinct from the cost of creation (which is approximately zero).

Figure 1 The three functions of money



of value, at least temporarily. Finally, for an asset to be considered a unit of account, it must be able — in principle, at least — to be used as a medium of exchange across a variety of transactions between several people and as such represents a form of co-ordination across society. For this reason, some economists consider the operation as a unit of account to be the most important characteristic of money. Indeed, it is commonly argued that a defining feature of monetary policy lies in central banks' control of the unit of account (Woodford (2003)).

Are digital currencies money?

The extent to which an asset serves the various roles of money varies from person to person and over time. **In theory, digital currencies could serve as money for anybody with an internet-enabled computer or device. At present, however, digital currencies fulfil the roles of money only to some extent and only for a small number of people. They are likely at present to regularly serve all three purposes for perhaps only a few thousand people worldwide, and even then only in parallel with users' traditional currencies.** The remainder of this section first examines how widely digital currencies are used before assessing this usage against the three functions outlined above.

How widely are digital currencies used?

It is difficult to estimate the number of people that own or use digital currencies. The largest and most widely used scheme is Bitcoin. As of 9 July 2014, there were almost 41 million addresses listed on the Bitcoin block chain, but only 1.6 million that contained a balance of more than 0.001 bitcoins (roughly £0.35). This figure will still overstate the number of users, however, as each user may possess any number of wallets and each wallet may hold any number of addresses.

Over the 30 days to 20 August 2014, almost 60% of Bitcoin trading with traditional currencies was against the Chinese renminbi, with 32% traded against the US dollar and 3% against the euro. Only 1.2% of trading was against sterling.⁽¹⁾

If the number of Bitcoin users in each country is proportional to the trading of that country's currency with Bitcoin, then this would suggest an upper limit of about 20,000 people in the United Kingdom that have any significant holding of bitcoins. It is further estimated that across all UK users, as few as 300 transactions may occur per day. It is important to emphasise the uncertainty about these figures, however.⁽²⁾

Assessing digital currencies against the three functions of money

An asset's worth as a **store of value** rests on people's beliefs regarding its future supply and demand. Although a constrained supply is largely assured with digital currencies, prospects for future demand are far less certain. Since digital currencies lack any intrinsic demand (for use in production or for consumption) and no central authority stands behind them, an opinion about their future demand should largely rest on (i) a belief about their future use as media of exchange and (ii) a belief that they will continue to remain in demand even further into the future.⁽³⁾ A brief discussion of some other relevant considerations is provided in the box on page 280.

While the non-zero prices of digital currencies reveal that they do have value for non-trivial numbers of users, they appear to be poor *short-term* stores of value given the significant volatility in exchange rates with traditional currencies. **Chart 1** shows the daily change of the prices of bitcoins (in blue) and sterling (in magenta) — both expressed in terms of US dollars — since the start of 2012. The standard deviation of daily moves for bitcoin is roughly 17 times greater than that for sterling. The worth of bitcoin as a *medium* or *long-term* store of value, however, depends on the strength of demand over time, which will in turn depend on users' evolving beliefs about the ultimate success of the digital currency.

One measure of the extent to which a currency is being used as a **medium of exchange** is the number of retailers that are prepared to accept it in payment. At present, there are several thousand retailers worldwide (predominantly, but not exclusively, internet-based providers) that are willing to receive payment in bitcoins.

The willingness of a retailer to accept a digital currency does not by itself imply, however, that the facility is widely used. A more indicative measure of a digital currency's worth as a medium of exchange is the number of transactions carried out

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- (1) These figures derive from the most active exchanges listed on <http://bitcoincharts.com>. Note that there may be unlisted exchanges that compete with these.
- (2) This calculation also assumes, for example, that transaction rates are similar between 'My Wallet' users and users in the United Kingdom in general.
- (3) A willingness to hold such an asset in period T requires a belief that it will be accepted by other people in period $T+1$, which in turn requires that in period $T+1$ it will be believed that the asset will be accepted by yet other people in period $T+2$, and so on.

Some factors influencing the prices of digital currencies

The valuation of a digital currency that is, at least in principle, able to be used as a medium of exchange needs to take a wide variety of considerations into account. These include:

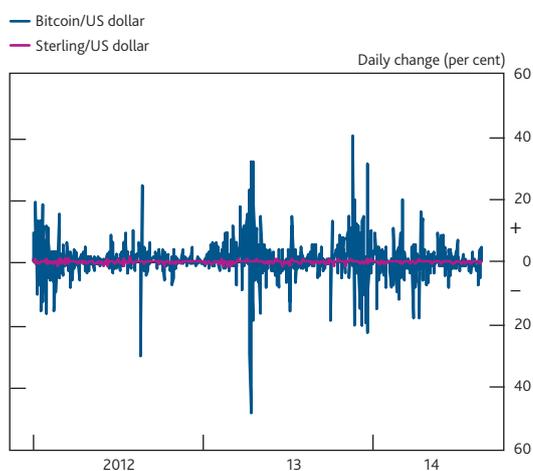
- The expected real return of holding the digital currency (that is, the nominal interest rate minus expected price inflation), relative to other options.
- Any risks associated with holding the digital currency relative to other currencies, including risks of theft or fraud, and price volatility.
- The relative benefits of using the digital currency as a medium of exchange when compared to traditional systems, including availability, transaction fees and degrees of anonymity.
- Any time constraints or costs associated with switching wealth between the digital currency and more traditional assets (including sterling).

- Any non-monetary concerns, such as an ideological preference for one particular currency.
- A view on how much other people value the currency (based on the above factors) and how this is expected to change in the future.

It is not generally possible to express all of these elements in a single mathematical model. When limiting attention to only the quantifiable factors, standard economic theory suggests that, under certain conditions,⁽¹⁾ the expected real rates of return on any two assets that might serve as money should be equal after adjusting for risk and the costs and benefits associated with using them for spending. For example, holding all else equal, a currency with lower transaction fees may be expected to offer a lower real rate of return (since holders are also compensated via the lower fees), while one with greater price volatility should offer a higher return (to compensate holders for the extra risk).

(1) For example, these conditions include a requirement that everybody have access to the same information, face the same costs in transferring their wealth between assets and are able to do so instantly.

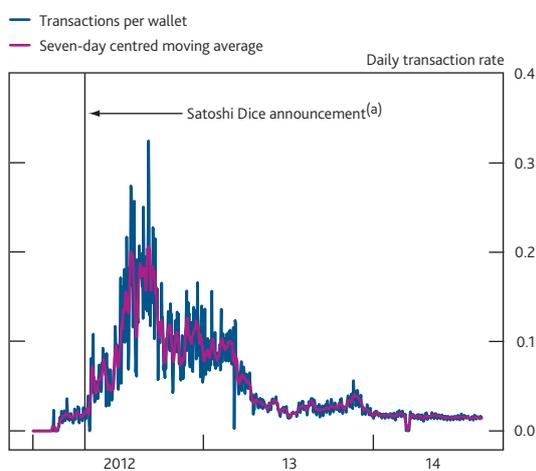
Chart 1 Bitcoin price volatility



Sources: Bank of England and the BitStamp exchange, via <http://bitcoincharts.com>.

by its users over a given period of time. While it is not possible to observe the transaction rate per user in any digital currency, there are some data for the transaction rate per *wallet* on the Bitcoin network. Chart 2 presents this measure among users of 'My Wallet', a popular wallet-hosting service. Like other measures of transaction rates,⁽¹⁾ it rose in the first half of 2012 following the announced launch of Satoshi Dice (a popular bitcoin-based gambling website), but has since fallen to quite low levels.⁽²⁾ So far in 2014, there have been, on average, fewer than 0.02 transactions per day for wallets held with 'My Wallet' (roughly one transaction per day for every 65 wallets). Most users appear to be simply holding their bitcoins rather than using them for day-to-day transactions.

Chart 2 Daily Bitcoin transaction rate per wallet



Sources: 'My Wallet' service offered by <http://blockchain.info> and Bank calculations.

(a) Refers to the announcement of Satoshi Dice, a popular bitcoin-based gambling website.

There is little evidence of any digital currency being used as a **unit of account**. Although a small number of transactions between individuals will occur in which the parties negotiate and agree a price in bitcoins, these are believed to be isolated and largely unconnected. Retailers that quote prices in bitcoins appear to usually update those prices at a high frequency so as to maintain a relatively stable price when expressed in traditional currencies such as US dollars or sterling. Indeed, start-up companies seeking to offer bitcoin

(1) A similar pattern emerges when looking at transaction rates per unique address used.

(2) Although eponymous, Satoshi Dice is not thought to be associated with Bitcoin developer Satoshi Nakamoto.

payment facilities typically offer retailers the opportunity to price entirely in fiat currencies, using the digital currency only temporarily as a payment system. The Bank is not aware of any business that accepts bitcoins in payment that also maintains its accounts denominated in that digital currency.

The sustainability of digital currencies' low transaction fees

This section moves beyond the question of whether digital currencies currently serve the roles of money to consider the extent to which they may come to act as money for an increasing number of people over time. The most relevant question in this regard is the extent to which people may come to use digital currencies as a means of payment.

A significant feature of digital currencies — and the primary driver of interest from retailers in accepting them in payment — is the promise of low transaction fees. At present, digital currency payments require transaction fees that are typically lower than those needed for retail electronic payments (such as paying by credit card) and international transfers using traditional currencies (and centralised payment systems).

Why transaction fees are currently low

Importantly, fees are low for digital currency payments despite the fact that, as currently designed, the marginal cost of verifying transactions by miners is generally *higher* than that for centralised payment systems. These higher marginal costs are due to increasing returns to scale in the operation of computer servers: it would generally be more cost efficient to process all transactions centrally. Moreover, while the marginal costs for traditional payment systems may be expected to remain broadly constant over time, those incurred by digital currency miners may be expected to rise as their usage increases and — in addition to that — to increase over time because of an incentive for overinvestment in new equipment. These drivers of marginal costs are explained in more detail in the box on page 282.

Low transaction fees for digital currency payments are largely driven by a subsidy that is paid to transaction verifiers (miners) in the form of new currency. The size of this subsidy depends not only on the current price of the digital currency, but also on miners' beliefs about the future price of the digital currency. Together with the greater competition between miners than exists within centralised payment systems, this extra revenue allows miners to accept transaction fees that are considerably below the expected marginal cost of successfully verifying a block of transactions.⁽¹⁾

The sustainability of low transaction fees

In the *near term*, the subsidies in the form of new currency that miners receive create an incentive for miners to promote

the wider adoption of the digital currency they support, since anticipated increases in demand should help to drive up the expected value of their future revenue from new currency. A willingness to accept extremely low transaction fees today can then persist so long as miners' optimism about future increases in system usage remains.

The eventual supply of digital currencies is typically fixed, however, so that in the *long run* it will not be possible to sustain a subsidy to miners. Digital currencies with an ultimately fixed supply will then be forced to compete with other payment systems on the basis of costs. With their higher marginal costs, digital currencies will struggle to compete with centralised systems unless the number of miners falls, allowing the remaining miners to realise economies of scale. **A significant risk to digital currencies' sustained use as payment systems is therefore that they will not be able to compete on cost without degenerating — in the limiting case — to a monopoly miner, thereby defeating their original design goals and exposing them to risk of system-wide fraud.**

The macroeconomic problems of a fixed money supply: a digital currency thought experiment

Digital currencies do not currently serve a substantial role as money in society and, as shown in the previous section, face significant challenges to their widespread use over the long run. This means that it is very unlikely that a digital currency, as currently designed, would be used as the predominant form of money in any economy.⁽²⁾ And as explained in this section, economic theory would suggest that social welfare would be lower in a hypothetical economy based on a current digital currency compared with a second hypothetical economy based on a fiat money system.

In most existing digital currency schemes, the future path of supply is pre-determined and governed by a protocol that ensures that the eventual total supply will be fixed. This has the effect of removing any discretion from the determination of the money supply. This would pose a number of problems for the macroeconomy: for example, it could contribute to deflation in the prices of goods and services (and wages). Importantly, the inability of the money supply to vary in response to demand would likely cause welfare-destroying volatility in prices and real activity.

(1) In particular, so long as miners expect the real marginal revenue from new currency to rise faster than their real marginal costs, there is no need for them to charge transaction fees (or, where fees are already being offered, to demand higher fees).

(2) Other current impediments to the widespread usage of digital currencies include: general unfamiliarity with the technology; the insufficient user-friendliness of applications associated with day-to-day use of the schemes; the increased need for personal security relative to deposits held with regulated institutions; and the volatility of digital currency exchange rates. Note that all of these issues are subject to ongoing investigation and development by the supporters of digital currencies.

The rising cost of mining

This box outlines two reasons why the underlying marginal cost of verifying a block of transactions in a digital currency may be expected to increase over time. The first relates to increases in the usage of digital currencies as media of exchange, while the second is due to an incentive for miners to collectively overinvest in computer hardware.

Digital currencies are designed to maintain a roughly constant time between transaction blocks (ten minutes in the case of Bitcoin — see the companion article for more details). As usage of the scheme rises so that the transaction rate increases, the number of transactions per block — and, hence, the size of each block — must therefore also increase.⁽¹⁾ This imposes both a direct cost on miners by requiring that they use more bandwidth from their internet service providers, and an indirect cost by raising the probability that the block will be ‘orphaned’ — that is, replaced by another block that is successfully verified at a similar time and which eventually becomes universally accepted.⁽²⁾

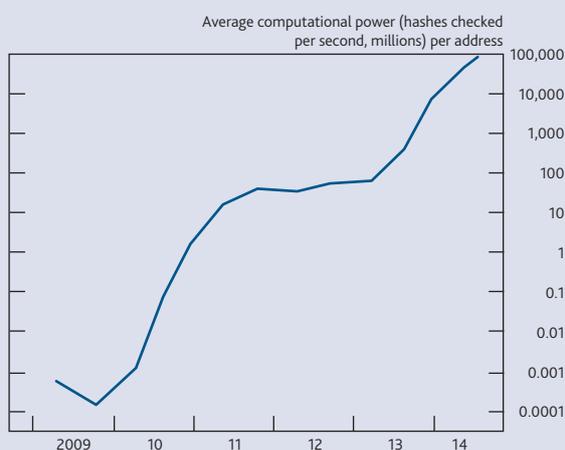
Moreover, to the extent that miners’ expected marginal revenue exceeds their expected marginal costs, miners’ costs are likely to increase over time. This should occur even if no additional people start to mine and independently from any increase in the number of transactions per block. This is because distributed systems involve a negative externality that causes overinvestment in computer hardware. The negative externality emerges because the expected marginal revenue of *individual* miners is increasing in the amount of computing power they personally deploy, but the difficulty of the problem they must each solve (and hence their marginal cost) is increasing in the total amount of computing power *across the entire network*. Individual miners do not take into account the negative effect on other miners of their investment in computing resources. Economic theory would therefore suggest that in equilibrium, all miners inefficiently overinvest in hardware but receive the same revenue as they would have without the extra investment.

When the prices of goods and services are falling, households have an incentive to postpone or even abandon spending plans. Expected price deflation also raises the minimum return an entrepreneur must offer in order to raise funding for investment in physical capital. Economic theory therefore predicts both aggregate demand and potential output to fall and, if the deflation is indefinite, the unemployment rate to be permanently higher.

Although current digital currency schemes have largely fixed money supplies, there is no technical reason why they could not adopt ‘smarter’ rules that seek to provide ongoing subsidies to miners and remove the incentive to postpone or

It is not possible to observe the average amount of computational power per miner in any given digital currency, but it is possible to calculate the computational power per *address* in the Bitcoin network. This is shown in **Chart A** as ‘hashes checked per second’, referring to the number of candidate solutions checked to the puzzles repeatedly posed to miners (see the companion article for more details). So long as the number of addresses per user and the share of users that act as miners are both roughly constant over time, then changes in this measure will capture changes in the average computational power deployed per miner. The average computational power per miner has indeed increased markedly, rising by a factor of more than 200 in the year to 9 July 2014.

Chart A Computational power per address in the Bitcoin network (log scale)^(a)



Sources: <http://bitcoinrichlist.com>, <http://blockchain.info> and Bank calculations.

(a) Excludes addresses with balances of less than 0.001 bitcoins. Points are taken at intervals of 25,000 blocks. Hash rates are taken as averages over the week preceding each block.

- (1) This is because each time a miner broadcasts their success at verifying a block they must include a copy of all of the transactions within that block so that other miners can confirm its validity.
- (2) Since the time it takes for a message to be shared across a network is increasing in the size of that message, this means that blocks with many transactions in them are transmitted more slowly, leading to a greater chance that they will be orphaned.

abandon spending. The simplest example would be a rule in which the money supply were permitted to grow at a constant rate per year, similar to that advocated by Friedman (1959, 1969). Supply would no longer be fixed, but in principle there would still be no discretionary management of the currency.⁽¹⁾

(1) In the 1970s and 1980s, official policymakers in a number of countries did attempt to ‘tie their own hands’ by adopting targets for the growth of money. But such rules are generally suboptimal from a welfare perspective. Indeed, they were typically abandoned following difficulties in defining and observing a stable measure of demand for money and a predictable relationship between the growth of money and inflation, ultimately in favour of ‘constrained discretion’ in the form of inflation targets.

A second problem derives from a pre-determined supply's inability to respond to variation in demand. Aggregate demand for money is volatile, for reasons that may be seasonal (such as Christmas shopping), cyclical (such as recessions) or structural (such as from technology improvements). If the money supply cannot respond to these variations, volatility in prices will ensue, causing welfare-destroying volatility in economic activity.

In order to address a need to respond to variation in demand, a more flexible rule would be required. For example, the growth rate of the currency supply could be adjusted to respond to transaction volumes in (close to) real time. Alternatively, a decentralised voting system could be developed. Finally, variant schemes could embrace existing monetary systems by seeking to match official broad money data or to target a fixed exchange rate, although this would require the abandonment of part of the schemes' original ideology.

Monetary and financial stability

Current situation

At present, digital currencies do not pose a material risk to monetary or financial stability in the United Kingdom.

Although these schemes have experienced a number of brief and very rapid periods of growth, they nevertheless remain very small. It is estimated that there is less than £60 million worth of bitcoins circulating within the UK economy, which represents less than 0.1% of sterling notes and coin and only 0.003% of broad money balances.⁽¹⁾ It is estimated that as few as 20,000 people in the United Kingdom currently hold any bitcoins, and that as few as 300 transactions may be conducted by those people per day.

Potential future risks

Nevertheless, it is possible to conceive of risks that may develop over time. This section provides an initial analysis of some monetary and financial stability risks that could emerge if digital currencies grew significantly and there were no mitigants implemented. Over time, although risks to financial stability are considered unlikely, they would, in general, be more likely to emerge (and sooner) than those to monetary stability. Risks to monetary stability could, in theory, emerge if a digital currency were to achieve widespread usage, but this is extremely unlikely over any foreseeable horizon under the design of current digital currencies.

Financial stability

The Bank's responsibility for financial stability is set out in the Financial Services Act 2012. The Act established an independent Financial Policy Committee (FPC), a new prudential regulator as a subsidiary of the Bank, and created new responsibilities for the supervision of financial market

infrastructure.⁽²⁾ This responsibility for financial stability does not entail targeting the prices of different asset classes, but a price crash in assets to which households, companies or financial institutions had large enough exposures could lead to financial distress and an impairment to the provision of critical financial services.

The prices of digital currencies can be very volatile, as illustrated in **Chart 1** for Bitcoin, and a price crash is not inconceivable. The total value of all digital currencies is too small to pose a threat in this way at present, but further increases in their prices cannot be ruled out. If marked increases in prices were to occur, it is possible that the total valuation may become large enough such that a price crash might have implications for financial stability in this manner.

The impact of any price crash would also, at present, be limited to the direct holders of the alternative currencies. But these effects could be magnified under a number of potential scenarios, such as:

- If a holder of digital currencies had increased their exposure by first borrowing money from someone else. A price crash in this scenario would have the potential to impose losses not only on the direct holders of digital currencies but also on those who had lent to them.
- If a systemically important financial institution were to have a significant unhedged exposure to a digital currency.⁽³⁾
- If a digital currency were to become entwined with financial instruments such as derivatives contracts, creating a mechanism whereby both the direct users of a digital currency and other financial market participants could hold leveraged positions against the currency. This could result in the total market exposure to digital currencies far exceeding the market value of digital currencies so that a price crash would have a magnified impact on the economy, and on a wider part of the economy than just direct participants.

A number of risks to financial stability could also emerge if digital currencies grew to a point where they played a significant role as a payment system. One new risk, specific to digital currencies, would be the possibility of system-wide fraud. If a single miner, or coalition of miners, came to control

(1) Figures are for July 2014. Note that 'broad money' refers to M4, excluding intermediate other financial corporations.

(2) The FPC is a committee of the Bank responsible for the stability of the financial system as a whole, the Prudential Regulation Authority (PRA) for the supervision of banks, building societies, credit unions, insurers and major investment firms and the Financial Market Infrastructure Directorate of the Bank for the oversight and supervision of infrastructure, including systemically important payment systems. See Murphy and Senior (2013) for more detail.

(3) Exchange rate risk with digital currencies is difficult to hedge (Yermack (2013)), which suggests that additional loss-absorbing capital may be required in that scenario.

a sustained majority of the computing power in a digital currency, that group would be able to control which payments were permitted or even to create fraudulent 'double spend' payments.⁽¹⁾ A related risk lies in the fact that the incentives implied by digital currencies are not yet fully understood. If a digital currency became systemically important before all incentives built into its design were completely mapped out, there would be a risk that a hitherto unrealised opportunity for disruption may be discovered and exploited.

Finally — and while not considered likely in the foreseeable future — financial stability could also be put at risk if fractional reserve banking were to emerge in an unregulated fashion above a digital currency, because of the need to protect against bank runs. Liquidity insurance would be another issue in this scenario, especially in the absence of any central bank able to create the base money for such a system in the event of a bank run. The box on page 285 considers this scenario in more detail.

Monetary stability

The greatest risk that could, in theory, be posed by digital currencies to monetary stability in the United Kingdom is an erosion of the ability of the Monetary Policy Committee (MPC) to influence aggregate demand as part of its remit to achieve 2% inflation in the consumer prices index.⁽²⁾ The MPC traditionally influences aggregate demand by adjusting Bank Rate, the interest rate paid on commercial banks' reserves at the Bank of England, up and down. There are several ways in which monetary policy affects aggregate demand, but one key channel is via the transmission of changes in Bank Rate to the interest rates offered by commercial banks to savers and borrowers. The subsequent spending decisions of households and businesses then influence the aggregate amount of economic activity and inflationary pressure in the economy.

Both the extent and the distribution of usage of digital currencies are of relevance in evaluating any risk to monetary stability. If a relatively small share of payments in the United Kingdom were to be made via a digital currency such that many people conducted some transactions in that currency, but made the bulk of their purchases via traditional, sterling-based payment systems, then the MPC would retain its ability to influence the level of aggregate demand across all segments of the economy, and thus achieve its monetary stability objectives.

Alternatively, if digital currency payments were concentrated among a small number of people that sought to transact as far as possible in that currency, then that would amount to a fragmentation of the UK economy. Depending on the trade links between those people and the rest of the population, the Bank's ability to influence demand within that subset of people may potentially be reduced.⁽³⁾

The greatest hypothetical risk to monetary stability that might be posed by digital currencies is if the economy were to become, for example, 'Bitcoinised' — where everybody sought to conduct the totality of their day-to-day transactions entirely within the alternative currency and switch into sterling only when strictly necessary for interaction with the state (such as to pay taxes). This would represent a significant change. Since in this extreme scenario all payments would be conducted away from sterling as base money for essentially all of the economy, the Bank's ability to influence price-setting and real activity would be severely impaired. But such an outcome is extremely unlikely given the current impediments to the widespread adoption of current digital currency schemes imposed by their designs and is, in any event, implausible absent a severe collapse in confidence in the fiat currency. It is much more likely that, if further adopted, digital currencies will be used in a limited fashion alongside traditional currencies.

Other relevant issues

This section has focused on potential impacts on the Bank's mission to maintain monetary and financial stability within the United Kingdom. Beyond the Bank's remit, however, there are other issues concerning consumer protection, taxation, money laundering and the possible use of new payment systems and alternative currencies in financing terrorism or other crime. **No comment is made on these other issues here.** Interested readers may wish to consult publications from other authorities, such as:

- HMRC guidance on the tax treatment of digital currencies (HMRC (2014)).
- An opinion issued by the European Banking Authority (EBA (2014)), which discusses a range of possible risks related to digital currencies.
- A report by the Financial Action Task Force (FATF (2014)) on risks related to money laundering and terrorist financing.
- A speech by the Chancellor of the Exchequer (Osborne (2014)) that announced a programme of work by the UK Government to explore 'the potential of virtual currencies and digital money'.

(1) Indeed, temporary control of a majority of computing power has already occurred on a number of occasions within the Bitcoin network, although the Bank is not aware of any evidence that it was achieved with malicious intent.

(2) There are, of course, other potential risks to price stability. For example, if a systemically important payment system, no matter what form of money it transmitted, were to experience a severe outage, then that would represent a shock to which the MPC would need to respond.

(3) An important question in this latter case would be whether the digital currency was still used as a unit of account. Some economists argue that so long as a central bank retains control of the supply of the unit of account, it does not matter the extent to which it is actually used as a medium of exchange or a store of value (Woodford (2003)).

Could a banking system based on a digital currency emerge?

There are significant barriers to any digital currency, as currently designed, becoming the dominant form of money in an economy. This also presents significant challenges to the emergence of a banking system denominated in a digital currency.

Nevertheless, it is at least conceivable that a financial institution could issue IOUs to the public that were denominated in a digital currency. If an institution issuing such claims were to back them one-for-one with actual digital currencies, it would amount to a form of 'narrow banking' — the general public's holdings of assets denominated in the digital currency would not have changed.

In such a setting, and if the digital currency were somehow to achieve widespread usage, then if demand for that digital currency were to grow while its supply remained fixed, an incentive would exist for financial institutions to create extra instruments (for example, by extending loans) that were not fully backed. This would create a form of fractional reserve banking, with the digital currency playing the role of base money and the total claims on issuers the role of broad money. An important question that would then emerge is whether banks could be constrained in their creation of broad money without regulatory oversight or central bank involvement in the management of the underlying base currency.

In this vein, there are some parallels with historical episodes of free banking, in which relatively unregulated banks were able to issue their own banknotes as a form of private money. The record shows that while some free banks did act with restraint, there is a risk of uncontrolled inflation (that is, a fall in the purchasing power of the banknotes) if private issuers overuse their ability to create currency at a very low marginal cost.

Modern-day advocates of a return to free banking, like promoters of digital currencies, have been motivated in part by their disapproval of monetary management as practised by central banks. Advocates suggest that free banks should be obliged to redeem their notes at par against official currency. Any overissuance would, it is said, simply flow back to them.⁽¹⁾ If free banks' notes were not convertible into an official currency, banks would compete to produce the most 'useful' notes — ones that maintained their purchasing power.⁽²⁾ By contrast, the safeguard offered by digital currency schemes amounts to an undertaking to issue and to recognise new currency only as indicated by an algorithm, which can be amended only with the assent of a majority of computing power on the relevant network.

The historical record shows that overissuance could occur under free banking, sometimes on a massive scale, but this was not always the case. Sometimes free banks exchanged notes with each other at par through a clearing house, as in Scotland before 1845 or in New England through the Suffolk Bank before the US Civil War. Membership of a clearing house was a valuable sign of a bank's soundness, and enabled the clearing house to exert some restraining influence over members' activities.

Although holders of free banks' notes elsewhere in the United States could, in principle, demand that they be redeemed at par, this did not always prevent overissuance. Professional 'money brokers' emerged, whose function was to take bundles of notes to the home offices of the issuing banks for redemption in specie (gold or silver). 'Wild cat banks', however, were set up in 'wild cat country' — areas that were difficult to access — in order to thwart the brokers' efforts. In other cases bank promoters were simply overoptimistic about their prospects. And convertibility was sometimes suspended.

The result was that free banks' notes by no means always traded at par. Indeed, money brokers published news sheets giving the market rate of various banks' notes in relation to specie, based partly on distance from the issuing bank but also on the probability of redemption. Many free banks were also short-lived and some holders of their notes suffered significant losses.

Historically, individual free banks faced a trade-off between overissuance for a quick gain and the benefit of low-cost funding over the long term. Promoters of existing digital currencies have no discretion to 'over issue' (relative to their algorithms). The analogy with free banking might, therefore, become more relevant if digital currencies were in future to adopt more flexible money supply rules.

(1) See, for example, Chapter 2 of Dowd (1993).

(2) See Chapters 8 and 11 of Hayek (1976).

Conclusion

Both digital currencies' status as money and the distributed ledger technology used by them have potential to develop over time. Most digital currencies, at present, deploy fixed eventual money supplies, although this is not strictly an essential feature. Usage of digital currencies is presently very low and, as currently designed, there are a variety of incentive problems that are likely to prevent their widespread adoption in the long run.

