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Quarterly Bulletin—Spring 2004

Markets and operations
(pages 5–20)

This article reviews developments since the Winter 2003 *Quarterly Bulletin* in sterling and global financial markets, UK market structure and the Bank's official operations.

Research and analysis
(pages 21–62)

Research work published by the Bank is intended to contribute to debate, and does not necessarily reflect the views of the Bank or of MPC members.

Durable spending, relative prices and consumption (by John Power of the Bank's Structural Economic Analysis Division). In real terms, the growth of durable spending has substantially outpaced that of spending on other goods and services since the mid-1990s. But that gap largely reflects the effects of falling relative prices: nominal spending on durables and on non-durables has grown at similar rates during that period. This article uses a simple framework to assess the behaviour of the real and nominal ratio of durables to non-durable spending in the long run. It also considers the current position of the ratios in more detail and provides some assessment of how we might expect them to have evolved given prevailing cyclical factors.

Asset pricing and the housing market (by Olaf Weeken of the Bank's Monetary Instruments and Markets Division). House prices have risen rapidly in recent years. While there is little doubt that the rates of increase observed are unsustainable, there is uncertainty as to the sustainability of the level of house prices. This article applies asset-pricing theory to the housing market to gain additional insights into some of the factors accounting for this rise in house prices. It presents estimates of the ratio of house prices to net rentals (a concept close to an equity market's price to earnings ratio). This ratio is currently well above its long-term average, a situation that in the past has often been followed by periods in which real house prices have fallen. However, a simple 'dividend' discount model of the housing market suggests that lower real interest rates can account for part of the increase in the ratio of house prices to net rentals since 1996. Nevertheless, to account fully for this increase, the housing risk premium would need to have fallen too. Comparing the implied housing risk premium now with that in the late 1980s may suggest that house prices are closer to sustainable levels now than was the case in the late 1980s. However, because of data and model limitations no firm conclusions can be drawn.

The relationship between the overnight interbank unsecured loan market and the CHAPS Sterling system (by Stephen Millard and Marco Polenghi of the Bank's Market Infrastructure Division). This article uses data on CHAPS Sterling transactions to describe the segment of the unsecured overnight loan market that settles within CHAPS. It assesses the size, timing and importance of these transactions for the underlying payments infrastructure. Advances and repayments of overnight loans are estimated to have accounted for around 20% of CHAPS Sterling activity by value over our sample period; four CHAPS Sterling members send and receive virtually all payments corresponding to these loans; and, finally, the value of CHAPS Sterling payments associated with this market rises towards the end of the CHAPS day.

How much does bank capital matter? (by David Aikman and Gertjan Vlieghe of the Bank's Monetary Assessment and Strategy Division). In this article we consider how the composition of banks' balance sheets between capital and deposits affects the transmission of economic shocks. We use a small, stylised model of the economy to analyse under which conditions firms are unable to borrow as much as they would like from banks, and banks are unable to attract as many deposits as they would like from households. We show that, following shocks to aggregate productivity and bank net worth, the response of output in this model economy with credit constraints is both larger and longer-lasting than in a similar economy where credit constraints do not bind. This is because an adverse shock lowers bank capital, which constrains lending to firms and amplifies the fall in output; and it takes time for banks to rebuild their capital so it takes time for output to return to its initial level. We find that, in our model, only a small proportion of the fluctuations of output in response to productivity shocks is due to the bank capital channel, but this channel is more important when there are direct shocks to bank capital.

Reports

(pages 63–73)

Measuring total factor productivity for the United Kingdom (by Charlotta Groth, Maria Gutierrez-Domenech and Sylaja Srinivasan of the Bank's Structural Economic Analysis Division). A good understanding of productivity growth is important for understanding aggregate supply capacity, and so for the conduct of monetary policy. To understand the sources of supply capacity well, it is important to measure output and factor inputs correctly. This article summarises recent and ongoing research at the Bank of England on improved measures of factor inputs. This work explicitly accounts for changes in the quality of these inputs and for the flow of services available from them, as well as for the costs of adjusting the level and utilisation of the inputs over time. This research was presented at a workshop on 'measuring factor inputs' held at the Bank of England in December 2003.

Markets and operations

This article reviews developments since the Winter Quarterly Bulletin *in sterling and global financial markets, UK market structure and the Bank's official operations.*(1)

- *The sterling ERI appreciated to the highest level since end-2002, and sterling reached an eleven-year high against the US dollar. In effective terms the dollar depreciated over the period.*
- *Short-term nominal interest rates fell internationally, as did sterling and dollar long-term rates. Credit spreads were little changed between November and February, but dollar high-yield spreads ticked up after the FOMC meeting in January.*
- *Equity markets continued to rise, with the Euro Stoxx 50 rising more than other international indices.*
- *In the sterling money market, use of gilt repo continued to expand, while the issuance of eligible bankers' acceptances fell sharply.*

Between 28 November and 27 February sterling rose by nearly 8% against the dollar and 4% against the euro, leaving the sterling ERI up just over 5% at 105.7 (Table A). International short-term forward interest rates fell over the period. Sterling and dollar long-term interest rates also fell, but euro long-term rates were broadly unchanged. The global equity market recovery continued, though the FTSE 100 rose less than other international indices in local-currency terms.

Table A
Summary of changes in market prices

	28 Nov.	27 Feb.	*Change*
June 2004 three-month interest rate (per cent)			
United Kingdom	4.75	4.41	*-34 bp*
Euro area	2.59	1.97	*-63 bp*
United States	1.75	1.23	*-52 bp*
Ten-year nominal government forward rate (per cent) (a)			
United Kingdom	5.05	4.83	*-22 bp*
Euro area	5.45	5.45	*0 bp*
United States	6.59	6.21	*-38 bp*
Equity indices (domestic currency)			
FTSE 100 index	4343	4492	*3.4%*
Euro Stoxx 50 index	2630	2893	*10.0%*
S&P 500 index	1058	1145	*8.2%*
Exchange rates			
Sterling effective exchange rate	100.5	105.7	*5.2%*
$/€ exchange rate	1.20	1.25	*4.2%*

Columns may not correspond exactly due to rounding.

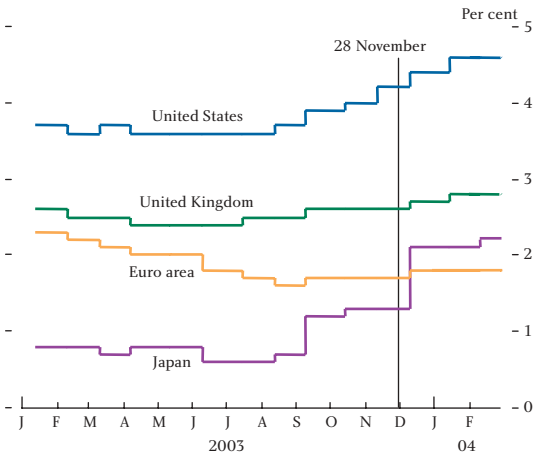
Sources: Bank of England and Bloomberg.

(a) Three-month forward rates, derived from the Bank's government liability curves.

Short-term interest rates

Over the period, economists' forecasts for GDP growth in 2004 were revised upwards for the United States, the United Kingdom and the euro area (Chart 1). Expectations for Japanese GDP growth in 2004 were revised up sharply. According to these surveys, the outlook for global growth in 2004 is now considerably stronger than it was in the middle of 2003.

Chart 1
Expected 2004 real GDP growth

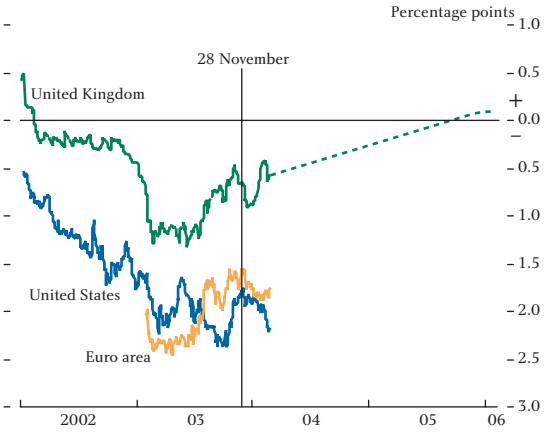


Source: Consensus Economics.

(1) The period under review is 28 November (the data cut-off for the previous *Quarterly Bulletin* article) to 27 February.

Chart 2 shows the gap between sterling, US dollar and euro three-year real spot interest rates and five-year real rates five years forward, derived from the respective inflation-indexed bonds (for sterling and US dollar) and inflation swaps (euro). That the UK real interest rate 'gap' was smaller than the US and euro-area gaps suggests that monetary conditions were perceived to be less accommodating in the United Kingdom than in the United States and the euro area.(1) The UK gap narrowed by around 40 basis points between 28 November and 27 February, while the US and euro-area gaps widened by around 20–35 basis points.

Chart 2
Market-based real interest rate gap (three-year spot—five-year, five years forward)(a)



Sources: Bank of England, Bloomberg and Tradition.

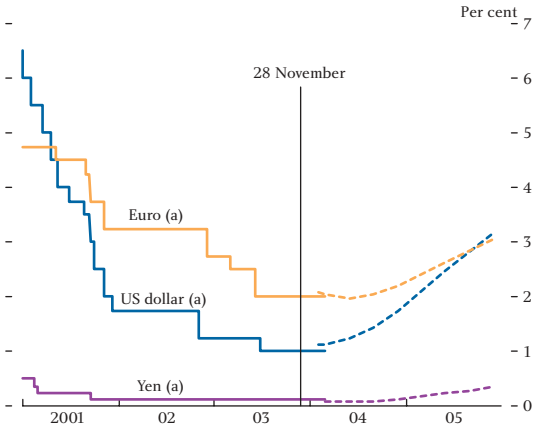
(a) US real rates calculated from TIPS yields, maturities of which may vary. Euro real rates subtract inflation swap rates from nominal government yields, which are not directly comparable due to credit risk.

In the United Kingdom there are sufficient index-linked gilts to derive a term structure of sterling real interest rates, so it is possible to trace out the implied path—shown by the dashed line in Chart 2—for these short and longer-maturity real rates to converge again, implying a movement towards more neutral monetary conditions (the presence of term premia in the real yield curve makes it difficult to be precise).

The United Kingdom's Monetary Policy Committee (MPC) raised the official repo rate by 25 basis points to 4.0% at its meeting on 5 February. US dollar, euro and yen official interest rates remained unchanged between 28 November and 27 February but the Federal Open Market Committee (FOMC) modified its accompanying statement on 28 January, with market contacts drawing attention to the replacement of the phrase 'the Committee believes that policy accommodation can be maintained for a considerable period' with 'the Committee believes it can be patient in removing its policy accommodation'.

Short-term nominal forward curves remained upward sloping (Charts 3 and 4) suggesting that markets expected policymakers to raise rates during 2005 as the amount of economic slack reduces. The US dollar forward curve was more upward sloping than the euro curve, reflecting relative cyclical positions and growth expectations (Chart 1), and US dollar forward rates were above euro-area rates beyond late 2005. However, these rates were still relatively low compared with historical experience. The US federal funds rate has averaged 5.8% during the post-war period, but US forward rates were below 5.0% out to 2009. This could reflect lower inflation expectations compared with the past, or it

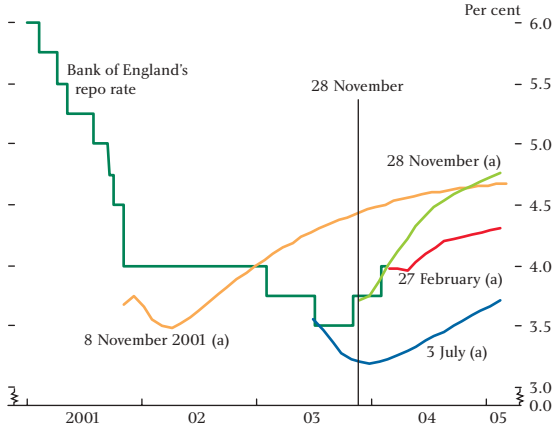
Chart 3
Short-term international nominal forward rates



Sources: Bank of England and Bloomberg.

(a) Three-month nominal forward rates implied by futures contracts, at 27 February (shown by dashed lines).

Chart 4
Short-term sterling nominal forward rates



Sources: Bank of England and Bloomberg.

(a) Two-week nominal forward rates implied by GC repo/gilt curve.

(1) Short-maturity real rates will be affected by the current outlook for economic growth, including the expected monetary policy response, whereas longer-maturity real rates are likely to be affected rather less by the cyclical position of the economy.

could reflect expectations of relatively low US dollar real interest rates for a considerable time to come, suggesting that monetary policy may remain loose for some time. Alternatively, it could reflect distortions to the shape of the US forward curve over the recent period.

Chart 4 shows the evolution of the sterling forward curve alongside the official repo rate since 2001. Forward rates rose from July 2003 when the MPC lowered the official repo rate from 3.75% to 3.5%. At that time, there was considerable discussion amongst market participants about the risks of deflation in some economies, and the minutes of the July 2003 MPC meeting noted that there had been some material international and domestic downside news since the May *Inflation Report*. But between July and the end of February some of these concerns receded, and the profile of forward rates at the end of February suggested that the outlook for the UK economy over the next couple of years was more positive than was expected in July. However, the profile of forward rates at the end of February suggested a more gradual sequence of rate rises than at the time of the Winter *Quarterly Bulletin*.

US data releases and short-term sterling interest rates have shown a surprising degree of comovement over the review period. For example, the release of the unexpectedly low December non-farm payrolls data on 9 January led to a sharp fall in implied sterling forward rates (Chart 5), compared with the range of responses to these data since January 2000 (the shaded area). One rationale for these data having such a big impact on sterling interest rates is that the non-farm payrolls data are seen as being closely watched by the FOMC as an indicator of US activity and the output gap. Positive news about US activity, given the strength of US domestic demand, might in turn indicate news about demand for UK exports and activity, and hence for the inflation and interest rate outlook in the United Kingdom. But it is questionable that this should lead to such a large response.

Chart 5
Range of changes in nominal forward rates implied by short sterling futures contracts on publication days of US monthly employment report(a)

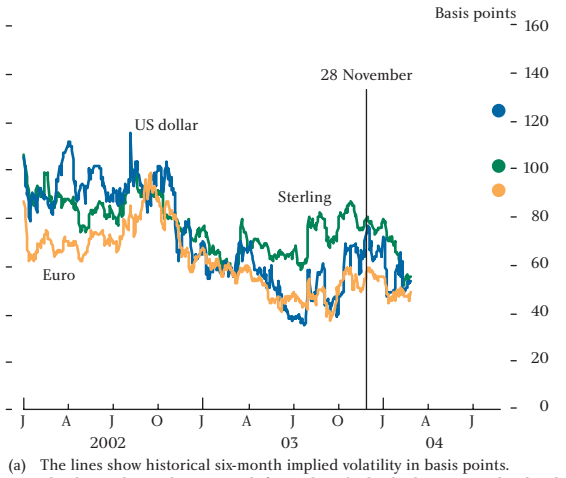
Source: Bloomberg.

(a) Grey area shows range of changes in interest rates on US employment report publication days from January 2000 to December 2003.

Uncertainty about interest rates

Since the start of 2004, uncertainty about short-term interest rates over the next six months, as measured by implied (basis point) volatilities from option prices, has fallen (with the exception of the immediate aftermath of the January FOMC meeting, and the revision of the accompanying statement). This fall in uncertainty suggests that views about the path of monetary policy over the first half of 2004 have become more settled (Chart 6). But six-month forward volatilities six months ahead, indicated by the dots in Chart 6, suggest that a high degree of uncertainty about short-term interest rates for the second half of 2004 remains, particularly in the United States. Over the past couple of years the US dollar forward term structure of implied volatility has been steeply upward sloping.

Chart 6
Six-month implied volatility from interest rate options(a)



(a) The lines show historical six-month implied volatility in basis points. The dots indicate the six-month forward implied volatility six months ahead.

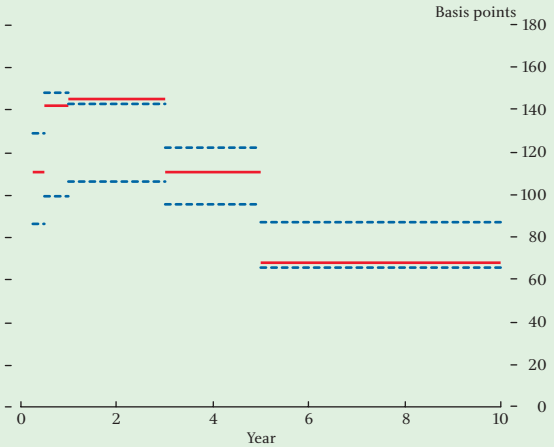
A measure of interest rate uncertainty at longer maturities is implied volatility derived from swaptions. The box on page 8 describes information about market perceptions of the path of monetary policy from swaption-implied volatilities.

Swaptions and monetary policy stance

Swaptions(1) can be used to examine implied volatilities for different maturity (or tenor) swap rates over different horizons. A box in the Winter 2003 *Quarterly Bulletin*(2) showed how near-term volatility varied in line with the tenor of the swap rate. Another approach is to show how implied volatility for a particular interest rate varies for European options with different periods to expiry. By calculating *forward* volatility, it is also possible to isolate over which periods of time in the future volatility is expected to be high.

Chart A shows implied forward volatilities for the US dollar one-year swap rate. The thick red lines show data on 27 February, the start of the line corresponds to the maturity of the option, the line's length represents the amount of time over which that level of volatility is expected to prevail. The blue lines follow the same pattern but show the average forward volatilities observed since January 1998 plus or minus one standard deviation. The idea is to indicate to what extent short-term interest rate uncertainty at the end of February differed from the past. From the charts we can see that peak uncertainty usually occurs six months forward from the present time.

Chart A
Forward implied volatility of US dollar one-year swaps derived from swaptions



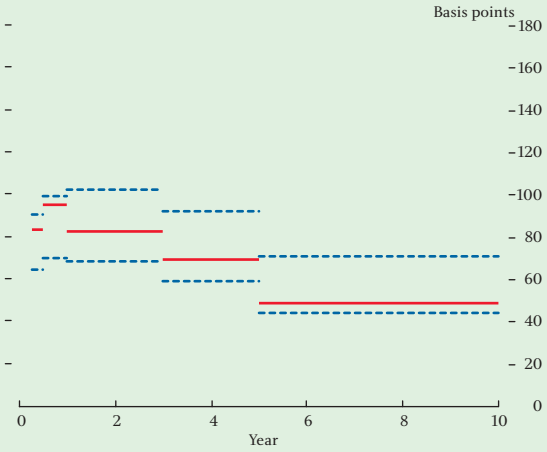
Note: Red lines show most recent data, dashed blue lines show average since 1998 +/– 1 standard deviation.

Sources: Bank of England and JPMorgan Chase.

At the end of February, implied forward volatility at the front end of the US dollar curve was unusually high. One reason for this might have been the low level of the policy rate in operation in the United States at the time. Other things being equal, the further away policy is from neutral(3) the higher forward volatility is likely to be. This is because market participants not only have to factor in everyday uncertainties but may also be unsure as to how the central bank will return policy rates towards neutral.(4) Forward volatility at the short end of the euro curve was also high relative to the past, at a time when the euro-area official interest rate was also at a low level (Chart B).

In contrast, forward volatility at the short end of the sterling curve was relatively low at the end of February compared with the past (Chart C).(5)

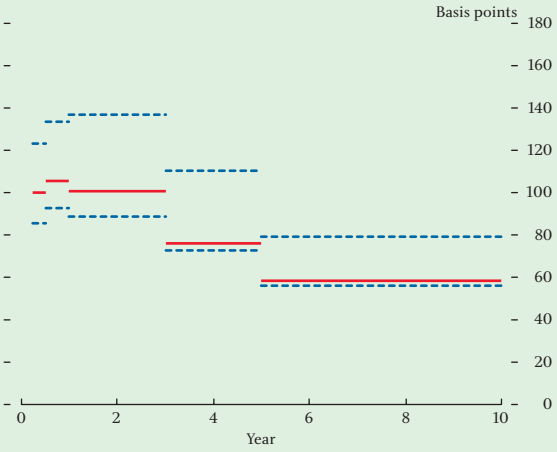
Chart B
Forward implied volatility of euro one-year swaps derived from swaptions



Note: Red lines show most recent data, dashed blue lines show average since 1998 +/– 1 standard deviation.

Sources: Bank of England and JPMorgan Chase.

Chart C
Forward implied volatility of sterling one-year swaps derived from swaptions



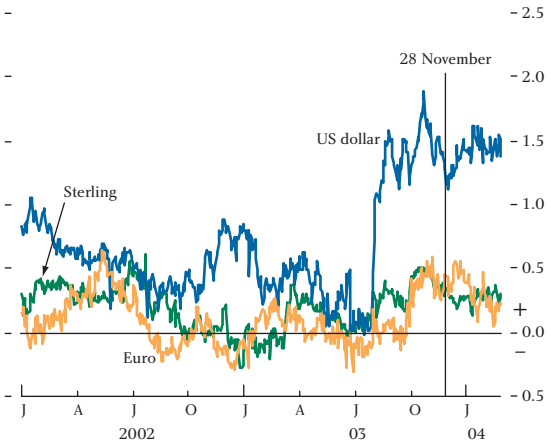
Note: Red lines show most recent data, dashed blue lines show average since 1998 +/– 1 standard deviation.

Sources: Bank of England and JPMorgan Chase.

(1) A swaption is an option on a swap. For more details see the box on page 24 of the June 2002 *Financial Stability Review*.
(2) *Bank of England Quarterly Bulletin*, Winter 2003, page 398.
(3) A neutral policy rate can be thought of as the official interest rate consistent with output growing at potential and inflation neither rising nor falling.
(4) For more on this topic see Paul Tucker's speech to the UK Asset and Liability Management Association in Egham, Surrey on 29 January 2004, reprinted on pages 84–96 of this *Bulletin*.
(5) The standard deviation boundaries for the United Kingdom are wider than for the United States and the euro area. This is mostly due to a dramatic rise in implied volatilities during the 1999 bond bear market. The boundaries narrow markedly when the standard deviation is calculated using data since 2000.

By looking at the prices of a number of interest rate options over a range of strike prices, it is possible to derive measures of skew which describe the perceived balance of risks to short-term interest rates (Chart 7). This shows that at the end of February the risks around sterling and euro forward rates were perceived to be broadly balanced for the subsequent six months. But US dollar rate skews had spiked up around August 2003 and remained positive up to the end of February, indicating that the risk that the Federal Reserve would raise official US dollar rates sooner, or by more, than was suggested by forward rates heavily outweighed the risks to the downside.

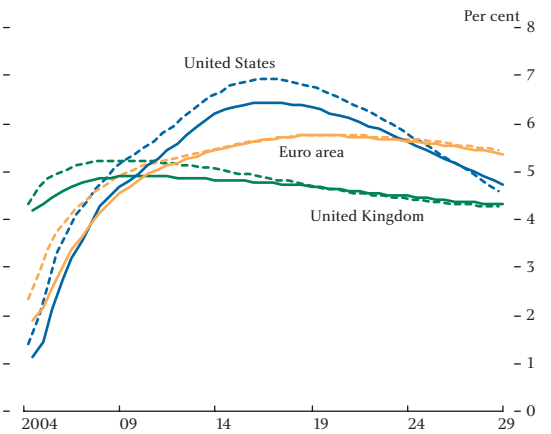
Chart 7
Six-month implied skew from interest rate options



Long-term interest rates

Sterling and US dollar ten-year nominal forward rates fell between November and February, but euro-area rates were little changed (Chart 8). If long-term nominal forward rates reflect long-term inflation expectations, real interest rates and various risk premia, the level of long-term sterling forward rates remains puzzlingly low. One explanation that continues to be offered by contacts is that the shape of the sterling forward curve is a result of the high level of demand for long-dated gilts by UK life insurers and particularly by UK pension funds for index-linked gilts, in part reflecting requirements to match assets to liabilities.

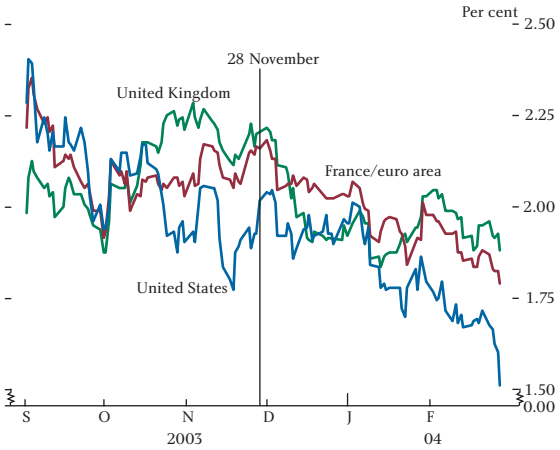
Chart 8
International nominal forward rates(a)



(a) Dashed lines indicate 28 November; solid lines indicate 27 February.

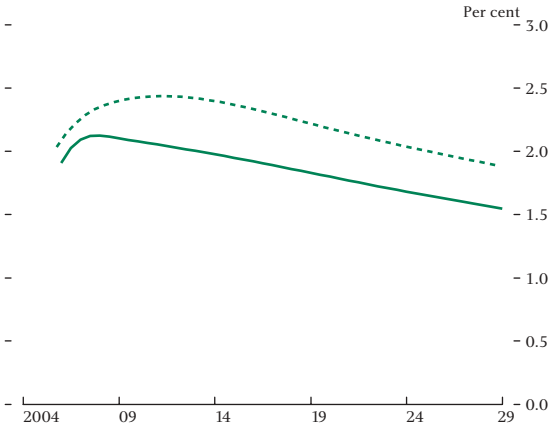
Ten-year spot real interest rates continued to decline between November and February (Chart 9). Sterling real rates declined at all maturities (Chart 10). At the short end, this could be interpreted as possible news about expectations of the path of monetary policy, but it is difficult to account for large changes in five-year rates five years forward in terms of fundamentals.