Digital currencies do not, at present, play a substantial role as money in society. But they may have the potential to come to exhibit at least some of the functions of money over time. There is little incentive for the pricing of goods and services to

change from traditional currencies, however, unless these currencies were to suffer from a wholesale collapse in confidence.

Digital currencies do not currently pose a material risk to monetary or financial stability in the United Kingdom. Should they achieve limited adoption as a payment system, they are unlikely to undermine the Bank's ability to achieve monetary stability. While that could, in theory, change if sterling were abandoned in favour of an alternative currency for a significant fraction of the economy, such a scenario is considered extremely unlikely at present. A variety of potential risks to financial stability could emerge if a digital currency attained systemic status as a payment system, most of which could be addressed through regulatory supervision of relevant parties.

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How might macroprudential capital policy affect credit conditions?

By Rashmi Harimohan of the Bank's Monetary Assessment and Strategy Division and Benjamin Nelson of the Bank's Prudential Policy Directorate.⁽¹⁾

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

Overview

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

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

The effects of changes in macroprudential capital policy on credit conditions will depend crucially on the way in which banks adjust their balance sheets which, in turn, will reflect any guidance from the FPC on how banks should adjust their capital ratios. Aside from this, a key determinant of the impact of macroprudential capital policies on credit conditions will be the extent to which banks' cost of funding is affected. This, in turn, will likely depend on the severity of financial frictions and the extent to which a policy announcement influences things like investors' beliefs about the soundness of the financial system and their expectations of future policy. The overall impact on the price and quantity

of lending will then depend on the extent to which banks pass through changes in funding costs to credit conditions and how much macroprudential capital policy influences borrower demand for credit. This article introduces a simple framework that can be used as a starting point for quantifying some of these channels. The framework adopts a 'general equilibrium' approach in order to try and take account of the decisions of savers and borrowers in the economy, as well as the banks themselves.

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

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

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

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

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

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

In addition to the direct effect of making the financial system better able to withstand shocks, there is also an indirect channel by which macroprudential capital policy can affect resilience via its impact on credit conditions and economic growth more generally. But the magnitude and direction of the relationship will depend on the conditions prevailing at the time. An increase in capital requirements during benign conditions could increase banks' overall funding costs by requiring them to finance more of their activities with equity, which is typically more expensive than other sources of

funding. Banks might then pass on these higher funding costs by charging higher interest rates on their loans, reducing the amount of credit supplied to the economy and thereby helping to avoid the build-up of the vulnerabilities associated with an overextension of credit. When confidence in banks' capital positions is low, this indirect channel could work in reverse: an easing in macroprudential capital policy would allow previously accumulated buffers to be reduced, leading to looser credit conditions.

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

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

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

(1) For more detail on the role of the PRA, see Bailey, Breen and Stevens (2012).

(2) For more detail on the role of the FPC, see Tucker, Hall and Pattani (2013) and Murphy and Senior (2013).

(3) In what follows, the term 'banks' is used to describe banks and building societies.

(4) For more detail on the role of banks, see Freixas and Rochet (2008).

(5) To some extent, the banking system is self-financing in that whenever banks make loans, they simultaneously create a matching deposit in the borrowers' bank accounts, thereby creating new funding. But what is true for the system as a whole does not necessarily hold for an individual bank. For more detail on money creation, see McLeay, Radia and Thomas (2014).

(6) 'Near term' in the context of macroprudential policy as used in this article refers to a period of up to two to three years from when a policy is announced. Note that this contrasts with 'near term' as used in discussions of monetary policy (such as in the *Inflation Report*), which typically refers to the coming few months.

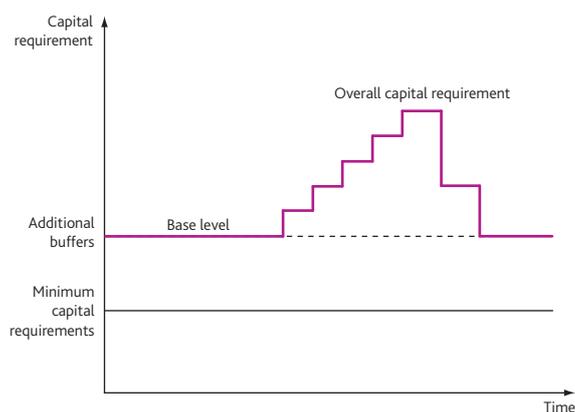
(7) For more on the interaction between monetary policy and financial stability policy, see the June 2013 *Financial Stability Report*; www.bankofengland.co.uk/publications/Documents/fsr/2013/fsrfull1306.pdf.

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

Setting the scene: macroprudential capital policy in the United Kingdom

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

Figure 1 Illustration of macroprudential capital policy^(a)



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

The FPC has two main sets of powers at its disposal. The first is a wide-ranging power to make *Recommendations* to mitigate systemic risks.⁽²⁾ The second is a power to give *Directions* to regulators to adjust specific macroprudential tools. To date, the Government has given the FPC direction power over sectoral capital requirements (SCRs) and, in May 2014, it made the FPC responsible for policy decisions on the countercyclical capital buffer (CCB).⁽³⁾ Both tools build on the existing microprudential regime and are designed to

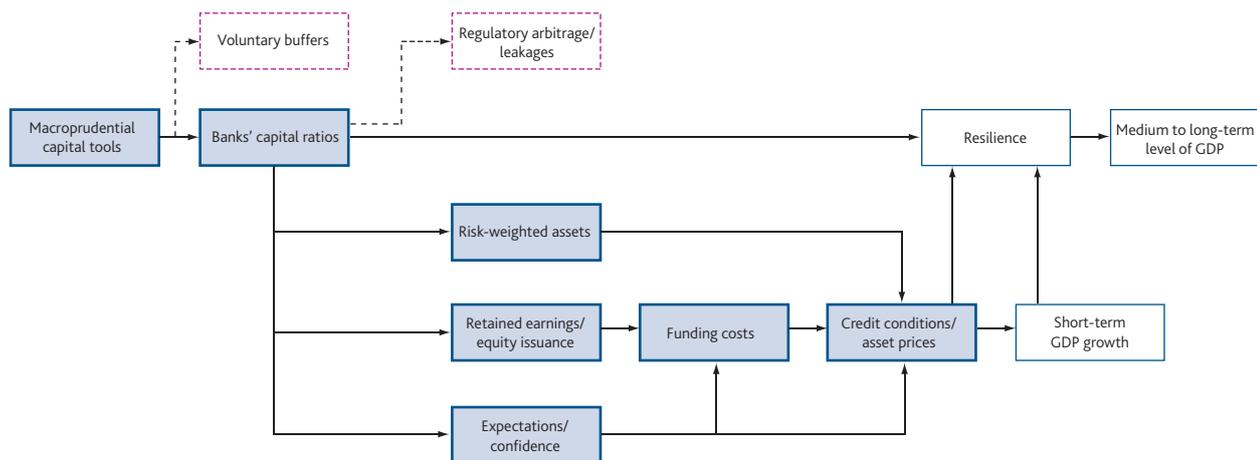
reduce the likelihood and severity of financial crises. The CCB tool allows the FPC to change bank capital requirements, over and above their microprudential level, in relation to all loans and exposures to UK borrowers. SCRs, meanwhile, allow the FPC to change capital requirements, over and above their microprudential level, on exposures to specific sectors of the economy that are judged to pose a risk to the system as a whole.⁽⁴⁾ These sectors could include residential property, commercial property, or other parts of the financial sector. As required under statute, the FPC published a Policy Statement in January 2014 describing these tools, the circumstances in which they might be used and the likely impact of these tools on financial stability and growth.⁽⁵⁾

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

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

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

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



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

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

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

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

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

$$\text{Capital ratio} = \frac{\text{Capital}}{\text{Risk-weighted assets}}$$

A bank can change its capital ratio by either adjusting the numerator or the denominator. For instance, a bank can increase its capital ratio either by raising capital or by reducing its risk-weighted assets (RWAs). In turn, capital can be increased either through raising equity or retaining more earnings.⁽³⁾ Or if a bank wishes to reduce its RWAs it can do so either by holding fewer assets (for instance by selling certain assets, or not rolling over loans as they fall due) or by altering

the composition of assets such that it holds a greater share of low-risk assets. The box on pages 292–93 describes three stylised ways in which a bank's balance sheet can mechanically adjust to meet higher capital ratio requirements.

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

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

(1) For more detail on the stress test see Box 2 in the June 2014 *Financial Stability Report*; www.bankofengland.co.uk/publications/Documents/fsr/2014/fsrfull1406.pdf.

(2) As shown in Figure A in the box on pages 292–93, a bank's balance sheet consists of its 'sources of funds' on one side (liabilities and capital) and its 'use of funds' (that is, its assets) on the other side. A bank's assets include loans to households and businesses and other assets like liquid assets, physical infrastructure and intangible assets. But some assets tend to be riskier than others and each asset class can be assigned a risk weight according to how risky it is judged to be. These weights are then applied to the bank's assets, resulting in RWAs. This allows banks, investors and regulators to consider the risk-weighted capital ratio, which is a bank's capital as a share of its RWAs.

(3) While the main component of a bank's capital resources is equity, banks can also count other instruments in their regulatory capital requirements. For more detail, see Farag, Harland and Nixon (2013).

(4) In addition, the impact of a change in capital ratios will also depend on whether banks are holding any voluntary capital buffers and the extent to which the new requirements bind for banks.

(5) See Table 4.A in the June 2013 *Financial Stability Report*; www.bankofengland.co.uk/publications/Documents/fsr/2013/fsrfull1306.pdf.

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

Impact on banks' cost of funding

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

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

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

reduction in the overall supply of (and, hence, demand for) loans.

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

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

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

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

Mechanics of balance sheet adjustment

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

Under **Option 1**, the bank achieves a higher capital ratio by increasing the level of its capital. One way a bank can increase its capital is by issuing new equity shares, either through 'direct placements' or 'rights issues'.⁽¹⁾ Another way a bank can increase the level of capital is to retain earnings. If the bank retires debt at the same time then this option would be consistent with no change in the overall size of the bank's balance sheet and no change in its domestic lending. Under **Option 2**, the bank achieves a higher capital ratio by reducing the level of its risk-weighted assets (RWAs) but it does not reduce its level of UK household and corporate lending. As shown in **Figure A**, this could be because the bank reduces its holdings of other assets such as non-UK loans or trading book assets, decreasing the overall size of the balance sheet. Alternatively, the bank could reduce the level of its RWAs without affecting the size of its balance sheet by switching

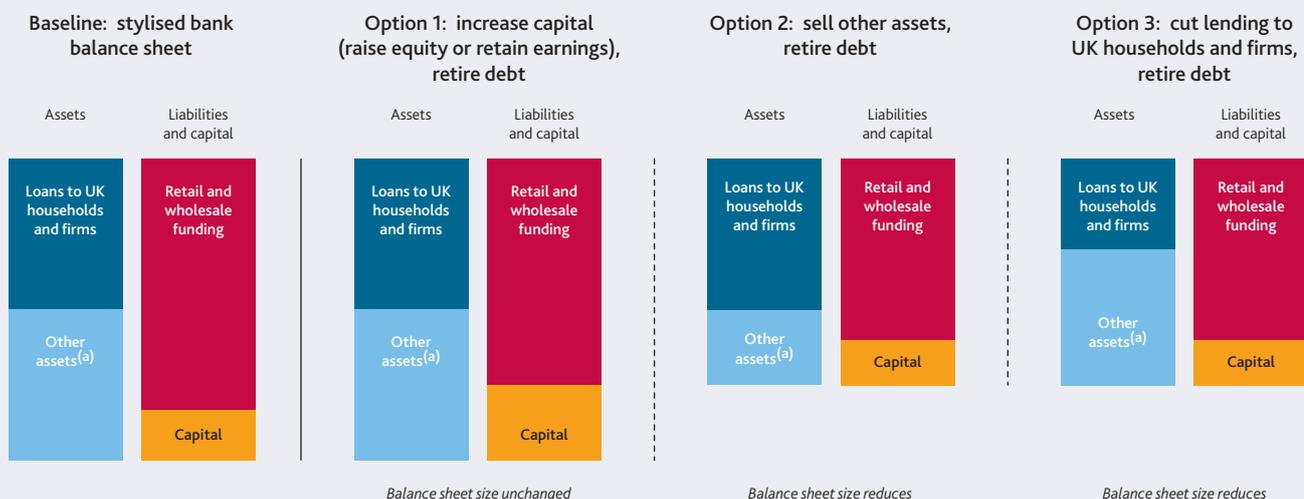
into assets that have lower risk weights. Under **Option 3**, the bank achieves a higher capital ratio by reducing its UK lending. But this does not necessarily imply a reduction in aggregate whole-economy lending, for instance if a bank reduces its loans by selling them to other financial market participants. Moreover, in the longer term, higher capital ratios should make the bank more resilient and support the stability of credit supply in the face of macroeconomic shocks.

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

How have banks adjusted their balance sheets in the past?

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

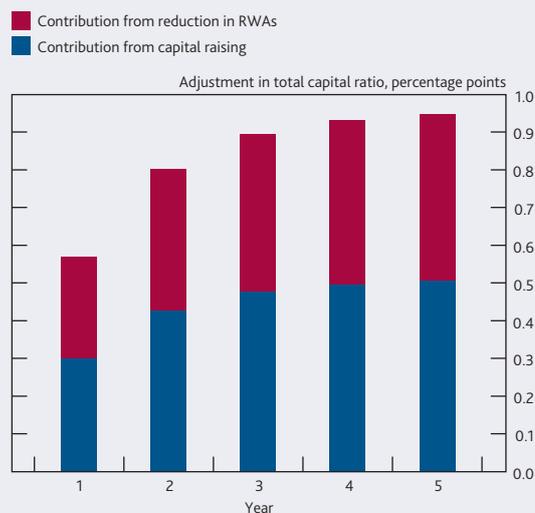
Figure A Options for how a bank might achieve a higher capital ratio



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

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

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



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

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

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

In the United Kingdom, an example of a change in macroprudential capital requirements is the Financial Policy Committee's (FPC's) capital shortfall exercise in 2013. In

response to the FPC's recommendation, major UK banks and building societies improved their capital ratios both through reductions in RWAs and increases in capital resources. And in line with the FPC's recommendation, the shortfalls were addressed without a reduction in lending to the domestic economy by selling non-core assets and scaling back investment banking operations.⁽⁶⁾

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

The Modigliani-Miller propositions and banks

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

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

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

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

Third, some bank debt liabilities, including bank deposit accounts, have a special role in providing **liquidity services** to customers. By 'storing' households' savings and providing access to these resources at short notice, bank deposit accounts help households to smooth consumption or meet

emergency expenditures without having to hold their savings in the form of notes and coins. Because of this liquidity benefit to households, they may be willing to hold their savings in the form of deposits for a lower interest rate than would otherwise be the case. This again would lower the cost of debt finance relative to equity.

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

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

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

(2) See Myers and Majluf (1984).

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

Impact on the amount of credit extended

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

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

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

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

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

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

The equilibrium impact on credit: a theoretical approach

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

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

(1) As a result, there are likely to be lags involved and adjustments in the aggregate stock of lending would therefore be likely to take several quarters.

(2) For lessons from the literature on some of these channels, see Giese *et al* (2013).

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

Partial equilibrium model

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

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

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

General equilibrium model

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

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

Figure 3a Partial equilibrium effect

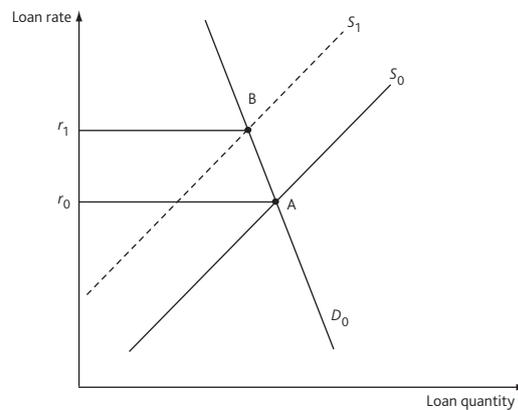


Figure 3b General equilibrium effect

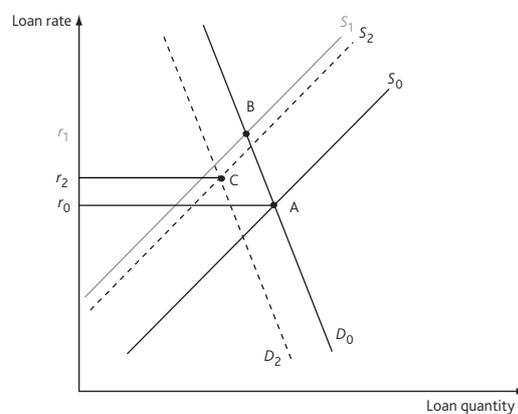
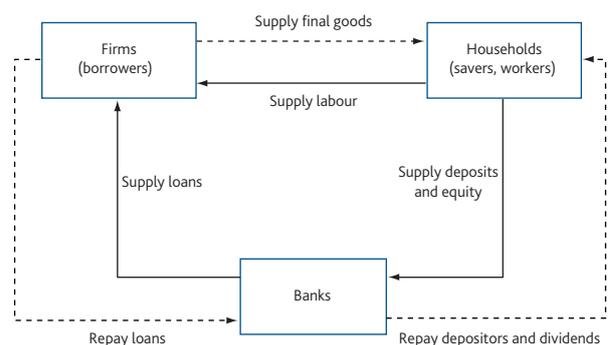


Figure 4 A stylised depiction of the general equilibrium model



equations and the calibration used to estimate the parameters of the model provided in the annex. A key assumption in the general equilibrium model relative to the partial equilibrium model is that borrowers and savers react to changes in macroprudential capital policy.

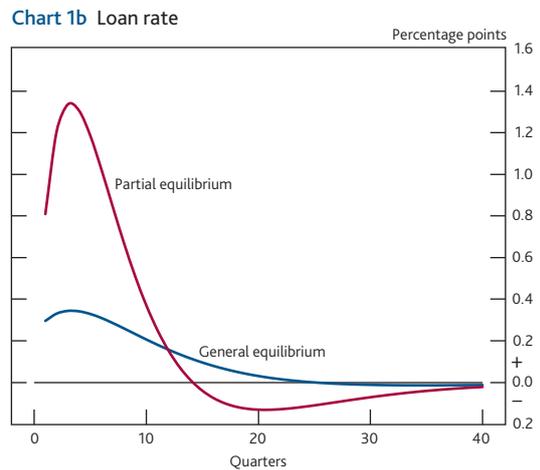
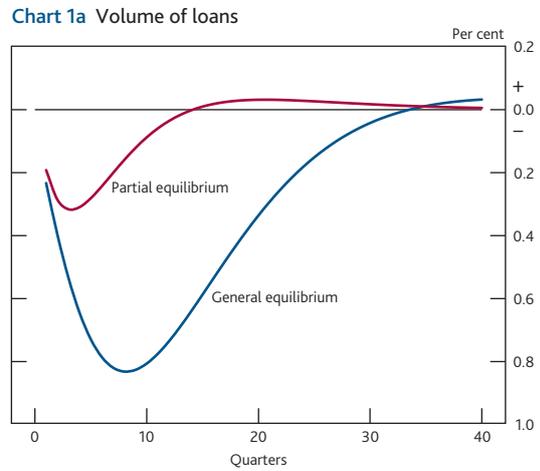
(1) See Button, Pezzini and Rossiter (2010) and Butt and Pugh (2014) for a detailed overview of how banks price loans.

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

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

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

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



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

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

credit conditions in the near term. That impact is also likely to vary with the severity of various financial frictions faced by banks and investors over time. **Chart A2** in the annex shows that as the severity of financial frictions falls, so does the impact of macroprudential capital policy on loan quantities, in the near term. Moreover, regardless of these effects, there is

(1) When the loan rate increases, it becomes expensive to borrow to finance capital goods, so investment falls. This reduces the future value of borrowers' collateral, and because the borrowing constraint continues to bind this reduces the demand for loans. So borrowers' constraints generate an additional reduction in loan quantities through a collateral channel.
 (2) And while the impact on loan rates is similar in order of magnitude to other simple approaches, the peak effect in the partial equilibrium (PE) model is at the higher end of other estimates. That is because the shock builds over the simulation, and because the approach neglects general equilibrium effects. Moreover, the PE model used here contains a set of second-round effects that arise in this (dynamic) model that are not typically captured in other simpler PE models.

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

Issues around the quantification of macroprudential policy

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

Non-linearities in the transmission mechanism

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

Disintermediation and regulatory arbitrage

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

Interactions with other regulatory requirements

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

Interactions with monetary policy

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

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- (1) There is evidence that the long-run benefits of higher capital requirements exceed the short-run costs. For instance, the Macroeconomic Assessment Group study (MAG (2010)) showed that the impact of the transition to Basel III capital requirements was net positive in the long run. In addition, Kapan and Minoiu (2013) show that banks that are well-capitalised going into a crisis can support the real economy by maintaining lending.
 - (2) Specifically, the FPC will set the CCB rate applied to UK lending by banks incorporated in the United Kingdom. But under the reciprocity arrangements set out in Basel III and the CRD IV/CRR, overseas regulators will be bound to apply a CCB rate to their banks' UK exposures which is no less than the rate chosen by the FPC for CCB rates up to 2.5% of RWAs.
 - (3) For more on the role of a leverage ratio within the capital framework of the United Kingdom, see Bank of England (2014b).
 - (4) See, for example, the box 'The relationship between a bank's capital and liquidity positions' in Farag, Harland and Nixon (2013).
 - (5) For more information on this recommendation, see www.bankofengland.co.uk/publications/Pages/news/2013/099.aspx.
 - (6) One way to interpret the results is to imagine that monetary policy were working in the background to keep demand in line with supply, such that inflation were perfectly stabilised in response to the macroprudential and credit boom shocks considered. Within this framework, there arises a neat separation between monetary stability and stability in the credit market: monetary policy aims at offsetting the implications of nominal frictions, like sticky prices, while macroprudential policy aims at offsetting the effects of financial frictions. In this world, the addition of macroprudential instruments helps to ameliorate the effects of financial shocks that monetary policy may otherwise be required to consider, and so the two tools are complementary.
 - (7) For more on the interaction between monetary policy and financial stability policy, see the June 2013 *Financial Stability Report*; www.bankofengland.co.uk/publications/Documents/fsr/2013/fsrfull1306.pdf.

Conclusion

Both the FPC and the MPC assess the impact of macroprudential policy on the credit market in discharging their policy remits. This article has set out a simple framework to help to understand the possible impact of macroprudential capital policy on credit conditions over the near term. Aside from any FPC guidance on how banks should adjust their balance sheets, the direction and magnitude of the impact is

likely to depend crucially on the state of the financial system and the economy as well as the way in which banks, financial investors and borrowers respond to changes in macroprudential capital policy. The simple framework set out in this article provides some insights on understanding the effects of macroprudential capital policy. Like monetary policy, our understanding of the impact of macroprudential tools will improve as theory advances and experience in deploying them accumulates.

Annex

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

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

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

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

$$E_t[\beta c_t(1+r_t)]/c_{t+1} = 1,$$

$$\chi c_t n_t^\varphi = (1-\alpha)(y_t/n_t)$$

where E_t denotes the expectations operator.

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

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

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

and borrowing satisfies:

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

- Output and capital satisfy:

$$y_t = k_t^\alpha n_t^{1-\alpha},$$

$$k_t = (1-\delta_k)k_{t-1} + i_t$$

and market clearing implies that:

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

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

$$r_t^l = \mu_t \left[r_t - \gamma \left(\frac{e_t}{l_t} - k_t \right) \left(\frac{e_t}{l_t} \right)^2 \right],$$

$$e_t = (1-\rho_t)e_{t-1} + \pi_{t-1}$$

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

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

Table A1 Baseline calibration used in simulations

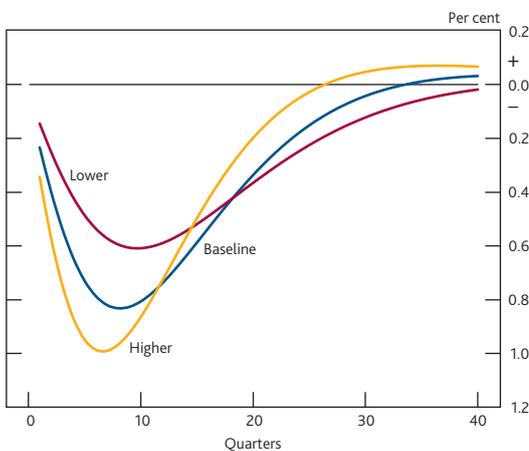
Parameter	Description	Value
α	Capital share in output	0.33
β	Discount factor (household)	0.9938
δ	Discount factor (firm owners)	0.8945
δ_k	Depreciation rate of capital	0.025
χ	Disutility of labour	4.0467
φ	Elasticity of labour supply	2.50
θ	Loan to value ratio	0.65
μ	Steady-state loan mark-up	1.98
ρ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

Additional simulations

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

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

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



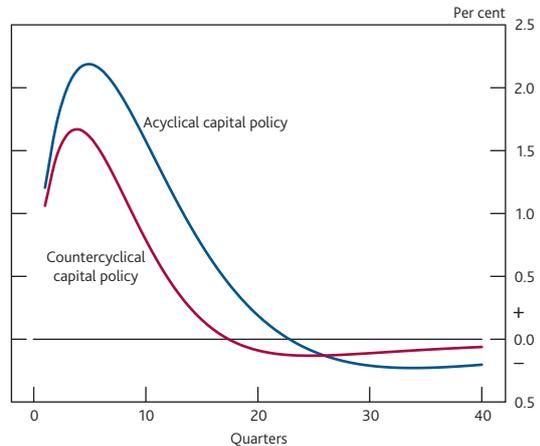
Sources: Gerali *et al* (2010) and Bank calculations.

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

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

balance sheets, so that bank capital ratios fall by less under the countercyclical policy.⁽²⁾ This, in turn, implies that loan rates fall by less, such that borrowing and output expand by less.

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



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

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

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

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

- (a) Results based on an econometric analysis of the impact of the UK Financial Services Authority’s microprudential Pillar 2 requirements over the period 1998–2007. Reported results show the cumulative impact across a range of estimated models on lending to private non-financial corporations, excluding the potential for leakages via foreign branch lending, with the maximum and minimum reported in square brackets. Monetary policy is held constant.
- (b) Bridges *et al* (2014) undertake an econometric analysis of the impact of changes in microprudential regulatory capital requirements on bank capital and bank lending in the United Kingdom between 1990 and 2011. They analyse the lending response in four different sectors. They find that banks, on average, cut, in descending order of magnitude based on point estimates, loan growth for commercial real estate, other corporates and household secured lending in the year following an increase in capital requirements. The response of unsecured household lending is smaller and not significant over the first year as a whole. Loan growth mostly recovers within three years. The result for aggregate lending displayed in the table is calculated as the cumulative impact over three years for each sector, weighted by each sector’s share of lending as at 2011. Monetary policy is held constant.
- (c) Results based on a loan pricing equation calibrated for US banks linking capital requirements to lending rates. The maximum effect refers to the case where banks are able to pass through in full the costs of higher aggregate capital requirements to their customers. The minimum effect assumes a modest decline in banks’ funding and administrative costs. Results are calculated from Tables 1 and 2 in Elliott (2009). Monetary policy is held constant.
- (d) Taken from Francis and Osborne (2012), Table 5. Results based on an econometric analysis of the impact of microprudential Pillar 2 requirements imposed by the UK Financial Services Authority over the period 1996–2007. Results assume a 44% pass-through from regulatory capital requirements to banks’ capital ratios. Monetary policy is held constant.
- (e) The Macroeconomic Assessment Group (MAG) analysed the impact of the transition to Basel III across a range of alternative models, calibrated across a wide variety of jurisdictions (including the United Kingdom). The reported figures in the table refer to the median impact across a range of estimated models (see Annex 2.2 in MAG (2010)), with the maximum and minimum reported in square brackets. Estimation assumes implementation of permanently higher capital requirements over two years. Results are for the 18th quarter of the simulation. Monetary policy is held constant.

(1) The severity of financial frictions are not likely to be constant over time, meaning that a given change in macroprudential policy would have effects that vary over time (see Tucker (2013)).
 (2) In this model, a bank’s capital ratio and its leverage move inversely, so a low capital ratio implies a high ratio of loans to equity — or high leverage.

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Household debt and spending

By Philip Bunn of the Bank's Structural Economic Analysis Division and May Rostom of the Bank's Banking System Division.⁽¹⁾

- This article is the first study to use microdata to assess the role of debt levels in determining UK households' spending patterns over the course of the recent recession.
- There is evidence that high levels of household debt have been associated with deeper downturns and more protracted recoveries in the United Kingdom.
- Cuts in spending associated with debt are estimated to have reduced the level of aggregate private consumption by around 2% after 2007, unwinding the faster growth in spending by highly indebted households, relative to other households, before the financial crisis.