Chart 9
International government ten-year spot real rates



Sources: Bank of England and Bloomberg.

Chart 10
UK real forward rates(a)

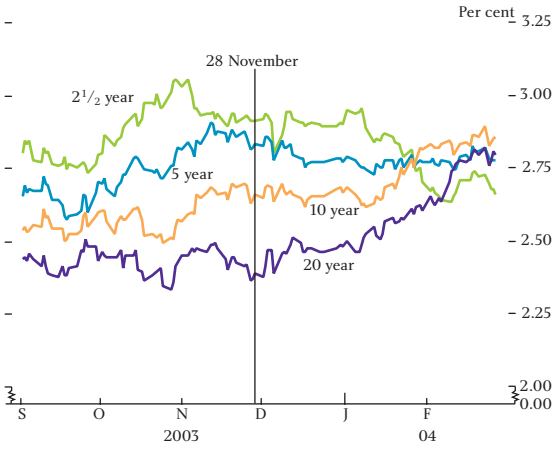


(a) Dashed line indicates 28 November; solid line indicates 27 February.

US dollar average implied ten-year inflation rates rose between November and February, while euro rates fell and sterling average ten-year implied inflation rates were

little changed. But for the United Kingdom this masked a decline in implied forward inflation rates at shorter maturities, and a rise at longer maturities (Chart 11). Since UK index-linked debt is indexed to the retail prices index (RPI), the change to the consumer prices index (CPI) target might have been expected to lead to a modest rise in long-term forward implied inflation rates. But the rise in long-term implied inflation rates occurred only in January, whereas the intention to change the target was announced in June, and the target rate of 2.0% was announced in December. Market contacts suggested that this might reflect limited liquidity in the UK index-linked market, leading to slow price adjustment.

Chart 11
Sterling inflation forward rates

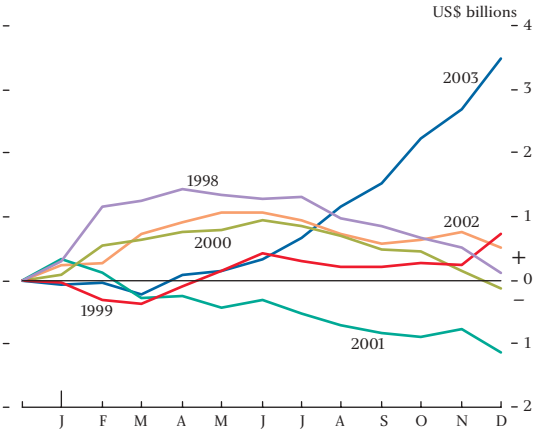


Corporate credit conditions

The low interest rate environment has been accompanied by, and possibly contributed to, a so-called 'search for yield', as discussed in the June and December 2003 *Financial Stability Reviews*.(1) For example, Chart 12 shows that US emerging market funds benefited from a further inflow of cash during the latter half of 2003. Alongside an improved outlook for the Asian economies, this may have contributed to a narrowing of emerging market economies (EME) credit spreads (Chart 13).

Continuing flows of cash during the latter half of 2003 into US high-yield mutual funds (Chart 14) were also consistent with a continued search for yield and between November and February, US dollar investment-grade corporate credit spreads narrowed (Chart 15). But credit spreads widened slightly over the latter half of the period, following the statement released

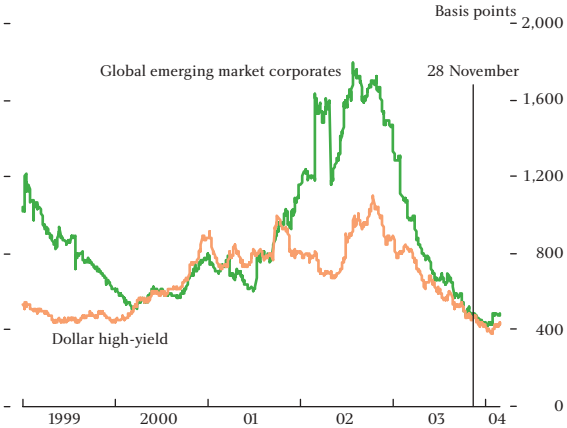
Chart 12
Cumulative asset flows into US emerging market mutual funds(a)



Source: Investment Company Institute.

(a) Net new cash flow including net exchanges.

Chart 13
Emerging market and high-yield bond spreads



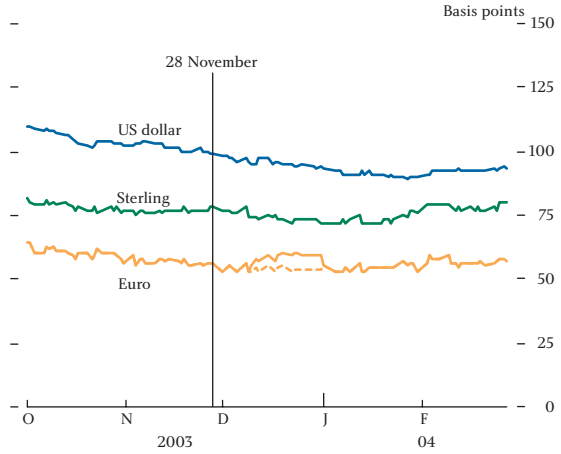
Source: Merrill Lynch.

Chart 14
Total assets in US high-yield bond mutual funds

Source: Investment Company Institute.

(1) See, for example, *Bank of England Financial Stability Review*, December 2003, page 13.

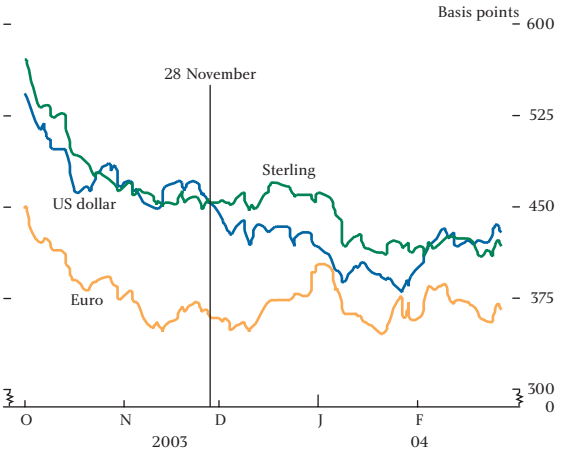
Chart 15
International investment-grade option-adjusted corporate bond spreads



Source: Merrill Lynch.

by the FOMC after its meeting on 28 January, which appeared to prompt a relatively sharp widening of US dollar high-yield credit spreads (Chart 16).

Chart 16
High-yield option-adjusted corporate bond spreads



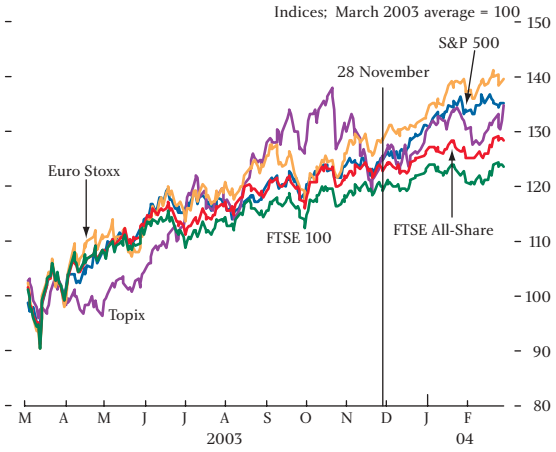
Source: Merrill Lynch.

Spreads on high yield euro-denominated corporate bonds were virtually unchanged over the period (Chart 16) and remained lower than US dollar and sterling spreads. The Parmalat scandal did not have an effect on either other investment-grade or high-yield euro-denominated spreads (the dashed line in Chart 15 shows euro-denominated spreads excluding Parmalat).

Equity markets

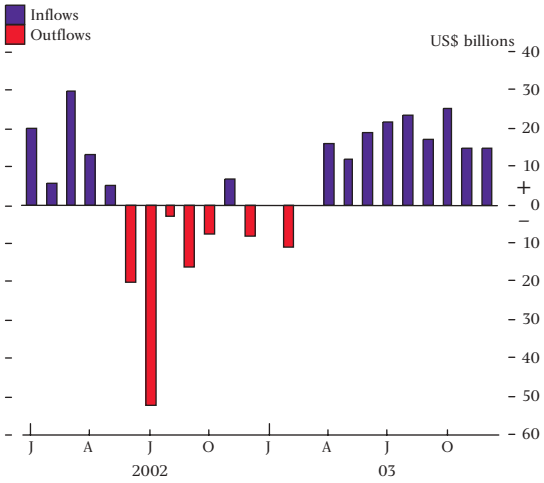
International equity market indices continued to rise between November and February. Compared with their average for March 2003, during which equity markets reached a trough, the FTSE All-Share rose by 30%, the S&P 500 by about 35% and the Euro Stoxx rose by nearly 40% in domestic-currency terms (Chart 17). In the United States the equity recovery continued to be accompanied by a steady net positive inflow into US equity mutual funds (Chart 18).

Chart 17
Selected equity indices (local currency)



Source: Thomson Financial Datastream.

Chart 18
Monthly net asset flows into US equity mutual funds(a)



Source: Investment Company Institute.

(a) Net new cash flow including net exchanges.

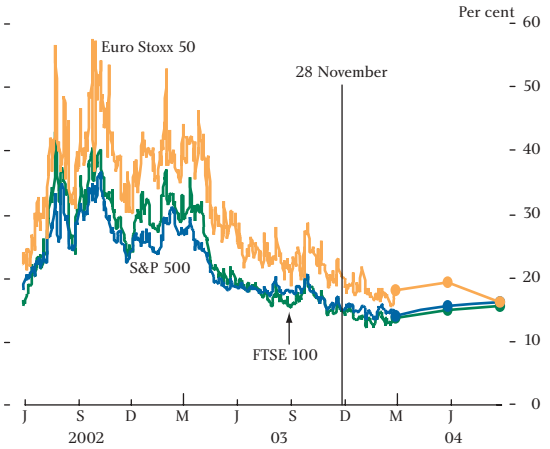
The Euro Stoxx rose by more than other international indices between March 2003 and February 2004 especially when the returns are considered in common-currency terms. Relative changes in euro-area growth expectations and interest rates were not sufficient to account for the recent strong performance of the Euro Stoxx. But in recent years the Euro Stoxx has generally been more volatile than the FTSE (the Euro Stoxx also fell further in the downturn). The strong performance since March 2003 may just have been a manifestation of this higher variability. One possible reason for this may be differences in index composition.

For example, the Euro Stoxx has a higher weighting of technology stocks than the FTSE All-Share. But it seems unlikely that composition alone can explain the extent of the divergence. An alternative explanation may be that many euro-area companies rely more heavily on debt financing. A higher debt to equity ratio may lead to more uncertainty about future cash flows to equity holders, since debt holders have a greater claim over future profits. But this line of reasoning suggests that there should be wider credit spreads on debt issued by euro-area companies, and there is little evidence of this in the data (Chart 15).

Implied volatilities, a measure of equity market uncertainty, remained low compared with the levels seen in 2002 and early 2003 (Chart 19), and suggested uncertainty was expected to stay low for some time. But Chart 20 provides a long-term view of actual (realised) equity market volatility, and in this context levels of volatility at the end of February do not look unusually low.

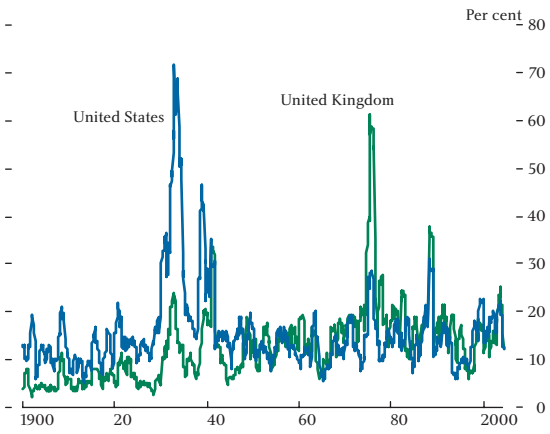
The rise in equity markets might reflect lower real interest rates, and stronger current profits (though longer-term forecasts have not risen), and perhaps also lower equity risk premia. As the equity market recovery has continued, the downside skew implied by equity options has increased in magnitude, especially for the FTSE 100 (Chart 21).

Chart 19
Three-month implied volatilities of selected equity indices(a)



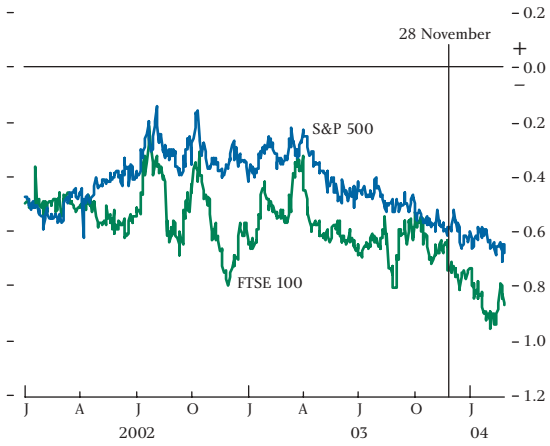
(a) The solid lines show three-month implied volatility in per cent. The dots indicate the three-month implied volatility three, six and nine months ahead respectively.

Chart 20
Historical equity volatility



Sources: Global Financial Data and Thomson Financial Datastream.

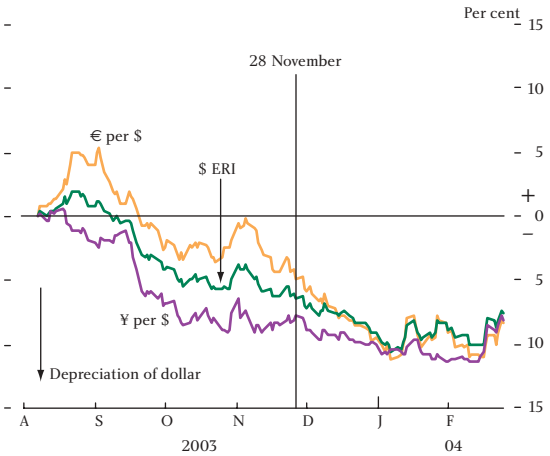
Chart 21
Six-month skew of FTSE 100 and S&P 500 derived from options



Exchange rates

Chart 22 shows that the dollar rose slightly in February, following several months of depreciation. According to contacts, significant events included the comments by ECB officials (made from 12 January) about 'excessive volatility' of the euro, and Chairman Greenspan's remarks on 11 February that the dollar's decline 'has

Chart 22
Cumulative changes in US dollar exchange rates since 1 August 2003

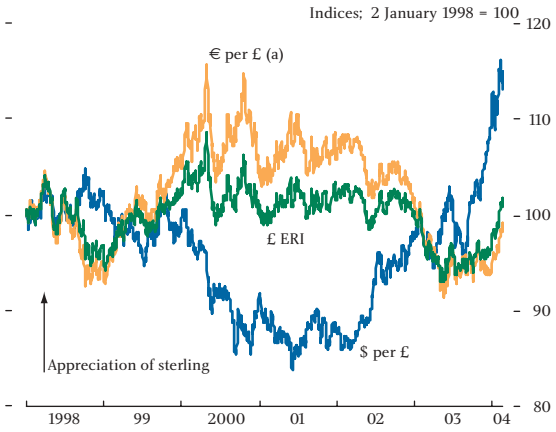


Source: Bloomberg.

been gradual, and no material adverse side effects have been visible in US capital markets'. The net effect was to leave both the IMF trade-weighted dollar ERI and the Federal Reserve's broad index down 1.2% since 28 November.

Chart 23 shows that by the end of February the sterling ERI was back up to the levels prevailing throughout 2000–02. Sterling appreciated by around 8% against the dollar between 28 November and 27 February, (reaching a peak of $1.91 on 18 February, the highest level since 11 September 1992) and appreciated by 4% against the euro. Contacts suggested that the prospect of potential future rises in sterling official interest rates, set against the perception that US dollar official rates might remain unchanged for some time and that euro official rates might potentially be reduced, had been a factor in sterling's appreciation.

Chart 23
Sterling exchange rates



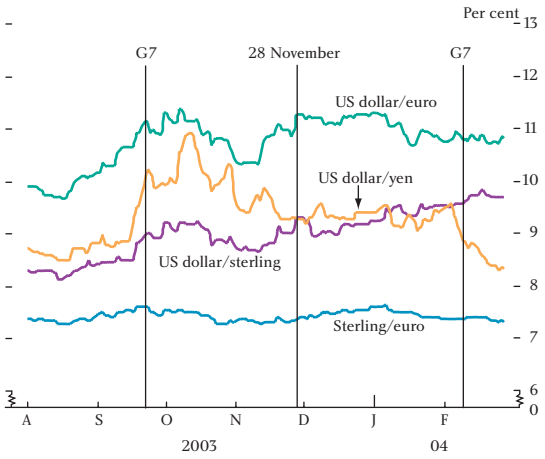
Source: Bloomberg.

(a) Deutsche marks per pound before 1999.

Measures of exchange rate uncertainty derived from foreign-currency options remained relatively low given the market debate about global imbalances (though twelve-month US dollar/sterling implied volatility increased over the review period, Chart 24). Twelve-month dollar/yen implied volatilities fell back after the G7 meeting on 6–7 February. Chart 25 shows that short-maturity dollar/yen implied volatilities spiked up around the time of the September and February G7 meetings, and declined rapidly afterwards.

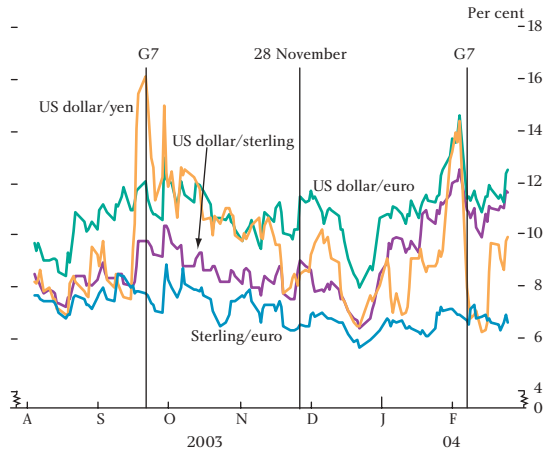
Foreign exchange risk reversals are instruments with a pay-off linked to large movements in the underlying bilateral exchange rate, and so their price should reflect market participants' views about the future balance of risks to bilateral rates. Dollar risk reversals versus euro and sterling remained small, suggesting risks were broadly balanced (Chart 26). Twelve-month dollar/yen risk reversals were larger, indicating that the balance of

Chart 24
Twelve-month implied foreign exchange volatilities



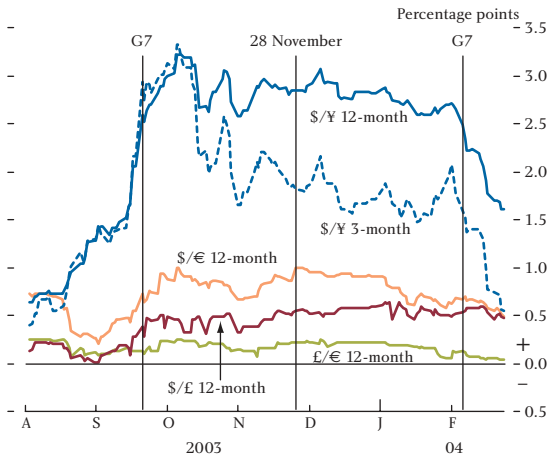
Source: British Bankers' Association.

Chart 25
One-week implied foreign exchange volatilities



Source: British Bankers' Association.

Chart 26
Foreign exchange risk reversals(a)



Sources: Bank of England and British Bankers' Association.

(a) A positive number indicates: a risk of euro appreciation versus sterling, a risk of euro appreciation versus dollar, a risk of sterling appreciation versus dollar, and a risk of yen appreciation versus dollar.

risks remained towards dollar depreciation, although less so than in the summer. Over the autumn a wedge opened up between three-month and twelve-month dollar/yen risk reversals. This may have indicated that the risk of a dollar depreciation against the yen had been pushed back; it was left broadly unchanged by the February G7 meeting.

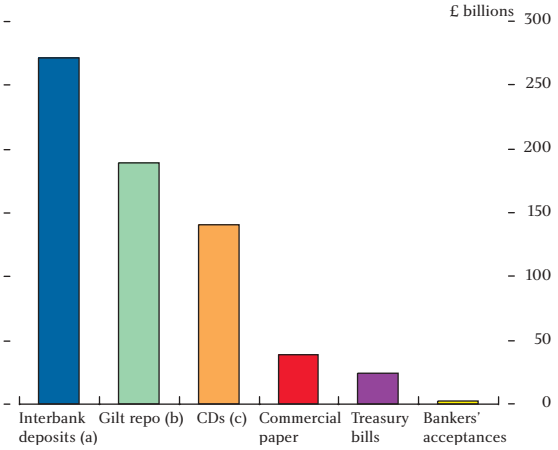
Developments in market structure

This section provides an update on developments in sterling and foreign-currency market structure and trading practices.

Sterling money market trends

The size of the sterling money markets can be estimated from a number of sources (Chart 27).

Chart 27
Size of the sterling money market, January 2004



Sources: Bank of England and Debt Management Office.

(a) Includes some intragroup deposits.
(b) November 2003.
(c) Issued by banks and building societies.

Interbank deposits appear, on these data, to account for the largest part of the money markets. However, reflecting the way they are collected, this item can include transfers *within* a single banking group—such as from a wholesale funding subsidiary to other parts of the group—as well as transfers *between* banking groups. In fact, transfers within banking groups—intragroup deposits—have increased sharply over recent years as banks have merged or restructured. Bank analysis, which has attempted to strip these out, suggests that 'genuine' interbank loans—between banking groups—are likely to account for only around a third of the published total (that is, less than £100 billion). A fairly large proportion of these loans is concentrated at short maturities: recent Bank research based on an examination of wholesale payments flows estimates the size of the overnight interbank unsecured loan market in 2002–03 to have been around £22 billion on average.(1)

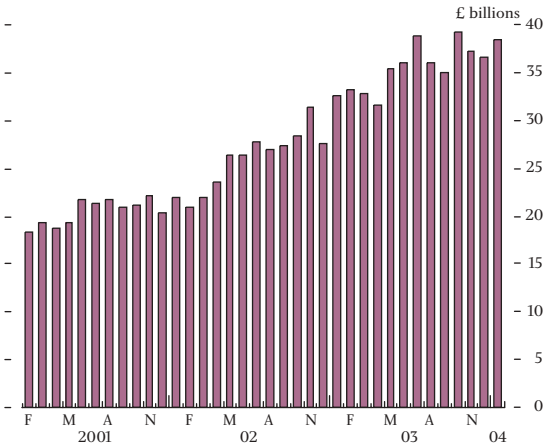
At end January 2004, there were £140 billion of sterling certificates of deposit (CDs) outstanding. UK-resident banks held around £65 billion of this total (direct unsecured interbank exposures). The CD market is likely to be of longer average maturity than the interbank market, with banks typically issuing CDs to raise short-term financing while using interbank deposits to manage day-to-day fluctuations in their liquidity.

While CDs and interbank deposits are bank liabilities, other money market instruments are partly or wholly non-bank liabilities, such as commercial paper (CP) and eligible bankers' acceptances.

CP is issued by non-banks as well as by banks. CP is typically of maturities of less than twelve months and is used both as a short-term cash management tool and for bridging purposes ahead of bond issuance. According to iMoneyNet's *Offshore Money Fund Report*, around 50% of sterling CP is purchased by AAA-rated institutional money market funds.

Though the sterling CP market remains small relative to its US dollar equivalent, it has grown rapidly over recent years (Chart 28). This has reflected various factors, including growth in asset-backed issuance and the development of money market funds since the late 1990s. To the extent that CP issuance is used as a

Chart 28
Size of the sterling commercial paper market

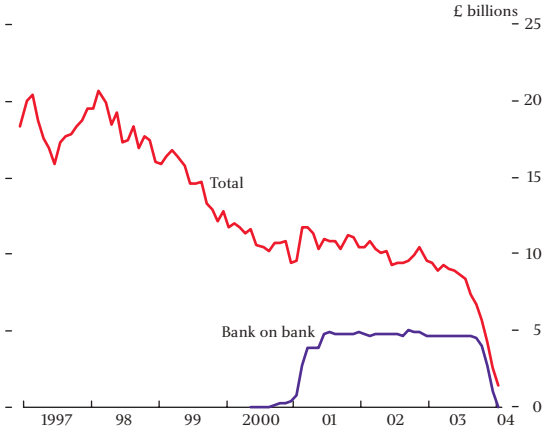


(1) See Millard, S and Polenghi, M (2004), 'The relationship between the overnight interbank unsecured loan market and the CHAPS Sterling system', in this *Quarterly Bulletin*, pages 42–47.

source of short-term funds for acquisitions, market participants suggest that the projected pickup in merger and acquisition activity may contribute to further growth.

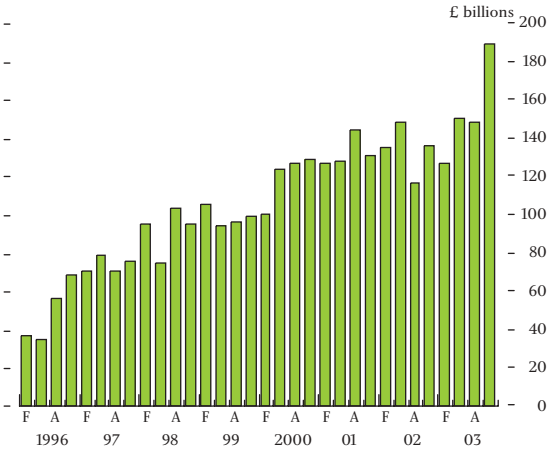
Bankers' acceptances are issued ('drawn') by an industrial or commercial borrower and are accepted by an eligible bank. 'Eligible' bills can be used as collateral by counterparties in the Bank's official operations in the sterling money market.(1) The Bank of England has for many years purchased outright or taken as collateral such bills in its sterling money market operations. However, the size of this market has fallen substantially since the late 1990s (Chart 29). The sharp decline since mid-2003 followed the Bank's decision to cease taking bankers' acceptances drawn on other banks (so-called 'bank-on-bank' bills) as collateral in its operations,(2) with drawing of such bills being wound down subsequently. Some drawers and acceptors may also have been discouraged from issuing bankers' acceptances by the additional legal documentation required before these instruments could be dematerialised and transferred from the Central Moneymarkets Office to CREST in October 2003.(3)

Chart 29
Size of the eligible bankers' acceptances market



Gilt repo, by contrast, has grown to form a major part of the sterling money market, as measured by the Bank's quarterly voluntary repo and stock lending survey (Chart 30).