Overview

This article investigates the relationship between household debt and consumption in the United Kingdom with a focus on whether increases in mortgage debt before 2007 helped to finance household spending, and whether high debt levels led to a deeper recession in 2008/09. There is no previous work for the United Kingdom that looks at this issue in detail. Knowing how households with debt respond in the face of shocks has important implications for both financial stability and monetary policy.

Analysis of microdata shows that UK households with high levels of debt cut their spending by more — relative to income — than households, on average, following the financial crisis. Cuts in spending associated with debt are estimated to have reduced aggregate private consumption by around 2% after 2007 (**summary chart**), which increased the depth of the recession and contributed to the protracted nature of the recovery.

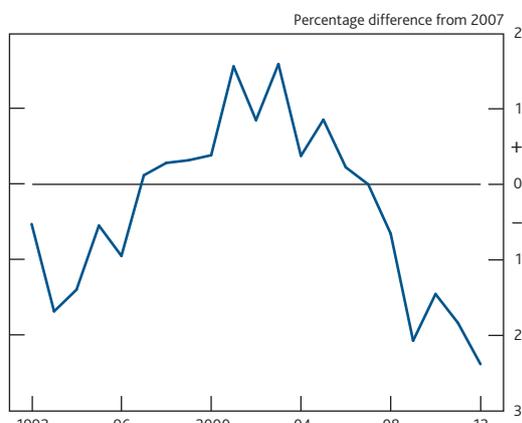
Survey evidence suggests that large cuts in spending by highly indebted households after 2007 reflect a combination of tighter credit conditions and increased concerns about ability to make future debt repayments.

There is also wider evidence that high levels of household debt can increase the depth of recessions. Debt is likely to have restrained UK aggregate spending during the early 1990s, albeit by less than in the 2008/09 recession, and there is a body of international evidence that is also

consistent with a role for debt following the recent financial crisis.

The potential for household indebtedness to lead to large adverse impacts on aggregate demand was an important reason why the Financial Policy Committee took policy action at its June 2014 meeting to insure against the risks from a further significant increase in the number of highly indebted households. This is an area that both the Financial and Monetary Policy Committees will continue to monitor closely.

Summary chart Estimated impact of debt on the level of total private consumption, relative to 2007^(a)



Sources: DCLG, LCF Survey, ONS and Bank calculations.

(a) See footnote to **Chart 8** for more details on how this chart is constructed.

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

A major development in UK household balance sheets in the decade before the financial crisis was the build-up of household debt. This article assesses the extent to which household debt has played a role in affecting consumption. It discusses whether the build-up of debt is likely to have helped to finance household spending before the crisis, and to what extent the subsequent recession was deeper, and recovery slower, as a result of indebted households reducing their spending by more than others. There is no previous work for the United Kingdom that looks at this issue in detail.⁽¹⁾

Understanding how households with debt respond to shocks has important implications for both financial stability and monetary policy. At higher levels of indebtedness, households are more likely to encounter payment difficulties following negative shocks to income or interest rates. Concern about the possibility of financial distress may also lead to sharp falls in spending, even if that distress does not eventually materialise. Increases in realised financial difficulties and in the risk of distress could pose direct risks to the resilience of the UK banking system and indirect risks via the impact on wider economic stability. The extent to which associated cuts in spending weigh on aggregate household consumption (which accounts for around two thirds of GDP) is also highly relevant for monetary policy decisions.

The potential for household indebtedness to have a large adverse impact on aggregate demand and on the banking system was a key reason why the Financial Policy Committee (FPC) took policy actions in June 2014 to insure against the risks from a further significant increase in the number of highly indebted households.⁽²⁾ The Committee recommended that:

- When assessing affordability, mortgage lenders should apply an interest rate stress test that assesses whether borrowers could still afford their mortgages if, at any point over the first five years of the loan, Bank Rate were to be 3 percentage points higher than the prevailing rate at origination.
- The Prudential Regulation Authority and the Financial Conduct Authority should ensure that mortgage lenders limit the proportion of mortgages at loan to income multiples of 4.5 and above to no more than 15% of their new mortgages.

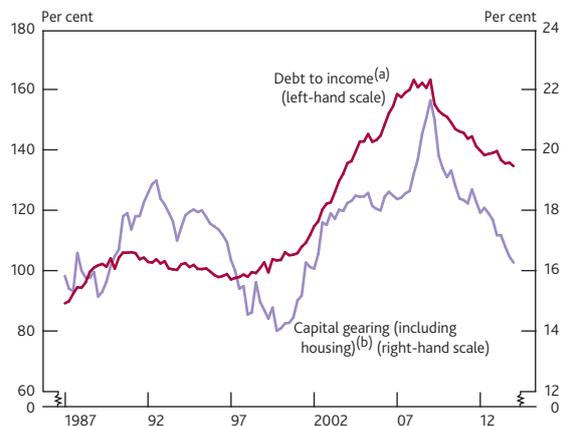
It is difficult to assess how debt has affected UK consumption using only aggregate data. To help better understand the role of debt, this article summarises microdata evidence on differences in spending patterns across households with different levels of debt. The article starts by providing an overview of trends in household balance sheets, before going on to explain why debt might affect spending in principle. It then reviews the evidence on the relationship between household debt and spending, primarily focusing on the

United Kingdom in the recent recession, and uses survey evidence to look in more detail at the reasons why highly indebted UK households made large cuts in spending after 2007. The final section concludes.

Trends in UK household balance sheets

Across the United Kingdom as a whole, the household debt to income ratio rose from around 100% in 1999 to a peak of 160% in 2008 (**Chart 1**). Mortgage debt accounts for around 80% of total household debt, and explains most of the increase in the aggregate debt to income ratio since the late 1990s. Since 2008, the stock of household debt has stabilised, with the fall in the debt to income ratio from its peak reflecting growth (albeit modest growth) in nominal incomes.

Chart 1 Household debt to income ratio and capital gearing



Sources: ONS and Bank calculations.

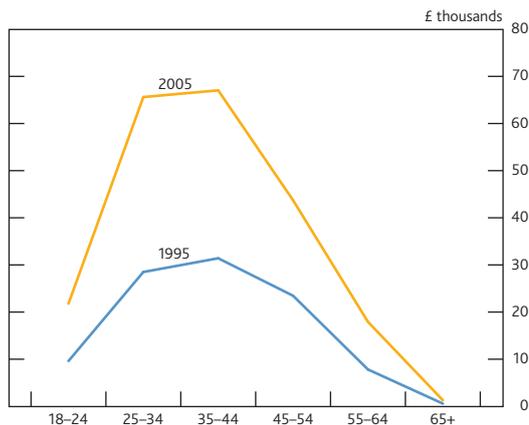
- (a) Total financial liabilities as a percentage of annualised total household resources.
 (b) Total financial liabilities as a percentage of households' total financial assets and residential building assets.

Estimates of capital gearing — which measure the stock of debt in relation to the value of assets — summarise the overall balance sheet position of the household sector. Aggregate gearing rose in the decade before the financial crisis (**Chart 1**), but more modestly than the debt to income ratio, given that house prices increased faster than income. Capital gearing in 2007 was similar to the levels recorded in 1992 although it fell and then rose during the intervening period. While it spiked up to exceed that previous peak during the financial crisis — as asset prices fell sharply — gearing is now somewhat below where it was in 1992 and 2007.

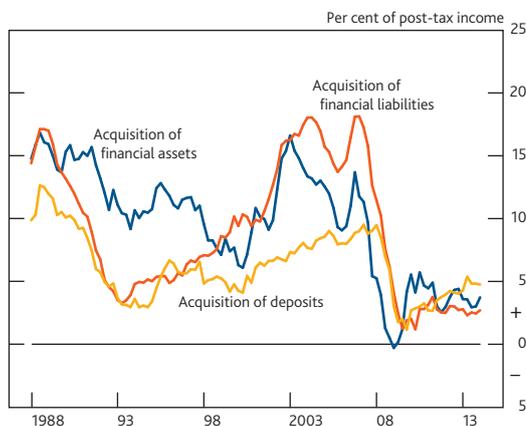
In aggregate, the build-up in household debt over the decade before 2007 was largely matched by a build-up of assets.

(1) A box on pages 22–23 of the May 2013 *Inflation Report* contains a summary of the preliminary results from the work presented in this article, available at www.bankofengland.co.uk/publications/Documents/inflationreport/2013/ir13may.pdf.

(2) See the June 2014 *Financial Stability Report* for more details on these measures, available at www.bankofengland.co.uk/publications/Documents/fsr/2014/fsrfull1406.pdf.

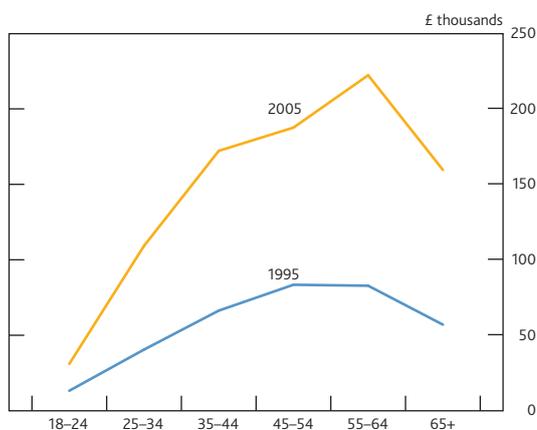
Chart 2 Average household debt by age

Sources: British Household Panel Survey (BHPS) and Bank calculations.

Chart 3 Households' net acquisition of financial assets and liabilities^(a)

Sources: ONS and Bank calculations.

(a) Four-quarter moving averages.

Chart 4 Average household gross wealth (including housing assets) by age

Sources: BHPS and Bank calculations.

When banks lend money to households they create matching deposits, which are initially held by the borrower. In the case of mortgages, those deposits are then transferred to the home seller when the mortgagor purchases a property and that money subsequently circulates around the economy. It can

either be retained within the household sector if households want to hold more deposits in their portfolio, or if it leads to additional housing market transactions. Alternatively, the money may flow to another sector in the economy or to overseas residents if it is used to purchase goods and services or other financial assets.⁽¹⁾

As house prices increased from the mid-1990s onwards, households entering the housing market or moving into bigger homes, who tended to be younger households, took out larger mortgages to be able to purchase a house (Chart 2). But, in aggregate, as borrowing rose, financial assets were acquired at a broadly similar rate to liabilities, with a large proportion of these assets being bank deposits (Chart 3), so there was little change in the net financial wealth of the household sector as a whole (Benito *et al* (2007)). Those additional assets were primarily acquired by older households, who tended to be those trading down in the housing market and who also saw the largest increases in the value of their existing houses (given that they tend to own larger houses). These two factors meant that older households saw significant increases in their wealth between 1995 and 2005 (Chart 4).

Why might debt affect spending?

Despite the large increase in UK household debt, it is not immediately obvious from standard economic theory that the existing stock of debt should affect households' (non-housing) spending decisions. Debt plays no causal role in determining the amount of spending in conventional consumption theory, which centres around the 'permanent income' (or 'life-cycle') model (Modigliani and Brumberg (1979)). In that model, consumption depends only on expected lifetime income and wealth, with households smoothing spending over their lifetimes. Typically, households should borrow to help finance their consumption when they are young and their incomes are relatively low. They then repay that debt later in life as their incomes rise and they build up savings ahead of retirement, when income falls back again.

The basic life-cycle model includes a number of simplifying assumptions, and relaxing some of those assumptions may imply a more active role for debt in explaining spending patterns. For instance, households are assumed to be able to borrow as much as they choose; the cost of borrowing is held constant; households can accurately predict their lifetime income; and more generally, these models assume that there is no uncertainty around the future path of economic variables. In practice, of course, households are not certain about their future income and they do face (time-varying) constraints on their ability to borrow. Theoretical models in the literature can therefore find a direct role for debt in

(1) See McLeay, Radia and Thomas (2014) for more details on the role of money in a modern economy.

affecting spending by allowing changes in income expectations or credit conditions to interact with debt.

The literature on how debt might affect spending dates back to Fisher's (1933) debt deflation theory. Fisher argued that in the US Great Depression, debt helped to amplify the initial shock as it propagated through the economy. King (1994) discusses how Fisher's work might have been relevant in explaining the weakness of UK consumption during the 1990s recession. King puts forward a model in which indebted households, who had borrowed on the expectation of higher future income, suffer adverse shocks to their future income expectations that lead them to consume less and repay debt. Even if other households experience offsetting positive shocks, they do not increase consumption by enough to fully offset the effect on aggregate spending.

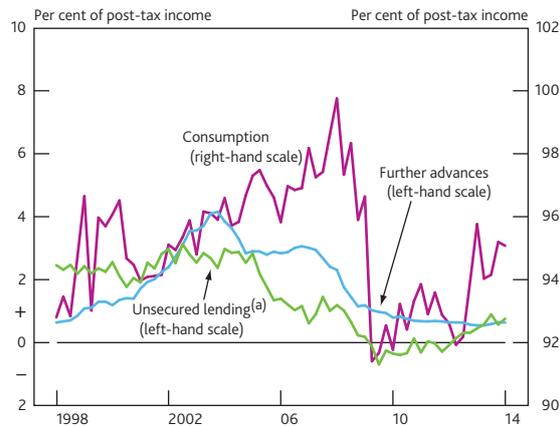
More recent theoretical research has shown how a tightening in credit conditions can interact with debt and reduce aggregate spending. For example, Eggertsson and Krugman (2012) assume that there is a limit on how much debt households can hold, and if that limit is revised down (for example because of a sudden realisation that collateral constraints were too lax), highly indebted households are forced to reduce spending sharply with no offsetting response from non-debtors.

Evidence on the link between debt and spending

It is difficult to evaluate whether debt has had any impact on UK household spending using aggregate data alone. Indeed, UK consumption grew at roughly the same rate between 1999 and 2007, when debt was rising rapidly, as it did between 1992 and 1998, when debt did not increase relative to income. This, together with the fact that increases in household debt were largely matched by a build-up in assets, is consistent with the suggestion that increases in debt did not provide significant support to consumption. And post-2008, there are a number of factors other than debt which might explain why spending fell sharply.⁽¹⁾ Nevertheless, it is also possible to make the case that debt played at least some role. Further advances on mortgages (additional borrowing secured against a house but not used to buy the property) and unsecured lending (such as personal loans or credit card debt) are forms of borrowing that are more likely to be used to finance consumption than new mortgage lending. Over the past fifteen years consumption has shown some correlation with further advances, although the relationship with unsecured lending is less clear (Chart 5).⁽²⁾

There are two main strands of literature that investigate the link between household debt and spending: analysis of how consumer spending varies with debt levels across (i) countries or (ii) households within a given country.

Chart 5 Consumption and borrowing available for consumption



Sources: Bank of England, ONS and Bank calculations.

(a) Excludes student loans.

The box on pages 308–09 discusses the international evidence on the relationship between household debt and spending. The main results are that, across countries, recessions preceded by large increases in household debt tend to be more severe and protracted, but there is less evidence that the level of pre-crisis debt is a good predictor of the subsequent adjustment in spending. Outside the United Kingdom, there are a number of household-level studies that find a link between high pre-crisis debt and weak consumption during the period that followed. The analysis in the remainder of this article focuses on household-level evidence for the United Kingdom.

UK household-level evidence: the recent recession

This section assesses the extent to which UK households with high levels of debt made large cuts in spending following the financial crisis. It makes use of microdata from the Living Costs and Food (LCF) Survey, which are described in more detail in the box on page 310. The first part of the section provides a descriptive analysis of differences in spending patterns across households with different levels of mortgage debt. Those differences may not necessarily just reflect debt; they could also be related to other characteristics. The second part therefore uses regression analysis to try to control for spending differences associated with other factors and to identify better how much of any difference is related to debt.

Overall, a key finding is that UK households with high levels of mortgage debt made larger adjustments in spending after 2007. In the second half of the 1990s, households with mortgage debt to income ratios greater than 2 appear to have increased the share of their income spent on non-housing consumption by more than mortgagors with lower debt to income ratios (Chart 6). But these higher debt mortgagors

(1) See, for example, Hackworth, Radia and Roberts (2013).

(2) Over the period from 1998 to 2013, the correlation coefficient between consumption as a percentage of disposable income and further advances is 0.6. The corresponding correlation coefficient with unsecured lending is 0.4.

International evidence on the link between debt and spending

As discussed in the main article, there are two main strands of literature that investigate the link between household debt and spending: analysis of how consumer spending varies with debt levels across (i) countries or (ii) households within a given country. This box provides an overview of international evidence using both approaches.

Cross-country analysis has the advantage that it offers lots of variation in debt levels to test whether there is a link to spending, but institutional differences can be large and it is hard to control for all other factors to be able to infer causality from the observed correlations. Household studies can test whether it is the highly indebted households that account for swings in aggregate spending. This can help infer causality relative to cross-country analysis, although it remains difficult to prove definitively. The biggest drawback of the microdata approach, and where cross-country analysis is more helpful, is that it is difficult to take account of possible offsetting responses elsewhere in the economy.

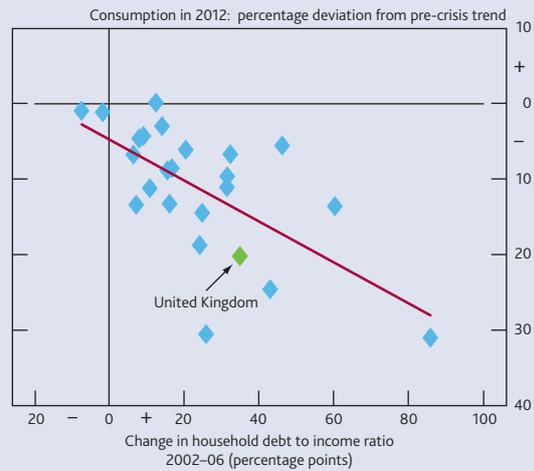
Cross-country comparisons

A number of studies have used cross-country data to document the fact that **recessions preceded by large increases in household debt tend to be more severe and protracted.**⁽¹⁾ Chart A illustrates how, in the recent recession, falls in the level of consumption relative to estimates of pre-crisis trends were greatest in countries that experienced the largest increases in aggregate household debt before the crisis. In the United Kingdom (shown by the green diamond on Chart A), the fall in spending was slightly larger than implied by the average cross-country relationship with debt growth.

Evidence that recessions preceded by large *increases* in household debt tend to be more severe and protracted is not restricted to recent experience. King (1994) shows that the same was true in the early 1990s and, going all the way back to the 1870s, Jorda, Schularick and Taylor (2013) show how excess credit growth is correlated with stronger booms and subsequently deeper recessions and slower recoveries. Even though this relationship is strongest when the recession coincides with a systemic financial crisis, it can also be detected in 'normal' business cycles where a financial crisis is absent.

There is less evidence, however, that the aggregate level of pre-crisis household debt is a good predictor of the size of the subsequent adjustment in spending. Chart B shows that there was little cross-country correlation between the level of household debt in 2006 and the amount that consumption

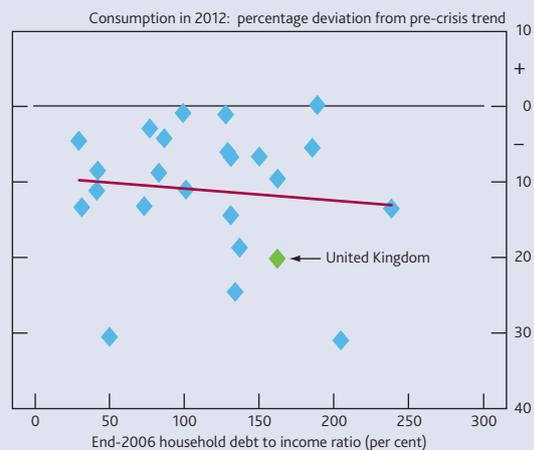
Chart A Cross-country falls in consumption and pre-crisis household debt growth^(a)



Sources: OECD National Accounts and Bank calculations.

(a) Includes data for Australia, Austria, Belgium, Canada, Czech Republic, Finland, France, Germany, Hungary, Ireland, Italy, Japan, Korea, Netherlands, Norway, Poland, Portugal, Slovak Republic, Slovenia, Spain, Sweden, Switzerland, United Kingdom and United States. Pre-crisis trends for each country are estimated as the average growth rate between 1997 and 2006. Debt to income ratio is debt as a percentage of gross annual disposable income.

Chart B Cross-country falls in consumption and pre-crisis household debt level^(a)



Sources: OECD National Accounts and Bank calculations.

(a) Includes data for Australia, Austria, Belgium, Canada, Czech Republic, Finland, France, Germany, Hungary, Ireland, Italy, Japan, Korea, Netherlands, Norway, Poland, Portugal, Slovak Republic, Slovenia, Spain, Sweden, Switzerland, United Kingdom and United States. Pre-crisis trends for each country are estimated as the average growth rate between 1997 and 2006. Debt to income ratio is debt as a percentage of gross annual disposable income.

was cut back following the crisis. Consistent with that, Cecchetti, Mohanty and Zampolli (2011) find that the level of household debt does not have a statistically significant effect on future growth in a cross-country data set going back to 1980 (although they do find a significant role for public debt, and in some instances corporate debt). However, Flodén (2014) argues that there is a clearer relationship between the level of debt and changes in consumption after 2007 once the level of consumption is adjusted for prior growth in debt, past consumption and the current account balance.

Non-UK household studies

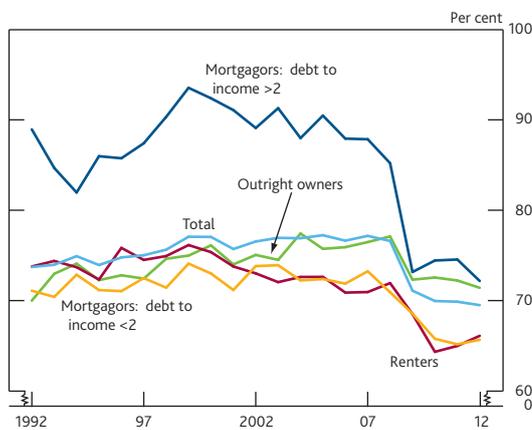
A number of non-UK household-level studies have found a link between high pre-crisis debt and weak consumption after the recent financial crisis. Dynan (2012) shows that US mortgagors with high loan to value (LTV) ratios pre-crisis subsequently experienced larger declines in spending (between 2007 and 2009), after controlling for other factors such as income and wealth. Baker (2013) finds that spending by highly indebted US households was more sensitive to income fluctuations than was the case for other households, although these effects become smaller and sometimes statistically insignificant once credit and liquidity constraints are controlled for.

Mian, Rao and Sufi (2013) analyse evidence across regions in the United States. They show that the decline in consumption following the crisis was greater in areas that had higher outstanding LTV ratios prior to the crisis.

In Denmark, Andersen, Duus and Jensen (2014) find similar evidence of a negative correlation between pre-crisis LTV ratios and consumption during the crisis. They also find that the highly indebted households who made larger adjustments in spending during the crisis had been consuming a greater share of their income before the crisis.

(1) See, for example, IMF (2012) and Jorda, Schularick and Taylor (2013).

Chart 6 UK non-housing consumption as a share of income^(a)



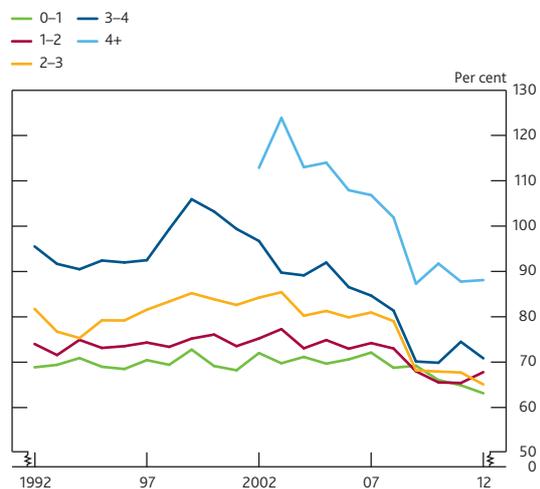
Sources: Living Costs and Food (LCF) Survey, ONS and Bank calculations.

(a) Non-housing consumption as a share of income net of mortgage interest payments. Data are scaled so that the total matches the National Accounts. Debt to income ratio is calculated using secured debt only.

subsequently made larger-than-average reductions in spending relative to income after the financial crisis. This analysis focuses on secured debt only, since only limited data on unsecured debt are available in the LCF Survey. Disaggregating the data for mortgagors further, the largest adjustment in spending relative to income after 2007 came among households with a mortgage debt to income ratio above 4 (Chart 7). Cuts in spending were more modest for those with debt to income ratios below 2.⁽¹⁾

Regression analysis confirms that households with higher debt levels made larger adjustments in spending after 2007, even after controlling for other factors. An econometric model in which households' consumption is determined — in part — by their mortgage debt to income ratio,⁽²⁾ can be used to estimate the impact of cuts in spending associated with debt on aggregate consumption since 2007. This estimate is constructed by taking the model's prediction, for each household, for spending in a given year, and then subtracting what the model predicts they would have spent if debt had

Chart 7 UK mortgagors non-housing consumption as a share of income by debt to income ratio group^(a)



Sources: Department for Communities and Local Government (DCLG), LCF Survey, ONS and Bank calculations.

(a) Data for 4+ not shown before 2002 as they are erratic and are based on a small sample. Non-housing consumption as a share of income net of mortgage interest payments. Data are scaled so that the total matches the National Accounts. Debt to income ratio is calculated using secured debt only.

had the same estimated influence on spending patterns in each year as it did in 2007, keeping all other characteristics unchanged. Differences are then summed across households. This approach suggests that cuts in spending associated with debt can explain around 2 percentage points of the almost 5% fall in aggregate private consumption after 2007;⁽³⁾ and, at least up until the latest available data in 2012, these effects had not unwound (Chart 8).

(1) The proportion of households with mortgage debt to income ratios above 4 was relatively small at around 6% in 2012, although it has risen from around 2% in the late 1990s. The group with debt to income ratios above 2 covered just under 20% of all households (and accounted for a quarter of total income).
 (2) The econometric model is a household-level consumption equation (with real non-housing consumption as the dependent variable) that incorporates a mortgage debt to income variable and where the coefficient on that debt to income variable is allowed to be different in each year. The coefficients on the debt variable are statistically significantly smaller after 2007 than in 2007. Other controls in the model include income (net of interest payments), date of birth cohort, age, household composition, education, employment status, region and house prices.
 (3) This refers to the fall in calendar-year consumption.

Living Costs and Food Survey microdata

The Living Costs and Food (LCF) Survey of households is conducted by the ONS in order to collect information on household spending patterns. The survey has been carried out in some form since 1957, having been previously known as the Family Expenditure Survey and subsequently the Expenditure and Food Survey.

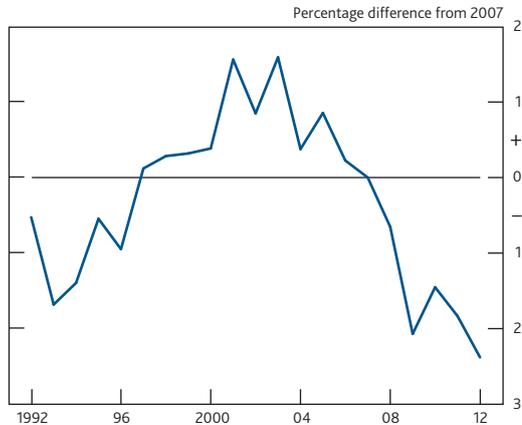
The LCF Survey is used by the ONS to define the basket of goods used in the retail prices index and the consumer prices index and is an important source for estimates of household expenditure in the National Accounts. However, the microdata behind the survey are also an important source of data for research and analysis of household spending patterns. The survey contains a number of detailed questions about households' expenditure, complemented by a two-week expenditure diary, and therefore provides the best-quality source of consumption data at the household level in the United Kingdom. There is also detailed information on income and other household-level information such as mortgage debt

that can be used to assess variation in spending patterns between different groups of households.

The LCF Survey is a repeated cross-section survey, which means that a different set of households are included in the survey each year. It covers around 6,000 households per year and is conducted continually throughout the year.

Consumption data from the survey do not directly correspond to the National Accounts measure. In part, that reflects differences in the way some components are measured. In particular, the housing consumption of owner-occupiers in the National Accounts is a measure of imputed rents, whereas in the LCF Survey it covers mainly mortgage interest payments. But aside from that, non-housing consumption implied by the survey data has tended to grow more slowly than the National Accounts measure. The LCF Survey non-housing consumption (and income) data reported in this article are adjusted so that aggregate measures from the survey correspond to the National Accounts. This implicitly assumes that any underreporting in the survey is common across all households.

Chart 8 Estimated impact of debt on the level of total private consumption, relative to 2007^(a)



Sources: DCLG, LCF Survey, ONS and Bank calculations.

(a) The impact on non-housing consumption is constructed by taking predicted spending for each household from the model described in footnote (2) on page 309, and then subtracting what the model predicts they would have spent if debt had had the same estimated influence on spending patterns in each year as it did in 2007, keeping all other characteristics unchanged. Differences are then summed across households. To get to a total impact on aggregate private consumption there is assumed to be no effect on housing consumption or the consumption of non-profit institutions serving households.

A larger adjustment in spending by indebted households after 2007 reflects an unwinding of faster growth in spending by this group before the crisis. The econometric estimates suggest that indebted households added around 2.5% to the level of aggregate private consumption between 1996 and 2003. This can be seen on **Chart 8** by the estimated impact of debt rising from -0.9% to 1.6% over this period (relative to 2007 levels). On average, that equates to a 0.35 percentage point a year contribution to annual consumption growth, which averaged approximately 4.5% over that period. However, the estimated effect of debt on the level of

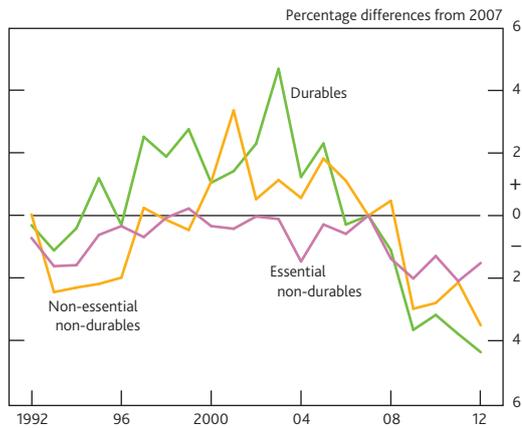
consumption falls back between 2003 and 2007, implying that it weighed modestly on growth, despite debt continuing to rise rapidly.

Much of the strength in spending by highly indebted households before the financial crisis and the larger adjustment afterwards was in durables and non-essential categories of spending (**Chart 9**).⁽¹⁾ While there was still some fluctuation in spending on essential non-durable items, the estimated impact was smaller — consistent with the intuition that households cut back on non-essential spending first when they face financial pressure.⁽²⁾

While the focus of this article is on the most recent recession, there is also evidence that households with high levels of debt also made large cuts in spending in the early 1990s recession. Those results are explained in more detail in the box on page 312. But the impact on aggregate consumption of cuts in spending associated with debt in the early 1990s is likely to have been lower than in the recent recession because there were fewer households with high levels of debt in that earlier period.

- (1) Durables are defined as vehicles, household goods, recreational goods, and clothing and footwear. Non-essential non-durables are recreational services, household services, personal goods and services, alcohol and tobacco. Essential non-durables are defined as food and beverages, transport fares and other transport costs. The definitions of essential and non-essential spending are only based on high-level categories and in practice there will be some elements of essential and non-essential spending within each category. For example, spending on food will include spending on luxury food items, which could be substituted for cheaper alternatives and therefore might be considered as non-essential.
- (2) A weighted average of the estimated impacts of debt on the three components of consumption shown in **Chart 9** is greater than the impact on total private consumption shown in **Chart 8**. That is because the estimates in **Chart 8** also include housing consumption and the consumption of non-profit institutions serving households, on which debt is assumed to have no influence.

Chart 9 Estimated impact of debt on the level of different components of consumption, relative to 2007^(a)



Sources: DCLG, LCF Survey, ONS and Bank calculations.

(a) Durables, non-essential non-durables and essential non-durables are defined as in footnote (1) on page 310. Estimates for each category of spending are constructed using the methodology explained in the footnote to Chart 8 (apart from there is no adjustment for housing consumption or the consumption of non-profit institutions serving households). Separate equations are estimated for each spending category.

The finding that highly indebted UK households' spending appears to be more sensitive to economic shocks over more than one recessionary period is consistent with evidence from Cloyne and Surico (2014). They show how between 1978 and 2009, the consumption response of mortgagors to income tax shocks that were not associated with the state of the economy was significantly larger than the response of outright owners, although they do not differentiate between households with different levels of debt. But not all work suggests a role for debt in explaining volatility in UK household spending. Using data between 1997 and 2004, Benito *et al* (2007) find little difference in the amount by which the spending of high and low-debt households responded to changes in their financial position, although this was a period where the macroeconomic environment was benign and the nature of the shocks is likely to have been different to those experienced after 2007.

There are a number of caveats to the analysis presented in this section which need to be taken into account when interpreting the results. First, we are not able to observe the same households over time — only ones with similar characteristics — because the LCF Survey covers different households from year to year. This means that we cannot observe what the pre-crisis debt of individuals surveyed after the crisis was; and equally, we cannot observe how the debt of individuals surveyed before the crisis has evolved since then. Second, the measure of income used is net of mortgage interest payments, which means that reductions in mortgage rates after 2009 that lowered interest payments will have helped to cushion the squeeze in incomes for mortgagors.⁽¹⁾ Alternative econometric estimates that include a measure of income that is not measured net of interest would imply a smaller (although not zero) impact on spending from debt than that described above. Third, this analysis focuses only on mortgage

debt because there is limited information available on unsecured debt in the LCF Survey and therefore we could be underestimating the true impact of total debt. However, mortgage debt accounts for 80% of all debt. And, as there are fewer consequences of walking away from unsecured debt, households with unsecured debt might be less concerned about having to default and therefore be less willing than mortgagors to reduce spending sharply rather than risk default.

The microdata analysis also implicitly assumes that most aspects of the economy were not affected by developments in household debt. Growth in debt could have had macroeconomic effects that may have fed back into consumption, for example, through its effects on employment, the public finances and asset prices. And, as explained in the first section, for some households to hold debt, others have to hold assets, and that could affect their behaviour. But attempting to evaluate either of these effects is beyond the scope of this article.

The analysis presented in this section illustrates how high levels of household indebtedness have led to a material adverse impact on aggregate household spending and overall demand over the recent past. A clear policy implication of these results is that limiting any further increase in the number of households with high levels of debt will limit the extent to which there is potential for large adverse impacts on aggregate demand following future negative shocks.

Why might highly indebted households have made large cuts in spending?

While there is evidence that the more indebted UK households made larger cuts in spending after 2007, this does not prove that debt was the cause of lower spending — there could also have been other factors, that are correlated with debt, that led to lower spending. Below are three possible explanations for why highly indebted households made larger cuts in spending. The first two imply that debt caused the larger spending adjustment in some way, but in the third the link to debt is coincidental rather than causal.

- (1) **Highly indebted households were disproportionately affected by tighter credit conditions.** In this case, high existing debt levels caused lower spending by restricting borrowers' ability to renew, or increase, existing debt, and by lowering expectations of future access to credit.
- (2) **Highly indebted households became more concerned about their ability to make future repayments.** Downward revisions to expected future income and/or

(1) This is also how income is measured in the National Accounts, although that measure of income is net of all interest payments not just mortgage interest payments.

UK household-level evidence — the early 1990s recession

It is more difficult to analyse the role of debt in earlier UK recessions because debt data from the LCF Survey are only available from 1992. It is possible, however, to infer an estimate of the outstanding stock of mortgage debt for each household before 1992 using data on mortgage interest payments and by assuming that all households paid the same mortgage interest rate as implied by aggregate data. While these data are less reliable than if households actually report debt itself, they provide an indication of how spending is likely to have varied by debt level in previous recessions. Over the period where actual debt data are available to cross-check against, the imputed data provide a reasonable approximation (shown by comparing the dashed and solid lines in **Chart A**).

There also appears to have been a large swing in spending by households with a debt to income ratio above 2 in the late 1980s/early 1990s (**Chart A**). While the precise estimates are highly uncertain, they suggest that the fall in non-housing consumption as a share of disposable income may have been even larger than following the recent recession. But an important difference between the two recessions is the fact that interest rates rose very sharply in the late 1980s, which would typically reduce the spending of highly indebted households. In the most recent recession, cuts in spending by indebted households were larger than average despite interest rates being reduced to historically low levels.

The impact on aggregate consumption from cuts in spending associated with debt is likely to have been smaller in the early

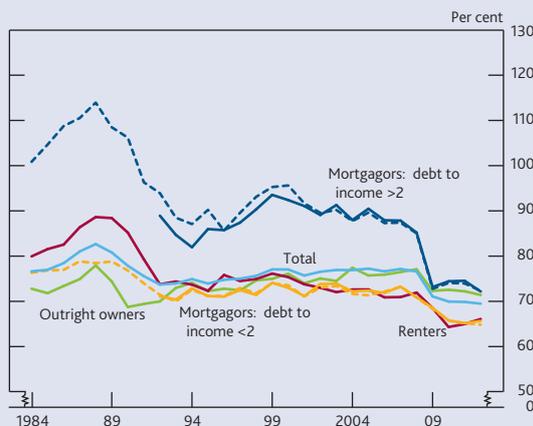
uncertainty about future income may have made highly indebted households more concerned about their ability to repay debt in the future. This group may therefore have made larger adjustments to spending than other households, even if high and low-debt households suffered the same-sized shock to expected future income.

(3) Highly indebted households may have made larger adjustments to future income expectations. This may be because they were too optimistic before 2007, and overly optimistic income expectations may have been what led these households to take on high debt in the first place. Here, debt has no causal link to the larger adjustment in spending by highly indebted households — households with high debt just happen to have experienced larger shocks to expected future income.

Evidence for the hypotheses

This section draws on evidence from the annual Bank of England/NMG Consulting survey — which includes questions

Chart A UK non-housing consumption as a share of income^(a)



Sources: DCLG, LCF Survey, ONS and Bank calculations.

(a) Non-housing consumption as a share of income net of mortgage interest payments. Dashed lines are based on imputed mortgage debt data, which is calculated from data on mortgage interest payments by assuming that all households pay the same mortgage interest rate as implied by aggregate data. Data are scaled so that the total matches the National Accounts. Debt to income ratio is calculated using secured debt only.

1990s because there were fewer households with high debt. The imputed debt data suggest that the number of households with a debt to income ratio above 2 in the late 1980s/early 1990s may have only been between a third and a half of the number in 2007, depending on the exact year chosen. Together with the fact that some of the reduction in spending by indebted households is likely to reflect the normal transmission of monetary policy, it is likely that cuts in spending associated with debt reduced the level of aggregate private consumption by less than 1% between 1989 and 1992.

on households' attitudes to spending — to investigate the reasons why households with high debt levels made larger reductions in spending after 2007.⁽¹⁾ The survey includes questions that relate to each of the above hypotheses: households were asked whether they had cut spending because of concerns about credit availability (hypothesis 1), whether they had cut spending because of concerns about debt (hypothesis 2) and whether they were worse off in 2013 than they had expected in 2006 (hypothesis 3 — being worse off than expected over the past might be correlated with downward revisions to future income expectations).⁽²⁾

Mortgagors who reported that they had cut spending due to concerns about credit availability had higher-than-average mortgage debt to income ratios (**Chart 10**). Debt to income ratios were also higher for households who had cut spending

(1) See Bunn *et al* (2013) for more details on the 2013 NMG Consulting survey.

(2) The question about cutting spending due to debt concerns has only been asked since 2010 (and was not included in 2011). The question about being worse off relative to expectations was asked for the first time in 2013.

particularly in the wake of the Great Recession. The microdata analysis presented in this article shows that highly indebted UK households made larger-than-average cuts in spending, relative to income, after 2007. This represents an unwinding of faster-than-average spending growth by this group before the crisis. Cuts in spending associated with debt are estimated to have reduced the level of aggregate private consumption by around 2% after 2007 (out of a total fall of around 5%).

It is difficult to prove that those more highly indebted households who made large cuts in spending after 2007 did so specifically because of their debts. However, survey evidence suggests that those spending cuts were driven by a combination of tighter credit conditions and increased concerns about ability to make future debt repayments, which is consistent with high indebtedness being the cause of those spending patterns.

The empirical evidence that debt can affect household spending is not just limited to the most recent UK business cycle. Debt is also likely to have had a more modest effect on aggregate UK spending during the early 1990s recession (given that there were fewer households with high debt then), and there is a body of international evidence that is consistent with a role for debt following the recent financial crisis.

The potential for household indebtedness to have a large adverse impact on aggregate demand was a key reason why the Financial Policy Committee took policy action at its June 2014 meeting. Those measures are designed to insure against a further significant increase in the number of highly indebted households. They should also therefore help to insure against the effects of debt on aggregate spending being any larger than over the recent past following any future shocks of a similar magnitude.

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Enhancing the resilience of the Bank of England's Real-Time Gross Settlement infrastructure

By Ed Kelsey and Simon Rickenbach of the Bank's Market Services Division.⁽¹⁾

- The Bank of England operates the United Kingdom's Real-Time Gross Settlement (RTGS) infrastructure for the settlement of the main electronic sterling payment systems. This infrastructure plays a vital role in the safe functioning of the UK financial system, and therefore in maintaining financial stability.
- The Bank continuously seeks to improve the resilience of its infrastructure. Recently, enhancement of the resilience of payment infrastructure has become a higher priority for central banks.
- The Bank, together with other central banks, worked with SWIFT to develop a new RTGS contingency infrastructure with which to settle payments should the principal infrastructure become unavailable. The Bank is the first central bank to adopt this contingency solution.

Introduction

Electronic payments and central banks

The ability to make electronic payments underpins the functioning of a modern economy. In the United Kingdom over 98% of sterling payments by value are made electronically. Such payments are used by individuals to buy goods, by companies to pay salaries, by the government to pay for public services, and by banks to make transfers to one another.

In the United Kingdom, electronic payments can be made through a number of payment systems, such as CHAPS — the United Kingdom's same-day, high-value payment system — or the Faster Payments Service, which allows retail payments to be made throughout the day, all year round. At their most basic level, all payment systems involve the transfer of funds from one entity to another.

The range of IT infrastructure that supports these payment systems must be highly resilient, since an infrastructure failure could greatly inhibit — or remove entirely — the ability of individuals and firms to make their payments. This would have severe consequences for economic activity.

In the United Kingdom, the Bank of England provides critical functionality through its role as a 'settlement agent' to allow direct participants in payment systems to settle their

interbank payment obligations in central bank money.⁽²⁾ The Bank operates the Real-Time Gross Settlement (RTGS) infrastructure that acts as the accounting database for participants in the main sterling payment systems. The RTGS infrastructure also holds the central bank reserves balances for the banking sector.⁽³⁾

The Bank's RTGS infrastructure accommodates two models of interbank settlement. The first is RTGS, where payment instructions are exchanged and settled in real time on a gross basis throughout the business day. CHAPS uses this model. The second is the periodic settlement of net obligations at the end of a 'clearing cycle', known as deferred net settlement (DNS). Retail payment systems, such as Bacs and Faster Payments, use this model. The disadvantage of the DNS model is that it leaves obligations owed to the recipient bank unfulfilled until settlement occurs. This could result in a loss if the paying bank were to default before net settlement had been completed. This risk can be mitigated by, for example, requiring banks to collateralise these exposures — as occurs in the Bacs and Faster Payments systems.

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

(2) Dent and Dison (2012) describe this in detail.

(3) As of July 2014, the approximate value of reserves was £300 billion. See the *Bankstats* page (data file A1.1.1), available at www.bankofengland.co.uk/statistics/Pages/bankstats/default.aspx.

The importance of RTGS to the UK economy

RTGS infrastructure performs a role in the settlement of the vast majority of electronic payments made by the UK population. The Bank, therefore, provides this service as part of its financial stability objective. The Bank seeks to make its infrastructure as reliable as possible, targeting RTGS availability of 99.95% of its defined operating hours. It has achieved 100% availability for the past four years.

As the provider of the infrastructure for CHAPS payment processing, the Bank's financial stability objective is aligned with the objectives of CHAPS as a payment system. Since 2012, the internationally agreed 'Principles for financial market infrastructures' have set out the standards which are considered best practice for high-value payment systems and their critical suppliers. These principles include the expectation that a critical service provider's disaster recovery plans should support 'the timely resumption of critical services in the event of an outage'.⁽¹⁾

To ensure that payments can continue to be settled safely and efficiently the Bank, like other central banks, continuously seeks to improve the resilience of its RTGS infrastructure against outright failures. In February 2014, the Bank introduced the 'Market Infrastructure Resiliency Service' (MIRS) as an additional contingency infrastructure that could be used in the event of a failure of its principal RTGS infrastructure. This ensures that banks can continue to settle CHAPS payments in the event of a disruption without resorting to a DNS model. MIRS also facilitates the net interbank settlement of the retail schemes.

This short article explains this recent improvement in the resilience of RTGS infrastructure. The article begins by explaining the drivers behind the need for improved contingency, before evaluating the key requirements defined by the central bank community for a contingency RTGS infrastructure, which resulted in the development of MIRS.

Why central banks require contingency for their RTGS infrastructures

The Bank operates its principal RTGS infrastructure from two sites in the London region. If the live site should become unavailable, RTGS can continue to operate from the standby site. The standby site duplicates the hardware and software of the live site and operators are present to control the system from both sites throughout each business day. Transactions between RTGS accounts applied to the live database are automatically copied to the standby database at the other location in real time.

However, it is conceivable that both sites could become unavailable at the same time. Environmental factors leading

to an inability to physically operate at a site, or IT hardware failures, could cause two simultaneous but unrelated problems. Alternatively, and perhaps more likely, there could be a software failure which creates a single problem that affects both sites. Such an event resulted in a six-hour service interruption to the Bank's RTGS infrastructure on 12 February 2007. More recently, public authorities and commercial institutions have needed to consider the risks to their systems arising from an external cyber attack.

While the loss of both sites is very unlikely, it would have a severe impact due to the critical role of the RTGS infrastructure in the safe functioning of the UK financial system. For this reason, continually developing improved resilience, including contingency procedures, is an important feature of any central bank's role in the provision of RTGS infrastructure.

Since the introduction of the Bank's RTGS infrastructure in 1996, and prior to adopting MIRS, a dual site failure would have caused an inability to settle CHAPS payments individually and in real time. Instead, the contingency solution was to settle the net obligations between banks arising in CHAPS at the end of the day, using a DNS model.⁽²⁾

In those circumstances, as settlement of payment obligations would not have occurred in real time, CHAPS direct participants would have incurred the **credit risk** associated with settling under an uncollateralised DNS model. Furthermore, there would have been significant **operational risk**, as it would have been difficult to establish exactly which payments had been processed at the point of failure.

Drivers for the Bank to improve its contingency

The Bank had been aware of the benefits of mitigating these risks, but three key factors have emerged over the past five years that have led to a renewed focus to address them through improving RTGS infrastructure contingency procedures:

- (i) Central banks have become more concerned with identifying and mitigating tail risks to financial stability. The financial crisis highlighted the need to address the risks of low probability, but high-impact, events. Had the Bank's RTGS infrastructure faltered during a significant market stress event, such as the failure of Lehman Brothers, the crisis could have been greatly exacerbated.⁽³⁾ As a result there has been a drive from the Bank to address latent risks, such as those associated with the RTGS infrastructure contingency procedures.

(1) See Annex F3 available at www.bis.org/publ/cpps101a.pdf.

(2) The retail payment systems already settle using a DNS model, so do not require a sophisticated contingency solution.

(3) See Salmon (2011).

- (ii) The Bank believes that the threat landscape facing payment infrastructure has worsened in recent years and the Bank needs to be proactive in combating emerging threats to infrastructure. One example of a risk that has been identified as becoming increasingly prevalent and sophisticated is cyber crime.⁽¹⁾ As Greg Medcraft, Chairman of the Board of the International Organization of Securities Commissions (IOSCO), recently remarked: 'Cyber crime has a huge potential impact on markets'.⁽²⁾ The heightened risk of a failure of a principal infrastructure has caused an increase in demand for contingency solutions.
- (iii) The operational risk of settling net obligations via the CHAPS settlement contingency solution increased with the introduction of the RTGS infrastructure's Liquidity Saving Mechanism (LSM) in 2013.⁽³⁾ While the LSM has been successful in reducing banks' liquidity costs, it has introduced a small period between the point that most CHAPS payments are submitted to the RTGS infrastructure and when they are definitively settled.⁽⁴⁾ This means that, in the event of an interruption to the service, it may not be possible to identify whether or not settlement had occurred for a payment caught between these two points in the payment process. In turn the impact of switching from using the principal infrastructure to the contingency solution increased.

The Bank was not alone in undertaking this analysis: other central banks had also become increasingly aware of their own drivers for improving their RTGS contingency solutions. Over the past five years, central banks have begun to investigate options for more sophisticated resilience solutions that could be invoked in the event of a dual site failure, which would address these risks.

One option that the Bank considered as a potential contingency solution was to construct a third RTGS site. As a public sector institution, the Bank seeks to provide value for money in fulfilling its objectives. The Bank weighs up the effectiveness of its contingency solutions against the risks it faces. It was concluded that developing a third site would have been too costly compared with the benefits it would bring; and furthermore that it may not offer the full risk-reduction benefits that were sought.

Developing a contingency solution that meets the requirements of RTGS infrastructure providers

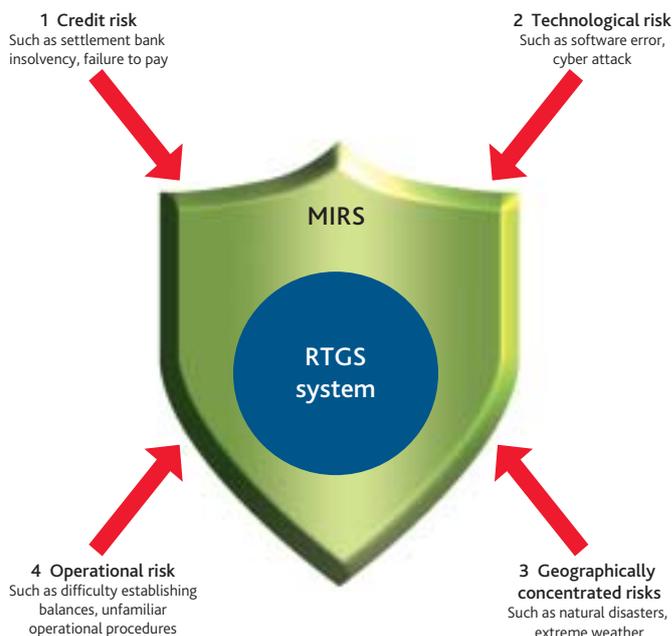
In order to transfer funds via a payment system, banks must use a standardised communication system. Many payment systems internationally, including in the United Kingdom, use a messaging service provided by a company called SWIFT.

From 2009, the Bank worked with SWIFT to identify the potential for an improved resilience model for an RTGS system.

Working in close co-operation with other central banks, a set of characteristics that would be required of an improved contingency system (that would be compatible with differing RTGS infrastructures) was identified.

The solution, which has been developed by SWIFT in conjunction with the central bank community, including the Bank, is the Market Infrastructure Resiliency Service (MIRS). It utilises SWIFT's position as communications network provider for many high-value payments systems internationally. MIRS is a basic RTGS contingency infrastructure that performs interbank settlement of payment obligations based on the information contained in SWIFT payment messages. MIRS meets the five main requirements discussed by central banks, which are detailed below. The first four of these relate to risks that an effective contingency system should mitigate and are summarised in **Figure 1**.

Figure 1 The risks that MIRS seeks to mitigate



Requirement 1: reducing credit risk by settling payments in real time

The first requirement was for the contingency system to settle payments in real time with certainty and without credit risk. This ensures that obligations between banks are extinguished

(1) For more information, see page 14 of Bank of England (2013).

(2) See www.ft.com/cms/s/0/82519604-2b8f-11e4-a03c-00144feabdc0.html?siteedition=uk#axzz3C8zZOMSO.

(3) This was implemented to give banks the opportunity to reduce their CHAPS intraday liquidity requirements. See Davey and Gray (2014).

(4) The average CHAPS payment takes around seven and a half minutes between submission and settlement across the RTGS infrastructure.

immediately, rather than building up until net settlement at the end of the business day. If activated, MIRS acts as an accounting platform that allows any new SWIFT payment messages sent by banks to be processed in real time, facilitating continuous settlement of high-value payments. Once the problem affecting the principal sites had been resolved, the account balances would be taken from MIRS and applied back to the principal infrastructure.

To facilitate the continuous settlement of obligations in real time it is desirable for a contingency to have the ability to process peak quantities of payments. MIRS has the capacity to process more than the peak CHAPS volume processing requirement of 300,000 payments in three hours.

Requirement 2: reducing technological risk

Operating infrastructure at multiple sites using the same IT software and hardware does not protect against technological risks as a defect in one area would be replicated across sites, making it vulnerable to the same risks. As outlined above, the Bank has experienced this type of technological vulnerability in the past. Analysis of cyber security suggests that a technologically independent contingency solution can mitigate this cyber vulnerability.⁽¹⁾

MIRS is run on an independent IT platform with different software suppliers and underlying programming from the principal infrastructure. This means that it is unlikely that the same software error that caused the principal RTGS infrastructure to fail would prevent settlement in MIRS.

Requirement 3: reducing geographically concentrated risks

Some localised disruptions — such as those resulting from unexpected extreme weather conditions, natural disasters, terrorist activity or power failures — could be on a large enough scale to affect both of a central bank's sites simultaneously. MIRS is hosted from SWIFT's sites, which are geographically remote from the sites operated by most central banks, mitigating the risk of geographical concentration.

While MIRS might mitigate the risk of a dual site failure, it does rely on SWIFT's IT platform. However, there is no direct link between a failure of RTGS infrastructure at both of a central bank's sites, and an outage that would affect SWIFT's ability to host MIRS.

Requirement 4: reducing operational risk

The fourth requirement sought by central banks from a contingency solution was the minimisation of exposure to operational risk. This was deemed to be required in three areas.

First, in establishing the participants' exact balances at the point of failure. New payments cannot be made if there is uncertainty about account balances, as a bank may not have

sufficient funds available to settle any further transactions. MIRS overcomes this problem by reconstructing the exact account balance at the point of failure — mitigating the increase in risk described in the previous section that relates to the temporary queuing of payments in the LSM. This functionality relies on the central bank's RTGS system sending MIRS a snapshot of each bank's settlement account balance at regular intervals throughout the business day so that MIRS has a remotely stored record with which to start reconstructing the balances. Then, in the event that it is invoked, MIRS takes the most recent balances that are known with certainty and applies all of the payment message confirmations that have been received since that point.

Second, operational risk arises when banks utilise processes that are unfamiliar to them. MIRS mitigates this risk by processing standard SWIFT messages, so the way that payments are processed by banks does not materially change.

Third, while developing an improved contingency solution may involve outsourcing the infrastructure that RTGS is operated on, most central banks would not be comfortable outsourcing the actual operation of their RTGS infrastructure, as this could introduce operational risk. To address this concern, MIRS allows central banks to remain in control of their RTGS infrastructure even when it is invoked.

Requirement 5: simplicity of design

To cater for all aspects of the various bespoke national RTGS systems would have made MIRS unfeasible, increasing the complexity and costs and introducing operational risk. MIRS was deliberately designed to be a simple RTGS system, and consequently it does not support all of the bespoke functions of individual central banks' RTGS infrastructures. To take one example, it does not replicate the Bank's RTGS LSM.

This is because MIRS is designed to provide an alternative to a principal RTGS infrastructure in the event of a worst-case scenario. It addresses the financial stability risks of banks being unable to settle their high-value payment obligations with certainty, providing the necessary basic functionality but without the additional cost and complexity of all the other functions of their RTGS infrastructure.

MIRS and the Bank of England

MIRS has been developed by SWIFT in conjunction with the central bank community, including the Bank, in order to fulfil these requirements.

In February 2014, the Bank became the first central bank to adopt MIRS as its contingency RTGS infrastructure. It concluded that MIRS provides a significantly improved level of resilience at a much lower cost than other potential

(1) See Goldman (2010).

contingency options considered. Other central banks are working towards a similar adoption of MIRS as their alternative contingency system.

Conclusion

The importance of payment systems in maintaining financial stability fosters a need for central banks to continuously improve the infrastructure that facilitates these payments.

The Bank of England's RTGS system has always had a high degree of operational resilience. Although the Bank hopes to never have to invoke its contingency RTGS infrastructure, MIRS has further improved the Bank's ability to continue safe and efficient settlement of payments under a range of extreme adverse scenarios.

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Recent economic and financial developments



Markets and operations

- UK short-term interest rate expectations implied by the forward curve declined a little over the review period, following the release of the *August 2014 Inflation Report*.
- Euro-area short-term interest rates fell relative to their UK counterparts, reflecting a combination of loosening of monetary policy by the ECB and weaker-than-expected economic data.
- Sterling rose early in the review period, briefly reaching a new post-crisis high. The currency subsequently depreciated, broadly consistent with moves in international interest rates.
- Geopolitical risks remained a key concern for market participants and contributed to a brief sell-off in risky assets, although much of this subsequently unwound.

Overview

UK short-term interest rate expectations implied by the forward curve declined a little over the review period. Much of that change came following the release of the *August 2014 Inflation Report*, which contacts suggested had indicated a more accommodative stance than anticipated by many market participants.

Euro-area short-term rates fell relative to their sterling counterparts, reflecting, in part, the loosening of monetary policy announced by the European Central Bank (ECB) at its June meeting. Contacts also attributed the decline to a further deterioration in euro-area growth prospects and falling inflation expectations. These developments were perceived to have increased the likelihood that the ECB would take additional easing measures, perhaps via outright asset purchases. After the end of the review period, the ECB cut all three of its policy rates further and announced asset-backed securities and covered bond purchase programmes.