Chart 30
Gilt repo amounts outstanding(a)

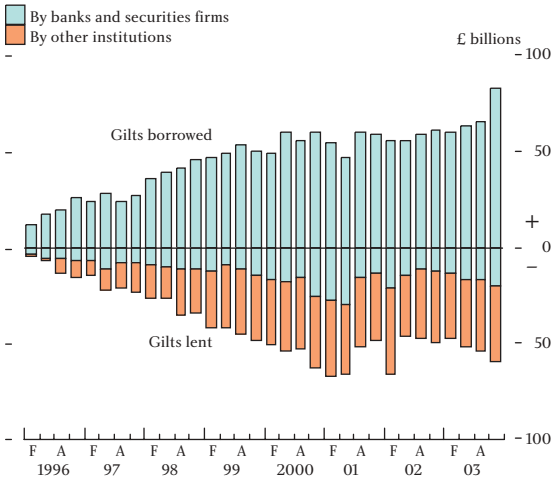


(a) Reported to the Bank in its quarterly repo and stock lending survey.

Responses to a recent Bank questionnaire addressed to firms that contribute to this survey revealed that the sterling repo market remains largely dominated by gilts, with use of other securities as collateral not yet widespread. A few banks reported growth in sterling repo against euro-denominated European government and supranational bonds. Sterling corporate bond repo trading was smaller and typically for the lending and borrowing of specific securities rather than as collateral for financing.

Banks and securities firms also borrow gilts from each other and from other institutions such as pension funds and life insurance companies (Chart 31).(4) Discussions

Chart 31
Gilt stock lending and borrowing outstanding(a)



(a) Reported to the Bank in its quarterly repo and stock lending survey.

(1) See Bank Notice 'Bank of England operations in the sterling money markets: eligible banks and eligible bankers' acceptances', www.bankofengland.co.uk/markets/money/eligbkopnot0003.pdf.
(2) Between March 2000 and early March 2004, bills drawn by banks were 'eligible' in the Bank's operations. Transition arrangements to end 'bank-on-bank' eligibility were put in place in September 2003. The Bank prefers to provide liquidity to the banking sector against the collateral of high-quality claims outside the banking sector.
(3) See recent *Quarterly Bulletin* 'Markets and operations' articles for details of the dematerialisation process.
(4) For a descriptive guide to the securities lending market, see Faulkner, M (2004), 'An introduction to securities lending', commissioned by the Association of Corporate Treasurers, British Bankers' Association, International Securities Lending Association, London Investment Banking Association, London Stock Exchange and Securities Lending and Repo Committee, available on the Bank's web site www.bankofengland.co.uk/markets/securitieslending.pdf.

with market participants revealed a more extensive range of collateral provided against gilt securities lending. CDs had often been used to collateralise gilt borrowing in the past, but contacts reported increased use of euro-denominated European government bonds, supranational debt and corporate bonds amongst collateral now provided. In some cases, this had led market participants to make greater use of triparty agents to manage collateral pools—this was also reported by those active in sterling repo against euro-area government securities. This contrasts with gilt repo, where the delivery-by-value (DBV) facility in CREST may limit the need for triparty agents.(1)

Market contacts reported that the inclusion of HM Treasury bills in general collateral (GC) repo baskets had become commonplace, following their dematerialisation in September last year.

Foreign exchange electronic broking systems

Spot foreign exchange trading in the interbank market is concentrated on the services provided by two electronic broking systems: the EBS Spot Dealing System and the Reuters Matching System. Prices determined in these systems are often used to supply automated feeds to other trading systems for end-users, including the internet-based systems which most large banks now offer their corporate customers and the multi-bank e-trading portals.(2) Hence the efficiency and effectiveness of the global foreign exchange market depends significantly on the smooth operation of these two systems, which operate continuously.

In early January 2004, the EBS systems suffered communication difficulties on three occasions (2, 6 and 7 January) on external links between the London and Tokyo hubs of its global network. Such problems with the interbank systems are normally very rare—the most recent previous occurrence was an outage on Reuters in Autumn 2002. The EBS communication problems lasted under two minutes each as back-up systems came in as scheduled, but even such short disruptions caused problems with the market, for example prices being offered in London were briefly invisible in Tokyo. A further disruption on 9 January was caused by an unrelated communication malfunction between New York and London, leading to around four minutes of slow running during a period of high trading volume following the release of major economic data in the United States. These volumes would not themselves have caused any difficulty.

The record of reliability of EBS and Reuters has been very high in recent years and contingency arrangements worked as intended in these latest incidents. Nevertheless they did cause difficulties for market participants which, in some cases, knocked on to prices offered to end-users via the banks' own e-commerce systems. The growing dependency of the market on automation and electronic trading systems is explored further in the speech 'E-commerce and the foreign exchange market—have the promises been met?', also contained in this edition of the *Quarterly Bulletin* (pages 97–101).

Bank of England official operations

Changes in the Bank of England balance sheet

Table B summarises changes in the components of the Bank's balance sheet between 26 November 2003 and 25 February 2004.

Both the foreign currency and sterling components of the Bank's balance sheet were broadly stable between these two dates. On 29 January 2004, the first of the

Table B
Simplified version of Bank of England consolidated balance sheet(a)

£ billions

Liabilities	25 Feb.	26 Nov.	Assets	25 Feb.	26 Nov.
Bank note issue	33	34	Stock of refinancing	21	23
Settlement bank balances	<0.1	<0.1	Ways and Means advance	13	13
Other sterling deposits, cash ratio deposits and the Bank of England's capital and reserves	6	6	Other sterling-denominated assets	4	3
Foreign currency denominated liabilities	9	11	Foreign currency denominated assets	10	12
Total (b)	**48**	**51**	**Total** (b)	**48**	**51**

(a) Based on published weekly Bank Returns. The Bank uses currency, foreign exchange and interest rate swaps to hedge and manage currency or interest rate exposures—see the Bank's 2003 *Annual Report*, pages 53 and 73–79 for a description. The Bank's full financial accounts for the year ended 29 February 2004 are due to be published in June.
(b) Figures may not sum to totals due to rounding.

(1) In DBV, CREST delivers to the cash lender a basket of securities to a specified current market value and meeting pre-defined criteria (eg gilts and HM Treasury bills).
(2) For more information see 'Foreign Exchange Joint Standing Committee e-commerce subgroup report' (2003), *Bank of England Quarterly Bulletin*, Summer, pages 235–39.

Bank's three-year euro-denominated notes, originally issued in 2001, matured. To maintain the nominal value of euro notes outstanding, the Bank created €2,200 million of notes maturing on 29 January 2007, €1,000 million nominal of which was auctioned on 20 January. Cover at auction was 3.2 times the amount on offer, and the average accepted yield was 2.867%, some 11 basis points below the three-year swap rate. A second auction of €1,000 million nominal of the 2007 note is scheduled for 16 March 2004.(1) The remaining €200 million nominal of notes will be retained by the Bank and may be made available for sale and repurchase operations with market makers for the note programme.

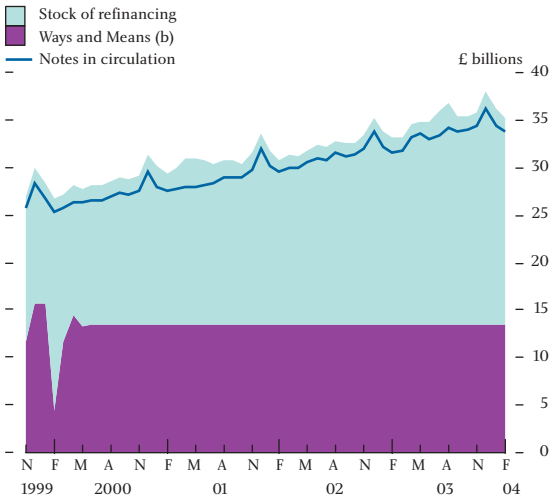
The Bank maintained the nominal value of its three-month and six-month euro-denominated bills outstanding at €3,600 million by rolling over bills at maturity. Average issuance spreads narrowed slightly—for three-month bills, they were 9.7 basis points below Euribor compared with 11.7 basis points in the previous period (September-November); and for six-month bills spreads were 11.7 basis points below euribor compared with 13.4 basis points previously.

Notes in circulation, the largest sterling liability on the Bank's balance sheet, increased to a peak of £40 billion on Christmas Eve before falling back in January following usual seasonal patterns.

The size of the stock of refinancing, which comprises the assets taken by the Bank of England in its open market operations (OMOs), moved in line with the notes in circulation, rising during December before falling back in January and February (Chart 32).

In the run-up to the MPC's 4–5 February meeting, at which the market broadly expected an increase in the Bank's repo rate to 4.0%, there was increased demand to borrow cash in the Bank's two-week repo operations at 3.75%: the bid to cover ratio (the amount of bids divided by the size of the shortage) in the Bank's OMOs in the week leading up to the MPC meeting averaged 3.7. As sometimes occurs, overnight rates fell some way below the policy rate for a short period ahead of the MPC decision. On 4 February, the overnight interbank rate fell to 2.875%, leading one counterparty to deposit £250 million in the overnight deposit facility (at a rate of 2.75%). This 'pivoting' in overnight rates around policy meetings is a feature of operating systems where

Chart 32
Bank notes in circulation, the stock of refinancing and 'Ways and Means'(a)

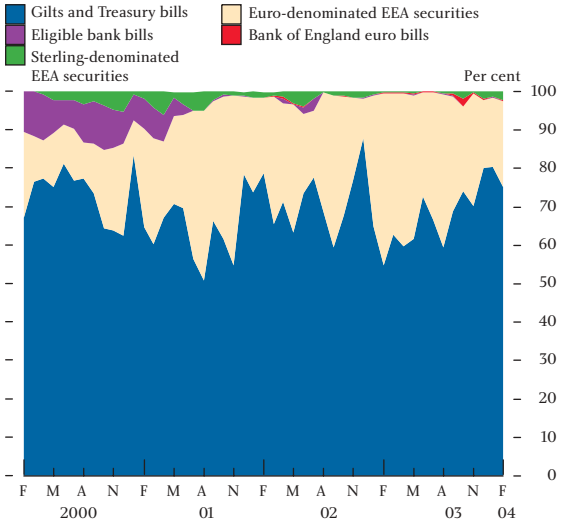


(a) Monthly averages.
(b) An illiquid advance to HM Government. This fluctuated prior to the transfer of responsibility for UK central government cash management to the UK Debt Management Office in April 2000. The Ways and Means is now usually constant, varying only very occasionally.

the maturity of the central bank's fixed-rate repo operations can span maintenance periods where different policy rates apply; the Bank's maintenance period is currently one day—settlement banks must end each day with a non-negative balance on their settlement account. This and other features of the Bank's operations in the sterling money markets are currently under review, as announced in October.(2)

Use of euro-denominated European Economic Area (EEA) government debt as OMO collateral was lower than average (Chart 33), consistent with greater

Chart 33
Instruments used as OMO collateral(a)

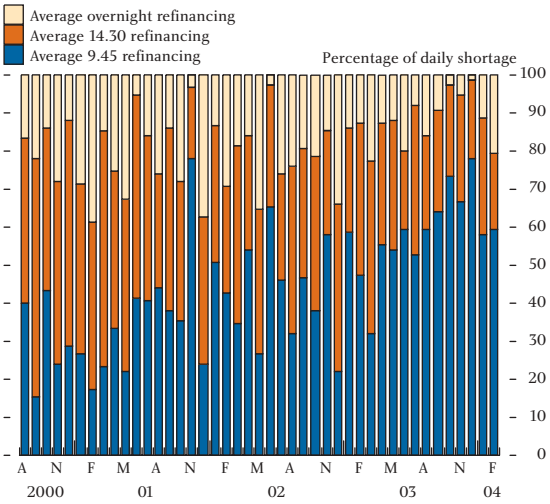


(a) Monthly averages.

(1) Shortly after this publication went to print.
(2) See Bank of England News Release, 15 October 2003, www.bankofengland.co.uk/pressreleases/2003/110.pdf.

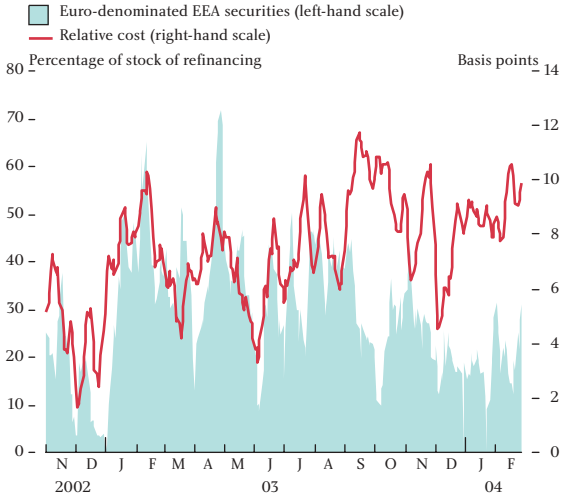
recourse to the overnight lending facilities than in the previous three months (Chart 34). These securities cannot be delivered in the 15.30 round, due to settlement timetable constraints, unless prepositioned by counterparties. The relative cost of gilts and euro-denominated EEA debt was very broadly stable over the period (Chart 35).

Chart 34
Refinancing provided in the Bank's open market operations(a)



(a) Monthly averages.

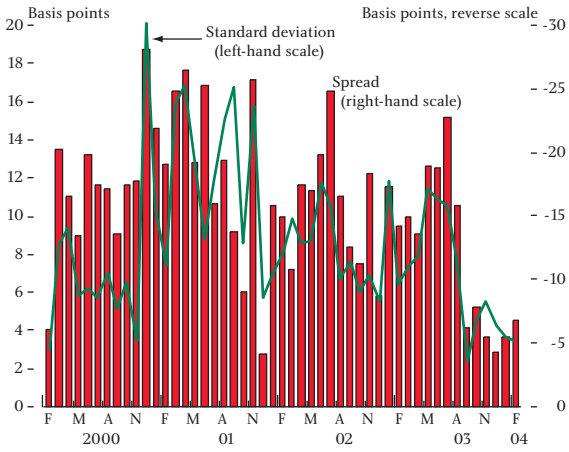
Chart 35
Relative cost and use in OMOs of euro-denominated EEA government securities(a)



(a) Relative cost calculated as difference between one-month BBA repo and Libor fixing spread and one-month European Banking Federation repo and euribor spread. A larger spread indicates a lower cost of repoing euro-denominated debt relative to repoing gilts.

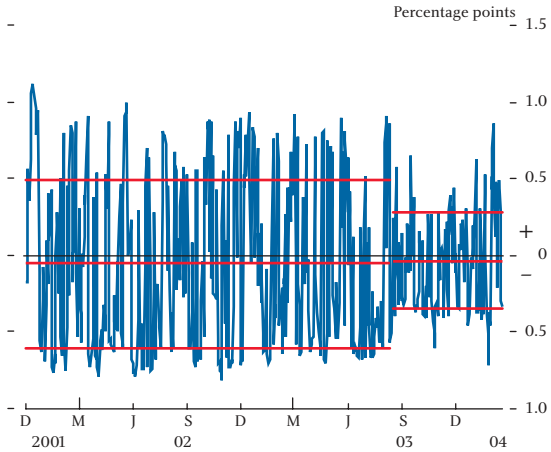
Spreads between short-dated sterling money market rates and the Bank's repo rate remained narrower than has been the case in many periods in the past: the two-week GC repo rate averaged 6 basis points below the Bank's repo rate from December to February (Chart 36), and variability in this spread also remained lower. The distribution of the sterling overnight indexed average rate (SONIA) around the policy rate has also been narrower since the summer (Chart 37).

Chart 36
Size and variability of two-week GC repo/Bank repo rate spread(a)



(a) Monthly averages.

Chart 37
SONIA/Bank repo rate spread: daily outturns and mean +/– one standard deviation, December 2001 to August 2003 and September 2003 to January 2004



Sources: Bank of England and Wholesale Markets Brokers' Association.

Forecasting the liquidity shortage

There was some deterioration in accuracy in the Bank's daily liquidity forecasts during the latest period (Table C). In part, this was seasonal, reflecting increased uncertainty about bank note demand. In response, the Bank increased the amount of the banking system's forecast liquidity need held over from the 9.45 to the 14.30 round from £200 million to £400 million around Christmas, in order to reduce the risk of oversupply. On 23 January, however, an error in the Bank's 9.45 forecast shortage left the banking system with a net surplus of liquidity by the 14.30 round. The Bank therefore invited counterparties to bid to place excess funds with the Bank overnight, collateralised by gilt DBV, via a variable-rate tender. This was the first 'mopping'

Table C
Intraday forecasts versus actual shortages

Mean absolute difference (standard deviation), £ millions

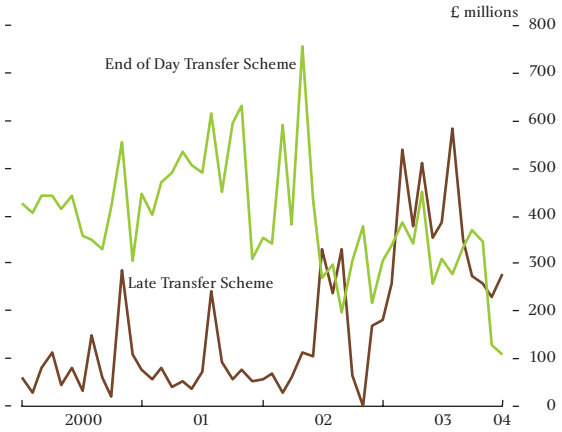
	9.45 forecast		14.30 forecast		16.20 forecast	
2000 (a)	121	(96)	99	(64)	103	(56)
2001	98	(205)	56	(51)	30	(73)
2002	83	(107)	43	(79)	30	(73)
2003	101	(123)	61	(96)	51	(85)
Oct. 2003	67	(50)	50	(40)	47	(29)
Nov. 2003	80	(124)	48	(65)	46	(49)
Dec. 2003	115	(86)	57	(66)	46	(30)
Jan. 2004	172	(146)	108	(112)	62	(64)
Feb. 2004	95	(74)	64	(45)	54	(31)

(a) From April 2000.

operation that the Bank had conducted since Summer 2002.

Use of both the End of Day Transfer Scheme (EoDTS) and the Late Transfer Scheme (LTS) declined (Chart 38).(1) This suggests settlement banks either improved the quality of their own liquidity forecasts over the period or were more disciplined in the management of their sterling payments at the end of the day.

Chart 38
Use of the Late Transfer Scheme and EoDTS(a)



(a) Monthly averages.

(1) For a description of the EoDTS, see page 163 of the Summer 2003 *Quarterly Bulletin*, or the APACS web site: www.apacs.org.uk/downloads/EoDT.pdf. LTS is intended to be used in the event of technical errors, system or authorisation failures that have prevented customer payments from settling in normal sterling CHAPS hours, not as a facility for settling market transactions made late in the day.

Influence of autonomous factors on the banking system's net liquidity need

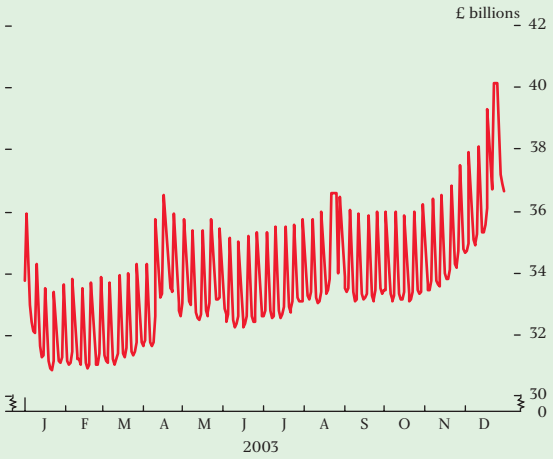
Under its current operational framework, the Bank seeks to keep the banking system in a net short liquidity position each day so that it can act as the provider of central bank money at the MPC's official rate. This is achieved by providing liquidity on a temporary basis in the Bank's open market operations (OMOs)—mainly reverse repos of government securities—at short maturities.(1) But the banking system's net liquidity need is also affected by some sizable elements of the Bank's balance sheet not under the Bank's direct control. For example, the Bank supplies bank notes to commercial banks daily on demand, and Bank customers, such as overseas central banks, may choose to vary their account balances. The Bank therefore needs to know, or predict, changes in these so-called 'autonomous factors' when determining the size and maturity of its OMOs.

Currently sterling settlement banks are required to hold non-negative balances on their Bank of England settlement accounts at the end of each day. In practice, the Bank provides for a positive level of aggregate balances within its forecast of the system's overall liquidity position, to reduce the risk of overdraft at any one settlement bank. But this amount is kept small, to avoid imposing large costs on settlement banks—these balances are unremunerated. The Bank therefore 'fine tunes' its OMOs in response to information about changes in autonomous factors by operating more than once per day and in amounts as small as £25 million.

The level of notes in circulation tends to increase over time with nominal GDP,(2) and exhibits seasonal patterns, for example, rising around Christmas/New Year and Easter.(3) There is also a significant weekend effect, with temporary increases in the Bank's note liabilities on Fridays.

These patterns in bank note liabilities can be forecast to a greater or lesser extent when the Bank plans its OMOs. Chart A shows the level of bank notes in circulation in 2003. The Bank forecasts the level of long-run bank note demand, and forecasts the size of daily changes for the next six weeks. For example, the Bank accommodates the Friday/Monday change in note issue by avoiding Friday and targeting Monday maturity dates in its reverse repo transactions, the aim being to achieve a smooth profile of daily banking system liquidity shortages. But the exact level of bank note demand is not known until the afternoon of any given day, through information collected by the Bank from members of the Notes Circulation Scheme (NCS).(4)

Chart A
Notes in circulation



Changes in the account balances of Bank of England customers are less easy to predict by contrast, and in many cases are not known until late in the day.

Table 1 shows the extent to which autonomous factors vary day by day.

Table 1
Daily contribution of changes in autonomous factors to banking system's net liquidity need

January-December 2003, £ millions

	Average	Standard deviation
Bank note issue (a)		
Monday	-2,583	141
Tuesday	-162	138
Wednesday	+21	110
Thursday	+217	171
Friday	+2,549	209
Customer transactions (b)	**+44**	**314**

(a) Excludes days affected by Bank Holidays.
(b) Excludes some days where there were unusually large flows.

(1) See 'The Bank of England's Operations in the Sterling Money Markets', May 2002, available on the Bank's web site at: www.bankofengland.co.uk/markets/money/stermm3.pdf. Very occasionally, the banking system may have a net long liquidity position (a surplus). On these days, the Bank acts as the borrower of central bank money, via short-term repos with its counterparties in open market operations.
(2) The level of interest rates, inflation and financial innovation (such as ATM networks and the use of credit and debit cards) also affect bank note demand. See the *Bank of England Inflation Report*, November 2002, page 9.
(3) There were also large increases in bank note demand over the 1999/2000 date change and around the 2002 Golden Jubilee holiday.
(4) NCS relates to the processing and distribution of bank notes, and governs the custody of Bank of England bank notes not in issue.

Durable spending, relative prices and consumption

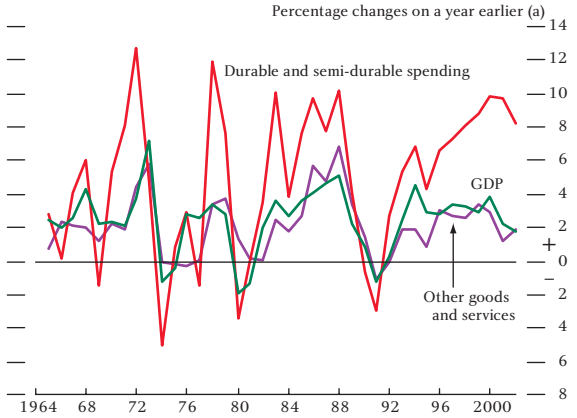
By John Power of the Bank's Structural Economic Analysis Division.(1)

In real terms, the growth of durable spending has substantially outpaced that of spending on other goods and services since the mid-1990s. But that gap largely reflects the effects of falling relative prices: nominal spending on durables and on non-durables has grown at similar rates during that period. This article uses a simple framework to assess the behaviour of the real and nominal ratio of durables to non-durable spending in the long run. It also considers the current position of the ratios in more detail and provides some assessment of how we might expect them to have evolved given prevailing cyclical factors.

Durable goods and consumption

Real annual consumption growth has averaged about 3.7% between 1998 Q1 and 2003 Q3—well above real average annual GDP growth of about 2.6% during that period.(2) Chart 1 shows that the buoyancy of consumer spending can be entirely accounted for by strong growth in durable and semi-durable goods expenditure (henceforth referred to as 'durable spending' unless otherwise specified). Since 1998 Q1 the annual growth rate of that spending has averaged 8.5%. In contrast, the growth of spending on other goods and services (which constitutes about three quarters of total consumer expenditure) has been much weaker, averaging 2.1% a year during that period.

Chart 1
Consumption and GDP



(a) Annual data.

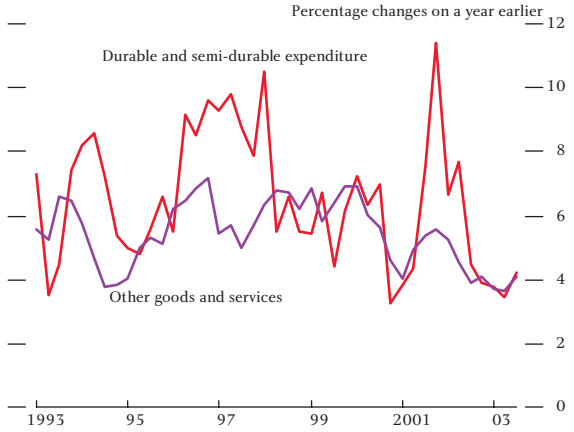
Chart 1 also shows that durable spending is volatile: it fluctuates more procyclically than non-durable spending. Periods of high GDP growth are accompanied by strong growth of durable spending relative to non-durable spending. And during recessions, durable expenditure typically falls back more sharply. This is consistent with economic theory which implies that households' purchases of durable goods could react more to economic news than households' demand for other goods and services. This is because durable goods provide a flow of services which households consume over a number of periods and those goods are typically purchased by households rather than rented. So, for example, given a perceived improvement in economic conditions (such as an increase in expected future income) households might seek to build up their stocks of those goods and therefore temporarily drive up their purchases of those goods relative to spending on other non-durable goods and services.

An initial analysis might therefore wholly attribute the relative strength of durable spending in recent years to positive cyclical factors, which have caused households to increase their relative demand for durable goods. But the persistence of the strength of durable spending is puzzling. The gap between the annual growth rates of durable and non-durable expenditure has exceeded 4 percentage points in every quarter since 1998 Q3. That is unlikely to reflect short-run factors. Moreover,

(1) The author would specifically like to thank the Household Expenditure branch at the ONS for providing additional data used in the analysis contained in this article.
(2) Note that the analysis in this article is based on ONS National Accounts data published in the ONS Quarterly National Accounts (QNA) release on 23 December 2003. More recently, and prior to publication of this article, Q4 GDP and consumption data, as well as back revisions to those data were published in the UK Output, Income and Expenditure (OIE) release on 25 February 2004. However, this article does not use the information in that release, as disaggregated consumption data on durables, semi-durables and other consumption expenditure were not published. (Typically those data are only published at the QNA stage of the data cycle.)

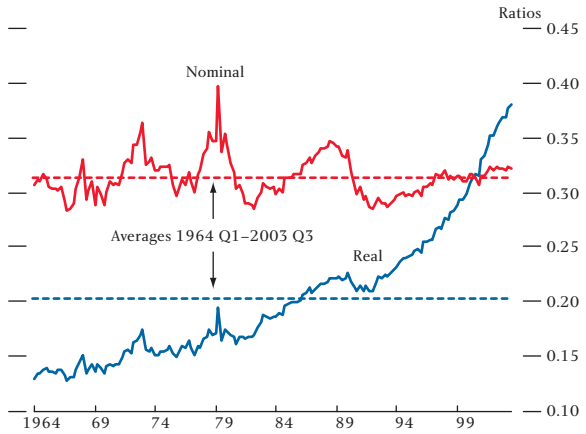
the strength of durable spending is largely a 'real'-only phenomenon. In nominal terms, since 1998 Q1 the annual growth rate of durable spending has averaged 5.9%—above, but not exceptionally higher than, the 5.4% average annual growth of spending on other goods and services (see Chart 2).

Chart 2
Nominal consumption



So a falling relative price of durable to non-durable goods and services must have contributed to the stronger relative growth of real durable spending. The falling relative price is not just a recent phenomenon: it has trended downwards since 1964, the earliest point for which disaggregated consumption data were published. That is reflected in the real ratio of durable spending to other consumption expenditure, which has risen during that period while the nominal ratio has remained relatively flat (see Chart 3). The real ratio is now well above its average, unlike the nominal ratio which is currently close to its average.

Chart 3
Ratio of durable and semi-durable spending to that on other goods and services

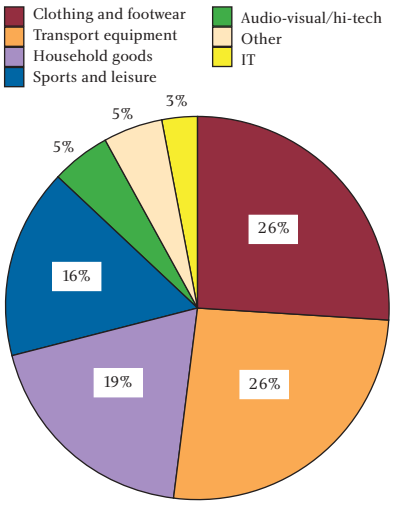


In order to assess any possible imbalances in durable spending relative to spending on other goods and services, it is necessary therefore to consider both the real and the nominal ratio of durable to non-durable spending. This article considers the behaviour of these ratios in long-run equilibrium. In the next section we outline the components of durable spending in more detail. Then we use consumer theory, and an application of the method recently used in the *Bulletin* to characterise the long-run equilibrium business investment to GDP ratio, to produce similar estimates for the ratio of durable to non-durable expenditure.(1) The article concludes by discussing the recent evolution of durable to non-durable spending and providing some assessment of where we might have expected those ratios to be given the prevailing cyclical factors.

The components of durable spending

Unlike most consumption goods, which provide a service for a limited time, durable and semi-durable goods can be used repeatedly or continuously and, on the ONS definition, typically for more than one year. Together, durable and semi-durable expenditure account for about 25% of total consumer spending (in roughly equal proportions). Within 'durables only', transport equipment (mainly vehicles) is the single largest component, followed by household goods (home furnishings, carpets, household appliances etc), and IT/audio-visual goods. The main components of semi-durable goods are clothing and footwear, followed by sports and leisure equipment. Chart 4 shows the current-price expenditure breakdown of durable and semi-durable goods in 2002. It is useful to note that in the National Accounts the purchase of new housing does not form part of durable consumption. Instead, housing

Chart 4
Expenditure composition of durable and semi-durable goods in 2002



(1) See Ellis and Groth (2003).

is treated as an asset; additions to the housing stock therefore form part of whole-economy investment. However, consumption of housing services is captured within the consumption data, as rents and imputed rents from owner-occupied housing form part of services spending.

Modelling durable goods spending

The decision by a consumer to purchase a durable good is similar to that of a firm that invests in a unit of capital. The firm will assess the cost of purchasing an additional unit of capital relative to the present value of expected future income that it will generate. The consumer's decision can be characterised as assessing the cost of purchasing an additional durable good by comparing the discounted future flow of services derived from that good to the utility from immediately consuming a non-durable good, or to saving the income and consuming it in a later period. The appendix sets out some simple consumer theory of durable goods. The variable E denotes durable spending and the variable C denotes non-durable spending. Under simplifying assumptions, we can show that in the long run the real and nominal ratios of durable to non-durable spending, $(e - c)^{real}$ and $(e - c)^{nominal}$, are given by the following relationships:

$$(e - c)^{real} = -\sigma p + \Psi \qquad (1)$$

$$(e - c)^{nominal} = p - \sigma p + \Psi \qquad (2)$$

where lower-case letters denote natural logarithms.

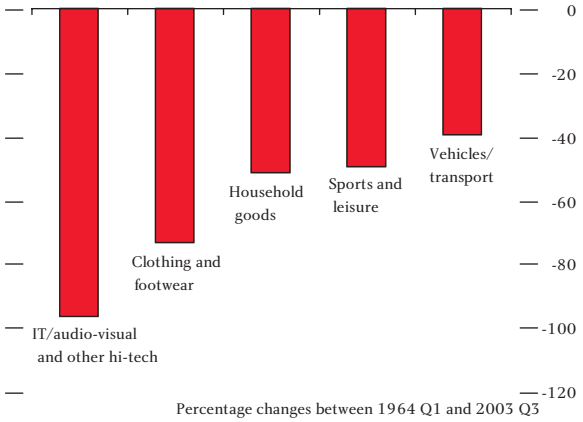
The long-run path of the ratio of durable to non-durable spending depends on the variable p, the relative price of durable to non-durable goods. The parameter σ is the elasticity of substitution between durable and non-durable goods which determines the degree of substitution consumers will make between these types of goods as the relative price changes. Because durable goods last for more than one period the ratio of durable to non-durable expenditure also depends on the costs/gain associated with holding the durable good, such as the real rate of interest, the expected capital gain or loss on those goods (the expected future price of the good) and how fast the good depreciates. The appendix outlines those parameters in detail, but for simplicity we can aggregate those and other structural parameters into a single variable denoted as Ψ.

Intuitively, like the analysis of the business investment to GDP ratio, we can think of the long-run equilibrium durable spending ratio as reflecting a 'demand' effect and a 'price' effect. If σ is large, there is a strong demand effect on the real ratio: consumers' demand for durable goods increases rapidly when the relative price falls. For the nominal ratio there is an offsetting price effect: as the relative price of durable goods falls, nominal spending on durable goods falls relative to that on other goods and services. In order to consider the long-run equilibrium path more quantitatively, estimates of the long-run behaviour of relative prices, σ, and the variable Ψ are required.

Relative prices

The relative price of durable to non-durable goods and services has fallen by about 64% between 1964 Q1 and 2003 Q3. Within durable goods, all the major categories have experienced declines in their relative prices during that period. The most notable falls have been among IT/audio-visual goods and clothing and footwear (see Chart 5).

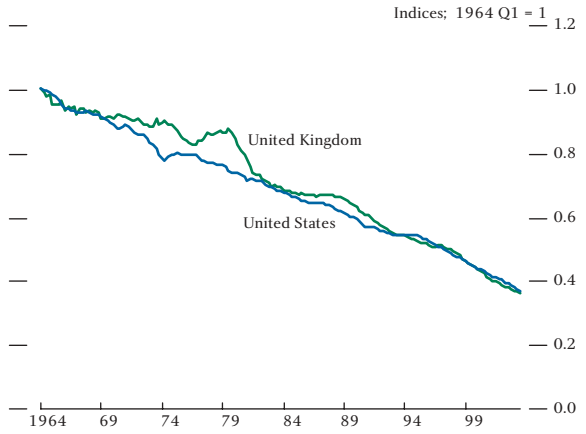
Chart 5
Relative price of durable to non-durable expenditure



Percentage changes between 1964 Q1 and 2003 Q3

The persistent decline in the relative price is likely to reflect faster technical progress in those sectors that produce durable goods, compared with those that produce other goods and services. The durable goods producing sectors are also likely to trade internationally and therefore are subject to more competitive pressures than producers of consumer services. If that is true, and if there is faster technical progress in the durable goods producing sector, then the relative price of durable goods should fall, not just in the United Kingdom but also in the rest of the world. Chart 6 shows that falling relative prices are likely to be a global phenomenon as the relative price of durable to non-durable spending has also fallen in the United States, in line with the decline observed in the United Kingdom.

Chart 6
Relative price of durable to non-durable expenditure



Sources: Bureau of Economic Analysis and ONS.

Chart 7
Relative price of durable to non-durable expenditure

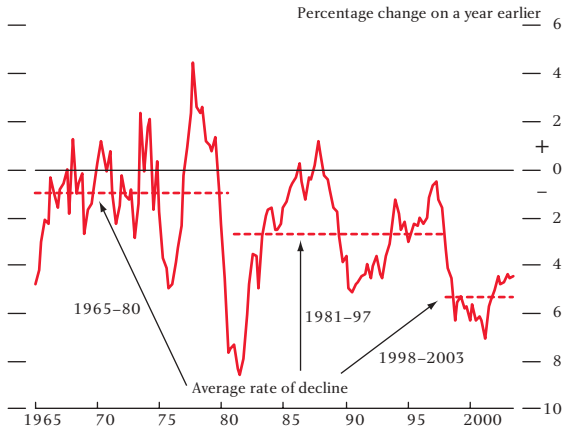
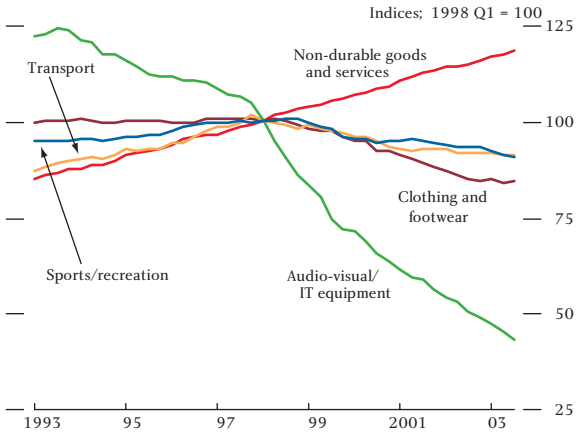


Chart 8
Consumption expenditure deflators



In the United Kingdom, the average rate of decline in the relative price has become more marked over time, particularly so since 1998 (see Chart 7). Between 1998 Q1 and 2003 Q3 the actual price deflator for durable and semi-durable goods fell about 14%, while the price of non-durable expenditure (which includes both goods and services) continued to increase. As Chart 8 shows, the actual prices of some of the major components of durable and semi-durable spending, such as vehicles, clothing and sports goods, have fallen since 1998. But within durables-only expenditure, the fall has been particularly acute among IT/audio-visual goods. The fall partly reflects an increase in the quality of the services these goods provide, rather than a decline in their retail price per unit.

The fall in the durable and semi-durable goods deflators since 1998 probably reflects a combination of factors. One possibility is that the decline follows from the rise in the UK terms of trade. Since 1995, the price of UK imports has fallen relative to that of UK exports, thus giving rise to an increase in the terms of trade. A recent *Quarterly Bulletin* article noted that, within goods, the rise can almost entirely be accounted for by the rise in the terms of trade for ICT goods, possibly reflecting an increase in the efficiency of foreign countries' ICT-exporting sector.(1) The import price of electrical engineering goods, which includes some of the raw material used in the production of ICT/audio-visual goods as well as finished ICT/audio-visual goods themselves, has fallen by about 24% since 1998 Q1. So that could have contributed to some of the fall in the deflator for IT and audio-visual equipment consumer goods if those goods have a high import content. It is likely that those goods (and indeed all durable goods) have a higher import content than the typical consumer good.

But import prices are unlikely to account for the fall in the deflator for some of the other major categories of durable goods, such as vehicles and clothing. That is because, although the import price deflators for those goods have fluctuated between 1998 and 2003, there has been either only a small trend decline or no trend decline in their import deflators during that period. Between 1998 Q1 and 2003 Q3, the vehicles import deflator fell by about 4%, while the clothing imports deflator actually rose by about 1%. That compares with a much larger fall in the clothing and vehicles consumption deflators (about 16% and 10% respectively).

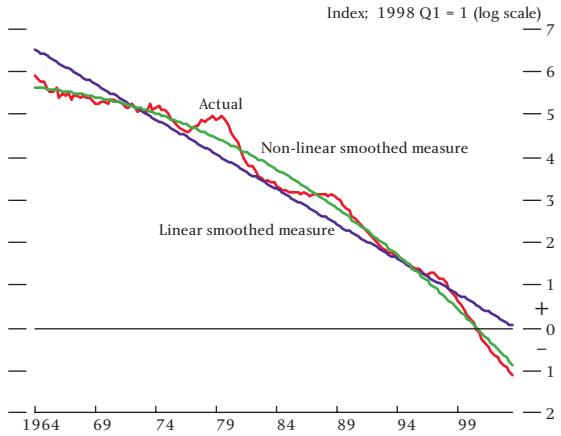
An alternative explanation is that there has been a more marked increase in competition in the UK retail sector during the past five years, which could have driven down the price of some durable goods. For example, following the publication of the Competition Commission's

(1) See Dury, Piscitelli, Sebastia-Barriel and Yates (2003).

inquiry into UK car dealing, car producers were required to offer retailers the same volume-related discounts afforded to fleet buyers, by 1 December 2000. The vehicles deflator fell by about 5% between 1999 Q4 and 2001 Q4, possibly reflecting the impact of that ruling. The fall in the clothing and sports/leisure goods deflator is also consistent with market anecdote that falling margins and discounting have become more prevalent in those retail sectors since the late 1990s.

Whatever the reason, the persistent decline in the relative price of durable goods should be reflected in the long-run estimate of the relative price path. One simple way to capture that would be to smooth through the actual relative price path with a linear time trend, as shown in Chart 9. That assumes that the long-run rate of change in relative prices is well characterised by its average since 1963. But it ignores the feature of the data that the relative price of durable and semi-durable goods has fallen at a faster rate over time. So an alternative would be to use a non-linear time trend, also shown in Chart 9. This follows the profile of the relative price more closely.

Chart 9
Relative price of durable to non-durable goods



The elasticity of substitution between durable and non-durable spending

There is little or no UK micro-literature on the elasticity of substitution between durable and non-durable spending. But the US literature suggests an elasticity of substitution of about 1.[1] Such an elasticity implies that a 1% rise in the relative price of durable goods will cause demand to shift away from durable goods by 1%. As a result, the nominal expenditure share of durable goods is unaffected by relative price movements: price effects are offset by corresponding volume effects, so the relative price terms disappear in the expression for the nominal ratio of durable to non-durable spending (equation **(2)**). The aggregate UK data appear to be consistent with a unitary elasticity (see Chart 3): relative price movements appear to have had little or no effect on the nominal ratio. So that value has been used to estimate the long-run equilibrium.

Other parameters and variables

The variable Ψ is a function of other structural parameters, including the depreciation rate of durable goods, the real interest rate, the long-run growth rate of the stock of durable goods, and the long-run rate of change of the relative price of durable goods. A rise in the real interest rate would lower Ψ and reduce the long-run equilibrium ratio. That is because higher interest rates reduce the discounted future resale value of durable goods (it increases their user cost). That could elicit some substitution away from durable goods to non-durable goods and services.[2] The sensitivity of durable spending to credit conditions should be even greater if expensive durable goods such as cars, household goods and audio-visual equipment are financed through borrowing. Changing depreciation rates have an ambiguous effect on Ψ. On the one hand, a higher depreciation rate reduces the future resale value of durable goods and therefore lowers the desired stock of durable goods. But on the other hand, although that stock might be lower, a higher depreciation rate requires increased spending on durable goods to maintain that particular level of stocks. The net effect on the ratio is ambiguous. An increase in the long-run growth rate of the desired stock would also increase Ψ and hence the long-run equilibrium ratio. By raising the resale value of currently purchased durable goods, an increase in the long-run rate of change of relative prices also increases Ψ.[3]

(1) Ogaki and Reinhart (1998) estimate an elasticity of 1.17 for the United States.
(2) In principle, a rise in interest rates should reduce both durable and non-durable consumer spending as a result of intertemporal substitution, but because the change in interest rates also affects the user cost of durables, that could elicit substitution away from durables to non-durable spending. Mankiw (1985) shows that durable spending in the United States is more interest rate sensitive than spending on non-durable goods and services.
(3) Higher future durable goods price inflation increases the resale value of durable goods bought today. That might elicit substitution toward the purchase of durable goods. This result relies on the existence of secondary markets (which may not be plausible for many durable goods). However, to the extent that consumers can delay purchases of durable goods, the intuition is still valid—higher expected future durable goods price inflation might induce people to buy goods now rather than later.

We consider two methods to estimate Ψ. The first method simply assumes that the structural parameters which determine Ψ are constant over time. We can choose the best fitting value by a linear regression: the value of Ψ that minimises the gap between the observed ratios and the estimated long-run equilibrium values for the relative price and the imposed value for σ. The second method assumes that the structural parameters which determine Ψ are time varying. Although we have no model to consider the evolution of those factors we can relax the assumption that they are constant over time by using a non-linear method to estimate Ψ. That may be a more appropriate way to estimate Ψ given that the non-linear long-run path for relative prices implicitly embeds the assumption that the rate of change of the relative price has varied over time.

Equilibrium paths

Charts 10 and 11 show the real and nominal long-run ratios consistent with the outlined assumptions. There are two long-run ratios in both real and nominal space. That reflects the alternative assumptions for the long-run relative price path and Ψ. For simplicity we use the constant-value assumption for Ψ with the linear relative price time trend (constant rate of change) and the time-varying assumption for Ψ with the non-linear relative price time trend (increasing rate of decline).

The actual real ratio is well above the estimated long-run ratio where long-run relative prices are estimated using the linear time trend and constant Ψ. Where the long-run relative prices are estimated using a non-linear time trend the actual ratio remains above the long-run equilibrium path, but the gap is narrower.

The unitary elasticity of substitution assumption between durable and non-durable goods implies that the long-run nominal ratio is unaffected by relative prices. So the long-run nominal ratio is simply determined by Ψ. The two methods to determine Ψ yield two alternative paths for the long-run ratio: a constant path and a time-varying path. Currently, unlike in the late 1980s, the nominal ratio is only slightly above both estimates of the long-run path.

Current issues and conclusions

The strength of real durable spending since 1998 largely reflects the effects of sharply falling relative prices. The previous analysis suggested that some of the rising real level was consistent with movements in an estimated

Chart 10
Real ratio of durable to non-durable consumption

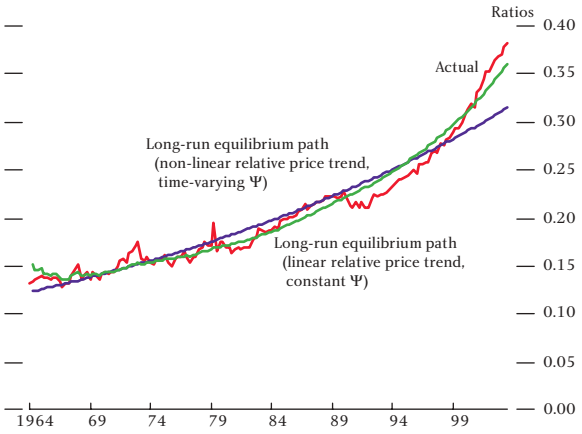
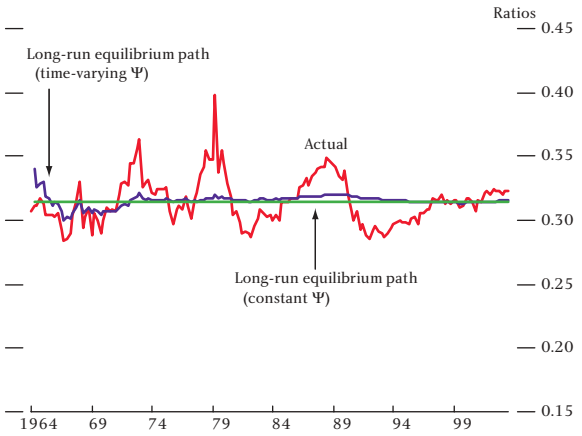


Chart 11
Nominal ratio of durable to non-durable consumption

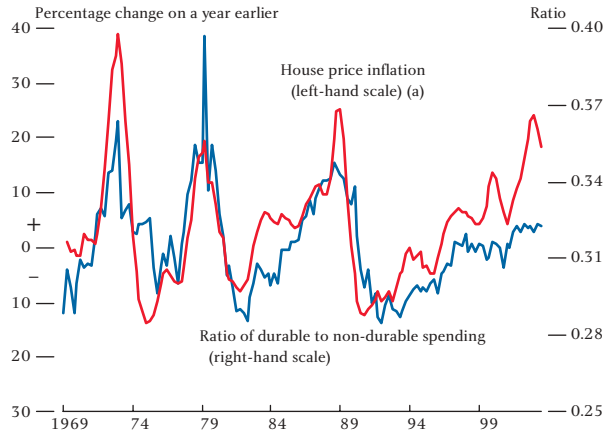


long-run equilibrium path. Looking forward, if relative prices continue to fall sharply, the strength of real durable spending should persist.

But abstracting from the effects of changing relative prices, Chart 2 also makes clear that, with the exception of a temporary pickup between 2001 Q3 and 2002 Q2, nominal durable spending has grown broadly in line with spending on other goods and services since 1998. Moreover, although the ratio of durable to non-durable spending has risen slightly in recent years, it has remained close to its estimated long-run path. That suggests that, unlike in previous cycles, there is currently little imbalance in durable spending.

This may be surprising, as we might have expected durable spending to have reacted more to the fall in interest rates and rising housing equity during the past two to three years. Indeed, there appears to have been a close relationship in the past between the nominal ratio of durable to non-durable expenditure and house price inflation (see Chart 12). That relationship probably

Chart 12
House price inflation and the nominal ratio of durable to non-durable expenditure



Sources: HBOS, Nationwide, ODPM and ONS.

(a) Deflated by the consumer expenditure deflator.

reflects several interrelated factors. First, the relative demand for durable goods and housing is likely to fluctuate procyclically. As mentioned in the introduction, if income expectations rise, households might temporarily increase their relative demand for durable goods in order to build up their desired stocks. But higher income expectations could also increase the demand for housing, which (in the presence of short-run supply constraints) would act to push up house prices. So, because house price inflation and durable spending react similarly to an income shock, that could lead to an indirect positive relationship between them. Second, the link between durable spending, income expectations and house price inflation could be more direct, given that some expensive durable goods such as cars, household goods and PCs tend to be financed through borrowing. For some households, particularly those which are credit-constrained, increased house price inflation might facilitate any increased demand for durable goods from higher income expectations. That is because higher house price inflation raises the collateral against which they can borrow on a secured basis. And secured borrowing tends to be less costly than unsecured borrowing. Third, even in the absence of changing income expectations, rising house prices could make it cheaper for households to borrow in order to increase their stocks of durable goods to their desired levels.

It is puzzling therefore that, unlike in the late 1980s, when house price inflation also increased sharply, there has only been a small pickup in the nominal ratio in recent years. Although there are a number of explanations why the nominal ratio has not risen more, one possibility is that rising housing equity and lower interest rates have not been accompanied by a marked increase in households' future income expectations, so they have not increased current durable consumption. Another is that, prior to the rapid rise in housing equity since 2001, consumers' credit constraints were already sufficiently relaxed that further rises in housing equity would not elicit the same consumption response from households as they might have done in the past. A final hypothesis is that households have viewed some of the recent increases in house prices and falls in interest rates as transitory and therefore have not changed their spending decisions.

Appendix
The theory behind the ratio of durable to non-durable spending

This appendix derives the two long-run relationships described on page 23 using consumer and user cost theory.