International long-term bond yields continued to decline. While the reasons for this remain unclear, contacts cited a number of plausible factors including lower expectations for policy rates, a lack of supply at longer tenors, liability-driven

investors shifting assets from equities into bonds, and a flight to quality resulting from geopolitical tensions. The fall in yields was largest in the euro area, which contacts thought was a result of weaker growth expectations compared with other major developed economies.

Sterling rose over the review period as a whole, particularly versus the euro. The moves were broadly consistent with changes in differences in international interest rates. After rising to its highest level since 2008, the sterling ERI declined towards the end of the review period.

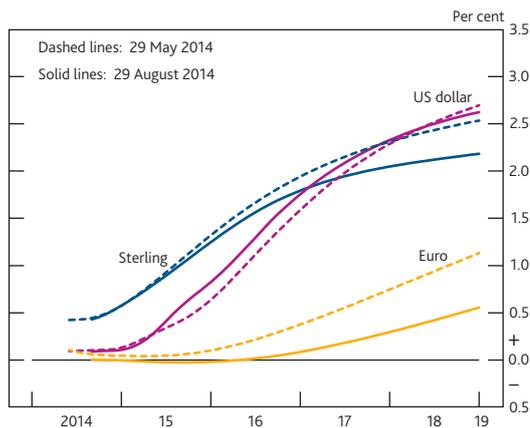
Geopolitical risk associated with tensions in Ukraine and conflicts in parts of the Middle East continued to cause sporadic periods of heightened risk aversion among financial market investors. There was a brief sell-off in some risky asset markets in July, which was particularly marked in the US high-yield corporate bond market. While much of this movement subsequently reversed, the level of US high-yield corporate bond spreads remained somewhat higher than earlier in the year. In contrast, while there was a brief sell-off in equities, the S&P 500 subsequently reached new all-time nominal highs. European equities also recovered, albeit to a lesser degree.

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 first section of this article reviews developments in financial markets between the 2014 Q2 *Quarterly Bulletin* and 29 August 2014. The second section goes on to describe the Bank's own operations within the Sterling Monetary Framework.

Monetary policy and interest rates

Sterling short-term interest rate expectations implied by the forward curve fell a little during the review period (**Chart 1**). In particular, there was a fall in UK forward interest rates with maturities of between three and five years, suggesting a slight slowing in the expected pace of policy tightening.

Chart 1 Instantaneous forward interest rates derived from overnight index swap (OIS) contracts^(a)



Sources: Bloomberg and Bank calculations.

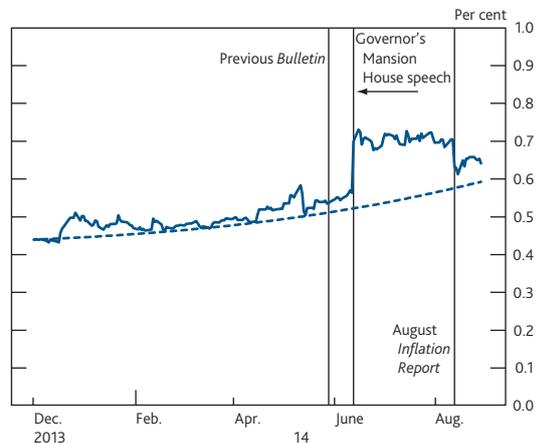
(a) Instantaneous forward interest rates derived from the Bank's OIS curves.

While there was some volatility in interest rates following communications on monetary policy during the review period, at the data cut-off, sterling short-term interest rates were close to the level implied by forward rates in December 2013 (**Chart 2**).

On 5 June, the European Central Bank (ECB) announced a package of monetary stimulus measures. The ECB lowered all three of its policy rates (including setting a negative deposit facility rate); it reaffirmed guidance that interest rates will remain at present levels for an extended period of time; it suspended sterilisation of the Securities Market Programme and extended fixed-rate tender procedures with full allotment at least up to 2016; and it announced plans to intensify preparatory work related to outright purchases of asset-backed securities. In addition, the ECB announced a series of targeted longer-term refinancing operations (TLTROs) that will offer participating banks a cheaper source

of funding than that available in markets. Contacts expect participation in the September and December TLTROs to be high, and euro money market rates declined around the ECB's announcement (**Chart 3**).

Chart 2 One-year spot OIS rates versus market expectations in December 2013^{(a)(b)}



Sources: Bloomberg and Bank calculations.

(a) Spot rates derived from the Bank's OIS curves.

(b) Dashed line shows the expected path of the one-year OIS rate, implied by the OIS forward curve at the start of December 2013.

Chart 3 One-year spot euro OIS rates and five-year euro inflation swap rates, five years forward^(a)



Sources: Bloomberg and Bank calculations.

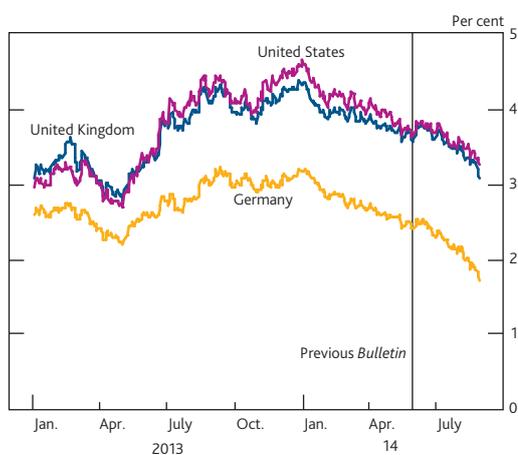
(a) Spot and forward swap rates derived from the Bank's OIS and inflation swap curves.

Euro-area growth prospects continued to deteriorate, and market expectations of medium-term inflation expectations, measured by five-year inflation swaps, five years forward, fell around 15 basis points in the first half of August (**Chart 3**). Comments by ECB President Draghi at the annual conference of central bankers at Jackson Hole were perceived by contacts to have increased the likelihood that the ECB would announce further loosening of monetary policy. And there was both a fall in euro-area short-term interest rates and a rise in inflation expectations following the speech (**Chart 3**). After the end of the review period, the ECB cut its main policy rates again and

announced a programme of asset-backed securities and covered bond purchases to start in October 2014.

International long-term interest rates continued on the downward path observed since the start of the year (**Chart 4**). Contacts pointed to a number of contributory factors, including lower expectations of the pace of increase in policy rates and their ultimate long-term levels, a shift from equities into bonds by liability-driven investors, a flight to quality resulting from geopolitical tensions, declining term premia and reserves accumulation by foreign central banks.

Chart 4 Selected five-year government bond yields, five years forward^(a)



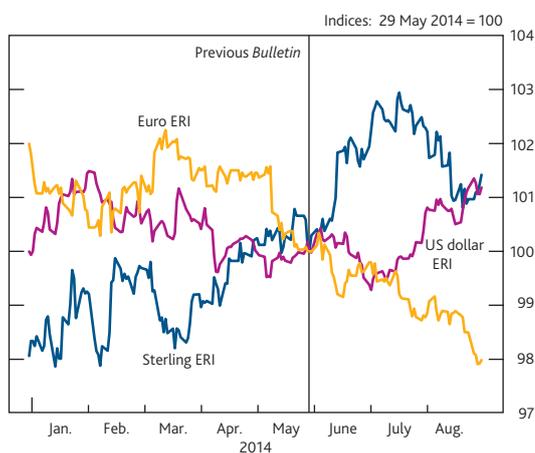
Sources: Bloomberg and Bank calculations.

(a) Forward yields derived from the Bank's government liability curves.

Foreign exchange

Sterling ended the review period about 1% higher than at the start, with the ERI reaching its highest level since 2008 in July (**Chart 5**). The majority of the rise in sterling was driven by an appreciation against the euro, consistent with the broad direction of changes in international interest rates.

Chart 5 Selected exchange rate indices



Sources: Bloomberg, European Central Bank and Bank calculations.

Market contacts thought that in recent years investors had become more focused on short-term interest rate differentials. And foreign exchange strategists continued to expect sterling to decline further over the second half of 2014, based in large part on their view that US short-term interest rates would increase relative to sterling rates over the coming months.

Foreign exchange (FX) strategists thought that central bank liquidity and forward rate guidance had lessened the scope for speculative activity in FX markets. Consistent with this, contacts reported that activity in FX markets had been relatively subdued in recent months. And, indeed, volumes data indicated that, broadly speaking, flows had been unseasonably low since the spring. The low level of activity was thought by contacts to be one of the drivers behind recent declines in volatility in the FX market, with implied volatility in several G10 currency pairs reaching pre-crisis lows.

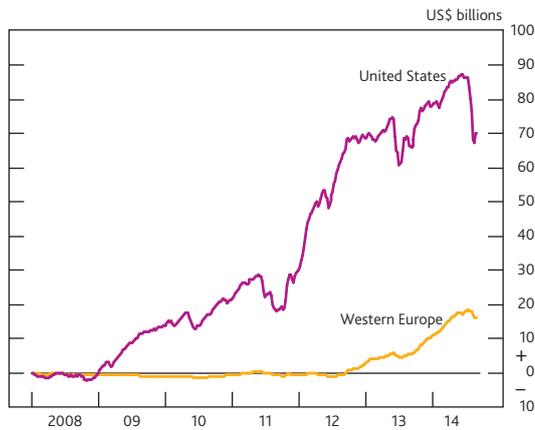
Corporate capital markets

There was a brief sell-off in risky asset markets from the beginning of July to the end of August. In part, that was thought to reflect rising concerns about geopolitical tensions in Iraq and Gaza, as well as the ongoing conflict between Russia and Ukraine.

The pull-back was particularly evident in the US high-yield corporate bond market, where contacts had noted for some time that assets looked expensive. Initial moves that began in early July were given added impetus following Federal Reserve Chair Janet Yellen's comment in mid-July that valuations looked 'stretched'. There were significant outflows from high-yield bond and exchange-traded funds during July and the beginning of August (**Chart 6**), equating to around 6% of total net assets. And US high-yield bond spreads increased by around 90 basis points from their recent low. But the sell-off did not appear to precipitate forced asset sales by fund managers, and much of the increase in yields subsequently unwound. There were broadly similar moves in spreads in euro and sterling-denominated markets (**Chart 7**).

The sell-off in risky asset prices was, to a lesser extent, also evident in developed equity markets. The S&P 500 fell by 4% between 24 July and 7 August, for example. While the S&P 500 recovered those declines and reached all-time nominal highs, European stocks remained lower than at the start of the review period, with the Euro Stoxx 50 down by 3% (**Chart 8**). Contacts attributed this decline to a combination of factors, including weak euro-area activity and the risk of spillovers to Europe from tensions in Ukraine. Implied volatility in equity markets across advanced economies picked up slightly at the end of July as the sell-off in risky asset markets became most pronounced, but has since fallen back to near-record lows (**Chart 9**).

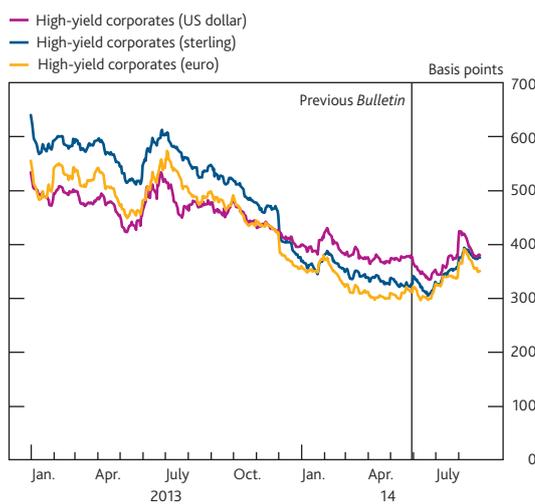
Chart 6 Cumulative cash flow into dedicated high-yield bond funds since 2008^(a)



Sources: Emerging Portfolio Fund Research and Bank calculations.

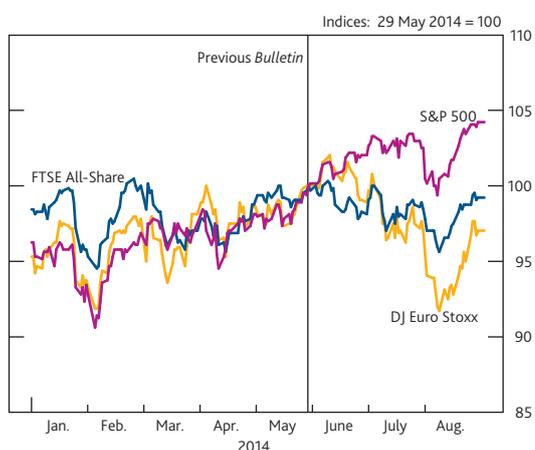
(a) Cumulative flows since January 2008.

Chart 7 International corporate bond option-adjusted spreads



Sources: BofA Merrill Lynch Global Research and Bank calculations.

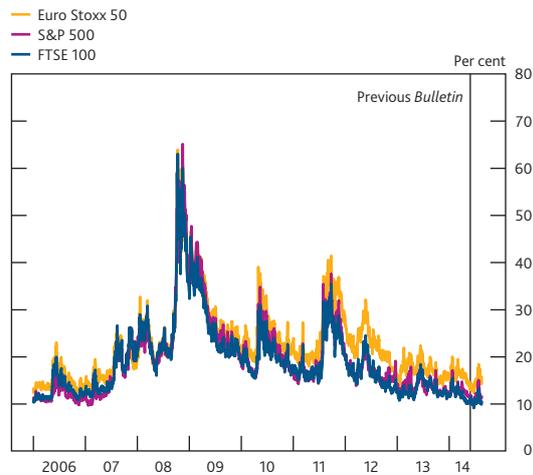
Chart 8 International equity indices^(a)



Sources: Bloomberg and Bank calculations.

(a) Indices are quoted in domestic currency terms.

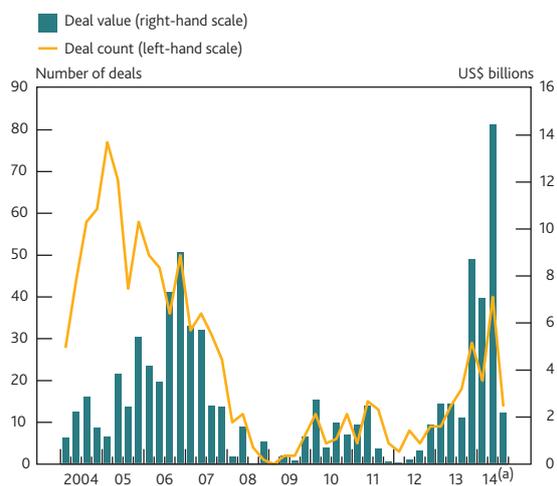
Chart 9 Three-month forward option-implied volatility in equity markets



Source: Bloomberg.

The buoyancy of the UK initial public offering (IPO) market persisted into the start of the review period. During June there were fifteen UK IPOs worth a total of US\$9.5 billion. As a result, the second calendar quarter of 2014 saw deals worth a total of US\$14.4 billion — the largest quarterly total on record (**Chart 10**). European and US IPO markets were also buoyant, although activity in all three slowed as usual during the quieter summer months, and perhaps also as a consequence of the uptick in volatility in risky asset markets.

Chart 10 Total value and number of initial public offerings by UK firms



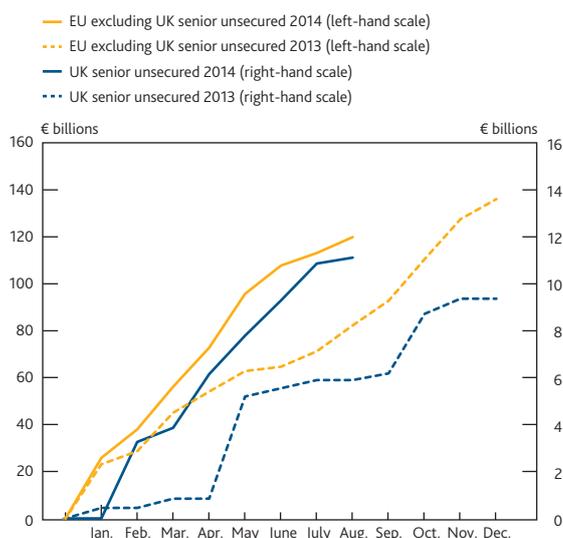
Source: Dealogic.

(a) Data up to 29 August 2014.

Bank funding markets

Primary issuance of both senior unsecured and covered bonds by UK banks was relatively strong at the beginning of the review period compared with a year earlier (**Chart 11**). In line with usual seasonal patterns, issuance slowed in July and August. European banks also continued to issue significant volumes of senior unsecured debt in public markets (**Chart 11**).

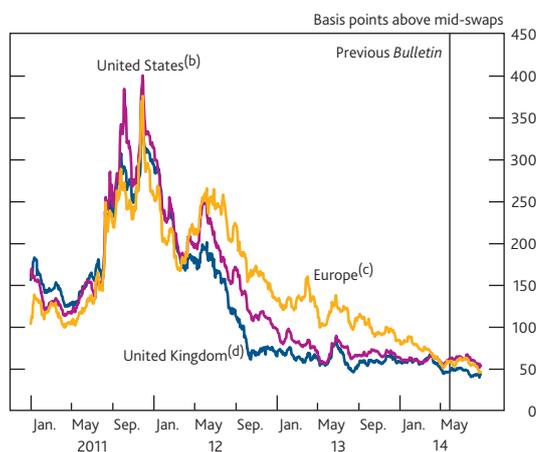
Chart 11 Senior unsecured bond issuance by UK and European (excluding UK) lenders in public markets



Sources: Bloomberg and Bank calculations.

In the secondary market, spreads on UK bank debt remained low, and there was only a limited impact on European banks' senior unsecured funding costs arising from the various market worries over the period (Chart 12). Indeed, European bank funding costs ended the period broadly in line with those for UK and US institutions, having been some way above them since around the middle of 2012.

Chart 12 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.

In contingent capital markets there was a pickup in spreads on additional Tier 1 instruments. Contacts thought that this was associated with the broader sell-off in riskier assets, precipitated largely by heightened geopolitical concerns.

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 May, June and July 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 10 June, 8 July and 12 August 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 (Chart 13).

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 short-term sterling liquidity.⁽¹⁾ The Bank judged that in light of market conditions, CTRF auctions were not required in the review period.

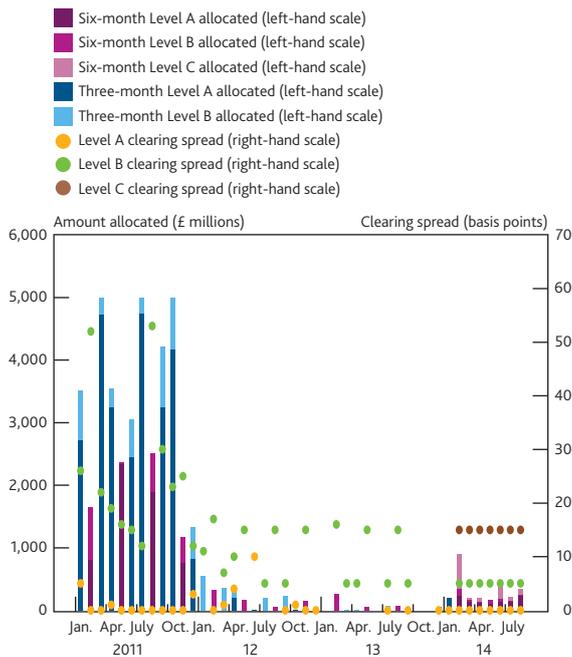
Discount Window Facility

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 return 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 March 2013, lent with a maturity of more than 30 days, was £0 million.

(1) Further details are available at www.bankofengland.co.uk/markets/Pages/money/ctrf/default.aspx.

Table A Indexed Long-Term Repo operations

	Total	Collateral set summary		
		Level A	Level B	Level C
10 June 2014 (six-month maturity)				
Minimum on offer (£ millions)	5,000			
Total bids received (£ millions)	435	140	40	255
Amount allocated (£ millions)	435	140	40	255
Clearing spread (basis points)		0	5	15
8 July 2014 (six-month maturity)				
Minimum on offer (£ millions)	5,000			
Total bids received (£ millions)	219	134	30	55
Amount allocated (£ millions)	219	134	30	55
Clearing spread (basis points)		0	5	15
12 August 2014 (six-month maturity)				
Minimum on offer (£ millions)	5,000			
Total bids received (£ millions)	345	240	10	95
Amount allocated (£ millions)	345	240	10	95
Clearing spread (basis points)		0	5	15

Chart 13 ILTR reserves allocation and clearing spreads^(a)

(a) Where there has not been any allocation to a collateral set, no clearing spread is marked.

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 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. During the three months ending 30 June 2014, nine of the 36 groups participating in the FLS extension made drawdowns totalling £3.2 billion. Participants also repaid £0.8 billion from the first stage of the FLS. This took outstanding aggregate drawings under the Scheme to £45.7 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. On 12 October 2011, the Bank also introduced 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 longer-term US dollar repo operations would be phased out. Monthly 84-day operations ceased on 23 April 2014. The current timetable for the seven-day operations will continue until further notice. 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 (CRDs). 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 billion of gilts and £0.4 billion of other debt securities.

Asset purchases

As of 31 August 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. There were no asset purchases, sales, or maturities over the review period.

(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/data.aspx.

(3) Further details are available at www.bankofengland.co.uk/markets/Documents/marketnotice140124.pdf.

Gilts

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 14).

Gilt lending facility⁽¹⁾

The Bank continued to offer to lend some of its gilt holdings via the Debt Management Office (DMO) in return for other UK government collateral. In the three months to 30 June 2014, the daily average aggregate value of £977 million of gilts was lent as part of the gilt lending facility. Average daily lending in the previous quarter was £385 million.

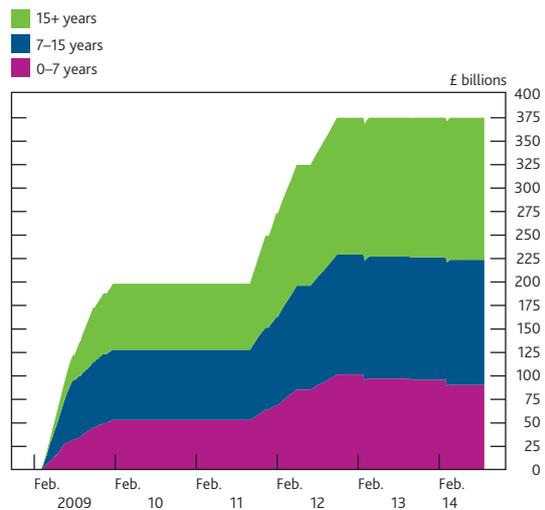
Corporate bonds

There were no purchases of corporate bonds during the review period. 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

Chart 14 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.

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' in the *Bank of England Quarterly Bulletin*, Vol. 50, No. 4, page 253; www.bankofengland.co.uk/publications/Documents/quarterlybulletin/mo10nov.pdf.

(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



Conference on Monetary and Financial Law

On Friday 16 May 2014, the Bank of England's Legal Directorate, in association with the Centre for Commercial Law Studies at Queen Mary, University of London, hosted its second annual Conference on Monetary and Financial Law.⁽¹⁾ The aim of the conference was to give central bankers and regulators, academics and practitioners — both lawyers and non-lawyers — an opportunity to take stock of international regulatory reform, five years after the Pittsburgh Group of Twenty (G20) meeting outlined an international response to the global financial crisis. Participants included staff from across the Bank; lawyers and other staff from financial regulatory bodies and other central banks; senior academics from the United States and the United Kingdom; and lawyers at law firms specialising in financial regulation.⁽²⁾

At the start of the conference it was noted that, as a result of the financial crisis, Government and Parliament have given the Bank a significant suite of new powers to protect and enhance the stability of the UK financial system. These powers include macroprudential authority, with the establishment of the Financial Policy Committee as a sub-committee of the Bank's Court; resolution authority for banks, bank holding companies and central counterparties; microprudential regulatory and supervisory responsibilities for deposit-takers, insurance companies and major investment firms through the Prudential Regulation Authority; regulatory responsibilities for central counterparties and securities settlement systems; and statutory oversight of recognised payments systems.

Each of these new regulatory responsibilities is derived from, and constrained by, law. As a result, understanding the legal framework underpinning money and finance is important for the Bank to achieve its mission of promoting the good of the people of the United Kingdom by maintaining monetary and financial stability.

The conference spanned four main sessions with the following titles:

- (1) Taking stock of the international regulatory reform agenda;
- (2) Divergent approaches in regulatory law — centralisation and diversity;
- (3) Resolution as the fourth pillar of Basel III⁽³⁾ — the impact of recovery and resolution on supervision policy and practice; and

- (4) Alternative currencies, payment systems and finance providers.

The conference was held under the Chatham House Rule. The views expressed in this report do not represent the views of the Bank of England.

Session 1: Taking stock of the international regulatory reform agenda

The first session began with a keynote speaker assessing progress made in the past five years to overhaul the global financial regulatory system. The speaker discussed reform initiatives that have been taken, or are in train.

Global regulatory reform efforts with the objective of promoting financial stability have been spearheaded by the Financial Stability Board (FSB), which provides global surveillance of the financial system. The speaker noted that the FSB operates through setting standards and providing guidance — so called 'soft law' — rather than by making binding legal rules (or 'hard law'). This point was considered again at length during the second session.

The speaker then enumerated many of the regulatory reform initiatives that have been undertaken internationally in the past five years. These include stronger cross-border oversight of financial firms and contingency planning through the establishment of regulatory colleges; the agreement and implementation of Basel III in order to establish new and improved capital and liquidity arrangements for credit institutions; the mandating of central clearing for certain 'over-the-counter' (OTC) derivatives; the development of a maximum leverage ratio as a complement to capital requirements calculated by risk-weighting assets; and the development of a framework to tackle the problem of 'too big to fail', including a framework for identifying global

(1) This report was prepared by Jonathan Grant and Jendy Zibin of the Bank's Legal Directorate, David Bholat of the Bank's Advanced Analytics Division and Sabrina Boukaddour, formerly of the Advanced Analytics Division. The next conference is scheduled for May 2015.

(2) The conference was organised by Rosa Lastra, Professor in International Financial and Monetary Law, Centre for Commercial Law Studies, Queen Mary University of London; Jonathan Grant, Bank of England; and David Bholat, Bank of England.

(3) *Basel III: A global regulatory framework for more resilient banks and banking systems 2010* (revised version June 2011) developed by the Basel Committee on Banking Supervision sets out global regulatory standards on bank capital adequacy and liquidity to strengthen the regulation, supervision and risk management of the banking sector.

systemically important financial institutions (G-SIFIs), ensuring that every jurisdiction has a resolution regime capable of ensuring that the critical functions of these G-SIFIs can continue, while ensuring that they can be recapitalised without recourse to taxpayers (through the use of shareholders' capital and/or through creditors being 'bailed-in').

But further progress on global regulatory reform is still required. Participants noted four main issues currently preoccupying central bankers and regulators:

- (1) **Implementation of FSB standards.** The FSB has no power to compel member states to implement G20 commitments — for instance, in cases where domestic political pressures constrain member states' ability to deliver on G20/FSB commitments. Given the scale of the financial crisis, participants debated whether the FSB should evolve into a body with legal powers to enforce commitments.
- (2) **Common rules for valuing financial instruments.** Some participants argued there is a need for a consistent approach to the valuation of financial instruments in order to come to a common assessment among regulators about the risks faced by firms. A transparent and consistently applied approach to the valuation of banks' assets, particularly for illiquid and complex assets, might improve confidence in banks' balance sheets and might reduce the potential for mispricing risk. A couple of attendees noted the definition for non-performing loans as a fundamental measure where it might be beneficial to have harmonised definitions.
- (3) **Shadow banking.** Some participants noted that, as regulatory scrutiny increases on banks, certain financial activities are likely to be undertaken by non-regulated so-called 'shadow banks'. For example, one participant noted the growth and size of the shadow banking market in China, and the size of assets under management in the investment funds industry.
- (4) **Commitment to regulatory reform.** Some participants noted that, in the period immediately after the financial crisis, there was momentum for regulatory reform. Now, as economic growth starts to return and memory of the crisis fades, some participants were concerned that the reform process might stall.

At the same time, a few participants argued that there are too many supervisory and resolution authorities applying too many complex and variable regulations to banks. Some argued that streamlining agencies and regulators would be beneficial (though supporters of this view conceded that it was unlikely to be achieved easily in practice). Other participants agreed that more cross-border co-operation was highly

desirable, with the number of cross-border crisis management groups for G-SIFIs as evidence of this intent. However, many participants noted that significant barriers to co-operation remain, including regulators not sharing data and the absence of a global cross-border insolvency regime for financial firms.

Session 2: Divergent approaches in regulatory law — centralisation and diversity

If the first session focused on *what* has been done, and remains to be done, in terms of international financial regulatory reform, in the second session the focus turned to the issue as to *which* institutional means are best for achieving the ends of monetary and financial stability.

Participants noted that, at an international level, the regulatory reform agenda largely has been pursued through the use of 'soft law' issued by bodies such as the FSB and the Basel Committee.

The alternative to 'soft law' is 'hard law', where international institutions make legally binding rules. International trade rules, made under the auspices of the World Trade Organisation (WTO), are an example of international 'hard law'.

Some participants argued that a 'hard law' approach would lead to greater centralisation in decision-making and therefore greater consistency in financial regulation across countries. The trouble is that, because 'hard law' rules are legally binding, it may be much more difficult to obtain agreement on them.

In contrast, it may be easier to obtain international agreement to 'soft law' that is not legally binding and can be adapted to suit local laws and conditions. The upshot is a diversity of approaches internationally and therefore the opportunity to learn from differences. However, as one participant noted, one jurisdiction's adaptation of 'soft law' to reflect the local environment may be regarded by other jurisdictions as non-compliance.

One participant noted that the 'hard law' versus 'soft law' debate defines a spectrum rather than a rigid dichotomy. International 'soft law' standards are frequently implemented into supranational eg European Union (EU) or national laws via 'hard law' legislation. For example, the 'soft law' standards of Basel III have been implemented in the EU by the 'hard law' CRD IV Regulation⁽¹⁾ and Directive.⁽²⁾

(1) Regulation (EU) No 575/2013 of the European Parliament and of the Council of 26 June 2013 on prudential requirements for credit institutions and investment firms (<http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32013R0575&from=EN>).

(2) Directive 2013/36/EU of the European Parliament and of the Council of 26 June 2013 on access to the activity of credit institutions and the prudential supervision of credit institutions and investment firms (<http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32013L0036&from=EN>).

Short presentations by various participants considered these issues from four perspectives: (1) in light of the recent European sovereign debt crisis; (2) the current nature of 'soft law' arrangements; (3) the differing approaches being taken in the United States, EU and United Kingdom to deal with the 'too big to fail' problem; and finally (4) in light of the new Single Supervisory Mechanism in the EU.

European sovereign debt crisis

A principal lesson from the eurozone crisis concerns the growing importance of collective action clauses (CACs). CACs permit a majority of bondholders to agree to restructure the terms of outstanding debt, with binding effect on dissenting creditor minorities. CACs have been a standard feature of bond documentation in English law since the 19th century, and more recently have become a standard feature in US bond issues. Recent developments include CACs having provisions so they can be invoked in aggregate (rather than invoking them separately for each bond issue). Aggregating a sovereign's bondholders into a single class makes it harder for creditors who object to the terms of the restructuring to delay or prevent the restructuring. For this reason, the European Stability Mechanism (ESM) treaty now makes it mandatory for all new eurozone sovereign bonds to include standardised and identical CACs from 1 January 2013.

One speaker suggested that there should be an international legal mechanism for dealing with sovereign debt restructurings. The International Monetary Fund (IMF) has proposed a sovereign debt restructuring mechanism (SDRM), but it is an idea which has yet to gain traction. An alternative to an SDRM, in the EU context, would be to amend the ESM treaty so as to require all sovereign debt issuances to have a clause stipulating that, where a sovereign debt restructuring is supported by the ESM and has 75% bondholder approval, any creditor who declines to participate in the restructuring cannot enforce its security in the eurozone.

'Soft law'

On the topic of 'soft law', one attendee argued that the old (post World War II) era of multilateralism is giving way to a new era of 'mini-lateralism' such that historically dominant multilateral organisations no longer monopolise economic affairs. The attendee noted that the previous multilateral era was defined by: aspirations to involve all countries in global initiatives when possible; the use of formal international legal organisations to solve problems; and an international economic system based on the US dollar. Now, the attendee argued, countries are resorting to 'mini-lateral' strategies like trade alliances and informal 'soft law' agreements to manage their stake in the global economy.

Volcker/Liikanen/Vickers

One area where some participants considered there is potential for divergence internationally is with respect to the

structural separation or prohibition of some activities undertaken by banks. In the United Kingdom, the Independent Commission on Banking Standards, chaired by Sir John Vickers, proposed the ring-fencing of vital banking services from investment banking and related activities. These proposals have now been taken forward in the Financial Services (Banking Reform) Act 2013. In the EU, the European Commission, following the Liikanen report, has proposed introducing a ban on proprietary trading activities and powers for supervisors to require the separation of certain trading activities from a deposit-taking entity within the banking group. And in the United States, the so-called Volcker rule, enshrined in the Dodd-Frank Wall Street Reform and Consumer Protection Act, prohibits banks from engaging in proprietary trading, and from owning or investing in certain types of funds. Where there are these differences in approach, some participants wondered how international firms will co-ordinate their compliance with Volcker, Vickers and Liikanen. One speaker also noted that while big banks in these jurisdictions might eventually not engage in proprietary trading, these activities may not disappear. Rather, these activities may migrate to jurisdictions without such rules or be undertaken by non-regulated shadow banks.

EU Banking Union

One participant noted that EU Banking Union is a good example of an incremental approach to regulatory harmonisation.

Establishment of the Banking Union will see the transfer to the European Central Bank (ECB) of supervisory powers over banks established in EU Member States who are members of the Banking Union (those in the eurozone and those that opt in to the Single Supervisory Mechanism (SSM)). Where, for legal or practical reasons, it has not proved possible to include aspects of the Banking Union arrangements in EU legislation, Member States are now turning to inter-governmental agreements (IGAs) to complete the arrangements. An example of this is the IGA establishing the Single Resolution Fund (part of the Single Resolution Mechanism pillar).

One speaker raised the future role of the European Banking Authority (EBA) given the ECB's expanded SSM powers. In response, another participant stated that the EBA will continue to have an important role in developing technical standards under CRD IV for the whole of the EU, rather than just Banking Union participant Member States. This speaker also noted that the EBA could be a useful mediator between the concentric layers of eurozone and EU Member States if disagreements arise in the course of the application of rules, as such rules (including the EBA's standards) will apply to all EU banks, whereas the Banking Union SSM only applies to a subset of banks where the Member State is part of Banking Union.

Concluding observations

At the close of the session, there was some discussion about the lack of a WTO-type body in the international financial regulatory arena. Countries (and their regulatory authorities) have no forum where they can make a formal legal complaint if another country is not complying with the agreed international rules. Some attendees argued that a treaty basis or 'hard law' is needed for this to happen, while other attendees suggested the WTO functional approach may be a good model for financial regulators to pursue, which would require identifying which regulatory functions would be most effective at a national level and which would be most effective at an international level.

Session 3: Resolution as the fourth pillar of Basel III, the impact of recovery and resolution on supervision policy and practice

The session on resolution considered the impact of recovery and resolution planning on supervision policy and practice. The chairperson of this session suggested that resolution had been effectively added as a fourth pillar onto the existing three Basel III pillars (Pillar 1: Minimum capital, liquidity and leverage requirements; Pillar 2: Supervisory review process; and Pillar 3: Market disclosure), but noted that questions remain about how resolution fits with the existing supervisory model.⁽¹⁾

Many participants identified cross-border issues as critical for effective resolution, such as whether home and host state regulators have confidence in each other and share information. There was a general consensus that an international bank resolution strategy requires co-operation between national regulators and resolution authorities, crisis management groups for each bank, Memoranda of Understanding, and structural decisions regarding how different domestic recovery and resolution plans (RRP) fit together as part of a coherent international strategy. For example, a global firm could have a US RRP and a UK/EU RRP. If the conceptual framework and standards of these were inconsistent, that could pose problems during resolution. Complexity was identified as another potential problem. One participant observed that some RRP can run to 10,000 pages, and questioned how realistic it was for such a plan to be used to resolve a firm in a short period of time.

In the EU, the Bank Recovery and Resolution Directive (BRRD) is focused not just on depositor interests, but also on the continuity of financial services and minimising the use of taxpayer money to bail out banks. One speaker suggested that this impacts supervisors by moving them from a compliance-based model regarding capital, to a more granular model where supervisors need to consider whether capital enables a bank to withstand shocks. Facilitating resolvability is

a judgement-based area for supervisors — and will be a relevant consideration in assessing firms' recovery plans and their overall business strategy.

The BRRD provides for going-concern loss-absorbing capacity (GLAC) in the form of a Minimum Requirement for own funds and Eligible Liabilities (MREL) as a means to recapitalise and stabilise banks when they enter resolution. Three main points were made regarding GLAC: (1) that it needs to be at the right point in the firm structure, being the point of entry into resolution; (2) that adequate GLAC should increase confidence of market participants and prevent host authorities from imposing excessive capital requirements; and (3) that while GLAC may comprise unsecured liabilities that could be converted into equity in resolution, it should not be interpreted as third-tier capital.

The session considered 'single point of entry' (SPE) resolution strategies, where resolution tools are applied to a single entity within a group, usually the group holding or parent company. One speaker noted that, to work well, SPE strategies needed close engagement between the home and host authorities at the planning and implementation level. SPE would be implemented only where host and home authorities co-operate in determining the non-viability point and bail-in levels. With a 'multiple point of entry' (MPE) strategy, there is less reliance on the home state, as both home and host states have a role in the resolution.

One participant stressed that the differences between SPE and MPE resolution strategies can be overdrawn. They argued that the most important issue is whether there is enough GLAC at each point of entry to recapitalise each subgroup. This is an issue of ongoing debate, and the FSB is expected to issue a GLAC proposal at the Brisbane Summit in November 2014.

In summary, most participants felt banks are more resolvable now than before, but policy is still evolving (for example, on GLAC). Some participants argued that while bail-in will work for a domestic bank experiencing an idiosyncratic incident, there may be complications to it working for an international bank owing to complicated home and host state issues.

The session on resolution concluded with broad agreement among attendees that over the past five years resolution has become a key part of the supervisory framework and the supervisor's toolkit. Most agreed that: (1) there remains further policy development work to do on resolution and Pillar 3 of Basel III to determine how transparent disclosures to the market on resolution should be; and (2) effective resolution will depend on the particular international

(1) Llewellyn, D T (2010), 'A framework for crisis prevention and management: where is Pillar 4?', paper presented at Annual Colloquium of the Belgian Financial Forum, November 2010.

home-host relationship, which is based on trust, not law, and so domestic legal changes alone are insufficient.

Session 4: Alternative currencies, payment systems and finance providers

The final session considered new sources of payment and finance, such as alternative currencies and payment systems that are at the borders of, or outside, the Bank's regulatory perimeter.

The session considered two examples of alternative currencies: 'local currencies' such as those used in Bristol, Brixton, Totnes and other areas; and 'digital' currencies such as Bitcoin.

One participant noted that the Bank considered local currencies in its 2013 Q4 *Quarterly Bulletin* article 'Banknotes, local currencies and central bank objectives'.⁽¹⁾ That article concluded that the size, structure and backing arrangements for local currency schemes meant that they were unlikely to pose a risk to the Bank's monetary and financial stability objectives. However, the article also noted that consumers should be aware that local currencies do not benefit from the same level of consumer protection as banknotes.

Local currencies represent prepayment (like a voucher). If such prepayment schemes fail, local currency holders would face losses. Some speakers expressed concern about whether members of the public might think local currencies are actually banknotes. One participant wondered whether a successful counterfeit attack on a local currency could spill over into reduced confidence in banknotes.

Digital currencies, like Bitcoin, are privately developed, internet-based currencies and payment systems. It was noted that the current UK market in Bitcoin is relatively small (estimated to be around £40 million). One speaker stressed that the payment technology underlying Bitcoin is its greatest innovation, as it appears to allow secure and verifiable payments with a publicly visible, distributed ledger. The speaker observed that such technology could be extended to create a publicly visible register of shares or to identify outstanding derivatives transactions. So such technology might enable regulators to see a chain of derivatives activity on a generally anonymised basis, facilitating the mapping of some financial stability risks while preserving privacy of financial agents.

Concluding remarks

Graham Nicholson, Chief Legal Adviser of the Bank, delivered the concluding remarks. He noted that following the crisis there was the imperative for governments and regulators to take action to restore financial stability, and prevent such a crisis happening again. This manifested itself in international efforts around resolution, better capital, leverage and liquidity regulation, ring-fencing and better supervision, which, in aggregate, are intended to lead to a safer financial system.

As part of these actions, the UK Parliament has given the Bank more legal powers and responsibilities than at any other time in its history, and as a result, engagement with legal academics and practitioners, both in the United Kingdom and internationally, is increasingly important and valuable to the Bank's monetary and financial stability mission.

Mr Nicholson concluded by thanking the participants for their contributions.

(1) Naqvi, M and Southgate, J (2013), 'Banknotes, local currencies and central bank objectives', *Bank of England Quarterly Bulletin*, Vol. 53, No. 4, pages 317–25, available at www.bankofengland.co.uk/publications/Documents/quarterlybulletin/2013/qb130403.pdf.

Monetary Policy Roundtable

On 3 July 2014, the Bank of England and the Centre for Economic Policy Research (CEPR) hosted their twelfth Monetary Policy Roundtable. These events provide a forum for economists to discuss key issues relevant to monetary policy in the United Kingdom.⁽¹⁾ As with previous Roundtable discussions, participants included a range of economists from private sector financial institutions, academia, public sector bodies and industry associations. There were two topics of discussion:

- what impact might a reduction in the stock of assets held by the Asset Purchase Facility (APF) have on the UK economy? and
- how worried should the Monetary Policy Committee (MPC) be about the United Kingdom's current account deficit?

This note summarises the main issues raised by participants.⁽²⁾ The Roundtables are conducted under 'Chatham House Rule' and so opinions expressed at the meeting are not attributed to individuals. This summary does not represent the views of the Bank of England, the MPC or the CEPR.

What impact might a reduction in the stock of assets held by the APF have on the UK economy?

In the immediate aftermath of the financial crisis, the level of interest rates necessary to keep inflation close to the target and to maintain supply in line with demand fell sharply and became negative. Having already reduced Bank Rate to record low levels, the MPC began a programme of asset purchases ('quantitative easing', or 'QE') in order to support demand through the injection into the economy of central bank money. Between 2009 and 2012 the MPC purchased £375 billion of assets, primarily gilts, and since March 2013 has reinvested the cash flows associated with the maturing gilts held in the APF in order to maintain the stock at £375 billion.⁽³⁾

In due course, the stance of UK monetary policy will normalise. Over time this will involve both increases in Bank Rate and a reduction in the stock of assets held in the APF (the MPC provided some guidance as to the respective roles of these instruments in its May 2014 *Inflation Report*).⁽⁴⁾ In this context, the first session of the Roundtable discussed participants' views regarding the impact that a future

reduction in the stock of assets held by the APF might have on the UK economy.

Analysis by Bank staff estimates that the peak cumulative impact of the MPC's asset purchases on the level of real GDP may have been around 2.5%.⁽⁵⁾ Participants noted that in addition to such estimates being uncertain, the impact of changes in the size of the APF are likely to depend crucially on conditions prevailing at the time, for example the degree of economic and financial stress both at home and abroad.

In order to gauge the impact of a reduction in the size of the APF, estimates based on past purchases might therefore provide a starting point. But simply assuming an equal and opposite impact was generally agreed to be far too simplistic. Many participants framed possible reasons why this may be the case in terms of the different channels through which asset purchases are thought to have affected the economy, including portfolio rebalancing, policy signalling, impacts on liquidity premia and changes in bank lending.

The portfolio balance channel refers to the mechanism whereby changes in the relative stocks of different assets available to be held by the private sector affect their relative prices. One speaker noted that this channel seemed to have been an important linkage between APF asset purchases and the UK real economy. But the strength of this channel will depend crucially on other factors affecting the balance of supply and demand in the gilt market. Another speaker emphasised the importance of institutional investors, whose appetite for gilts will depend, in ways that can be hard to predict, on a number of factors, including regulatory and legislative changes. Returns on gilts relative to other governments' debt, and so monetary policy in other countries, was also thought to be important for the impact of changes in

(1) This report was prepared by Maiting Zhuang of the International Directorate area of the Bank, together with Matt Roberts-Sklar and Matt Trott of the Monetary Analysis area.

(2) For both this and previous summaries, see www.bankofengland.co.uk/publications/Pages/other/monetary/roundtable/default.aspx.

(3) The APF also had facilities for the purchase of private sector assets through the Commercial Paper Facility, the Corporate Bond Secondary Market Scheme and the Secured Commercial Paper Facilities. See www.bankofengland.co.uk/markets/Pages/apf/default.aspx.

(4) See page 41 of www.bankofengland.co.uk/publications/Documents/inflationreport/2014/ir14may.pdf.

(5) See, for example, 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 and Weale, M and Wieladek, T (2014), 'What are the macroeconomic effects of asset purchases?', *External MPC Unit Discussion Paper No. 42*, available at www.bankofengland.co.uk/research/Documents/externalmpcpapers/extmpcpaper0042.pdf.

the size of the APF. Several participants emphasised the impact of gilt issuance by the Debt Management Office (DMO), which was projected to remain high for several years, on the net demand for gilts. The Bank's intention to liaise with the DMO when deciding any programme of sales was reiterated in the May *Inflation Report*.

Another mechanism through which asset purchases were thought to have affected the real economy was by sending a signal about the future stance and potency of monetary policy. The first round of asset purchases in particular was thought to have had a larger impact in part because it demonstrated that policy stimulus could be provided even if Bank Rate was not cut further, and perhaps also because it signalled that Bank Rate would remain low for an extended period. Participants generally agreed that the signalling effect from any announcement of a reduction in the stock of assets would depend on MPC communications and, in particular, the nature of any prevailing policy guidance regarding Bank Rate. Several participants noted that over the periods that asset purchases had taken place, their ultimate total scale was unknown. By contrast, much more is now known about the extent to which the APF may reduce in size. The signalling impact of any given reduction in the APF might therefore be greater if it were taken to preface a programme of subsequent further reductions. On the other hand, the ultimate extent of the reduction being more clearly bounded than was the case for purchases may lessen signalling effects. One participant felt that the signalling channel could have a particularly large impact on the economy via the exchange rate, although there was a range of views on both the sign and magnitude of such an effect.

Some participants felt that the much improved functioning of financial markets since the period when assets were purchased meant that the impact of changing the size of the APF on liquidity premia could be smaller. Others, though, noted that an excessively rapid reduction in assets held could still lead to material effects through this channel. By contrast, it was noted that the effect on bank lending of reducing the stock of assets could be greater than it had been for purchases, given improvements in the capacity of the banking sector to lend since purchases took place. Increased demand by banks to hold gilts to help satisfy regulatory requirements was cited by one speaker as a potential factor affecting the strength of the bank lending channel.

A recurring theme throughout the session was that the effect, through all of the channels discussed above, of the APF reducing in size would depend crucially on MPC communications regarding this process. The box in the May 2014 *Inflation Report* on asset purchases and Bank Rate as the economy recovers was therefore welcomed. There was some discussion of the extent to which the impact of reductions in the size of the APF would start to take effect

upon relevant announcements or only as these changes actually take place. Participants generally agreed that announcement effects could be important through the signalling and portfolio balance channels, as suggested by market moves in 2013 around the time of the US Federal Open Market Committee's communication on tapering its asset purchases. But the act of reducing the stock could matter more for the liquidity premia channel.

Some participants thought that MPC communications relating to a reduction in the size of the APF could be complicated by the fact that, under plausible assumptions, HM Treasury may in the future need to transfer sizable sums to the APF. In November 2012, HM Treasury announced arrangements to transfer gilt coupon payments received by the APF, net of interest costs and other expenses, to the Exchequer. As has been flagged previously,⁽¹⁾ the Treasury's indemnification of the APF means that a proportion of these flows may well need to flow in the other direction as assets in the APF mature or are sold. While not a macroeconomic risk, participants felt that this would need to be explained clearly if it were not to confuse broader communications on policy normalisation.

In summary, there was general agreement that the impact of reductions in the stock of assets was uncertain and would probably differ from the past impact of comparable purchases. While the MPC's communication to date on the principles of normalising policy was welcomed, participants emphasised the need for further careful communication ahead of reducing the stock of assets.

How worried should the MPC be about the United Kingdom's current account deficit?

The United Kingdom's current account deficit reached a record level of 5.9% of nominal GDP in 2013 Q3, and remains large by historical standards. Unlike previous episodes in which a sizable current account deficit has opened up, the deterioration since 2011 has not reflected an increasing trade deficit but rather a marked reduction in net investment income from abroad. Yet despite repeated deficits, the value of foreign assets held by UK residents relative to the claims of foreigners on domestic assets — the United Kingdom's net international investment position (NIIP) — has changed very little. In the second session of the Roundtable participants discussed some of the potential causes of the current account deficit and whether it should be seen as a cause for concern about the UK economy in general and for the Monetary Policy Committee in particular.

Attendees noted that a current account deficit may be worrisome if it were considered symptomatic of persistent

(1) See, for example, the speech by Spencer Dale, available at www.bankofengland.co.uk/publications/Documents/speeches/2012/speech622.pdf.

imbalances in an economy. In some extreme cases, the current account balance could be forced to close sharply through a reduction in capital inflows and a pronounced depreciation of the currency. Marked movements in the exchange rate could have important impacts on the outlook for inflation.

Some attendees looked to historical precedent to help assess the implications of the deficit. One speaker felt that while deficits of a similar size may have been associated with sterling crises in past decades, this seemed unlikely to be repeated given the subsequent deepening of financial markets and the establishment of a credible inflation-targeting regime in the United Kingdom. Another noted that while there is some evidence that current account deficits in emerging market economies tend to precede a period over which the associated currencies depreciate, such a relationship appears absent for advanced economies.

There was a broad consensus that in order to assess the risks posed by a current account deficit, it is insufficient to focus exclusively on its size. It is also important to consider its composition, its counterparts in the financial balances of sectors of the domestic economy and the stock of net foreign assets (the NIIP).

In terms of the composition of the deficit, some saw the absence of a deterioration in the trade balance as a source of comfort. One participant contended that, after abstracting from idiosyncratic factors, the United Kingdom's trade balance had evolved broadly as one would have expected following the sharp depreciation of sterling in 2007–08. Another speaker noted that the recent deterioration in net investment income could reflect the United Kingdom's cyclical position relative to its main trading partners, for example through a reduction in returns on investment projects in the euro area relative to those in the United Kingdom. In this case, a recovery in the euro-area economy would help to improve the United Kingdom's current account balance.

The counterparts to the current account — a country's external financial balance — are the net financial balances of sectors within the domestic economy. For one speaker, a current account deficit may be less worrying if its counterpart is a financial deficit in the corporate sector, as this is likely to

be associated with investment and so a future stream of income. Conversely, a deficit in the household sector might signal greater cause for concern. This speaker claimed that the United Kingdom's present current account deficit corresponds to a deficit in the public sector. They inferred that while no pronounced shift in private sector behaviour was obviously required to close the deficit, its persistence would be a function of fiscal policy.

The United Kingdom's estimated net external asset position has remained broadly in balance even as the current account has deteriorated, in part reflecting capital gains on the United Kingdom's foreign assets.⁽¹⁾ The apparent resilience of the United Kingdom's NIIP, and so a healthy external 'stock' position, reduced the likelihood many participants foresaw of the current account deficit posing serious difficulties in the near term. However, measuring and interpreting a country's external debt position is difficult: the NIIP can be affected by revaluation effects, exchange rate moves and companies changing the country in which they are domiciled.

It was nonetheless thought important to monitor developments in the current account carefully. One risk was that the net income position would not improve along with the euro-area economy. More generally, persistent external imbalances could indicate chronic distortions in the domestic economy, such as resource misallocation between the tradable and non-tradable sectors, which monetary policy makers would need to take a view on when deciding on their policy stance.

Overall, there was a broad consensus among participants that the United Kingdom's current account deficit is unlikely to be the primary cause of a large depreciation of sterling in the near future, although it might limit the extent to which the appreciation of sterling over the past year or so will continue. In addition to the points noted above, one speaker argued that although the United Kingdom is highly leveraged in the sense of having a large external balance sheet relative to GDP, this primarily reflects London's position as a global financial centre: they did not think the United Kingdom in aggregate was using this leverage to fund excessively risky investments and nor did they feel it was associated with a worrying maturity mismatch between assets and liabilities.

(1) Bank estimates suggest the NIIP might in fact be positive (May 2014 *Inflation Report*, page 22, available at www.bankofengland.co.uk/publications/Documents/inflationreport/2014/ir14may.pdf).

Changes to the Bank's weekly reporting regime⁽¹⁾

Overview

A core function of a central bank is to provide liquidity insurance to the financial sector. This may be done through market-wide operations such as the Bank of England's Indexed Long-Term Repo (ILTR) operations. There will, however, be occasions when a liquidity shock affects one or more individual institutions and in such cases the Bank may need to be ready to provide liquidity bilaterally to the affected institutions, either through its published facilities in the Sterling Monetary Framework, or on a bespoke basis via an Emergency Liquidity Assistance (ELA) operation. It is possible that a bank might lose access to funding markets even if it ultimately had sufficient assets that could, in time, pay out on its liabilities: as Bagehot⁽²⁾ put it, a bank can be illiquid but solvent. In those circumstances, a better outcome for depositors and the wider economy can sometimes be achieved if the central bank provides the bank with temporary liquidity assistance. Experience suggests that it is more effective for such operations to remain covert at the time, so as not to further undermine confidence in the institution receiving support.

At the same time the Bank is committed to being open and accountable about its activities and from 1844 it was required to publish a weekly balance sheet — the 'Bank Return'. The financial crisis underlined the trade-off that exists between being transparent and open at all times and seeking to maintain financial stability. This article explains how the current Bank Return is being replaced with a new publication that will include additional detail across some parts of the Bank's balance sheet but omit data relating to bilateral operations. This will allow the Bank to carry out such operations but disclose them with a delay, while moving towards a more modernised approach to reporting.

The Bank Return

The current form of the Bank Return summarises key components of the Bank of England's balance sheet, such as reserves balances and notes in circulation, as well as the total size of the Bank's balance sheet. This is useful for providing transparency of monetary policy activities but, conversely, it can impinge on the Bank's ability to successfully undertake financial stability support operations in times of stress. The publication of the Bank of England's full balance sheet on a weekly basis, which in some circumstances allows observers to

identify the presence of liquidity support operations, can be counterproductive where the success of an operation depends on it remaining covert. The Bank will be amending its weekly reporting structure to best manage these conflicting issues: this article sets out the rationale and provides details of the new reporting structure.

Financial Stability Objective

Section 238 of the Banking Act 2009 introduced a new statutory objective for the Bank, to 'contribute to protecting and enhancing the stability of the financial systems of the United Kingdom'.⁽³⁾ The Bank now pursues this objective through a number of channels, including: prudential regulation of financial institutions by the Prudential Regulation Authority; decisions of the Financial Policy Committee; the Bank's role as a resolution authority; and the Bank's financial stability operations, including under the Sterling Monetary Framework, and as lender of last resort.

As the central bank, the Bank of England is well placed — due to the ability to create sterling liabilities — to act as a backstop provider of liquidity. This role has been fulfilled by the Bank of England for over 140 years. The Bank may provide liquidity where a specific firm is facing a liquidity shortage. Where the aim of this intervention is to restore confidence such operations, at least initially, need to be conducted covertly as disclosure can itself be a cause of financial instability. This was witnessed during the Northern Rock crisis when unauthorised disclosure of central bank support sparked a run on the bank. Around that time, observers familiar with Bank publications were able to track the size and duration of liquidity support by analysing the change in the value of 'other assets' included in the weekly publication of the Bank Return. This emphasised that the Bank Return in itself could become the route for inadvertent disclosure.

In response to the financial crisis, Section 245 of the Banking Act 2009 removed the legal requirement for the Bank of England to publish a Bank Return, to provide scope for the Bank to provide covert liquidity operations.⁽⁴⁾ At the time,

(1) This article was prepared by Ankita Mehta of the Bank's Customer Banking Division and Chris Salmon, Executive Director for Markets.

(2) See Walter Bagehot, *Lombard Street: a description of the money market*.

(3) See Banking Act 2009:

www.legislation.gov.uk/ukpga/2009/1/pdfs/ukpga_20090001_en.pdf.

(4) *Ibid.*

History of the Bank Return

The statutory requirement for the Bank to publish a weekly Bank Return in the *London Gazette* was introduced by Section 6 of the 1844 Bank Charter Act⁽¹⁾ to strengthen confidence in the currency by providing transparency over the assets backing the notes issue. The format of the statutory return did not keep pace with changes in the Bank's activities and from 1928 the Bank has published an expanded Return, whose format has been amended from time to time. Following the Banking Act 2009, publication of the statutory Return in the *London Gazette* ceased in January 2010. However, the Bank Return continued to be made available on the Bank of England's website every Thursday, providing figures as at the close of business Wednesday. The first Bank Return from 1844 can be found in Annex 1.

(1) See Bank Charter Act 1844:
www.bankofengland.co.uk/about/Documents/legislation/1844act.pdf.