The user cost of durables

Where goods are non-durable (or the service from the good is exhausted during the period in which it is purchased), the cost of using them (user cost) is just their relative price. However, durable goods provide a flow of services over a number of periods, so their user cost per period is less than their purchase price.

We can derive the user cost of durable goods as follows. We consider the constant elasticity of substitution case. In any period the consumer's utility (U) depends on the stock of durable goods (D) and non-durable goods (C).

$$U = \left[\alpha C_t^{-\rho} + (1-\alpha) D_t^{-\rho} \right]^{-1/\rho} \qquad \textbf{(A1)}$$

$$\sigma = \frac{1}{1+\rho}$$

σ is the elasticity of substitution between durable and non-durable consumption goods.

The consumer faces a budget constraint, in any period, to choose either to increase the stock of durables (which depreciates at a rate δ), purchase the non-durable good, or save the consumer's income in a risk-free asset (A). P_t is the relative price of the durable good (the price of the non-durable good is 1) and r_t is the real risk-free interest rate.

$$A_t = A_{t-1}(1 + r_t) - C_t - P_t[D_t - (1 - \delta)D_{t-1}] \qquad \textbf{(A2)}$$

It is useful to point out some underlying simplifying assumptions inherent in this model at this stage. We assume that the consumer's utility depends directly on the outstanding stock of durable goods. But in principle the consumer's utility in any period should depend not on the stock, but on the service flow from that stock. So this case assumes that the service flow is linearly related to the stock in each period. This is a reasonable assumption where there is only one durable good which depreciates at a constant rate. However, in reality, there are many types of durable goods, which depreciate at different rates (for example IT goods depreciate more quickly than some household goods) and which have different relative prices. So the link between the service flow and the stock at any particular point is not clear-cut. But in order to make the analysis tractable it is useful to consider this simple case. Hamilton and Morris (2002) present a flow of services measure of consumption which makes different service-life assumptions for the components of durable goods. We can update those service flow estimates and also consider a rough estimate of the stock of durable goods. The estimates suggest that the assumption of the service flow being linearly related to the stock is reasonable.

We consider the user cost from the first-order conditions of the consumer's maximisation problem. In equilibrium the user cost of the durable good equals the marginal rate of substitution of the utility flow from the durable and non-durable good (the ratio of the marginal utilities). This is similar to a consumer's maximisation problem for two non-durable goods, where consumers will adjust their consumption bundle such that at any point in time the utility trade-off between consuming an additional unit of either good is given by their relative price. For the case of the durable and non-durable good, the appropriate relative price is the user cost. The key point however is that in any period the user cost of the durable good is less than the relative price of the durable good as the good can be re-used or resold in a future period. It can be shown that the user cost of durable goods relative to that of non-durable goods and services is given by **(A3)**, or equivalently **(A4)**:

$$\text{Usercost} = P_t - P_{t+1}\left(\frac{1-\delta}{1+r_t}\right) \quad \textbf{(A3)}$$

$$\text{Usercost} = P_t\left[\left(\frac{r+d}{1+r}\right) - \left(\frac{1-d}{1+r}\right)\left(g_t^p\right)\right] \quad \textbf{(A4)}$$

(A3) says that the user cost is the relative price of the good, P_t, less the discounted proceeds of its resale value in the next period (in each period the good depreciates at a rate δ). Assuming constant future interest and depreciation rates, **(A3)** can be rewritten in terms of the future rate of increase in relative prices, g^p **(A4)**.

(A4) shows that the user cost rises as the relative price of durable goods increases. But if their price is expected to rise in the future, then the user cost falls. That is because future price increases raise the resale value of the good. The user cost also increases as the real interest rate and depreciation rate rise.

Given the constant elasticity of substitution utility function, the maximisation problem yields an equilibrium condition for the stock of durable goods relative to other consumption goods:

$$\frac{D_t}{C_t} = \frac{1}{\left(\frac{1-\alpha}{\alpha}\text{usercost}\right)^{\sigma}} = \frac{1}{\left(\frac{1-\alpha}{\alpha}p_t\left[\left(\frac{r+\delta}{1+r}\right) - \left(\frac{1-\delta}{1+r}\right)E\left(g_t^p\right)\right]\right)^{\sigma}} \quad \textbf{(A5)}$$

The stock of durables relative to other consumption goods rises if the user cost falls. The sensitivity of the stock of durables to changes in the user cost is given by the elasticity of substitution: if durables and non-durables are highly substitutable then small changes in the user cost will have a relatively large impact on the stock of durables relative to other consumer spending.

Ratio of durable to non-durable spending

Noting that in any particular period durables expenditure is given by:

$$E_t = D_t - (1 - \delta)D_{t-1} \quad \textbf{(A6)}$$

and taking logs (where lower case indicates the natural logarithm), it can be shown that:

$$d_t = e_t - \ln\left(\frac{g_t^d + \delta}{g_t^d + 1}\right) \quad \textbf{(A7)}$$

where g^d is the growth rate of the stock of durables.

Taking logs of **(A5)**, and substituting for d_t with **(A7)** gives the real ratio of durable spending (e_t) to non-durable goods spending (c_t) in **(A8)**

$$\left(e_t - c_t\right)^{\text{real}} = -\sigma p_t + \ln\left(\frac{g_t^d + \delta}{g_t^d + 1}\right) - \sigma\ln\left(\frac{1-\alpha}{\alpha}\right) - \sigma\ln\left(\left[\frac{r+\delta}{1+r}\right] - \left[\frac{1-\delta}{1+r}\right]g_t^p\right) \quad \textbf{(A8)}$$

In nominal terms **(A8)** becomes:

$$\left(e_t - c_t\right)^{\text{nominal}} = p_t - \sigma p_t + \ln\left(\frac{g_t^d + \delta}{g_t^d + 1}\right) - \sigma\ln\left(\frac{1-\alpha}{\alpha}\right) - \sigma\ln\left(\left[\frac{r+\delta}{1+r}\right] - \left[\frac{1-\delta}{1+r}\right]g_t^p\right) \quad \textbf{(A9)}$$

An increase in the growth rate of the desired stock would raise the share of durable to non-durable consumption, as would a fall in the user cost (through interest rates, relative prices, or the rate of change of relative prices). However, changes in the depreciation rate have offsetting effects on the share of durable to non-durable spending. On the one hand, by increasing the user cost, an increase in the depreciation rate reduces the desired stock of durables (and the steady-state flow of durables expenditure) relative to other consumption expenditure (through the fourth right-hand side term in **(A8)**). But in order to maintain a given desired stock a rise in the depreciation rate requires increased durable spending, thus offsetting the 'user cost' effect (the second right-hand side term in **(A8)**). The net effect depends on several factors. However, under reasonable assumptions which the data tend to support it is likely that the second effect dominates, so rising depreciation causes the share of durable to non-durable spending to increase.(1)

For positive values of the elasticity of substitution, **(A8)** and **(A9)** suggest that spending on durables relative to other consumer spending falls if the relative price of durables increases (p_t). However, if the elasticity of substitution is one (Cobb-Douglas preferences), then the current-price share of durable to non-durable spending is unaffected by movements in relative prices—any price effects are offset by a corresponding volume effect.

We can rewrite the ratio of durable to non-durable spending as a function of the level of relative prices and other structural terms:

$$(e_t - c_t)^{\text{real}} = -\sigma p_t + \Psi_t \qquad \textbf{(A10)}$$

$$(e_t - c_t)^{\text{nominal}} = p_t - \sigma p_t + \Psi_t \qquad \textbf{(A11)}$$

By making assumptions about the long-run behaviour of p and Ψ, as is done in the main text, we can drop the time subscripts and consider the equilibrium ratio of durable to non-durable spending:

$$(e - c)^{\text{real}} = -\sigma p + \Psi \qquad \textbf{(A12)}$$

$$(e - c)^{\text{nominal}} = p - \sigma p + \Psi \qquad \textbf{(A13)}$$

which are equations **(1)** and **(2)** in the text.

(1) For a unitary elasticity of substitution between durable and non-durable goods, the condition that the real interest rate be greater than the sum of the growth rate of the stock of durables and the rate of change of relative prices is sufficient for rising depreciation rates to have a positive effect on the share of durable spending. Given that relative prices are falling rapidly, the data suggest that this condition is currently supported.

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Asset pricing and the housing market

By Olaf Weeken of the Bank's Monetary Instruments and Markets Division.

House prices have risen rapidly in recent years. While there is little doubt that the rates of increase observed are unsustainable, there is uncertainty as to the sustainability of the level of house prices. This article applies asset-pricing theory to the housing market to gain additional insights into some of the factors accounting for this rise in house prices. It presents estimates of the ratio of house prices to net rentals (a concept close to an equity market's price to earnings ratio). This ratio is currently well above its long-term average, a situation that in the past has often been followed by periods in which real house prices have fallen. However, a simple 'dividend' discount model of the housing market suggests that lower real interest rates can account for part of the increase in the ratio of house prices to net rentals since 1996. Nevertheless, to account fully for this increase, the housing risk premium would need to have fallen too. Comparing the implied housing risk premium now with that in the late 1980s may suggest that house prices are closer to sustainable levels now than was the case in the late 1980s. However, because of data and model limitations no firm conclusions can be drawn.

Introduction

House prices have risen rapidly in recent years. Precise rates of increase depend on the house price index chosen, but using the average of the Nationwide and Halifax indices as an example, the annual inflation rate in February 2004 was about 17%. There is little doubt that such rates of increase are unsustainable. But there is uncertainty as to the sustainability of the current level of house prices, or the likelihood of price falls. A reversal of a house price misalignment would be likely to have strong repercussions on the economy. Reflecting its importance, the housing market has been a recurring theme in Bank research.(1)

This article extends this work by applying asset-pricing theory to the UK housing market.(2) It is organised as follows. The next section briefly outlines the basic model and how it relates to the literature on housing in an asset-pricing framework. The following section uses two approaches to analyse housing market valuations. It first compares the ratio of house prices to net rentals (a concept close to an equity market's price to earnings ratio) with its historic average. It then uses a model akin to the dividend discount model familiar from the literature on equity valuation, to account for recent house price movements. The penultimate section investigates to what extent special features such as the indivisibility of housing may alter the results. The final section concludes.

The basic asset-pricing framework

Theoretical models of housing have been developed both in and outside the Bank. The model used in this article is a simple version where households either rent or own the housing stock. It is most closely related to the models in Aoki, Proudman and Vlieghe (2002) and Piazzesi, Schneider and Tuzel (2003), which treat housing as a durable asset that provides utility via the flow of housing services.

In this framework the price P of an asset is the present value of its expected future pay-offs D discounted at a rate R that accounts for the risk associated with holding that asset. Assuming that the risk premium k and the real risk-free rate r^f that make up R are both constant, this can be written as:

$$P_t = \sum_{j=1}^{\infty} \frac{D_{t+j}}{(1+R)^j} \qquad (1)$$

(1) Wood (2003) and Thwaites and Wood (2003) are some recent examples.
(2) See also Bank of England (2003).

If pay-offs grow at a constant real rate g, equation **(1)** can be rearranged into **(2)**:

$$P_t = \frac{D_t(1+g)}{(R-g)} = \frac{D_t(1+g)}{(r^f + k - g)} \qquad \textbf{(2)}$$

In equity valuation, the pay-off D is usually proxied by dividends. As will be discussed in more detail later, a similar pay-off proxy can be constructed for housing. However, while the equity risk premium is a familiar concept, the notion of a housing risk premium is less so. But like equities, property does not guarantee payment of a known income and return of a known principal at maturity. It is therefore a risky asset.

As with other risky assets, the housing risk premium depends on whether housing provides returns at times when they are most needed.(1) The reason is that consumers are primarily concerned about smoothing out consumption volatility, not asset return volatility. In other words, it is the covariance between expected returns and expected consumption growth that matters.(2) Risk-averse consumers would require a positive risk premium if housing provided high returns at a time when consumption growth was already expected to be high, ie if expected housing returns and expected consumption growth were positively correlated. But they would be prepared to *pay* a premium if housing provided them with high returns when consumption growth was expected to be low, ie if they were negatively correlated and housing provided insurance.

The next section applies this framework to UK data.

Application to UK housing market data

The ratio of house prices to net rentals

The price to earnings ratio (or its inverse, the earnings yield) is a popular valuation measure when analysing equity markets. But such data are not readily available for the housing market. First, because no two dwellings are identical and repeat sales of dwellings are infrequent, house prices(3) are more difficult to measure than equity prices, which are the outcome of frequent trades in identical shares. Second, in the context of the housing market, rent payments received by the landlord do not correspond to the earnings measures used in company accounts. The reason is that rent represents only a gross income to the landlord, who incurs operating costs, eg for maintenance, management and utilities. These costs need to be deducted from the rent payments received. The resulting 'net rentals', denoted E^h, broadly correspond to earnings.

Data on both *gross* and *net* rental yields published by some estate agencies and research institutes show that the difference between *gross* and *net* rentals can be large. For example, Investment Property Databank (IPD) estimates that the average gross yield on UK residential property in 2002 was 7.0%, while the net yield, which takes voids and irrecoverable operating costs into account, was 4.4%.

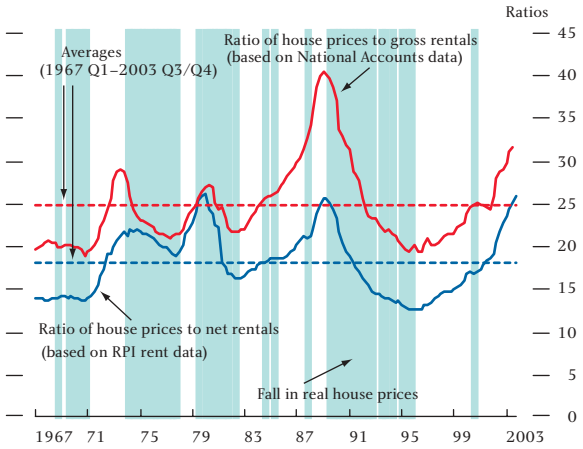
The inverse of such net rental yields, henceforth the ratio of house prices to net rentals P/E^h, probably corresponds most closely to the price to earnings ratio used in equity analysis. Under the assumption that consumers are indifferent between obtaining housing services via renting or owning property, these data may provide a benchmark for the housing market as a whole.(4) But they are only available for recent years and time-series data need to be estimated by combining data from different sources.

Chart 1 shows an estimate of the UK ratio of house prices to net rentals. This estimate uses the inverse of the IPD estimate of the net rental yield as a benchmark for the ratio of house prices to net rentals. The data are then extrapolated by using the historical ratio of house prices to rentals. The data are described in more detail in the data appendix. But it needs to be stressed from the outset that, because of the data limitations described above, the estimates presented are subject to a large error margin of unknown quantity and are therefore only illustrative of broad trends. For comparison, Chart 1 also shows an alternative ratio of house prices to *gross* rentals, based on National Accounts data.(5)

Despite the levels differences, the two measures show a broadly similar profile over time, with the ratio of house

(1) These returns could reflect capital growth or rental income.
(2) More formally, the risk premium depends on the covariance between expected returns and the 'stochastic discount factor'. Under the assumption of 'power utility', this translates into consumption growth. For details see Cochrane (2001).
(3) Thwaites and Wood (2003) provide details about the measurement of house prices.
(4) In other words, for two identical properties, one rented, the other owner-occupied, 'net rentals' of the former equal imputed 'net rentals' of the latter.
(5) It is calculated as the ratio of personal sector residential housing wealth to actual and imputed rents for housing.

Chart 1
The ratio of house prices to rentals and falls in real house prices



prices to rentals having risen in recent years to well above its historical average. This result is similar to those obtained by Broadbent (2003) for the United Kingdom, by Krainer (2003) and Leamer (2002) for the United States and Ayuso and Restoy (2003) for the United Kingdom, the United States and Spain.(1) The shaded areas in Chart 1 show that periods of deviations from the average have in the past often been followed by periods in which real house prices (ie house prices deflated by the RPI) have fallen for prolonged periods.(2)

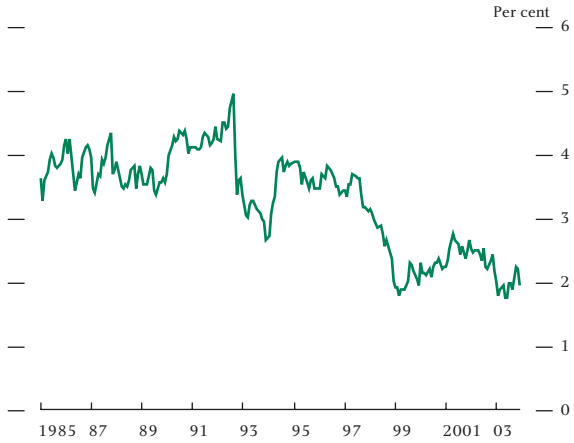
Real interest rates and the housing market risk premium

Vila Wetherilt and Weeken (2002) show that simply focusing on deviations of valuation measures from their historical averages ignores possible effects from other variables. This is illustrated by rearranging equation **(2)** to obtain the ratio of house prices to net rentals on the left-hand side where $\theta = D^h/E^h$ is the payout ratio. The long-run growth rate of 'housing dividends' D^h (ie the part of 'net rentals' (E^h) not spent on new housing investment)(3) is given by $g = (r^f + k^h)(1-\theta)$.(4)

$$\frac{P_t}{E_t^h} = \frac{(1+g)\theta}{r^f + k^h - g} \qquad \textbf{(3)}$$

For example, other things being equal, a lower real risk-free rate r^f could sustain a higher house price to rentals ratio than in the past. Chart 2 shows that real interest rates, as measured by the yields on index-linked gilts, fell markedly during the 1990s.(5)

Chart 2
UK ten-year spot real interest rates



By the same token, a lower housing risk premium k^h, or a higher long-term 'net rentals' growth rate g, could also sustain a higher price to rentals ratio.

Decomposing house price changes

Decomposing changes in house prices to account for the relative contribution of these variables may provide further insights into house price movements.

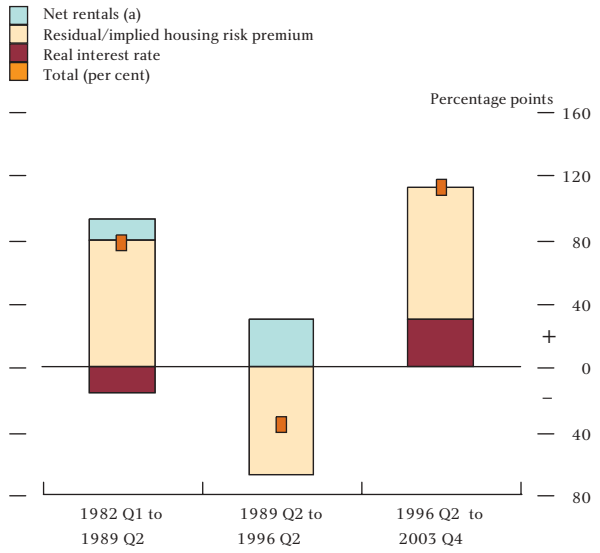
Chart 3 illustrates such a decomposition of changes in the real Nationwide mix-adjusted house price index, based on the proxies for r^f, P/E^h and θ defined above.

Again, it needs to be stressed that estimates of many of the variables entering equation **(3)** are subject to a margin of error. For example, to calculate the payout ratio θ, data on 'housing dividends' D^h are required. In addition to the data limitations already described above, these 'housing dividends' are difficult to estimate.

Moreover, expectations of near and medium-term growth in 'housing dividends' are not available and cannot be incorporated in the model. This may be important as planning restrictions on new housing may result in the

(1) The RICS letting survey provides corroborative evidence. It shows that UK gross rental yields (the inverse of the ratio of house prices to gross rentals) have mostly been falling for the past few years.
(2) The shaded areas represent periods in which real house prices have fallen compared with the previous quarter. This could reflect a fall in the money value of houses or the money value of houses increasing by less than retail prices.
(3) In accounting terminology, the difference between 'net rentals' and 'housing dividends' corresponds to 'retained earnings'. The net investment could reflect property improvements which should enable the landlord to receive higher rental income in the future. In practice, new housing investment has been low relative to net rentals, with the payout ratio close to one. See the data appendix for more details.
(4) See Panigirtzoglou and Scammell (2002) for a derivation of the long-term growth rate g.
(5) Constant-maturity ten-year spot real interest rates were derived from index-linked gilts using the variable roughness penalty (VRP) method described in Anderson and Sleath (1999). Scholtes (2002) discusses why these rates are an imperfect measure of the risk-free rate.

Chart 3
Contributions to changes in the real Nationwide house price index



(a) Using the net rentals estimate based on RPI rent data.

returns on housing investment exceeding the cost of finance for a considerable period of time.

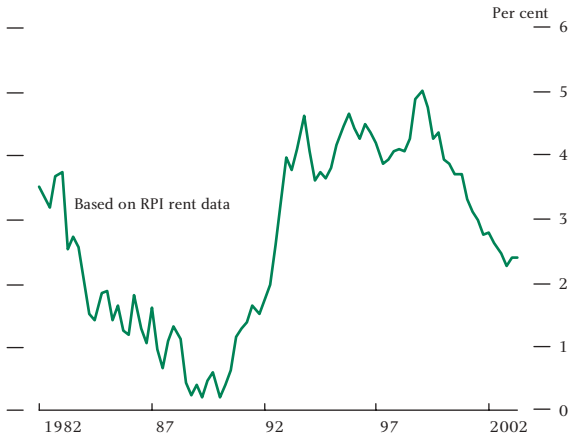
The residual contribution in Chart 3 is thus a mixture of the effects of these data limitations and omissions, inappropriate valuations of housing assets and the unobservable housing risk premium k^h.

Interpreting the results

Chart 3 shows that, although growth in net rentals made a positive contribution, changes in the residual are needed to account for the increase in real house prices between 1982 and 1989 and the subsequent falls during 1989–96. For the most recent period the model attributes part of the rise in real house prices to a fall in the ten-year real spot interest rate (a proxy for the real risk-free rate). But the residual component also makes a large positive contribution.

The extent to which this residual reflects changes in the unobservable housing risk premium, rather than distortions resulting from poor data, may influence the interpretation of house price movements. Chart 4 shows a time series of the residual backed out from equation **(3)** consistent with Chart 3 and the estimate of the ratio of house prices to net rentals based on RPI rent data shown in Chart 1. It shows large movements in the

Chart 4
The UK housing residual/risk premium



residual over time. Are such movements plausible for the housing market risk premium?

Vila Wetherilt and Weeken (2002) discuss changes to risk premia in the context of equities. The analysis carries through to other risky assets such as housing. In particular, changes in the expected variability of consumption, the variability of housing returns, the correlation between housing returns and consumption growth or changes in investors' risk preferences could each explain changes in the housing risk premium.

It is conceivable that past economic stability reduces expectations about the number and/or strength of future shocks to the economy, and/or that it increases confidence in policymakers' ability to deal with such shocks. This may lower the expected variability of consumption growth and asset returns and the risk premium required. Risk preferences may also be affected by the economic cycle. For example, the literature on habit formation implies that in booms consumption rises and risk aversion and risk premia fall, whereas the opposite happens in recessions.(1)

All these factors may have affected the risk premium, thus contributing to changes in the residual shown in Chart 4. But the rapid rise in house prices and their subsequent fall during the late 1980s/early 1990s suggest that the low level of the residual during this period may also have reflected an overvaluation of housing assets, for example caused by mistaken perceptions of underlying fundamentals.(2) It is not

(1) Cochrane (2001) discusses such models.
(2) An additional explanation is that house price increases over that period may have been fuelled by fiscal changes affecting mortgage holders, not captured in our simple empirical model. For example, Baddeley (2003) suggests that the announcement of forthcoming restrictions to Mortgage Interest Relief at Source (MIRAS) contributed to the rapid rise in house prices of Summer 1988.

possible to say whether the fall in the residual over recent years reflects genuine changes in the housing risk premium or an overvaluation of housing assets. But comparing the residual now with that in the late 1980s may suggest that house prices are closer to sustainable levels than was the case in the late 1980s.

Limitations of the model

Data limitations have already been described above. In addition, the basic model described here rests on several assumptions that may not hold in practice. Most importantly:

Limited arbitrage opportunities

The model assumes that there are no arbitrage opportunities by which excess profits can be made without risk. Borrowing constraints or transaction costs could mean that this assumption is violated. For example, if people suspect that houses are too cheap, they are in practice limited in how many houses they can buy, and if they believed that they are too expensive they cannot in practice 'short sell' houses that they do not have.(1)

Moreover, compared with transaction costs for many financial assets, which are very low, transaction costs for housing are high. The latter include financial costs such as stamp duty, estate agent, surveyor and legal fees, as well as time spent searching for a property and the long time lag between making an offer for a property and the transaction being finalised.

Lumpiness of housing

It can be shown that if people can make small adjustments to their asset holdings they would all hold the same portfolio of risky assets (including housing), regardless of risk preferences. In this 'market portfolio' the specific risk associated with any particular asset would have been diversified away. In contrast to equities, where mutual funds enable agents to hold a small share of the overall stock market, housing is lumpy and investors cannot hold a small share of the overall housing market. This has two implications. First, a homeowner's property will typically account for a large share of his total wealth. This means that he is not well diversified across asset classes such as equities, bonds and property. Second, since the typical homeowner only owns a single house he is not even diversified across residential properties.(2) In other words, the lumpiness of housing reduces diversification benefits. This may lead to a higher housing risk premium than would be required otherwise.

Imperfect substitutability

Our simple model implies that people are indifferent between consuming the housing services through owning or renting a property. In this case volatility in rentals maps into volatility in imputed rents. A richer model could allow for a wedge between rentals and housing services. This distinction is implicit in Sinai and Souleles (2003), who argue that, while owner-occupiers are exposed to house price fluctuations, homeownership provides a hedge against fluctuations in future rent payments. To the degree that this hedging demand is capitalised into house prices this would lead to a lower housing risk premium in areas where rent variability was more important than house price variability.(3)

Distortionary taxes and regulation

Taxes and regulation—such as subsidised rental accommodation and rent controls (the latter were abolished in the late 1980s)—could cause two types of distortions. First, they could drive a wedge between market rents and imputed rents of owner-occupation. Second, taxes and regulation could drive a wedge between the post-tax return on property and other investments such as shares. For example, while capital gains tax is generally levied on financial investments, capital gains on the primary residence are not taxed. In addition, rental income is taxed differently from dividends or coupon payments. And owner-occupiers are not taxed on their imputed rents.

Moreover, because of changes to taxes and regulations these distortions have not been constant. For example, the value of Mortgage Interest Relief at Source (MIRAS), which gave tax breaks to mortgage holders, was reduced over time, before the scheme was fully abolished in 2000. Changes to local government taxes in the late

(1) Derivative products that allow betting on house prices are only a recent innovation in the United Kingdom.
(2) For example, Nationwide mix-adjusted regional house price data show that the average variability of annual house price changes across regions in the United Kingdom between 1975 and 2003 was 10.7%. This is higher than the variability of average UK house price increases (9.3%). That average variability is greater than the variability of the average reflects the fact that house prices in some regions rose while they fell in others.
(3) Nordvik (2001) is a related example. He develops a theoretical model in which households desire to trade up to larger properties. In this case investing in housing can insure against house price fluctuations affecting the consumption of future housing services, thereby generating a negative housing risk premium.

1980s/early 1990s will also have temporarily altered the relative attractiveness of property and financial investments.

Taken together, it is not clear into which direction the estimated housing risk premium should be adjusted to take account of these limitations. Although in aggregate and over time the effects of these limitations should be less severe, it is not completely straightforward to apply the simple asset-pricing framework to housing.

Conclusion

This article applied asset-pricing theory to the housing market to gain additional insights into some of the factors accounting for the recent rise in house prices. It showed that estimates of the ratio of house prices to rentals are currently well above their long-term average, as rapidly rising house prices have outpaced growth in rentals. Such a situation has in the past often been followed by periods in which real house prices have fallen. However, a simple 'dividend' discount model of the housing market suggests that lower real interest rates and a fall in the residual (which could reflect a fall in the housing risk premium) can account for the increase in the ratio of house prices to net rentals since 1996. The fact that the residual has fallen by less than in the late 1980s may suggest that house prices are closer to sustainable levels now than was the case in the late 1980s. However, because of data and model limitations no firm conclusions can be drawn.

Data appendix

House prices and house price indices

Unless stated otherwise, data for the money value of house prices and the house price index used throughout this article refer to the Nationwide quarterly mix-adjusted house price data. Thwaites and Wood (2003) provide an overview of UK house price indices.

The house price to rentals ratio

Two estimates of this ratio are provided, one using net rentals, the other using gross rentals.

The first estimate uses a measure of net rentals. End-2002, net rental yield data were obtained from Investment Property Databank (IPD). IPD defines the net rental yield as income received over the year net of property management and irrecoverable costs divided by year-end capital value. The data were inverted to provide an end-2002 estimate for the ratio of house prices to net rentals. The time series for the ratio of house prices to net rentals was obtained by applying the ratio of the Nationwide house price index to the RPI rent index to the end-2002 estimate (both series were seasonally adjusted). The resulting estimate is only indicative, as the approach described above is subject to a number of caveats.

First, it assumes that the development over time of the RPI rent index is a good proxy for the development over time of 'net rentals'. Second, while the Nationwide house price index is mix adjusted, the rent data are not. Furthermore, the mix of dwellings in the Nationwide data is likely to differ from the mix of dwellings in the IPD data and the RPI rent data. The latter are likely to contain more smaller properties, flats and maisonettes.

The second estimate uses a National Accounts based measure of gross rentals. It is calculated as the ratio of personal sector residential housing wealth to actual and imputed rents. Similar to the first measure described above, the National Accounts based estimate is subject to caveats, as many of these rent data are estimated.

'Housing dividends'

To apply the dividend discount model to the housing market, a measure of 'housing dividends' is needed. These 'housing dividends' are that part of 'net rentals' not spent on new housing investment.

First, an estimate of total economy net rentals is needed. 'Average' net rentals can be constructed from the ratio of house prices to net rentals and data on the money value of house prices described above. The estimate of economy-wide net rentals was constructed by multiplying this estimate of 'average' net rentals by the ODPM data of the number of households.

Second, data on new housing investment (ie net investment) need to be estimated. This is proxied by the difference between current-price private sector gross dwellings investment and dwellings capital consumption.

The difference between total-economy net rentals and housing investment broadly corresponds to 'housing dividends'. Because housing investment is small relative to net rentals, the ratio of 'housing dividends' to net rentals (ie the payout ratio) has been around 97% over the sample period.

Technical appendix

This appendix sets out a model in which housing is both an asset and a durable consumption good. It is a much-simplified version of the kind of models set out in Aoki, Proudman and Vlieghe (2002) and Piazzesi, Schneider and Tuzel (2003).

Consumer's optimisation problem

The representative landlord-consumer derives utility from consumption (of goods and services other than housing) c, and also from housing services ('living in a house') h. Furthermore, the consumer is always required to need somewhere to live each period. There is a finite housing stock H, and the representative landlord-consumer can choose to rent part of this stock, f, out for a rental price η, and to live in the rest of the stock. (Rented houses are assumed to be rented out to another class of agents, not described here, who rent whatever stock is allocated to them.)[1] The price of housing is denoted q. This 'housing in the utility function' is not dissimilar to the familiar 'money in the utility function'.

The representative landlord-consumer maximises utility

$$\max_{\{c_t, h_{t+1}, f_{t+1}\}} E_0 \sum_{t=0}^{\infty} \beta^t u\left(c_t, h_t\right) \qquad \textbf{(1)}$$

subject to a budget constraint which holds each period

$$c_t + q_t H_{t+1} \leq y_t + q_t H_t + \eta_t f_t \qquad \textbf{(2)}$$

where E_t is the conditional expectations operator, β is the subjective discount factor measuring the consumer's impatience to consume, c is non-housing consumption and y is endowment income.[2] Moreover, rental housing f and lived-in housing h sum to the total housing stock H.

$$f_t + h_t = H_t \qquad \textbf{(3)}$$

We assume standard conditions on the shape of the utility function, in particular that marginal utility is decreasing in both housing and non-housing consumption, and that both non-housing consumption and the stock of lived-in housing must be strictly positive.

First-order conditions and derivation of the risk premium

The landlord's first-order conditions imply the following intra and intertemporal relationships between marginal utilities u_h and u_c:

$$\beta E[u_h(c_{t+1}, h_{t+1})] - u_c(c_t, h_t)q_t + \beta E_t[u_c(c_{t+1}, h_{t+1})q_{t+1}] = 0 \qquad \textbf{(4)}$$

$$\beta E[u_h(c_{t+1}, h_{t+1})] - \beta E_t[u_c(c_{t+1}, h_{t+1})\eta_{t+1}] = 0 \qquad \textbf{(5)}$$

Combining equations **(4)** and **(5)** and dividing through by $u_c(c_t, h_t)q_t$ gives:

(1) Renters need to be included in the problem so that landlords have someone to occupy their rented property. But because house purchase does not enter their utility maximisation problem, focusing on the landlords is sufficient to derive an asset-pricing equation for houses.
(2) Adding financial assets to the budget constraint would not alter the relationships derived below.

$$E_t\left[\frac{\eta_{t+1}}{q_t}\frac{\beta u_c\left(c_{t+1},h_{t+1}\right)}{u_c\left(c_t,h_t\right)}\right]+E_t\left[\frac{q_{t+1}}{q_t}\frac{\beta u_c\left(c_{t+1},h_{t+1}\right)}{u_c\left(c_t,h_t\right)}\right]=1 \quad \textbf{(6)}$$

With $\frac{\beta u_c\left(c_{t+1},h_{t+1}\right)}{u_c\left(c_t,h_t\right)}\equiv m_{t+1}$ and rearranging:

$$E_t\left[\frac{q_{t+1}+\eta_{t+1}}{q_t}m_{t+1}\right]=E_t\left[\left(1+\frac{q_{t+1}-q_t+\eta_{t+1}}{q_t}\right)m_{t+1}\right]=1 \quad \textbf{(7)}$$

Defining the total gross return on housing, ie price appreciation and rental income as:

$$1+R^h_{t+1}\equiv\left(1+\frac{q_{t+1}-q_t+\eta_{t+1}}{q_t}\right) \quad \text{where } R^h=k^h+r^f \quad \textbf{(8)}$$

equation **(7)** becomes:

$$E_t\left[\left(1+R^h_{t+1}\right)m_{t+1}\right]=1 \quad \textbf{(9)}$$

Equation **(9)** is the equivalent to the standard asset-pricing equation (see Cochrane (2001)). Expanding this expression gives:

$$E_t\left[\left(1+R^h_{t+1}\right)\right]E_t\left[m_{t+1}\right]+\mathrm{cov}_t\left[\left(1+R^h_{t+1}\right),m_{t+1}\right]=1 \quad \textbf{(10)}$$

The gross return on a risk-free asset satisfies:

$$\left(1+r^f_{t+1}\right)E_t\left[m_{t+1}\right]=1 \quad \textbf{(11)}$$

Combining equations **(10)** and **(11)**, the housing market risk premium k^h can be written as:

$$k^h_{t+1}=E_t\left[R^h_{t+1}\right]-r^f_{t+1}=-\frac{\mathrm{cov}_t\left[\left(1+R^h_{t+1}\right),m_{t+1}\right]}{E_t\left[m_{t+1}\right]} \quad \textbf{(12)}$$

This expression shows that the basic asset-pricing framework for financial assets also holds for housing. The risk premium on any risky asset (including housing) will depend on the expected covariance of the returns from that asset with the stochastic discount factor *m*. This is true even if housing is treated as a durable consumption good and features as an argument in the utility function.

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The relationship between the overnight interbank unsecured loan market and the CHAPS Sterling system

By Stephen Millard and Marco Polenghi of the Bank's Market Infrastructure Division.

This article uses data on CHAPS Sterling transactions to describe the segment of the unsecured overnight loan market that settles within CHAPS. It assesses the size, timing and importance of these transactions for the underlying payments infrastructure. Advances and repayments of overnight loans are estimated to have accounted for around 20% of CHAPS Sterling activity by value over our sample period; four CHAPS Sterling members send and receive virtually all payments corresponding to these loans; and, finally, the value of CHAPS Sterling payments associated with this market rises towards the end of the CHAPS day.

Introduction

This article uses data on transactions processed in the Clearing House Automated Payment System (CHAPS Sterling) to provide a description of the segment of the sterling interbank overnight unsecured loan market that settles within CHAPS. In particular, we examine the size of this market, the costs of these loans and the timing of settlement of these loans. In addition, we consider the implications of these payments for the system through which they are made.

Whether a loan is brokered or is the result of a direct deal between two financial institutions, it will eventually result in a payment from one bank to another. Unless the two involved financial institutions are customers of the same settlement bank (in which case the transaction may be settled on the books of the settlement bank) this will be settled in CHAPS Sterling. The Bank of England operates the CHAPS system and keeps a record of all transactions among the settlement banks for surveillance and research purposes.(1) Here, we use this information to match the two legs of an unsecured overnight loan as the payment and repayment are made across CHAPS Sterling.

We find that around £22 billion of overnight interbank loans are processed across the CHAPS Sterling system every day. This represents a large proportion of total CHAPS Sterling activity; in particular, we estimate that 22% of all CHAPS Sterling transactions by value are advances or repayments of overnight loans. Although there are 13 settlement banks (including the Bank of England) in CHAPS Sterling, we find that four members send and receive virtually all payments corresponding to overnight loans. Finally, we find that the value of CHAPS Sterling payments associated with this market increases as the day progresses.

Data

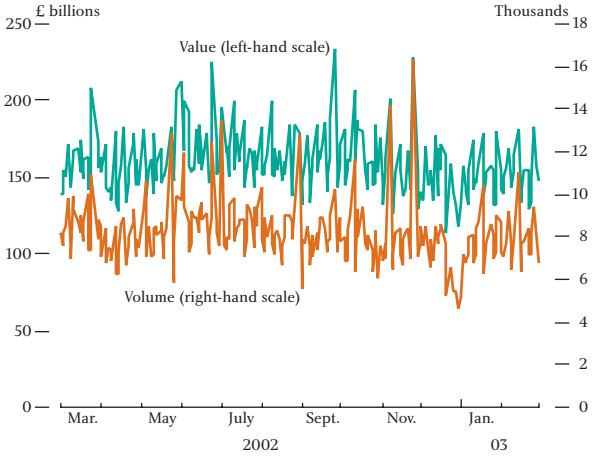
The Bank of England keeps track of all CHAPS Sterling transactions that occur among the settlement banks.(2) We use data from 4 March 2002 to 4 March 2003. Removing weekends, holidays and the one day on which the system encountered operational problems leaves 252 days of data. The average total daily CHAPS Sterling value was around £200 billion over the sample period. Though CHAPS is designed to handle large-value payments, it is common to find small-value transactions as well. We consider only payments of value larger than £1 million. We also exclude those payments where one of the sides is known to be a non-bank customer of a bank and consider only transactions that occur among banks.(3) Finally, CHAPS Sterling involves a total of 13 banks but we ignore transactions involving the Bank of England and, though NatWest and RBS still run separate accounts in CHAPS,

(1) An example of published work is James, K (2003), 'A statistical overview of CHAPS Sterling', *Financial Stability Review*, June, pages 115–21.
(2) We exclude movements of money into and out of CREST and, hence, ensure that we do not pick up secured loans that settle in CREST, such as 'delivery by value' trades (DBVs).
(3) We do this by using part of the SWIFT message attached to each transaction. This will still leave some non-bank transactions; in particular, our data will include payments made on behalf of non-bank customers of correspondent banks. But this is unlikely to affect our results in a material way.

we merge their accounts and consider them as a single group.

With these criteria in place, we were left with CHAPS Sterling payments averaging £155 billion a day (about 7,900 payments). Chart 1 depicts the value and volume of the selected payments while Table A reports the mean and standard deviation for total volumes and total values.

Chart 1
CHAPS Sterling volume and value



Source: Bank calculations.

Table A
CHAPS Sterling volume and value

	Volume (000s)	Value (£ billions)
Mean	7.9	155.2
Standard deviation	1.7	23.7

Source: Bank calculations.

Method

An overnight interbank unsecured loan involves one bank entering into an agreement to borrow from another bank a sum, K, with the promise to repay the following working day an amount equal to this sum plus interest, $K(1 + r)$, where r is the overnight interest rate. Provided that the two banks are not customers of the same settlement bank and the trade is not settled on its books, both legs of the transaction will appear as CHAPS Sterling payments. So it should be possible to see both the loan advance and the repayment within data on CHAPS payments. In what follows, we apply the method developed by Furfine (1999) in order to identify pairs of payments made in CHAPS Sterling on consecutive days that are associated with overnight loan advances and their repayment.(1)

The basic intuition underlying the algorithm is simple: it looks for pairs of payments on consecutive days that look as if they may be loans. More specifically, it looks for payments from A to B on day t that are 'slightly larger' than round-valued payments from B to A on day $t - 1$. The idea is that loans are made in round values and that the 'slight difference' in the payment size represents the interest paid on the loan. For each pair of payments, V_1 and V_2, say, the algorithm calculates the implied annualised interest rate, $\frac{V_2 - V_1}{V_1} * 365$, and if this looks 'reasonable', which we define as being in the interval 3% to 6%, then the payments are logged as the advance and repayment of an overnight unsecured loan.(2)

We select a band of between 3% and 6% as it encompasses the repo rate—which was 4% for most of the sample period—and ensures that we consider only overnight loans as opposed to loans made for a longer duration.(3) To see this, consider a loan for £1 million made on day t over two days at an annualised rate of 4%. The repayment would be £1,000,219 on day $t + 2$. Now if there were a payment from the lending bank to the borrowing bank of £1 million on day $t + 1$, our algorithm would consider it as a possible overnight loan made on day $t + 1$. But the implied interest rate of 7.99% would be outside our band and so the pair of payments would be rejected. This would be the case for any loan of maturity longer than one day whose interest rate was between 3% and 6%.

More specifically, the precise algorithm used to identify the payments (at date $t - 1$) and the repayments (at date t) works as follows:

(1) At date t, round all payments down to the nearest hundred thousand figure. For example, £251,345,891.54 is approximated by £251,300,000.00. In other words, we start by assuming that all non round valued payments on day t are potential repayments of overnight loans and we calculate the values of the advances that we

(1) Furfine, C (1999), 'The microstructure of the Federal Funds market', *Financial Markets, Institutions and Instruments*, Vol. 8, No. 5, pages 24–44.
(2) As a reality check, we found that, although there appeared to be some loans made at less than 3% or more than 6%, relaxing either of these bands did not change significantly either the total size or the average cost of our identified set of loans.
(3) It is important to be sure that we are identifying only overnight loans, since in the United Kingdom, unlike in the US Federal Funds market where Furfine (*op cit*) applied the algorithm, there is an active interbank loan market at many points in the maturity spectrum other than overnight.

would wish to look for on day $t - 1$ that would correspond to such repayments.

(2) Compute the implied interest rate, r, using the simple rate rule. In our example, r = (£251,345,891.54/£251,300,000.00 – 1) *365 = 0.0667. We do this in order to eliminate some of the payments identified as possible repayments of overnight loans in Step (1) on the grounds that such repayments would imply an interest rate that was either too high or too low to be 'reasonable'.

(3) If the implied rate, r, lies between 3% and 6%, select the rounded payment and the associated rate, otherwise exclude the payment. Having excluded these payments we are left with a set of possible repayments and a set of associated advances (the rounded payments) that we now wish to look for on day $t - 1$.

(4) Check if the selected advances left after Step (3) can be found among the payments at day $t - 1$. If the answer is yes, then this payment is considered to be the advance of an overnight loan and its associated payment on day t the repayment of this loan, otherwise it is discarded. Given this approach, we will only pick up overnight loans as opposed to loans of two or more days' maturity, since, unless the payment can be matched to one made the previous day, it is dropped.

(5) Repeat Steps (1)–(4) for all payments for each pair of banks and for each pair of consecutive business days.

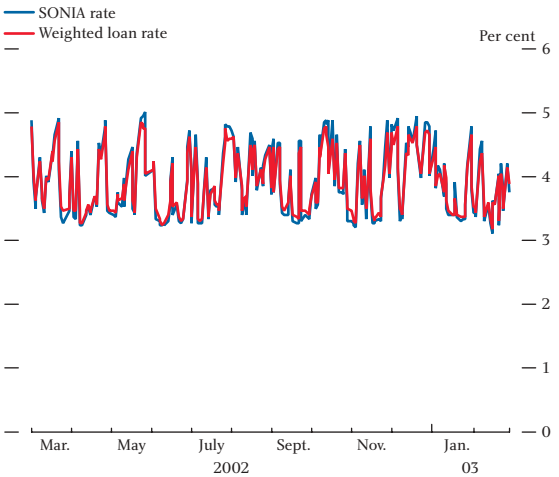
The algorithm assumes that the principal and the interest are repaid together as one CHAPS Sterling transaction. Furfine suggests that in Fedwire it is possible to pay the principal and the interest separately, that is, as two payments.(1) Also, we use a first in, first out (FIFO) rule for the timing of the payments and repayments. This means that the first loan is assumed to be the first one repaid the day after. Finally, our algorithm will catch overnight loans that are negotiated on previous days, ie forwards. But this will not affect any of our conclusions with respect to the volumes and timings of payments associated with such loans.

Have we identified overnight unsecured loans?

In order to identify overnight unsecured loans, we have not explicitly used the intraday quoted overnight rates. So we can evaluate how good our method is by comparing the rates of interest charged on what we identify as loans with quoted overnight rates. Of course, even if we perfectly identify unsecured overnight loans, our rates will still differ slightly from quoted rates because quoted rates are only indicative and may differ from the actual rates applied to the transactions. In addition, there may be a significant time lag between when the loan is agreed and when the payment is transferred over the CHAPS Sterling system.

We have computed both a simple arithmetic average of the rates we calculated and an average weighted by the value of the loans, and these look similar to each other. In Chart 2, we compare our weighted average with the sterling overnight indexed average (SONIA) rate.(2) They are close, with our rate averaging 3.87% and the SONIA rate averaging 3.89% over the same period of time, a difference of only 2 basis points. Moreover, the correlations between the daily level of the SONIA and the daily average level of interest rates that we calculate, and between changes in the levels of these interest rates are both high, at 0.97 and 0.94, respectively. This evidence strongly suggests that our algorithm has been successful in identifying overnight unsecured loans.

Chart 2
Weighted average daily loan rate and SONIA rate



Source: Bank calculations.

(1) The Fedwire Funds Service is a real-time gross settlement (RTGS) payment system in the United States.
(2) The SONIA rate is the weighted average rate of all unsecured sterling overnight cash transactions brokered in London by Wholesale Markets Brokers' Association (WMBA) member firms between midnight and 4.15 pm with all counterparties in a minimum deal size of £25 million.

Caveats

There are several reasons why our data set and method will not be able to detect all activity in the overnight interbank market, but rather only a subset of it. First, as the CHAPS system records only transactions between settlement banks, a loan between two correspondent banks that use the same settlement bank may not be picked up in the database.

A second qualification is related to foreign exchange (FX) swap operations where one side of the transaction is typically adjusted for the interest rate differential between the two currencies, while the other side remains unchanged. So, if we had an FX swap transaction in which the sterling leg is adjusted for the interest rate differential and this differential fell within our 3% to 6% range, then our algorithm would identify such a swap as an unsecured loan. At face value, the effect of this could be significant. But, in practice, the effects are likely to be much smaller.

In ¥/£ swaps, the yen leg is typically fixed. We used the Bank of Japan's unsecured overnight call rate as a proxy for the actual overnight rates charged. Given that its average in 2002–03 was 0.002%, it is possible that some of the loans we identify are sterling/yen swaps. But the value of sterling/yen swaps of maturities less than one week was small, about £280 million, and so the value of overnight sterling/yen swaps is likely to be smaller still.

In €/£ swaps, the euro leg is usually fixed. During 2002 and 2003, the interest rate differential between the sterling Libor and the EONIA rate was small, averaging 78 basis points and peaking at 210 basis points.(1) Since we have used a 3% to 6% band to identify possible overnight loans, it is unlikely that sterling/euro swaps are included in our data set.

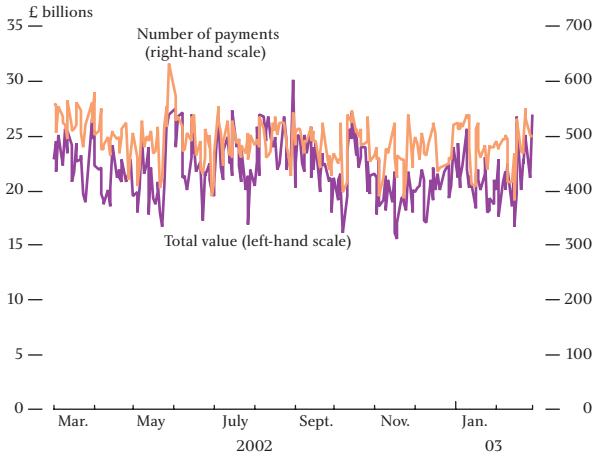
In $/£ swap operations, the sterling leg is usually, but not always, fixed. So, in principle, we should not pick them up in our data set. Nonetheless, given the large volume of activity in $/£ swap operations, it is worth checking whether some transactions we identify as unsecured loans are in fact legs of FX swaps. Over the sample period, the average spread between the sterling Libor and the federal funds rate was 234 basis points, and it was above 300 basis points on many days. An indirect way to check whether we identify some of these swap transactions as unsecured loans is to compare our identified average daily total loan value on days when the sterling/dollar interest rate spread is greater than 3 percentage points—which might lead our algorithm to identify swaps as unsecured loans—with that on days when the spread is smaller than 3 percentage points. We would then expect the average daily value of loans we identified to be larger when the spread was greater than 3 percentage points. In fact, we found the opposite. This suggests that we are not often identifying sterling/dollar swap transactions as unsecured overnight loans.

Results

Size of the market

Applying our algorithm and keeping in mind the previous caveats, we identify unsecured overnight loans averaging about £22 billion daily from our data set. Chart 3 depicts the daily total volumes and values for the loans we identify while Table B gives summary statistics. We find that about 11% of the £200 billion daily average value of CHAPS Sterling payments

Chart 3
Total loan volume and value



Source: Bank calculations.

Table B
Payments in CHAPS Sterling representing advances of unsecured overnight loans

	Volume	Value (£ billions)
Mean	486	21.7
Standard deviation	38.3	2.6

Source: Bank calculations.

(1) The BBA Libor overnight fixing is a measure of the interest rate at which banks borrow funds from other banks in the London interbank market reported to the BBA at 11 am by a panel of banks. The EONIA rate is the effective overnight reference rate for the euro area. It is computed as a weighted average of the rates charged on all overnight unsecured lending transactions undertaken in the interbank market, initiated within the euro area by banks contributing to its construction.

represents advances of overnight unsecured loans. If we also include repayments, the figure rises to 22% of total CHAPS Sterling flows.

The Wholesale Markets Brokers' Association (WMBA) collects data on unsecured sterling overnight cash transactions brokered in London, essentially the same segment of the money market we are considering. Using their pre-June 2003 definition, the average daily volume of brokered overnight loans for our sample period was around £12 billion, which, when compared with our figures, would be consistent with anecdotal evidence that roughly half of this market is brokered while the rest takes place through direct contacts.(1) There is one caveat to this, however. We detect only transactions within CHAPS Sterling. If a brokered deal is settled between two correspondent banks that have the same settlement bank or between a correspondent bank and its own settlement bank and if that deal settles within the settlement bank's own books, then this would be recorded in the WMBA series but not in ours.