Parliament specifically discussed the rationale for this change and it was acknowledged by the Exchequer Secretary to the Treasury that there are circumstances in which the disclosure of liquidity support is in no one's best interests.⁽¹⁾

In 2012, Ian Plenderleith completed a review of the Bank's provision of ELA to the Royal Bank of Scotland and HBOS in 2008–09.⁽²⁾ Regarding the future publication of the (non-statutory) Bank Return, the review recommended that the Bank 'should consider ceasing to do so at an appropriate time, in order to improve its ability to provide covert liquidity assistance in future'. The Bank's public response was to agree the recommendation and pledge to undertake further analysis.⁽³⁾ The Bank publicly committed to completing this analysis in the first half of 2014.

Transparency

Given the breadth of the Bank's statutory duties it is important that the Bank is transparent, independent and accountable to its stakeholders. This is why 'Open and Accountable' is one of the four pillars in the Strategic Plan that the Bank announced in March 2014.

In many cases, being transparent about the Bank's financial operations can aid their effectiveness: for example being transparent about the size of the loan to the Asset Purchase Facility created by the Bank's quantitative easing programme helps to anchor inflation expectations, which in turn leads to more stable inflation outcomes, thus supporting the Bank's monetary policy objective. For these operations, considerations of policy effectiveness and transparency work in the same direction.

In relation to liquidity support operations, as noted above, considerations of policy effectiveness and transparency have the potential to conflict with each other. But even here the conflict can be reconciled through time: for any given instance of liquidity support, the financial stability benefit of keeping that assistance covert is only temporary. With a sufficient lag, disclosure that a firm had received temporary liquidity support from the Bank should not undermine confidence in that firm or the financial system as a whole. This also explains why the Bank publishes data on the use of its Discount Window Facility (DWF) — its published tool for providing bilateral liquidity insurance — with a five-quarter lag.

As such, when considering Ian Plenderleith's recommendation, the Bank has weighed up two competing public policy considerations: the benefits from being transparent about the Bank's regular operations versus the benefits of delaying disclosure of certain balance sheet items to provide the scope for the Bank's ability to provide covert liquidity assistance.

It is important to note that under the Memorandum of Understanding on Crisis Management,⁽⁴⁾ all ELA operations require the Chancellor's approval. The Chancellor and the Treasury are responsible for keeping Parliament and the public appropriately informed of action taken to manage a crisis. In this way, the Bank remains accountable to HM Treasury and Parliament. Additionally in response to the Plenderleith review, the Bank agreed to undertake a quarterly review about whether and when it is possible to publicly disclose the existence of ELA.

New reporting

The Bank plans to reconcile the competing considerations by replacing the Bank Return with a new Weekly Report which will maintain the Bank's current level of transparency in relation to balance sheet items that affect monetary conditions, but will not include line items which have the scope to inadvertently reveal the provision of covert liquidity support. Those items will be reported on a quarterly basis but with a five-quarter lag — the same disclosure lag as applies to DWF usage.

The new Weekly Report will be an operational report that provides data on all assets and liabilities generated through the Bank's monetary policy operations. The Report will include separated data on liquidity operations (ILTR and Contingent

(1) See transcript from Session 1007-08, Banking Bill, Public Bill Committee, Clause 223: www.publications.parliament.uk/pa/cm200708/cmpublic/banking/081030/pm/81030s01.htm.
(2) See Plenderleith, I (2012), 'Review of the Bank of England's provision of Emergency Liquidity Assistance in 2008–09', available at www.bankofengland.co.uk/publications/Documents/news/2012/cr1plenderleith.pdf.
(3) See Bank of England (2013), 'Response of the Bank of England to the three Court-commissioned reviews', available at www.bankofengland.co.uk/publications/Documents/news/2013/nr051_courtreviews.pdf.
(4) See the Memorandum of Understanding on Crisis Management, available at www.bankofengland.co.uk/about/Documents/mous/moufincrisis.pdf.

Bilateral facilities in the Sterling Monetary Framework

Bilateral facilities can be used by individual banks at their initiative, as opposed to market-wide operations undertaken at the initiative of the Bank. In October 2008, the Bank replaced the existing bilateral facility in its Sterling Monetary Framework with two new facilities. They are an Operational Standing Facility offering overnight loans and deposits to absorb technical frictions in the overnight money markets and a Discount Window Facility to provide longer-term liquidity insurance in the event of stress. From 2006 to 2008 the Bank had included a line in the Bank Return for standing facility deposits and assets. However this had helped to make banks unwilling to make use of the facility and thus frustrated its purpose. When the two new bilateral lending facilities were introduced, reporting on standing facilities was removed from the Bank Return and information on their use provided with a delay in order to address banks' unwillingness to access Bank facilities. The Bank's approach to disclosure on these facilities was further refined in its response to Bill Winters' review of the Sterling Monetary Framework, published in October 2013.⁽¹⁾

(1) See Bank of England (2013), 'Liquidity insurance at the Bank of England: developments in the Sterling Monetary Framework', available at www.bankofengland.co.uk/markets/Documents/money/publications/liquidityinsurance.pdf.

Term Repo Facility), the loan to the Asset Purchase Facility and the foreign currency assets that constitute the Bank's own foreign currency reserves⁽¹⁾ together with the foreign currency liabilities that finance them. In designing the report the Bank has sought to identify a format that will be helpful and relevant for users of the data. Overall, this new report will typically continue to disclose over 90% of the Bank's balance sheet by value.

Compared with the current Bank Return the main omissions will be the overall size of the Bank's balance sheet and 'other

assets' and 'other liabilities'. But a number of items currently included in these 'other' categories — such as the loan to the Asset Purchase Facility — will be shown separately in the new Report. The other change is that the Bank will cease publishing separate reports for the Issue and Banking Departments⁽²⁾ on a weekly basis. The current Bank Return as at 25 June 2014 and a template of the new Weekly Report can be found in Annexes 2 and 3. An accompanying article, 'Replacement of the Bank Return and changes to the release of notes and coin data', will be published in *Bankstats* on 30 June and will provide a description of the changes being made to the Bank's statistical reporting.

The information provided in the Weekly Report will be augmented on a quarterly basis, with a lag of five quarters, with data for those assets and liabilities which had not previously been disclosed, completing the balance sheet. This will enable the Bank to provide full balance sheet disclosure on a delayed basis. These data will be published on the Bank's website.

The Bank will continue to publish its end-of-year balance sheet each year within its *Annual Report*, which is typically published three to four months after the end of the Bank's financial year. The Bank's *Annual Report* disclosures will not be affected by the changes to the weekly reporting structure, and will continue to report the Issue and Banking balance sheets.

Timetable for introducing the Bank's Revised Disclosure Policy

The final Bank Return will be published on 25 September 2014, with the first Weekly Report being published on 2 October 2014. The first quarterly disclosure of the Bank's balance sheet will be data as at 30 September 2014 which will be published with a five-quarter lag. The Bank has chosen to pre-announce the change to dispel any speculation that might otherwise exist that the change in reporting arrangements was tied in any way to the provision of liquidity to a specific counterparty.

(1) This excludes the HM Treasury Exchange Equalisation Account (EEA) which holds the United Kingdom's reserves of gold, foreign currencies and International Monetary Fund Special Drawing Rights.

(2) The Issue and Banking Departments were created by the Bank Charter Act 1844. These are not organisational units of the Bank, but serve to divide the note-issuing business of the Bank from its other activities.

Annex 1
The first Bank Return

First return

Bank of England.

An ACCOUNT pursuant to the Act 7 and 8 VICT. cap. 32. for the Week ending
on Saturday, the *7th* day of *September* 1844

ISSUE DEPARTMENT.

	£		£
Notes Issued	28 351 295	Government Debt	11 015 100 ✓
	<i>20 176 270</i>	Other Securities	2 984 900 ✓
		Gold Coin and Bullion	12 657 208 ✓
		Silver Bullion	1 694 087 ✓
	<u>£ 28 351 295</u>		<u>£ 28 351 295</u>

Dated the *12th* day of *September* 1844

Matthew Marshall *M M* Chief Cashier.

BANKING DEPARTMENT.

	£		£
Proprietors' Capital	14 553 000	Government Securities (including Dead Weight Annuity)	14 554 834 ✓
Rest	3 564 729	Other Securities	7 835 616 ✓
<i>Exch. 2.198,</i> Public Deposits (including Exchequer, Savings Banks, Commissioners of National Debt, and Dividend Accounts)	3 630 809	Notes	8 175 025
Other Deposits	8 644 348	Gold and Silver Coin	857 765 ✓
Seven Day and other Bills	1 030 354		
	<u>£ 31 423 240</u>		<u>£ 31 423 240</u>

Dated the *12th* day of *September* 1844

Gazette 13th Sept 1844 *M M* Chief Cashier.

Annex 2
Current Bank Return

BANK OF ENGLAND

Wednesday, the 25th of June 2014

CONSOLIDATED STATEMENT

<u>LIABILITIES</u>	£	<u>ASSETS</u>	£
Notes in circulation	61,409,605,670		
Reserve balances	303,599,009,466		
Short-term open market operations		Short-term open market operations	
Fine-tuning sterling	-	Other maturity within-maintenance period sterling reverse repos	-
One-week sterling	-	One-week sterling reverse repos	-
Other maturity within-maintenance period sterling	-	Fine-tuning sterling reverse repos	-
		Longer-term sterling reverse repos	1,908,000,000
		Ways and Means advances to HM Government	369,847,840
Foreign currency public securities issued	3,540,133,333	Bonds and other securities acquired via market transactions	16,673,808,255
Cash ratio deposits	4,127,828,548		
Other liabilities	32,120,321,189	Other assets	385,845,242,111
Total liabilities	404,796,898,206	Total assets	404,796,898,206

Annex 3
Template of new Weekly Report

BANK OF ENGLAND

Weekly Report

	25 June 2014 £mn	18 June 2014 £mn
<u>Sterling Liabilities</u>		
Reserves balances	303,599	303,435
Short-term open market operations	-	-
Fine-tuning sterling	-	-
One-week sterling	-	-
Other maturity within maintenance period sterling	-	-
Notes in circulation	61,410	61,164
<u>Sterling Assets</u>		
Short-term open market operations		
Fine-tuning sterling	-	-
One-week sterling	-	-
Other maturity within maintenance period sterling	-	-
Longer-term sterling reverse repos		
Indexed linked term repos	1,908	1,908
Contingent term repo facility	-	-
Sterling denominated bond holdings	10,247	10,197
Loan to Asset Purchase Facility	375,000	375,000
<u>Foreign Currency Liabilities</u>		
Foreign currency public securities issued	3,540	3,547
<u>Foreign Currency Assets</u>		
Foreign currency reserve assets	3,531	3,537

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 June 2014 are listed below.

[Unemployment and the conduct of monetary policy in the United Kingdom](#)

Ben Broadbent, Deputy Governor, August 2014.

www.bankofengland.co.uk/publications/Documents/speeches/2014/speech752.pdf

Speaking to the Federal Reserve Bank of Kansas City's Economic Policy Symposium in Jackson Hole, Ben Broadbent discussed the role of unemployment in the conduct for monetary policy. He started by pointing out that, over the past century and a half, the only periods where there was a stable relationship between UK unemployment and wage growth were when there was a clear nominal anchor: the gold standard and, almost 100 years later, the inflation target. He continued by making two main points. First, during the inflation-targeting period and before the crisis, the UK monetary authority seemed to have mainly reacted to movements in output. He argued that this was in fact analogous to reacting to inflation developments because supply and cost growth appeared to move little so stabilising inflation and stabilising the real economy amounted to the same thing. Second, after the crisis as the Monetary Policy Committee (MPC) became more uncertain about its projection for potential growth, labour market data, even if with a lag, provided a valuable steer about the evolution of supply and inflation. It was in this context that the MPC conditioned its 'forward guidance' on the rate of unemployment. But as unemployment continued to fall and the supply of labour increased, the MPC started to consider wages as well. He concluded by saying that meeting the inflation target was still the ultimate objective of the MPC irrespective of the 'range of indicators' that would, as always, be considered.

[Halfway up the stairs](#)

Andrew Haldane, Executive Director and Chief Economist, August 2014.

www.bankofengland.co.uk/publications/Documents/speeches/2014/speech751.pdf

In this article for the *Journal of Central Banking's* 25th Anniversary, Andrew Haldane considered some of the big questions on central banking. How have central banks evolved over the last quarter of a century? How has the crisis affected that evolution? And what lies in prospect for them over the next 25 years?

The article first discussed some of the key developments in central banking over the past century.

Andrew then considered two hypothetical future paths for central banks. The first is one in which the extraordinary measures taken over the recent crisis are returned to being tools for emergencies only. Here monetary, financial and regulatory policy would move to a more settled pattern over time. The other hypothetical path considered is one in which central banks' operational policies would remain expansive. In this scenario, their role in shaping the fortunes of financial markets and financial firms would likely rise.

[The UK current account](#)

Ben Broadbent, Deputy Governor, July 2014.

www.bankofengland.co.uk/publications/Documents/speeches/2014/speech750.pdf

In a speech at Chatham House, Deputy Governor Ben Broadbent discussed why he did not view the UK current account deficit as posing an independent threat to UK growth. He started by recognising that if the global economy remains sluggish, it will inevitably be harder for an open economy like the United Kingdom to achieve both strong and balanced growth. But he explained that the composition of the United Kingdom's overseas balance sheet, the presence of a balanced net asset position and a floating currency reduce the threat from a large current account deficit. More specifically, he made three points. First, while the United Kingdom has run a current account deficit for most of the past 20 years, the stock of net foreign assets has been broadly unchanged. Second, the net asset position has some bearing on the empirical relationship between the current account deficit and subsequent rates of growth — it is a better indicator of crisis risk, and of the likelihood of the need for a sudden correction in the deficit, than the current account alone. Third, the United Kingdom's ability to earn more on its overseas assets than it pays on its liabilities may depend in part on the credibility of our economic policy. He then concluded that the United Kingdom has in place a hard-won policy framework that did not exist when it went through the traumas of the 1976 crisis, something that should never be taken for granted.

[Making resolution work in Europe and beyond — the case for gone-concern loss-absorbing capacity](#)

Andrew Gracie, Executive Director, Resolution, July 2014.

www.bankofengland.co.uk/publications/Documents/speeches/2014/speech749.pdf

At a Bruegel breakfast panel Andrew Gracie summarised international and European Union (EU) initiatives seeking to end the notion 'too big to fail'. Gone-concern loss-absorbing capacity (GLAC) is effectively an internationalisation of the EU's concept in the Bank Recovery and Resolution Directive of a minimum requirement for eligible liabilities (MREL). The aim is the same: ensuring that banks' losses and recapitalisation needs can be addressed in a resolution. Andrew walked through the necessary ingredients for a resolution transaction — including use of a bail-in. GLAC, of sufficient size and quality and distributed appropriately within group structures, should enable authorities to resolve banks without recourse to public funds. Andrew concluded by highlighting forthcoming work on GLAC including technical standards on MREL due from the European Banking Authority and upcoming proposals in November from the Financial Stability Board.

[Winning the economic marathon](#)

Mark Carney, Governor, July 2014.

www.bankofengland.co.uk/publications/Documents/speeches/2014/speech748.pdf

Speaking at the opening of the 20th Commonwealth Games, the Governor drew inspiration from great Scots, each of whom pointed to an essential ingredient of economic success.

William Paterson showed the need for a central bank. Its modern variant was a leading macroprudential institution, well equipped to face the challenges of promoting a balanced expansion.

David Hume demonstrated the virtues of free trade. The United Kingdom, already one of the most open economies, could help lead the development of new EU trade deals as businesses diversified their markets.

Adam Smith showed the importance of social capital. With a financial system that was a global good and a national asset, the United Kingdom was leading financial reforms to build a resilient global financial system with fair and effective markets at its core.

And finally, Olympic medallists Allan Wells and Liz McColgan showed the enormous pay-offs for hard work, dedication and perseverance. Winning the economic marathon would take

similar determination. But the prize of a durable expansion was great and, if inspired by some of Scotland's many heroes, the United Kingdom would succeed.

[The role of the leverage ratio and the need to monitor risks outside the regulated banking sector](#)

Sir Jon Cunliffe, Deputy Governor, July 2014.

www.bankofengland.co.uk/publications/Documents/speeches/2014/speech746.pdf

Jon Cunliffe discussed the two illusions exposed by the financial crisis: the capital illusion and the liquidity illusion. At the height of the crisis, the market simply did not believe the published numbers for bank capital adequacy. Together with reforms to the risk-weighted capital framework that suggested a need for an alternative gauge of capital adequacy: a leverage ratio, which did not rely on complex mathematical models. Prior to the crisis, lax regulatory standards allowed dealers to run with high levels of inventory and to accommodate easily shifts in the demand for market-making. However, that left them vulnerable to a change in conditions: when faced with severe stress, they were forced to withdraw from market-making altogether. Though tighter regulation could mean that market liquidity might start to fall away at an early point, the risk of a complete failure of market liquidity should be much reduced. One concern around the investment fund management sector is that heavy asset sales in times of stress could disrupt systemically important asset markets. In this respect it was currently quite puzzling that, when market participants seemed to be worried about the impact of regulation on market-making, liquidity risk premia seemed to be so compressed.

[The capital adequacy of banks: today's issues and what we have learned from the past](#)

Andrew Bailey, Deputy Governor, July 2014.

www.bankofengland.co.uk/publications/Documents/speeches/2014/speech745.pdf

Andrew Bailey explained that the pre-financial crisis capital adequacy regime failed to provide the necessary protection. This was because the definition of capital set in Basel I included instruments that did not properly absorb losses, capital requirements were set too low in relation to the underlying riskiness of the assets, and banks were able to move risky assets into the trading book. Since the crisis the quantum and quality of capital held by banks has increased significantly. Key elements of the revised framework include: (i) a common definition of capital resources focused on genuine loss absorbency in going concern; (ii) capital buffers which vary depending on the size and nature of the bank and throughout the cycle; (iii) assessing capital adequacy using a combination of different approaches — risk-based

assessments, stress tests and a leverage ratio; and (iv) using internal models in a way that recognises their benefits while guarding against weaknesses and incentive problems.

[The Bank of England's Monetary and Financial Policy Committees: guiding the economy towards a sustainable and safe recovery](#)

Sir Jon Cunliffe, Deputy Governor, July 2014.

www.bankofengland.co.uk/publications/Documents/speeches/2014/speech743.pdf

Jon Cunliffe explained how the Financial Policy Committee (FPC) and Monetary Policy Committee (MPC) work together to meet the Bank's mission of promoting the good of the people of the United Kingdom by maintaining monetary and financial stability. The MPC's role is to balance supply and demand in the economy to get the best outcome consistent with keeping inflation at target in the medium term. The FPC aims to preserve financial stability by ensuring the underlying financial system is resilient by identifying risks and taking action to prevent them crystallising. The stress test of major UK banks and the FPC's action on the housing market are two examples of how the FPC approaches its task. The point of the stress test is to explore how the financial system would cope with an unlikely but plausible combination of adverse circumstances. The FPC's actions on the housing market seek to make a period of stress less likely to occur in the first place. The measures should be thought of as insurance against a substantial increase and concentration in household debt that could make a crash more likely and more severe.

[All Party Parliament Group on Insurance and Financial Services](#)

Andrew Bulley, Director of Life Insurance, July 2014.

www.bankofengland.co.uk/publications/Documents/speeches/2014/speech744.pdf

Andrew explained that the two most significant events affecting the life insurance industry in the past year had been the *Budget* announcement reforming the at-retirement market and the political agreement over Solvency II reached in November 2013. Andrew commented that the impact of the 2014 *Budget* announcements on the annuity market was still unclear but the effect was clearly likely to be significant. Andrew set out the Prudential Regulation Authority's (PRA's) attitude towards insurers' investments, saying that from a supervisory perspective, as long as insurers are able to understand and control the risks, and hold capital commensurate with those risks, the PRA does not take a view about the intrinsic and relative merits of individual asset classes. However, the PRA will require appropriate risk management of all an insurer's investments, not just those in infrastructure, because it is the performance and risk

management of these assets that underpin critical payments such as pensions.

[What do you think about when you think about a market?](#)

Andrew Haldane, Executive Director and Chief Economist, June 2014.

www.bankofengland.co.uk/publications/Documents/speeches/2014/speech753.pdf

In this article, published as a chapter in the book *Show me the money: the image of finance, 1700 to present*, Andrew Haldane reflected on the evolving nature of markets in modern society.

For more than 800 years, depositing and lending were the preserve of high street banks. Yet we may be about to enter an era where banking, too, becomes virtual. A world where payments are electronic and contactless, where lending is anonymous and digitised.

Yet trade relies on repeat business, reputation and trust. Trust is earned by individuals not automata. It is built not on transactions but relationships. And five years into this crisis, surveys reveal that banks remain at the very bottom of the trust league table. Regaining that trust is far from simple. Doing so may require us to rethink — or remember — what a market really is. Not an anonymised transaction, but a personalised relationship.

[The UK productivity puzzle — a sectoral perspective](#)

Ian McCafferty, Monetary Policy Committee member, June 2014.

www.bankofengland.co.uk/publications/Documents/speeches/2014/speech739.pdf

In this speech, Ian McCafferty argued that recent weak aggregate productivity relative to pre-crisis has masked stark differences across sectors. Using new analysis which drew on Bank Agency intelligence, Ian showed that the contribution to the shortfall in productivity accounted for by sectors where the weakness is underpinned by predominantly non-cyclical drivers, such as stricter regulation and changes in business mix, is slightly greater than that of sectors where weak productivity primarily reflects 'demand-contingent' factors. Assessing the pace at which slack is absorbed requires a judgement on how much aggregate supply is likely to respond to increases in demand through a recovery in productivity growth. That 60% of the productivity shortfall appeared to be unrelated to the demand cycle suggested that a more rapid recovery than currently expected may be hoping for too much. Faced with uncertainty about the likely pace of absorption of slack, a prudent policymaker would want to start to remove some stimulus a little before the output gap is fully closed.

Spare capacity and inflation

Martin Weale, Monetary Policy Committee member, June 2014.

www.bankofengland.co.uk/publications/Documents/speeches/2014/speech737.pdf

In a speech given to the Northern Ireland CBI in Belfast, Martin Weale addressed the question fundamental to the work of the MPC: what factors influence the outlook for inflation and what can we learn from studying them? He focused on two areas of the economy where inflationary pressure can build and which MPC action can influence. First, pressures within firms, affecting how they set prices. Second, pressures in the labour market, which affect wage growth.

Using data from the CBI's *Industrial Trends Survey*, Martin found that measures of firms' capacity utilisation — how intensively they use their existing physical capacity and labour — are poor predictors of how firms intend to change their prices over the next twelve months. Developments in wage costs, he found, are a far more accurate indicator for how firms will set prices and are the most important component of inflation in the economy overall. Martin therefore turned to focus on the impact of labour market slack on wage growth, and the conflicting signals that the MPC is currently receiving on the extent of spare capacity in the labour market.

The corridor of uncertainty

Andrew Haldane, Executive Director and Chief Economist, June 2014.

www.bankofengland.co.uk/publications/Documents/speeches/2014/speech738.pdf

In this speech, Andrew Haldane discussed the latest developments in the UK economy and the role of monetary policy in supporting it. He argued that monetary policy makers on the MPC today face a dilemma. Should monetary policy hold back until key sources of uncertainty about the economy have been resolved? Or instead push forward to prevent leaving it too late?

Andrew discussed three sources of uncertainty, although noted that there are others. The first is that the economy could stall in its recovery. The second is that inflationary pressures instead take hold. The third concerns the financial side of the economy and the global appetite for risk.

Faced with these uncertainties, there is at least consensus among the MPC: any rate rise need not be immediate, that they are intended to be gradual, and that interest rates in the medium term are likely to be somewhat lower than their historical average.

Taking shadow banking out of the shadows to create sustainable market-based finance

Mark Carney, Governor, June 2014.

www.bankofengland.co.uk/publications/Documents/speeches/2014/speech740.pdf

Writing in the *Financial Times*, the Governor noted that, as further progress was made in reforming the global banking system, and as risk appetite returned to financial markets, wider attention was beginning to focus on shadow banking.

The goal of the relevant authorities, led by the Financial Stability Board, was to replace a shadow banking system prone to excess and collapse with one that contributed to strong, sustainable, balanced growth of the world economy.

The reform programme to deliver this was composed of three elements. First, new standards to limit large exposures of traditional banks to shadow banks were being implemented, installing a firebreak between the sectors. Second, reforms were in train to make the institutions and markets at the heart of the shadow banking system more resilient. The third reform was to build a mature framework for monitoring and addressing financial stability risks arising from shadow banking.

There once was an ugly duckling

Andrew Haldane, Executive Director and Chief Economist, June 2014.

www.bankofengland.co.uk/publications/Documents/speeches/2014/speech741.pdf

In 1931 Hugh Macmillan, a Scottish judge, chaired a commission into the problems of finance and industry. It unearthed structural fault lines in the provision of small and medium-sized enterprise (SME) finance — the so-called 'Macmillan gap'. In this article, Andrew Haldane highlighted that the Macmillan gap was re-exposed by the financial crisis and is now even more acute because SMEs now account for more than half of UK employment.

The stock of lending to UK SMEs has been falling for at least the past four years and the stock of lending to all UK businesses has fallen by a quarter from its pre-crisis peak.

One important way of improving matters is to make assessing SME creditworthiness easier. One way of achieving that is to create a database on companies' credit performance, as outlined in a recent Bank of England consultation document. Such a database could radically improve the information available and help transform the SME lending landscape.

[The Governor's speech at the Mansion House](#)

Mark Carney, Governor, June 2014.

www.bankofengland.co.uk/publications/Documents/speeches/2014/speech736.pdf

The Governor began by noting that the economic recovery had steadily gained momentum and breadth over the previous twelve months. The challenge was to turn that recovery into a durable expansion characterised by balance in the housing market, the macroeconomy and the financial sector. To do that, the Bank would need to use all of its tools in as complementary a fashion as possible.

The Financial Policy Committee was considering using macroprudential policies to insure against potential vulnerabilities associated with the housing market, reducing the need for monetary policy to be diverted to address a sector-specific risk.

However, macroprudential policy was not a substitute for monetary policy, especially if it was used for insurance purposes. The need for internal balance — to use up wasteful spare capacity while achieving the inflation target — would likely require gradual and limited interest rate increases as the expansion progressed.

The Bank was also working with others in the public and private sector to restore balance in financial markets. As part of that, the authorities were already seeking to complete the job on ending 'too big to fail' and aligning risk and reward by developing a new remuneration code. The Bank was also leading a Fair and Effective Markets Review, which would ensure that everyone on every trading floor understood that dealing in a market meant serving the needs of clients, investors and customers fairly and effectively.

[Managing cyber risk — the global banking perspective](#)

Andrew Gracie, Executive Director, Resolution, June 2014.

www.bankofengland.co.uk/publications/Documents/speeches/2014/speech735.pdf

Speaking at a British Bankers' Association conference on cyber, Andrew outlined why cyber matters from a financial stability perspective and the FPC's interest in the subject. He highlighted challenges that cyber poses compared to other operational risks. Andrew considered the Bank's work to address the FPC's recommendation; a systematic survey of the sector and CBEST, a new vulnerability-testing framework. CBEST brings together threat intelligence from public and private sources and enables firms to identify not only where their vulnerabilities lie, but the significance of cyber threats. In addition, firms need to co-operate to share information on potential threats and ensure effective co-ordination of

responses to attacks. Andrew also noted that the Bank is unlikely to prescribe rules as to how firms manage their cyber risks. The threat is dynamic; our approach will be risk-sensitive and proportionate.

[The Financial Policy Committee of the Bank of England; an experiment in macroprudential management — the view of an external member](#)

Richard Sharp, Financial Policy Committee member, June 2014.

www.bankofengland.co.uk/publications/Documents/speeches/2014/speech733.pdf

Speaking at the London School of Economics, Richard Sharp described the factors which led to the creation of macroprudential policy and, in particular, the FPC. He outlined the changes to the United Kingdom's financial regulatory structure in response to the recent financial crisis and the statutory objectives and powers given to the FPC. He then described some of the current key challenges for setting macroprudential policy in the United Kingdom, including: how different policy objectives should be balanced; difficulties in identifying and measuring potential risks at an early stage; and uncertainty about the effectiveness of the tools available to macroprudential policymakers, which makes it difficult to select and calibrate tools. The need to acknowledge the massive uncertainties in economics was noted. He concluded by outlining the risks he is currently concerned about, including the fragile UK economic position, and vulnerability to a snapback in rates and external shocks.