Market participation

From a financial stability perspective, it would be desirable to determine the most active players in this market. But from the available information only the identity of the settlement banks can be tracked. So it is possible to know that a certain CHAPS bank has made a payment to another direct member, but we do not know the final identity of the payer and of the payee. Without additional information, we can draw conclusions only on the operational role played by the settlement banks in sending and receiving the loans on behalf of their clients. This does not imply that the settlement banks are not themselves involved in the overnight loan market (they are), but rather that it is not possible to derive their level of direct participation.

We find that four CHAPS Sterling members send and receive virtually all payments corresponding to overnight loans. So an operational disruption to any of these four banks, to the extent that the ultimate lenders and borrowers could not switch settlement bank quickly in time, could impair the functioning of the overnight interbank market.(2)

Time distribution of payments connected to overnight lending

One important risk to a payment system is that of an operational failure. The impact of any such event—whether it affects individual settlement banks or the whole system—will depend upon what payments still need to be settled on the day the event occurs. From the point of view of the system operators, the effect of a given operational event will be larger the more payments that remain to be settled after the event has occurred (since they may have to find alternative means of processing them). From the point of view of the participants, on the other hand, the effect of a given operational event will be to leave some banks overdrawn with their settlement banks (since loans they had negotiated to square off their positions would not come through). In turn, if there were no robust arrangements for dealing with such contingencies, these settlement banks would be unable to clear their intraday overdraft with the Bank of England and this would result in them being left with an overnight overdraft, potentially charged at a penal rate. And the problem is likely to be worse the higher the value of payments remaining to be settled, suggesting that the higher the value of payments settled late in the day, the more important it is to have robust arrangements for dealing with such contingencies.

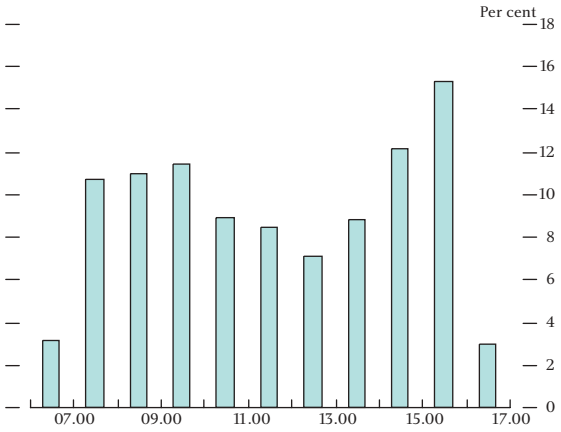
Using the time stamp associated with each payment, we can derive the fraction of the total value and volume of loans that is settled (as opposed to agreed) in each time interval and, thus, assess the effect of operational risk in the CHAPS Sterling system in respect of overnight loans.

Chart 4 depicts the average time distribution over the sample period by number of payments made in relation to loans being advanced through the system (that is, not including repayments). Chart 4 suggests that payments made in CHAPS Sterling associated with advances of overnight unsecured loans are fairly evenly spread throughout the day with roughly 11% of payments made in each hour between 7 am and 10 am, 12% between 2 pm and 3 pm and 18% between 3 pm and 5 pm. So an operational failure at 3 pm that was not corrected by the end of the CHAPS day would probably leave fewer than 100 payments resulting from interbank loans for the

(1) On 2 June 2003, after extensive consultation, the WMBA broadened the definition of qualifying transactions used in the calculation of the SONIA rate. The calculation had previously been based only on interbank transactions. This has now been extended to all sterling overnight cash transactions with a minimum size of £25 million, irrespective of counterparty status. See 'Markets and operations' (2003), *Bank of England Quarterly Bulletin*, Summer, page 159.

(2) Wells, S (2002), 'UK interbank exposures: systemic risk implications', *Financial Stability Review*, December, analyses how interlinkages among banks may provide a channel through which financial difficulties in an individual bank can be propagated to other banks.

Chart 4
Time distribution of loan advances made through CHAPS Sterling by volume

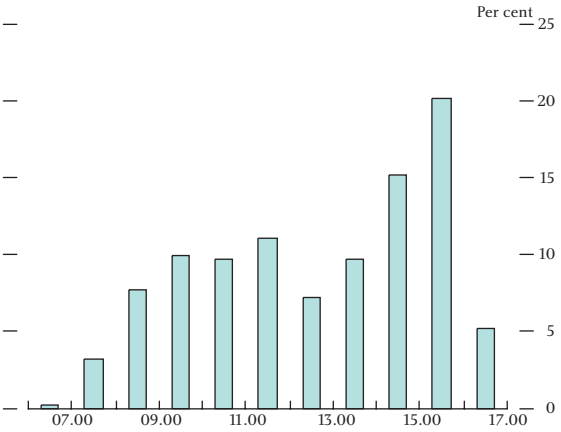


Source: Bank calculations.

system operators to sort out.(1) This suggests that the overnight interbank loan market does not greatly increase the impact of an operational event in CHAPS Sterling at the moment, at least from the point of view of the system operators.

Chart 5 shows that the fraction of payments made in relation to loans being advanced (again, as opposed to repaid) through the system by value rises in the morning; there is a hiatus around lunchtime; and then it rises again throughout the remainder of the CHAPS Sterling day which ends at 4.20 pm. Indeed, 25% of these payments by value are effected during the last hour and a half of the CHAPS day. This concentration of payment transfers associated with loans underlines the importance of robust systems at the settlement banks and the Bank of England, as well as the importance of robust contingency arrangements such as those that CHAPS has sought to put in place.(2)

Chart 5
Time distribution of loan advances made through CHAPS Sterling by value



Source: Bank calculations.

Conclusions

In this article, we have provided a description of the segment of the sterling overnight unsecured loan market that settles within CHAPS Sterling. We found that payments associated with overnight loans represent a large proportion of CHAPS Sterling flows. In particular, around 22% of all CHAPS Sterling transactions by value represent advances or repayments of overnight loans. This suggests that any change in the size of the overnight loan market could have a large impact in terms of the total value of payments flowing through CHAPS Sterling.

Although there are 13 settlement banks in CHAPS Sterling (including the Bank of England), we found that four members send and receive virtually all payments corresponding to overnight loans.

Finally, we found that CHAPS transfers representing advances of overnight unsecured loans are spread fairly evenly over the CHAPS Sterling day by volume, but increase in value over the course of the day. This underlines the importance, recognised by CHAPS, of both the settlement banks and the payment system having robust arrangements to deal with operational disruption late in the day.

(1) 18% of the 486 payments made on average through the CHAPS Sterling system that represent advances of loans would equal 87 payments. (See Table B.)
(2) In practice, CHAPS has developed a set of robust procedures for dealing with such contingencies. For example, the 'Stricken bank scheme' enables the system to deal with cases of operational failures at individual settlement banks and 'Bypass mode' gives the system operators a means of ensuring that payments can be made even if the RTGS central system experiences a serious failure.

How much does bank capital matter?

By David Aikman and Gertjan Vlieghe of the Bank's Monetary Assessment and Strategy Division.

In this article we consider how the composition of banks' balance sheets between capital and deposits affects the transmission of economic shocks. We use a small, stylised model of the economy to analyse under which conditions firms are unable to borrow as much as they would like from banks, and banks are unable to attract as many deposits as they would like from households. We show that, following shocks to aggregate productivity and bank net worth, the response of output in this model economy with credit constraints is both larger and longer-lasting than in a similar economy where credit constraints do not bind. This is because an adverse shock lowers bank capital, which constrains lending to firms and amplifies the fall in output; and it takes time for banks to rebuild their capital so it takes time for output to return to its initial level. We find that, in our model, only a small proportion of the fluctuations of output in response to productivity shocks is due to the bank capital channel, but this channel is more important when there are direct shocks to bank capital.

Introduction

The role of banks in the economy continues to be of interest to both policymakers and academics. The most recent illustration of this is the economic situation in Japan. The health of the banking sector is a key feature of most analyses of the Japanese economy.(1) Elsewhere too, concerns have occasionally been raised over banking sector health and its effect on the wider macroeconomy.(2) In this article, we investigate the role of bank balance sheets in the economy.(3) In particular, we ask whether weak bank balance sheets are likely to make an economy more vulnerable by causing a greater contraction in loans and, ultimately, output, in response to adverse shocks compared with an economy with healthy banks or an economy where banks play a less important role in financing investment. Our focus is on the relative impact of different shocks, and on the underlying factors in the economy that determine whether the impact of a particular shock is exacerbated because of bank balance sheet positions.

Why do banks and their balance sheets matter?

Banks fulfil a variety of roles in the economy: among other things, they provide payment services, transform liquid short-term deposits into illiquid long-term loans, and monitor borrowers on behalf of depositors. In practice, these functions are all important, and are at least partly interrelated. For example, banks are well placed to monitor borrowers precisely because they enter into long-term relationships with them, which may give them better information than the average depositor could obtain on his own about the likelihood that a borrower will be able to repay the loan. It is generally accepted that bank finance is likely to be more important for some types of borrowers than for others. Smaller firms, or firms without a sufficient credit history, are more likely to be dependent on banks to fund their investment expenditure. The importance of bank finance also partly depends on the structure and history of the domestic financial system.(4)

(1) See, for instance, Kashyap (2002), IMF (2003), and the article in the Winter 2003 *Quarterly Bulletin* by Farrant, Markovic and Sterne (2003).
(2) In recent years, this issue has arisen in both developed and developing countries. During the late 1980s and early 1990s, for instance, several OECD countries (Scandinavia and the United States in particular) experienced banking crises that coincided with contractions in output. At the time, many observers attached a causal role to developments in the banking sector. Similarly, during the Asian crisis of 1997, banking sector problems were seen by a number of observers as playing a causal role in the downturn. Hoggarth *et al* (2002) provide a cross-country comparison of the output cost of several recent banking crises.
(3) We build on a recently developed theoretical framework by Chen (2001). The particular version of the model we use differs in a few details, as described in the appendix.
(4) The evolving role of banks is discussed in a speech by former Bank of England governor Sir Edward George (1997).

Given that banks are important, why does the structure of their balance sheets matter? Table A shows a simplified version of a bank balance sheet. Banks hold a variety of assets: they make loans to consumers, to non-financial companies, to other financial institutions, and to governments. Such loans can be made with an explicit loan agreement (eg a mortgage), or by buying a bond issued by a company or the government. These loans are financed by deposits and bank equity, which together represent banks' liabilities. Deposits can be in the form of accounts held at the bank, or in the form of debt issued by the bank, such as certificates of deposit, or longer-maturity debt instruments. The equity portion of the liabilities consists of money injected by shareholders, and profits retained by the bank. For the purposes of this paper, we will call the equity portion of liabilities 'bank capital'.(1)

Table A
A simplified bank balance sheet

Assets	Liabilities
Loans	Deposits Equity

A celebrated insight by Modigliani and Miller (1958) is that, if firms have perfect access to borrowing markets and there are no other distortions in the economy (such as taxes, bankruptcy costs or imperfect information), the structure of liabilities will not affect their investment decisions. Interpreting banks as 'firms', this suggests that a bank's lending decision will be unaffected by the structure of its balance sheet. Why might this logic fail to hold in practice, so that the quantity of bank capital does influence lending decisions?

Two elements are required: first, it must be more costly for banks to raise equity finance rather than deposit finance. That would, of course, lead banks to issue only the lowest cost finance, ie deposits. So a second element is required: there must be some reason why banks need to hold capital. Equity finance may be more costly than deposit finance because of transaction costs(2) or taxes (if interest payments are tax deductible and dividend payments are not). Some equity finance may nevertheless be required for the following reasons. First, bankruptcy is not costless, so a sufficient 'buffer' of equity may be needed to protect a bank against unanticipated losses and reduce the cost of debt. Second (and related to the previous point), capital regulation generally requires banks to hold some minimum level of equity as a fraction of their assets.(3) Third, informational problems may exist between the banks and their depositors, which can be alleviated if the bank holds sufficient amounts of equity. For these reasons, shocks that lower bank equity may feed through into lower loan supply.

This article focuses on informational problems as the reason why banks are required to inject equity. In particular, we assume that depositors cannot observe how much risk a bank is taking in its lending business. But depositors know that banks with more equity invested in the lending will be less likely to take excessive risks—equity, after all, represents the shareholders' own money that is at stake, so they have more to lose if things go wrong. So depositors may only be willing to put their money in a bank with sufficient equity. The amount of equity therefore limits how much deposit finance a bank can attract, which in turn limits the amount a bank can lend.

If banks fulfil an essential role in the economy, and the structure of their liabilities matters, then weakened banks (ie those with lower capital) must lead to worse outcomes. But the more difficult question to answer is: how much worse will these outcomes be, and what do they depend on? There is much empirical evidence on this matter,(4) but the evidence is often open to alternative interpretations. This is because it is difficult to disentangle relative movements in the supply of bank loans versus the demand for loans: bank loans, bank capital and interest rates on loans can all be expected to move with the economic cycle, even if they do not themselves affect the economic cycle. They may just reflect demand conditions. A further difficulty is that, even if bank balance sheets have only small effects on average, there may be episodes when they become much more important. Such episodic effects are difficult to estimate empirically. Given these difficulties, a complementary approach is to try and give a theoretical answer to the problem: under certain assumptions about how consumers, firms and banks behave in an

(1) In practice, the definition of bank capital for regulatory purposes also includes some forms of longer-term debt issued by the bank.
(2) Interpreted broadly, these could include both direct transaction costs incurred in issuing equity, and the implicit costs resulting from the fact that equity issues are sometimes interpreted as signalling bad news about the bank's profitability.
(3) The details of these requirements are described in BIS (1988).
(4) See, for example, Peak and Rosengren (1997), Kashyap and Stein (2000), Angeloni *et al* (2003) and references therein.

economic model, how much does bank capital matter and what does it depend on? This is the approach taken in this article.

A stylised model of banks

To investigate the role of banks in the economy, we use a theoretical model by Chen (2001).[1] In this simple set-up, households deposit their savings in banks, and banks make loans to entrepreneurs (ie firms) to finance investment in physical capital.

The structure of balance sheets plays an important role in this model because it is assumed that there is imperfect information in the economy. Specifically, households cannot perfectly observe banks' lending activity, and banks cannot perfectly observe entrepreneurs' investment activity. This creates a so-called 'moral hazard' problem for both banks and entrepreneurs. The intuition is as follows: entrepreneurs can choose the riskiness of their projects. In choosing the project, the entrepreneur weighs up what he earns if the project goes well against what he loses if the project fails. If the project is successful, the entrepreneur gets the output from the project plus the value of his physical capital, less what he owes the bank in interest. If the project fails, there is no output, and no interest to pay, but he loses any of his own wealth that was invested in the project. Provided that entrepreneurs have a large enough stake (ie entrepreneurial net worth) in the project, they will not be tempted to choose excessively[2] risky projects because they will have too much to lose if the project fails.

A similar moral hazard problem occurs in the banking sector: banks can monitor entrepreneurs and thereby influence the range of projects available so that less risky projects are chosen.[3] But monitoring is costly for the banks, and depositors cannot observe whether the bank is monitoring or not. Banks may therefore be tempted not to monitor if the costs are too high. But if banks have a large enough stake (ie bank capital) in the projects they are lending to, they will always monitor, because they have too much to lose by letting entrepreneurs choose risky investment projects.

This is therefore an economy with credit constraints: the quantity of bank capital affects how much banks are able to lend and the quantity of entrepreneurial net worth affects how much entrepreneurs are able to borrow. We now consider how the economy responds over time to shocks. We first consider a shock to productivity, and then a direct shock to bank net worth.

The economy's response to a productivity shock

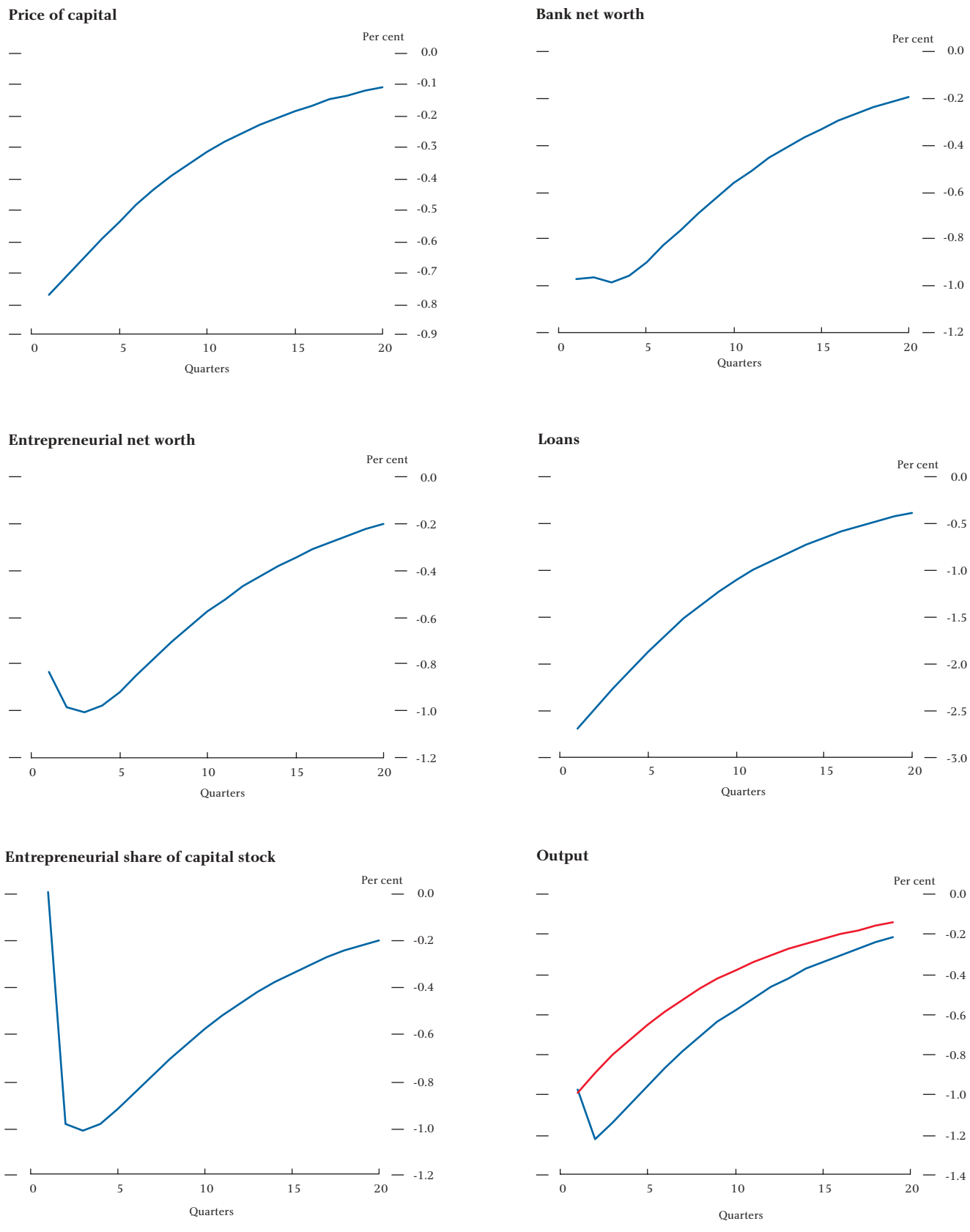
Chart 1 shows how the key variables in the model respond to a persistent negative shock to productivity. An adverse productivity shock initially reduces output, which lowers the *ex-post* return on all entrepreneurial projects. Bank and entrepreneurial net worth thus immediately fall.[4] In an economy where credit constraints do not bind, the effect on output would stop there.[5] But with binding credit constraints, there are second-round effects.

There are two distinct channels through which these second-round effects occur. First, the bank capital channel. With less of their own money at stake, and engaging in lending to borrowers who have lower productivity returns, banks are perceived by households as having a smaller financial stake in the projects they are monitoring, and this makes them riskier places to deposit funds. Banks therefore find it harder to attract deposits. Less capital and deposits mean fewer resources are available for lending, and loan supply contracts. Second, the borrower net worth channel. It acts in a similar way: with less net worth and lower expected returns (due to lower productivity), borrowers are viewed as having less at stake in the outcome of their projects—they have less to lose when projects fail. Banks therefore curtail their lending even further.

As a result of this squeeze on credit, entrepreneurs are able to buy less capital for use in the following period. This shift lowers expected future returns from capital, depressing the current price of capital. Moreover, part of entrepreneurs' net worth consists of their holdings of this physical capital, so the drop in its price further reduces current entrepreneurial net worth. There is

(1) Chen's model in turn builds on the work of Holmström and Tirole (1997).
(2) All possible projects that the entrepreneur can choose are risky, but it is assumed that the riskier projects have negative net present value to society, so it is not desirable for entrepreneurs to pursue them.
(3) It is assumed that banks can only partially influence entrepreneurs' choices. Since they cannot fully control which projects the entrepreneurs choose, both banks and entrepreneurs need to have enough of their own wealth at stake for the best investment projects to be chosen.
(4) In this dynamic model, banks' net worth consists of retained profits from their lending activity. And entrepreneurs' net worth consists of retained profits from their production activity plus the value of physical capital retained from the previous period.
(5) In this model, labour supply is assumed to be fixed so there is no endogenous labour supply response.

Chart 1
Response to a productivity shock



Note: Responses to a 1% fall in the level of productivity, with an autocorrelation of 0.9 (ie 90% of the shock persists into the next period and so on). Units along the vertical axis are percentage deviations from the initial level of each variable. The blue line in the bottom right panel represents the response of aggregate output when credit constraints are binding; the red line represents the output response when credit constraints are non-binding. The time scale along the horizontal axis represents quarters. And the shock occurs after one quarter.

therefore a feedback effect from net worth to capital good prices, and then back from capital good prices to net worth. And this magnifies the impact of the initial shock.

How much amplification and persistence is generated by the binding credit constraint? The bottom right panel in Chart 1 illustrates the model's prediction. It compares the output response of the constrained economy (blue line) with that of a version of the model where the borrowing constraints do not bind (red line), ie an economy where entrepreneurs can borrow as much as they need to finance profitable projects.(1) The behaviour of output is clearly quite different in the two cases. In the unconstrained economy, output starts to return to its initial level immediately following the shock. But in the constrained economy, output continues to contract for a while as the credit squeeze reduces the amount of capital that entrepreneurs can afford to buy. It takes time to close the gap between the constrained and unconstrained level of output because it takes time for banks and entrepreneurs to restore their balance sheets via the accumulation of net worth.(2)

The economy's response to a direct shock to banks' net worth

In the previous experiment, bank balance sheets acted to propagate the effect of an exogenous shock to productivity. We now analyse the effect of a direct adverse shock to bank capital; one that is entirely separate from demand and supply factors in the economy. Such a shock could be loosely interpreted as a reduction in bank capital due to a fall in the value of a bank's foreign assets, since there is no corresponding reduction in the value of domestic loans. So, if foreign banks are active in an economy, it could reflect an adverse shock to their assets in their home economy. It could also be interpreted as a one-off reduction in bank capital resulting from the discovery of fraud. Chart 2 shows the dynamic response of the economy following such a shock.

The immediate effect of the reduction in banks' net worth is to reduce the funds available for lending. This lowers the amount of capital that entrepreneurs can buy to produce output in the following period, which again lowers expected future returns leading to a fall in the current price of capital. Because the capital stock held by entrepreneurs is now worth less, their net worth also falls, which again leads to a further contraction in loan supply. And from this point on, the shock is propagated in a qualitatively similar way to the productivity shock case described earlier.

The bottom right panel of Chart 2 shows that the reduction in output following the fall in bank net worth is again persistent: it takes approximately ten quarters before output returns to its initial level. The effects of the shock are again also amplified: in an unconstrained economy, the reduction in bank net worth would have no effect on output, so the reduction in output is entirely due to credit constraints binding.

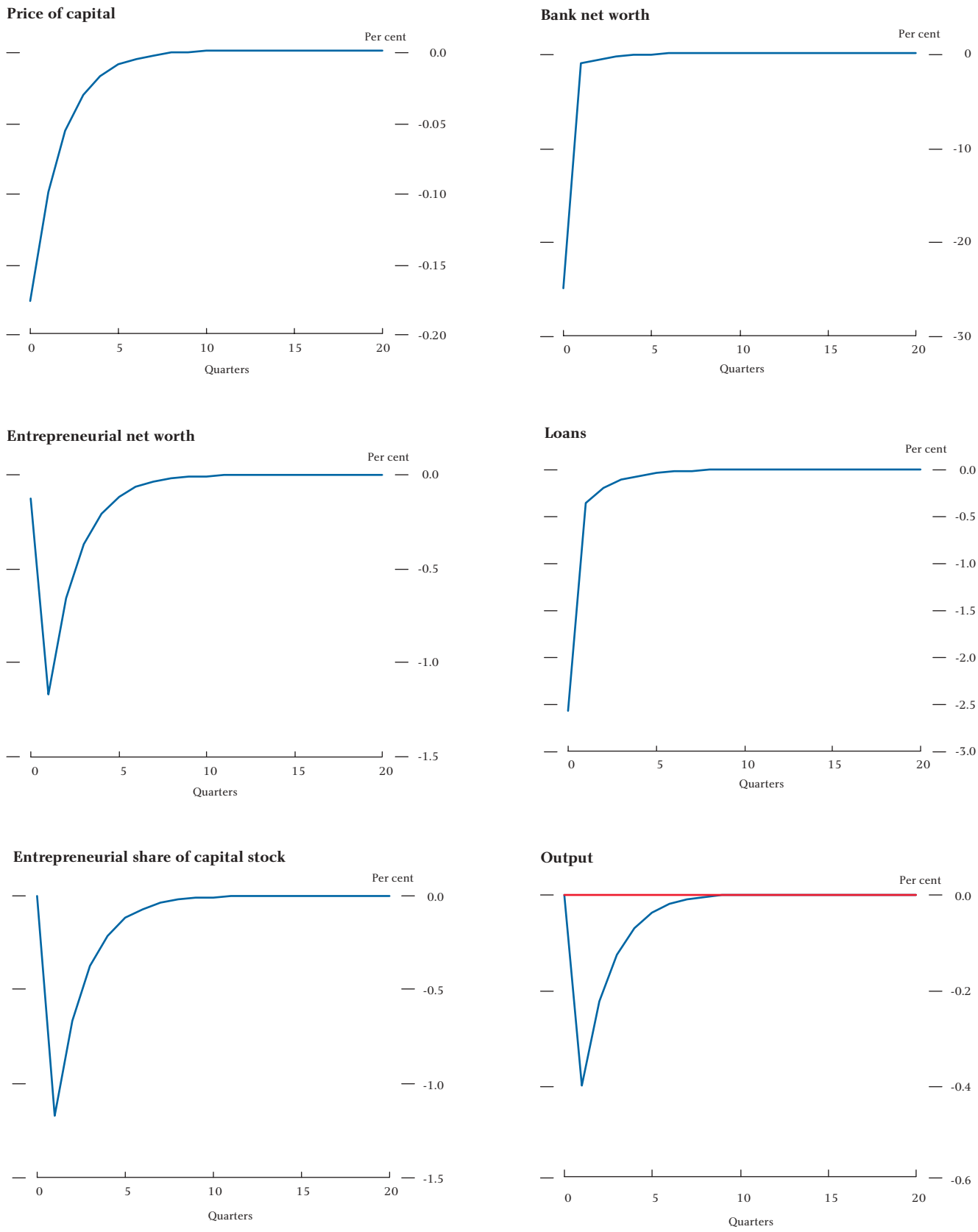
There are, however, two notable differences from the effects of the productivity shock. First, since output is initially produced with capital that was already in place, the bank net worth shock affects output with a lag rather than immediately.