[A missing tool against 'too big to fail'](#)

Sir Jon Cunliffe, Deputy Governor and Dr Andreas Dombret, Board Member of the Deutsche Bundesbank, June 2014.

www.bankofengland.co.uk/publications/Documents/speeches/2014/speech734.pdf

In an article, published in *The Wall Street Journal* and co-authored with Andreas Dombret of the Bundesbank, Jon Cunliffe explained the remaining steps necessary to tackle the problem of 'too big to fail'. Revised capital and liquidity standards were already being put in place and over-the-counter derivative contracts had been mandated for central clearing. But the conditions were not yet in place to support effective resolution regimes for failed banks. Though legal frameworks to recapitalise failed banks by putting losses on bondholders had been agreed, an international standard was needed to ensure that banks had sufficient debt that could be safely 'bailed-in' at the point of failure. Work was progressing to develop such a gone-concern loss-absorbing capacity standard with the aim of having a draft standard in place by the Brisbane G20 summit in November. Banks' contracts also needed to be restructured to prevent a

disorderly unwind of contracts with close-out rights in a resolution scenario. That work was progressing jointly between the Financial Stability Board and the International Swaps and Derivatives Association.

UK deposit-taker responses to the financial crisis: what are the lessons?

Summary of Working Paper No. 501 William B Francis

While the financial crisis had an adverse effect on the UK banking sector overall, some institutions fared worse than others in dealing with the onset of economic stresses. Those that fared worse were forced to undertake a host of more intensive actions, including debt-equity swaps (a form of bail-in), mergers with/acquisitions by stronger competitors and outright closure. But what was it about these firms that made them less capable of dealing with the downturn and what can regulators learn from these cases?

Toward addressing these questions, this paper takes a closer look at what drove UK deposit-takers' responses to the crisis. It specifically investigates the role that firm-level financial profiles played in influencing the intensity of such responses. It uses data spanning 2005 to 2011 on UK building societies, which, because of their mutual status, face similar constraints in their ability to tap external capital markets. This approach can help isolate the effect of financial condition, as opposed to market access, on response intensity.⁽¹⁾

The study groups firms into two separate and distinct categories according to the intensity with which they responded to the crisis. The first includes firms that resorted to more intensive efforts (ie debt-equity swap, mergers, acquisition, closure), while the second is effectively a catch-all category, consisting of firms that responded in other, less intensive, ways. It uses well-known empirical techniques (ie limited dependent variables models) and financial attributes from the research examining the determinants of bank failure/distress to investigate whether these factors are also useful in explaining UK deposit-taker response intensity. The financial factors examined include the well-known CAMEL attributes that analysts typically use to evaluate the condition of deposit-takers and that previous research finds useful in profiling banking institutions: Capital adequacy, Asset quality, Management capability, Earnings performance and Liquidity.

The paper's key result is that a small set of these financial attributes effectively distinguishes firms that undertook less intensive responses (ie less vulnerable firms) from those that resorted to more intensive responses (ie more vulnerable firms) to deal with the onset of economic stress. I also find

that, compared with risk-based capital measures, a simple leverage (ie capital to assets) ratio was better at classifying response intensity and, therefore, characterising financial vulnerability under the prudential regulatory regime that existed before the crisis. This evidence supports the recent regulatory emphasis on updating the regime to include consideration of non risk-based capital measures alongside risk-based measures.

A useful aspect of the modelling approach discussed in this paper is its objective consideration of a broad set of financial attributes and their interactions in profiling firm-level vulnerability. This approach means, for example, that low capital ratios would not be the sole criterion for triggering heightened supervisory attention. Rather, concerns about an institution's ability to deal with stress would be based on the financial CAMEL attributes as a group and their relative importance in explaining how firms responded to previous economic downturns. The output from the approach could also complement regular stress-testing efforts and assist in evaluating firms' recovery plans by pointing to firms that exhibit features similar to those that were less capable of dealing with the onset of adverse economic conditions in the past.

While the profiling approach discussed in this paper may be of interest to regulators for use in off-site monitoring, a key caveat limits its use in that capacity. In particular, the estimates in this study are conditioned on a prudential regime that excluded a leverage requirement. This study's findings, as a result, reflect UK deposit-taker behaviour that could conceivably differ from that under a regime that includes such a requirement (eg Basel III). This means that the set of financial measures — and the relative importance of each measure — found useful in distinguishing relatively more vulnerable firms in this study may be different under a revised prudential framework if deposit-takers alter business models and capital management practices in response. Still, the results are useful for highlighting potential shortcomings of the pre-crisis regulatory regime and for gaining initial insight into the effects of proposals aimed at addressing such flaws.

(1) Extending this analysis to include data from the wider UK banking sector is an area for future work.

The effect of the financial crisis on TFP growth: a general equilibrium approach

Summary of Working Paper No. 502 Stephen Millard and Anamaria Nicolae

The aim of monetary policy is to keep inflation low and stable. A major influence on inflationary pressure is the balance between an economy's capacity to supply goods and services — potential output — and the demand for these goods and services. In the wake of the financial crisis output in the United Kingdom fell dramatically while labour productivity fell initially and remains about 5% below its pre-crisis peak. This paper aims to show how a financial crisis might have a permanent impact on supply, specifically looking at total factor productivity (TFP): the element of productivity that cannot be explained by increases in inputs, particularly capital.

We use a simple growth model in which the growth rate is not fixed, but determined within the model, specifically by research and development (R&D) spending and the innovation that results from this. In this model a financial shock leads to a rise in the spread between the rate of interest paid by firms and the risk-free rate. Since firms in the model have to borrow to finance their R&D spending, the rise in the spread leads to a fall in R&D spending, which affects innovation and, hence, reduces TFP growth. In turn, this leads to permanent falls in the levels of output and labour productivity.

The key question for this paper is, then, to what extent the model suggests that the financial crisis can account for the weakness in UK productivity since the crisis via this channel. We would not expect the model to account for all of the fall in productivity as it leaves out, for example, the potentially long-lasting effects on productivity of impediments to capital being reallocated from less productive to more productive uses, the temporary effects of labour hoarding over the recession and of a labour supply response to the recession, the direct contribution of the financial sector to UK productivity, and the contribution of the oil and gas extraction sector (ie North Sea Oil), whose productivity was falling since before the crisis began. In addition, the effects in the model are likely to happen too quickly relative to the real world given that the lags between spending on R&D and the innovations resulting from such spending are likely to be much longer than the one quarter assumed in the model.

To be more specific, we perform the following simple experiment. We first construct a series for a 'financial shock' that replicates what happened in the United Kingdom in the wake of the financial crisis. We then run that shock process through the model and examine the implications for the endogenous variables of the model: in particular, labour productivity and TFP. We then compare these outcomes with the UK data on labour productivity.

The model suggests that we might expect the financial shock to lead to falls in GDP, TFP and labour productivity and that we would have expected several quarters of negative labour productivity growth, as we saw in the United Kingdom. However, the model fails to match the quantitative response of labour productivity growth suggesting a fall in average quarterly productivity growth of less than 0.05 percentage points during this period as compared with a fall in average productivity growth of just over 0.5 percentage points in the UK data.

We suggest several reasons why the modelled productivity response to the financial shock operating through this channel is quantitatively so small. First, it is not clear that we have managed to capture the full impact of the financial crisis on bank lending as it is likely that we saw an increase in quantitative constraints on borrowing, over and above the rise in spreads that drives the results. Second, the response of innovation to a given fall in R&D spending is likely to be much larger in the data than it is in our model on account of the fact that the general increase in uncertainty about demand that has been apparent since the crisis, and that is likely to act as a disincentive to innovation, is simply not modelled. If we put through our model a fall in innovation similar to that seen in the UK data, we are able to explain roughly 15% of the lower-than-expected UK labour productivity growth since the financial crisis. Adding in the effects of the financial shock on consumption and investment would probably help explain more of the short-run fall in productivity, as would allowing for an effect coming through working capital costs.

Peering into the mist: social learning over an opaque observation network

Summary of Working Paper No. 503 John Barrdear

Communication pervades human existence, and economic behaviour is no exception to this rule. In addition to the myriad of cultural interactions, people directly share economic information such as job opportunities and prices, and indirectly reveal information to each other as they trade goods and services. The study of how information is shared over a network of interactions is therefore an important field of economic research.

The topic of social learning — examining if, how, and how quickly people's beliefs might converge — when people communicate via a network has been examined extensively in the microeconomic literature. There has been little to no application to questions of macroeconomics, however, despite the common acceptance that imperfect access to information is critical to explaining the movement of aggregate variables. For example, firms' price-setting decisions may be influenced by observing each other's individual prices.

The reason that network learning has not been previously explored within macroeconomics is that three other features commonly deemed essential to the discussion of macroeconomics — that agents act repeatedly; that agents act strategically, with their pay-offs a function of other agents' actions; and that although imperfectly informed, agents' expectations are (close to) rational — make comprehensive analysis of network learning intractable in anything other than trivially small networks.

This paper presents a solution to this problem by proposing a simplifying assumption: that the network is 'opaque' in that economic players ('agents') such as households or firms do not know exactly who is connected to whom. Instead, it is supposed that agents know the probability distribution from which everybody draws the identity of their observees. That is, it is known that agent 1 is observed with a specific probability, agent 2 is observed with another probability, etc. The model also includes a key feature of actual networks by supposing that while most agents are unlikely to be observed, some groups of agents are disproportionately highly observed, even as the number of people in the network becomes very large.

Agents are attempting to learn about an unobserved or hidden 'state' variable (eg, the level of demand) by observing each other's actions. In the paper, the way that the possible expectations of this state (the 'hierarchy' of expectations) adjust over time is derived. With an opaque network, the hierarchy includes the average expectation regarding the hidden state, the average expectation of the average expectation, etc, but also includes an infinite sequence of weighted-average expectations and higher-order combinations between them.

Following a shock to the hidden state, average expectations respond more quickly than they do when agents do not observe each other in a network, but also temporarily overshoot the truth in a kind of herding behaviour that relies on the agents' observations of each other and their strategic motives (strategic meaning that they act taking into account beliefs about how others will respond). The degree of persistence of expectations is shown to be increasing in the number of competitors observed.

Idiosyncratic shocks (that is, those that affect only individual agents), which in many models have no effect on aggregate variables, are shown to influence the hierarchy of aggregate beliefs. Even when idiosyncratic shocks last only one period, these effects are also shown to be persistent, lasting for several periods. The paper therefore contributes to a new field of research demonstrating that aggregate volatility may emerge from idiosyncratic shocks.

Because of the focus on a setting with an underlying state that evolves over time and the way the hierarchy of average expectations evolves, those interested in exploring models of this type are able to determine the aggregate effects of network learning without a need to simulate individual agents' decisions. This makes the model particularly amenable to nesting within broader general equilibrium models of the economy that take account of all the interactions within and between different sectors of the economy — in other words, macroeconomic models.

Quantitative easing and bank lending: a panel data approach

Summary of Working Paper No. 504 Michael A S Joyce and Marco Spaltro

In response to the sharp deterioration in the global financial crisis in Autumn 2008, the major central banks cut their policy rates dramatically and began looking for other unconventional measures to loosen monetary conditions further. In the United Kingdom and United States, a key element of these unconventional measures has been the policy of large-scale asset purchases financed by central bank money, sometimes referred to as quantitative easing (QE).

In the United Kingdom, the Bank of England's Monetary Policy Committee (MPC) announced the introduction of the QE policy in March 2009, at the same time as it reduced Bank Rate to 0.5%, a historical low. In announcing the new policy, the Committee noted that without further measures there was a serious risk inflation would undershoot the 2% consumer prices index inflation target in the medium term. By the end of the first round of purchases that ended in January 2010 the Bank of England had purchased £200 billion of assets, consisting almost exclusively of government bonds — an amount equivalent to 14% of annual nominal GDP. In October 2011, the Bank resumed its QE purchases and by November 2012 the Bank had completed a further £175 billion of purchases.

There is now a large and growing literature that attempts to measure the impact of central bank asset purchases during the financial crisis in the United Kingdom and elsewhere. So far, the vast majority of research on QE has focused on its impact on economic growth and financial markets, while the effect of QE on bank lending has received much less attention. This relative neglect reflects the fact that policymakers in the United Kingdom and elsewhere expected QE to affect demand mainly through its impact on asset prices, while the effect on bank lending was expected to be small because of banks' incentives to deleverage and reduce the overall size of their balance sheets. This reasoning is consistent with the literature on the so-called bank capital channel, which suggests that capital can be an important driver of banks' lending decisions particularly in periods of market stress.

The MPC's caution about the strength of the bank lending channel was reflected in the design of the Bank of England's asset purchase programme, which was targeted towards the non-bank financial sector by skewing purchases towards medium and long-term maturity government securities (gilts), rather than the shorter-maturity gilts typically held by banks for their liquidity needs. However, to the extent that the Bank's QE asset purchases came from non-banks (directly or indirectly), the banking sector will have gained both additional reserves and a corresponding increase in its deposits. The additional reserves mean that banks' holdings of liquid assets will have increased, which might make banks more

willing to extend illiquid loans. At the same time, by increasing their deposits, QE will have made banks less reliant on seeking other funding to manage their liquidity needs. Put another way, the extra deposits that banks consequently held will have helped relieve any funding constraints they may have faced. Since these constraints are more likely to bind in times of financial stress, it seems possible that this might have led to additional lending. While any effects on lending might have been expected to be weak during a period when the banks were also trying to deleverage, it seems unlikely that there will have been no effect at all. In other words, relative to the counterfactual of no QE, bank lending seems likely to have been larger.

The contribution of this paper is to test for the existence of this bank lending channel historically and thereby to quantify the likely size of the effects of the Bank of England's QE policy during 2009–10 on bank lending, using a new non-publicly available quarterly panel data set on UK banks. The use of this unique data set allows us to model the relationship between bank lending growth and its determinants over a 20-year period pre-dating the financial crisis and to explore whether the relationship between deposits and bank lending changed during the crisis. We are also able to explore heterogeneities between large and small banks and to control for balance sheet effects, by including information on bank capital ratios at the level of individual banks. Using the historical relationships between bank lending growth and deposit growth, macroeconomic indicators and individual controls, we can then simulate the potential effects of QE on the banking sector.

We find that historically movements in the deposit ratio have a small but statistically significant effect on bank lending growth, which suggests that QE may have led to an increase in bank lending through its effect on deposits. These effects, however, are likely to have been small, both because the estimated marginal effects through deposits are small and also because we assume as a benchmark that there was a full pass-through from QE to deposits, which seems likely to overstate the impact. We also find no evidence that the impact from deposits increased during the QE period. Our analysis suggests that the effects on bank lending were heterogeneous across banks, as we find lending by small banks to be more responsive to the level of deposits than the lending of large banks. We also find evidence that bank lending is positively related to how well capitalised banks are, suggesting that the impact of QE on bank lending may have been weaker because of the lower levels of capital during the crisis. In a sense, this is to be expected and justifies the emphasis policymakers gave to QE going round the banks. At the same time, it suggests that macroprudential policy may potentially influence the effectiveness of monetary policy.

The cost of human capital depreciation during unemployment

Summary of Working Paper No. 505 Lien Laureys

Unemployment is an important driver of potential supply, and of crucial interest to policymakers for this reason, as well as the effect on the well-being of households. It is well understood that one undesirable aspect is that skills — human capital — may deteriorate as unemployment spells lengthen. This paper analyses how this human capital depreciation affects the efficiency of aggregate labour market outcomes. This may help us to understand the dynamics of unemployment better.

The framework of analysis is an otherwise standard model of search for jobs by the unemployed to which human capital depreciation is introduced. Workers who had their human capital eroded while being unemployed are less productive upon re-employment than workers who were not so affected. At the same time, it allows for learning-by-doing such that workers with depreciated human capital can regain skills while being employed.

In the presence of human capital depreciation during unemployment, firms' hiring decisions affect not only the unemployment rate, but also the share of workers with eroded skills in the unemployment pool. Hiring therefore influences workers' chances of finding jobs, average unemployment duration, and thus the extent of skill erosion. For example, when firms hire less, unemployed workers have a smaller chance of finding a job, which increases their unemployment duration. Longer unemployment spells in turn raise the probability that their human capital erodes. As a result, a drop in hiring increases the relative share of job-seekers with eroded skills in the unemployment pool.

In the model, it is assumed that the unemployment pool's skill composition determines how likely it is that job-seekers with or without eroded skills show up for job interviews. Thus, the pool's composition determines the average productivity of job candidates. Consequently, firms' hiring decisions, through their effect on job-seekers' skills, affect the output that can be

generated by other firms' new matches. This amounts to a composition externality (a cost or benefit imposed on other firms) related to job creation, which arises in addition to the familiar congestion externality following from the search frictions (whereby an extra unemployed person makes it harder for other unemployed workers simply because there are more people searching). The composition externality arises because firms ignore how their hiring decisions today affect the unemployment pool's skill composition in the next period, and hence the expected productivity of other firms' new hires. As a result, when human capital depreciates during unemployment, there are gains from job creation which are not fully internalised.

Insight into the composition externality may be provided by analysing the policy instrument that can replicate a hypothetical planner's solution when this externality is the only source of inefficiency, and financing goes through non-distortionary taxation. In the model, the instrument takes the form of a state-dependent employment subsidy implying that because of this externality job creation in the *laissez-faire* economy is too low in all states of the economy from a social point of view. But the extent to which job creation is too low varies over the cycle. This is because the externality's magnitude, which depends on the impact of job creation on the pool's skill composition, reduces when the share of unemployed workers who already have eroded skills increases. How this externality's magnitude varies over the cycle depends on the dynamic path of human capital depreciation, as this will influence the point in the cycle at which this share starts to increase.

Calibrating the model to the US economy shows that the composition externality is quantitatively relevant. When skill loss is the only source of inefficiency, restoring constrained-efficiency entails a drop in the average unemployment rate in the range of 0.92 to 0.27 percentage points.

Tailwinds from the East: how has the rising share of imports from emerging markets affected import prices?

Summary of Working Paper No. 506 John Lewis and Jumana Saleheen

Over the past fifteen years, there has been a significant rise in the share of UK imports coming from industrialising or emerging market economies (EMEs), such as China, India and the new EU member states of Central and Eastern Europe. Since these countries typically have much lower prices and wages, policymakers and academics have argued that the growing share of imports from EMEs has pushed down on import prices in developed economies.

Our goal is to quantify the impact of the rising share of EME imports on import prices in the United Kingdom. The argument runs that as 'cheap imports' displace the products of industrialised countries with cheaper goods from EMEs it will push down on aggregate import prices. This happens partly as importers 'switch' to the cheaper goods from lower-wage economies — we term this the 'switching effect'. And partly because producers from other countries lower their prices in response to the increased competition from EMEs — we term this the 'competition effect'. But there is another potentially countervailing effect that has gained attention recently. It relates to the observation that EME inflation has been higher than developed economies recently, so greater exposure to EMEs would lead to upward pressure on import prices — we call this the 'inflation effect'. This paper investigates the size of each of these channels.

A rising share of imports from EMEs may also feed through to affect a broader set of producer and consumer prices; either because of competition effects or because imports are used as in intermediate input in the production process. In this paper we focus only on import prices.

We think that impact comes through the three main channels described above, and we seek to quantify the size of each.

Our main data source is the UK customs authority (HMRC), which includes data on both the volumes and values of imports, by country of origin for over 3,000 industries, 2,000 of which are in manufacturing. This highly disaggregated data allows us to account for differences across industry groups. We also allow for different effects across EME country groups by dividing our sample of EMEs into China, the new EU member states and other low wage cost economies such as India.

We find that when China gains market share in an industry, import prices do tend to fall, although this effect differs across industries. For the other EME country groups we find no clear link between gaining market share and lower import price inflation. We also find little evidence for the 'inflation effect'. Overall, that implies that emerging economies have lowered, rather than raised import price inflation in the United Kingdom.

The finding that China exerts that largest and statistically significant downward impact on UK import prices reflects the fact that China has gained market share more quickly than other EMEs and, that China has a lower price level than most other EMEs. We estimate this 'tailwind' from China has lowered UK import price inflation by around 0.5 percentage points per year. Although there is some variation from year to year, there is no discernible trend over time, so we conclude that the tailwinds from China were blowing just as strongly in 2011 as they were a decade ago.

Estimating time-varying DSGE models using minimum distance methods

Summary of Working Paper No. 507 Liudas Giraitis, George Kapetanios, Konstantinos Theodoridis and Tony Yates

Much modern macroeconomic research and policy analysis is predicated on the idea that the model is 'stable over time'. What we mean by this is that the structural parameters (ie, 'deep' determinants such as households and firms' preferences, the nature of production functions, how prices are set and properties of the random shocks that constantly buffet the economy) are constant over time. Models are estimated invoking this assumption and then used to explain past macroeconomic data or to forecast the future.

However, this assumption of 'constancy' is just that: an assumption. A literature has grown up that looks into this parameter constancy, and often finds that empirically it appears not to hold. This paper contributes to this effort. A standard empirical time-series model is estimated on US data where every variable in the system is a function of all lagged variables in the system (known as a vector autoregressive model) but where the theory-free non-structural parameters of this empirical model are allowed to vary with time. The next step is to estimate a popular theoretical model, spelling out the economic theory with a specific structural parameterisation used by many academic researchers and central banks by choosing its parameters so the theoretical model displays dynamic responses to shocks that match those predicted by the empirical model as closely as possible. This is done for every period in the sample, as the time-varying parameters of the time-series model define responses that are different for every period in the sample.

It emerges that there is substantial variation in key parts of the model. These include the 'stickiness' that determines the speed of adjustment of prices and wages; the speed with which investment responds to changes in the user cost of

capital; and changes in the determinants of how swiftly consumption responds to shocks.

These parameters have been the focus of criticism before, from economists that associate themselves with the view that macroeconomies are relatively frictionless, and argue they lack independent empirical evidence that justify their existence in the theoretical model. So the fact that they move around a lot over time might be taken as evidence to reinforce their scepticism. Furthermore, models that change markedly over time could simply be misspecified. In which case, our results suggest, echoing findings from previous papers, that there is work to do to dig deeper in those aspects of the macroeconomy that give rise to this apparent time variation in the parameters.

On the other hand, if one is prepared to accept the notion of time-varying theoretical models, they can be put to work to see whether they change the answers to questions that were previously only posed in the context of fixed-parameter models. For example, the parameters that define monetary policy behaviour moved less than has previously been suggested. There is no dramatic difference in the estimates between pre and post-Volcker monetary policy; the dramatic difference in performance is explained as a difference between the variance of supply shocks over the two periods. As another example, there are substantial fluctuations in the contributions of different shocks at different time periods to the business cycle. This might explain some of the controversy in the fixed-coefficient literature that has looked at the same issue, using different data sets and different time periods. So all this suggests that time variation has important implications for policy.

How does credit supply respond to monetary policy and bank minimum capital requirements?

Summary of Working Paper No. 508 Shekhar Aiyar, Charles W Calomiris and Tomasz Wieladek

Traditionally national authorities have regulated banks from the perspective of the safety and soundness of individual institutions. Such 'microprudential' regulation has operated separately from the main policy instrument employed to smooth aggregate fluctuations in business activity, monetary policy. But following the recent global financial crisis, 'macroprudential' regulation, such as varying banks' capital requirements countercyclically, has increasingly been viewed as a desirable instrument of policy. Changing banks' capital requirements countercyclically not only has the familiar aim of building up capital in good times to act as a buffer to absorb losses in bad times, it also can have the goal of stabilising the credit cycle itself, leaning against the cycle to reduce credit growth when the economy overheats, and mitigating disruptive credit crunches when the economy suffers a downturn. This latter goal is appropriately 'macroprudential', since a shallower credit cycle should reduce the incidence of financial crises generated by imprudent lending and the mispricing of risk, thus enhancing the stability of the financial system. But higher capital requirements could also increase lending at banks with very low or negative net worth, in particular if they helped to overcome a so-called 'debt overhang' problem.

There is already a substantial and rapidly growing theoretical literature on the expected credit supply impact of bank capital requirements (alongside the venerable literature on the credit supply impact of monetary policy). Moreover, some papers predict that monetary policy should interact with changes in bank capital requirements through various channels when the two instruments are deployed jointly. That is to say, a bank's lending response to a change in capital requirements may be different if there is a simultaneous change in monetary policy, and a bank's lending response to a change in monetary policy may be different if there is a simultaneous change in capital requirements. So far, however, there have been no empirical

tests of whether or not this is the case, despite their evident and urgent relevance to policy.

This paper provides the first empirical estimate of how banks' credit supply responds to monetary policy and minimum capital requirements, when the two instruments are used together. The analysis is made possible by an apparently unique policy experiment performed in the United Kingdom during the 1990s and 2000s, where the Financial Services Authority varied individual banks' minimum risk-based capital requirements. The extent of this variation across banks was large (the minimum required capital ratio was 8%, its standard deviation was 2.2%, and its maximum was 23% of risk-weighted assets). The variation in the average minimum capital requirement over the business cycle was also large, and tended to be countercyclical, as envisaged under macroprudential regulation. This data set on individual banks' minimum capital requirements over time is combined with Bank of England data on lending by the same banks.

The empirical analysis suggests that tightening monetary policy and increasing banks' minimum capital requirements both have independent negative effects on banks' supply of loans to the non-financial private sector. Consistent with previous work it is found that lending by large banks does not react as much as the lending of small banks to changes in monetary policy, perhaps because large banks have greater flexibility in accessing non-deposit funding. Changes in capital requirements, on the other hand, have large effects on the loan supply of large and small banks alike, suggesting greater relative potency for this instrument in economies with banking systems comprised of a small number of large banks. Finally, contrary to existing theoretical perspectives on the interaction of monetary policy and capital requirement changes, no interaction effects are found between changes in monetary policy and capital requirements.

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

2010 Q4

- The history of the *Quarterly Bulletin*
- Index of articles 1960–2010
- The UK recession in context — what do three centuries of data tell us?
- The Bank's money market framework
- Managing the circulation of banknotes
- Understanding the weakness of bank lending
- Evolution of the UK banking system
- The financial position of British households: evidence from the 2010 NMG Consulting survey
- The foreign exchange and over-the-counter interest rate derivatives markets in the United Kingdom
- Global finance after the crisis

2011 Q1

- Understanding the recent weakness in broad money growth
- Understanding labour force participation in the United Kingdom
- Global imbalances: the perspective of the Bank of England
- China's changing growth pattern
- Monetary Policy Roundtable

2011 Q2

- Assessing the risk to inflation from inflation expectations
- International evidence on inflation expectations during Sustained Off-Target Inflation episodes
- Public attitudes to monetary policy and satisfaction with the Bank
- The use of foreign exchange markets by non-banks
- Housing equity withdrawal since the financial crisis
- Using internet search data as economic indicators
- A review of the work of the London Foreign Exchange Joint Standing Committee in 2010

2011 Q3

- The United Kingdom's quantitative easing policy: design, operation and impact

- Bank resolution and safeguarding the creditors left behind
- Developments in the global securities lending market
- Measuring financial sector output and its contribution to UK GDP
- The Money Market Liaison Group Sterling Money Market Survey
- Monetary Policy Roundtable

2011 Q4

- Understanding recent developments in UK external trade
- The financial position of British households: evidence from the 2011 NMG Consulting survey
- Going public: UK companies' use of capital markets
- Trading models and liquidity provision in OTC derivatives markets

2012 Q1

- What might be driving the need to rebalance in the United Kingdom?
- Agents' Special Surveys since the start of the financial crisis
- What can the oil futures curve tell us about the outlook for oil prices?
- Quantitative easing and other unconventional monetary policies: Bank of England conference summary
- The Bank of England's Special Liquidity Scheme
- Monetary Policy Roundtable

2012 Q2

- How has the risk to inflation from inflation expectations evolved?
- Public attitudes to monetary policy and satisfaction with the Bank
- Using changes in auction maturity sectors to help identify the impact of QE on gilt yields
- UK labour productivity since the onset of the crisis — an international and historical perspective
- 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

2014 Q3

- Innovations in payment technologies and the emergence of digital currencies
- The economics of digital currencies
- How might macroprudential capital policy affect credit conditions?
- Household debt and spending
- Enhancing the resilience of the Bank of England's Real-Time Gross Settlement infrastructure
- Conference on Monetary and Financial Law
- Monetary Policy Roundtable
- Changes to the Bank's weekly reporting regime

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. 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

No. 501 UK deposit-taker responses to the financial crisis: what are the lessons? (June 2014)

William B Francis

No. 502 The effect of the financial crisis on TFP growth: a general equilibrium approach (June 2014)

Stephen Millard and Anamaria Nicolae

No. 503 Peering into the mist: social learning over an opaque observation network (August 2014)

John Barrdear

No. 504 Quantitative easing and bank lending: a panel data approach (August 2014)

Michael A S Joyce and Marco Spaltro

No. 505 The cost of human capital depreciation during unemployment (August 2014)

Lien Laureys

No. 506 Tailwinds from the East: how has the rising share of imports from emerging markets affected import prices? (August 2014)

John Lewis and Jumana Saleheen

No. 507 Estimating time-varying DSGE models using minimum distance methods (August 2014)

Liudas Giraitis, George Kapetanios, Konstantinos Theodoridis and Tony Yates

No. 508 How does credit supply respond to monetary policy and bank minimum capital requirements? (September 2014)

Shekhar Aiyar, Charles W Calomiris and Tomasz Wieladek

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:

<i>Quarterly Bulletin</i>		<i>Inflation Report</i>	
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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