Second, and more importantly, 'financial' shocks and productivity shocks affect banks' incentives to monitor—and therefore the size of the bank capital channel—in quite different ways.(3) In particular, bank moral hazard problems become less severe when bank net worth falls exogenously. So even though the reduction in bank net worth has adverse consequences, this is partly offset by a fall in the fraction of net worth that banks need to hold against loans (ie their capital to asset ratio), as Chart 3 illustrates. The opposite occurs following a shock to aggregate productivity: banks are required to take a larger stake in the projects they monitor (ie the required capital to asset ratio rises)—which reinforces the initial effect of the shock.

Why do moral hazard problems ease after a financial shock, but tighten following a productivity shock? Simply because different shocks have different effects on a bank's incentives to undertake the costly monitoring of firms that it lends to. In the case of an adverse productivity shock, the driving process is the reduction in current and future productivity of firms. This leads simultaneously to a shortage of bank capital and a reduction in the return that banks can expect on their

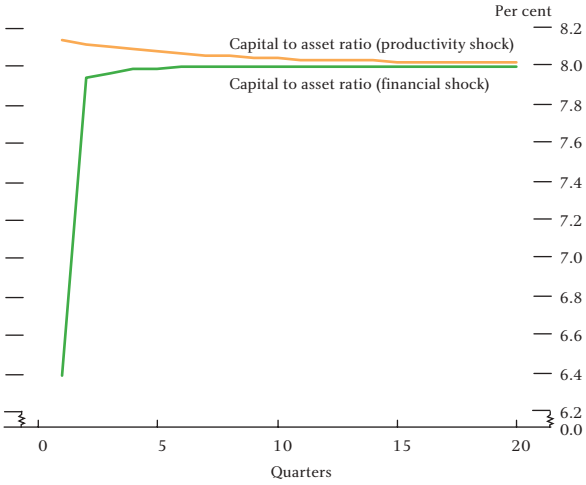
(1) Both responses are drawn as percentage deviations from the initial level. But note that the initial level of output in the unconstrained economy is higher as the capital stock is more efficiently used. So productivity shocks in the constrained economy cause more variability in output around a lower level.
(2) Our results about the extent to which financial variables feed back onto real variables such as output are not particularly sensitive to values chosen for the moral hazard parameters: the monitoring cost and private benefit.
(3) We focus this discussion on the effect that these shocks have on banks' incentives to monitor. But entrepreneurs' incentives to put in high effort are also affected by these shocks.

Chart 2
Response to a bank net worth shock



Note: The figures show the percentage deviations from long-run equilibrium for each variable following a once-and-for-all shock that reduces bank capital by 25% (ie were loans to remain constant, the capital to asset ratio of the banking sector would fall from 8%—the assumed long-run value—to 6%). The blue line in the bottom right panel represents the response of aggregate output when credit constraints are binding; the red line represents the output response when credit constraints are non-binding. The time scale along the horizontal axis represents quarters. And the shock occurs in quarter one.

Chart 3
Banks' capital to asset ratios following different shocks



Note: Banks in our model hold capital that is worth 8% of their loans in the steady state. The units along the vertical axis represent the actual value of each ratio.

loan portfolio, because their customers, the firms, are less productive. This reduction in expected returns on loans lowers banks' incentives to behave diligently: since banks have less to lose, they have less incentive to perform the costly monitoring. Depositors realise this, and demand that banks keep a larger stake in the projects they lend to, in the form of a higher capital to asset ratio.

In the case of the adverse financial shock, the driving process is an immediate reduction in bank capital that is at first not associated with any changes in productivity. Since banks lend out their own capital as well as deposits, a reduction in bank capital reduces banks' ability to lend, so reduces the amount of financing that entrepreneurs can obtain to invest in physical capital. When entrepreneurs have lower levels of physical capital, this increases the productivity of that capital. This is the result of diminishing returns to physical capital: when firms hold more capital, the productivity of an additional unit of capital falls. So when firms are forced to hold less capital, as is the case when a financial shock reduces banks' ability to lend, the productivity of an additional unit of physical capital rises. This improves the incentives of the banks: the return they can expect from their loan portfolio has increased, so banks have a greater incentive to perform the costly monitoring. Depositors realise this, and allow the banks to operate with lower capital to asset ratios while they recover from the adverse financial shock. So while a reduction in bank capital is obviously bad for the economy as a whole, it improves the banks' incentives to act diligently, and therefore cushions the adverse effect of the shock. This contrasts with the productivity shock, where incentives worsen, and therefore amplify the effect of the shock.

These results highlight the importance of having a well specified model to analyse the role of net worth: the role of bank capital in transmitting shocks is likely to depend upon the nature of the disturbance.

How important is the bank capital channel?

What is the relative contribution of the two types of financial frictions to the amplification of shocks previously documented? To address this, we modify the model by allowing the depositors of each bank to observe (at no cost) whether banks are adequately monitoring the entrepreneurs they are lending to—effectively 'switching off' the friction that forces banks to hold capital. By comparing this economy with the benchmark economy studied above, we can then quantify the marginal role played by bank capital in this model.

We would expect a less amplified response to shocks when this friction is 'switched off': if bank capital is no longer playing a crucial role in providing the right incentives for banks, bank balance sheets cannot serve to amplify shocks. Chart 4 explores this possibility by comparing the economy's response to the adverse productivity shock considered earlier, with and without bank moral hazard. Blue lines in the figure refer to the benchmark economy studied previously; red lines refer to the economy with the bank capital channel switched off.

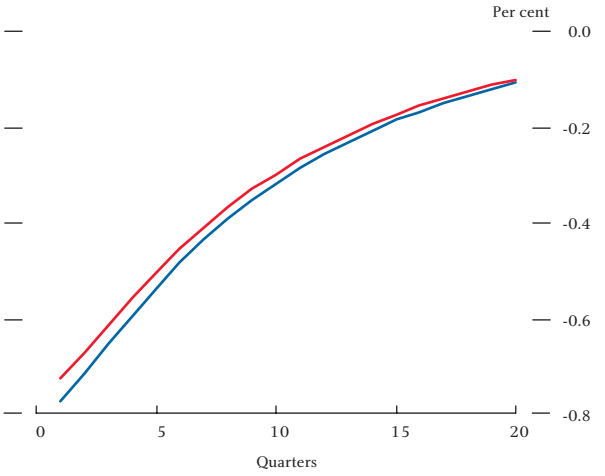
When the bank capital channel is switched off, there is clearly less volatility in most of the key variables of the model. As Chart 5 shows, however, the quantitative impact of this channel on the volatility of output (given by the difference between the blue and red line) is very small. The peak response of output falls only slightly(1) and there is no impact at all on its timing. Clearly, little of the amplification and persistence displayed by the benchmark economy was due to the bank capital channel.

What are the reasons for this result? The quantity of capital held by banks in the benchmark economy is very small relative to the net worth of entrepreneurs. This

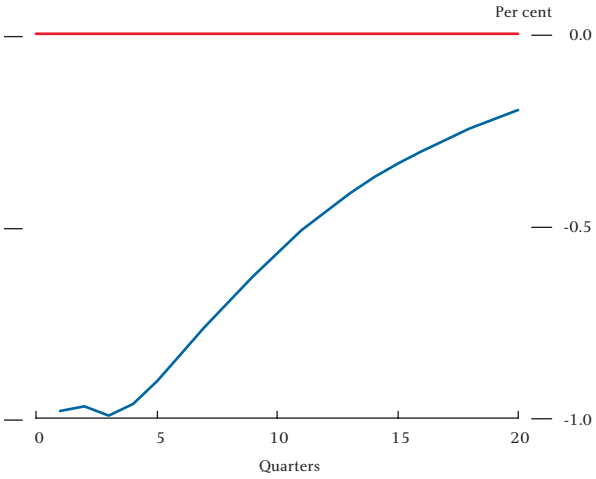
(1) The peak response without bank moral hazard is 20% larger than the peak response without any constraints. It is 23% larger in the benchmark economy with both bank and entrepreneurial moral hazard, relative to the unconstrained case.

Chart 4
Responses with and without a 'bank capital channel'

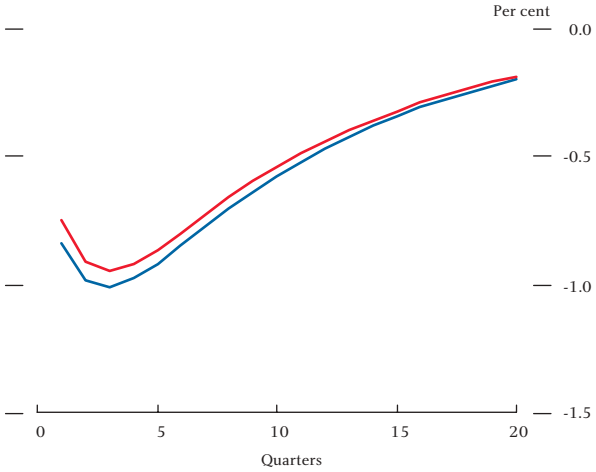
Price of capital



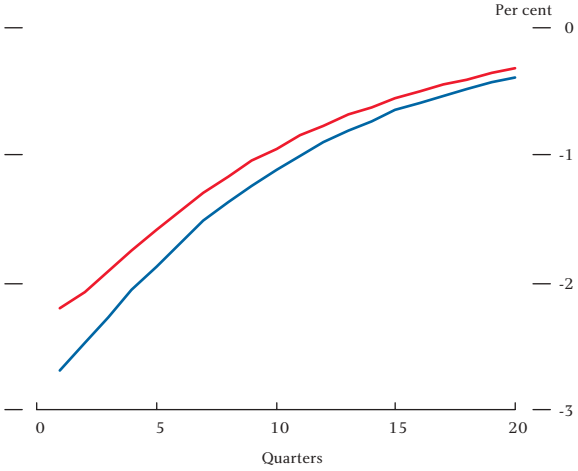
Bank net worth



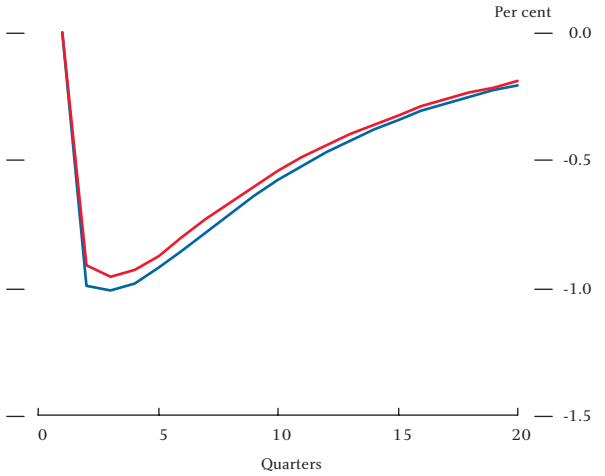
Entrepreneurial net worth



Loans

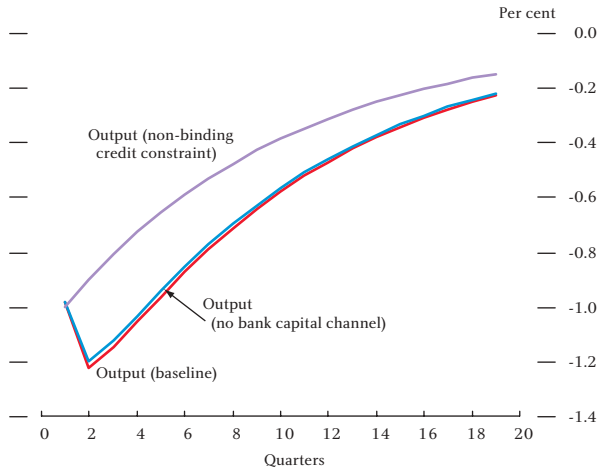


Entrepreneurial share of capital stock



Note: Responses to a 1% fall in the level of productivity, with an autocorrelation of 0.9. Blue lines refer to the benchmark economy studied previously; red lines refer to the economy with the bank capital channel switched off. The units along the vertical axis are percentage deviations from the initial level of each variable.

Chart 5
Response of output



reflects the real world: firms in the United Kingdom typically hold net worth of approximately the same value as their loans; banks, on the other hand, are very highly leveraged institutions, and they typically keep a ratio of only around one tenth of the value of their loans. So entrepreneurial net worth is about ten times as large as bank net worth. If banks need to earn a larger return on their net worth as a result of increased moral hazard, this uses up only a small fraction of the total resources of the economy.

This result that bank balance sheets do not matter much in the transmission of productivity shocks should not, however, be taken to be a general conclusion. It is a consequence of the many modelling choices that have been made. It is probably related at least in part to the fact that there is no time-varying default rate for entrepreneurs in the model (firms fail in the model, but at a constant exogenous rate). So any effect of bank capital on the real economy must arise due to changes in the return that banks earn on their net worth. And as previously stressed, achieving a change in banks' returns does not require a large diversion of resources from other sectors. A legitimate concern may be that in the real world banks also lose money in recessions because a higher than expected proportion of their borrowers default on loans. Even a small change in the outstanding value of loans due to defaults can have a large impact on banks' net worth precisely because of banks' low capital to asset ratio. So the effect of a shock in such an economy might look like a combination of our productivity shock and our bank net worth shock.

Finally, we should note that eliminating bank moral hazard also affects the long-run properties of our model. Borrowing constraints ease (as the supply of loans is no longer tied to the net worth of the banking sector) and entrepreneurs end up holding a greater fraction of the capital stock. The economy therefore moves closer to the unconstrained case. Our simulations suggest that this effect is quantitatively quite large.

Conclusions

We have examined the role of bank capital in the economy using a model where asymmetric information leads to moral hazard problems between depositors and banks, and between banks and entrepreneurs. We find that the response of the economy to shocks in the presence of these financial frictions is both amplified and more persistent relative to a similar economy where credit constraints do not bind. The intuition is that an adverse shock lowers the net worth of banks and entrepreneurs, which in turn lowers the lending capacity of banks and the borrowing capacity of entrepreneurs, amplifying the effect of the initial shock on output. It takes time for entrepreneurs and banks to rebuild their net worth positions, so the effect of the shock persists. However, the nature of the shock also has important implications. Adverse productivity shocks increase moral hazard problems between depositors and banks, whereas direct shocks to bank net worth reduce these moral hazard problems.

We also find that only a small proportion of the amplification and persistence displayed by the benchmark economy is due to the bank capital channel, unless there is a direct shock to bank capital. A more general model incorporating time-varying borrower default, however, may give bank capital a more important role even for shocks that are not directly to bank capital.

Appendix

The model we use to generate the simulations in the text is based on Chen (2001). The exact version we use differs in a few details from Chen's original model as we now describe. The interested reader should consult Chen (2001) for a fuller description of the model. We use the same notation.

Our benchmark model (used to generate the impulse responses in Charts 1 to 3) contains two modifications to the basic Chen model. First, we adopt a constant elasticity of substitution specification for the marginal product of capital in home production. Denoting the technology available to households for transforming capital into consumption goods by $Y_t = G\left(K^h_{t-1}\right)$, the marginal product is defined as:

$$G'\left(K^h_{t-1}\right) \equiv \frac{1}{\beta}\left(\frac{\lambda K^e_{t-1}}{\overline{K}}\right)^{\frac{1}{\varepsilon}}$$

where β represents each agent's subjective discount factor, $K^e / \overline{K}$ represents the fraction of the total physical capital stock held by entrepreneurs, ε is the (constant) residual supply of capital from households with respect to the user cost, and λ is a scaling parameter. This affects the model properties as we move from the baseline model to the 'no bank capital channel' model.

Second, we assume that the private benefits (or reduction in effort) available to entrepreneurs when choosing riskier projects ('bad' and 'rotten' projects in Chen's terminology) are denominated in terms of consumption goods. This has the advantage that private benefits and monitoring costs are treated symmetrically in the financial contract.

To generate the results on the relative importance of the bank capital channel (Charts 4 and 5), we modify the model by making the monitoring action of banks public information (ie observable at zero cost by all other agents in the economy). This change allows us to drop banks' incentive compatibility constraint from the list of equilibrium conditions. Banks in this case will no longer be able to command a share of the surplus from projects they monitor. And like households, they will receive an expected return just sufficient to satisfy their participation constraint:

$$E_t v_{t+1} p_H R^b_t K^e_t \geq \frac{A_t}{\beta}$$

The incentive for banks to postpone consumption continually and accumulate net worth is therefore eliminated and, given linear utility, the exact time path of consumption and savings will be indeterminate. We assume that banks accumulate zero net worth and consume their endowment period by period.

Given that there is now one agent less needing to be paid off from the entrepreneurial project's surplus, *ceteris paribus* more of the surplus can be pledged to depositors. Depositors are therefore willing to invest more and leverage goes up. This effect is summarised in the following equation linking capital purchases by the entrepreneur to net worth:

$$K^e_t = \frac{W_t}{\tilde{Z}_t}, \text{ where } \tilde{Z}_t \equiv q_t + c - \beta\left[p_H\left(E_t v_{t+1} R - \frac{b}{\Delta p}\right)\right] + E_t q_{t+1}$$

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An empirical analysis of the dynamic relationship between investment-grade bonds and credit default swaps

Working Paper no. 211

Roberto Blanco, Simon Brennan and Ian W Marsh

Risky corporate and sovereign bonds are among the most recent securities to benefit from the trading of associated derivative contracts. Credit derivatives are financial instruments that can be used to transfer credit risk from the investor exposed to the risk (the protection buyer) to an investor willing to assume that risk (the protection seller). Single-name credit default swaps (CDS) are the most liquid of the several credit derivatives currently traded and form the basic building blocks for more complex structured credit products. A single-name CDS is a contract that provides protection against the risk of a credit event by a particular company or country. The buyer of protection makes periodic payments to the protection seller until the occurrence of a credit event or the maturity date of the contract, whichever is first. If a credit event occurs the buyer is compensated for the loss (possibly hypothetically) incurred as a result of the credit event, which is equal to the difference between the par value of the bond or loan and its market value after default.

This paper addresses the validity and implications of a theoretical relationship equating credit default swap prices and credit spreads using data for a small cross-section of US and European firms for which high-quality data are available. For this sample of investment-grade firms, the theoretical arbitrage relationship linking credit spreads over the risk-free rate to CDS prices holds reasonably well on average for most of the companies (but especially for US firms), when the risk-free rate is proxied by the swap rate. Where the relationship does not hold, imperfections in the CDS market or measurement errors in the credit spread may be responsible. Due to contract specifications in credit default swaps, particularly in Europe, a cheapest-to-deliver option may also be included in the CDS price making it an upper bound on the true price of credit risk. We are unable to incorporate the repo cost of corporate bonds in our analysis due to a lack of reliable data. As a result, the measured credit spread may underestimate the true credit spread, and so forms a lower bound on the true price of credit risk. Subject to these caveats, for most reference entities, both the cash bond and credit default swap markets appear to price credit risk equally on average. We demonstrate, however, that price discovery takes place primarily in the CDS market. We speculate that price discovery occurs in the CDS market because of (micro)structural factors that make it the most convenient location for the trading of credit risk, and because there are different participants in the cash and derivative market who trade for different reasons.

The second part of the paper examines the determinants of changes in the two measures of the price of credit risk. Variables suggested by the structural literature on credit risk are capable of explaining around one quarter of the weekly changes in credit default swap prices. The same variables are less successful in capturing changes in credit spreads. Firm-specific equity returns and implied volatilities are statistically more significant and of greater economic importance for CDS prices than for credit spreads. The pricing discrepancy between CDS prices and credit spreads is closed primarily through changes in the credit spread, reflecting the CDS market's lead in price discovery. It is through this error correction mechanism that both CDS and credit spreads price credit risk equally in the long run. We argue that these findings are supportive of the structural models of credit risk.

Crisis spillovers in emerging market economies: interlinkages, vulnerabilities and investor behaviour

Working Paper no. 212

Michael Chui, Simon Hall and Ashley Taylor

Many emerging market economy (EME) financial crises in the 1990s quickly spread to other countries. By contrast, immediate spillovers from the Argentina crisis in 2001–02 were much more limited. Why do some crises spread quickly and widely, while others are constrained to only a few countries? How is financial distress transmitted across countries? Do crises spread purely to countries with existing vulnerabilities? And can individual EMEs or the international community do anything to limit the potential for shocks to have harmful effects elsewhere? To address these questions, we need to enhance our understanding of how crises can be propagated.

Drawing on elements of both the contagion and early-warning system literature we propose a simple methodology for assessing potential spillovers to EMEs from crises elsewhere which stresses the joint importance of intra-EME linkages, related country-specific vulnerabilities and investor behaviour. The first element is an assessment of the potential for shocks to pass from a crisis economy to other EMEs through real and financial interlinkages, both directly and indirectly through third economies. Obviously, an examination of these *ex-ante* linkages can only offer a first pass at assessing potential for shock transmission: in some crises new (or strengthened) linkages will open up, for example, when investors reassess the fundamental vulnerabilities of EMEs following a crisis elsewhere; in other cases pre-existing linkages may turn out to be less important in crisis dynamics than expected. The second component is an examination of specific vulnerabilities of EMEs to shocks potentially transmitted from a crisis EME. Other important factors, which are more difficult to quantify *ex ante*, include the potential responses of policymakers and investors to the initial shock and crisis transmission.

This framework provides insights into the reasons for different spillovers in two case studies—Asia 1997–98 and Argentina 2001–02. These studies suggest that the framework might be a useful starting point for assessing the likelihood of a crisis spreading from one EME to another. However, our case studies also highlight what we do not know about the spread of crises. Actual crisis dynamics are affected by a much wider range of factors. Some crises spread through mechanisms we have not been able to measure. For example, we have limited information on non-bank financial channels. And even for bank channels, theory offers us little guidance on how creditors will adjust their lending in the event of losses on part of their portfolio due to an EME crisis. Further work in these areas might shed light on the evolution of recent crises, help to provide forward-looking tools for spotting incipient future crises, and potentially help policymakers to identify measures that might prevent them.

Investment-specific technological change and growth accounting

Working Paper no. 213

Nicholas Oulton

In a set of related and influential papers, Greenwood, Hercowitz and Krusell, hereafter GHK, have claimed that the growth-accounting framework that they ascribe to Jorgenson is flawed. They also claim that the methodology of the national accounts is flawed, at least for the purposes of productivity analysis. They develop an alternative framework centred round the concepts of 'neutral technological change' and 'investment-specific technological change'. They use their framework as the basis for determining what proportion of growth is due to investment-specific technological change, ie what is the quantitative importance of 'embodiment'. Embodiment means (roughly) the extent to which in the long run productivity growth is due to improvements in the quality of machinery and equipment, rather than (say) greater efficiency in the way in which production of consumption goods is carried out. GHK claim that Jorgensonian growth accounting severely understates the role of embodiment.

Contrary to their claim, this paper shows that their model can be analysed as a special case of the more general Jorgensonian approach. Consequently, as is also shown, their criticisms of the Jorgenson framework are incorrect. The equations of the GHK model can be derived from a two-sector model in which the production functions are the same up to a scalar multiple (total factor productivity (TFP)). Investment-specific technological change (ISTC) is then found to be closely related to the more familiar concept of TFP growth. In fact, in this special case of the two-sector model, ISTC equals the difference between TFP growth in the investment good sector and TFP growth in the consumption good sector. Neutral technological change is found to equal the growth rate of TFP in the consumption sector.

The two-sector model from which the GHK approach can be derived is consistent with Jorgensonian growth accounting. Jorgenson's approach does not employ the particular aggregate production function that they attribute to him. In his approach, the growth of aggregate output is measured by weighted averages of the growth rates of output in the various sectors, where the weights are the time-varying shares of each sector in the value of output: there is no need to assume that the relative price of investment goods is constant.

GHK criticise the methodology behind the US (and other countries') national accounts, arguing that expenditure on investment goods should be deflated by the price of consumption goods, not the price of investment goods. This argument must also be rejected. The two-sector model that lies behind GHK's results is itself consistent with standard national accounting principles. However, if our interest is in measuring welfare rather than output, there is a case for deflating all types of expenditure by the price of consumption. But then it is net, not gross, domestic product that we should be looking at.

In the empirical section of the paper, we compare two studies of the importance of technical progress in the equipment-producing sectors in explaining US growth, the first by GHK, the second a growth-accounting study by Jorgenson and Stiroh. GHK find embodiment to be twice as important as do Jorgenson and Stiroh. The main reason for this difference is found to be data, not methodology. GHK use a deflator for equipment that falls much more rapidly than the official one. Methodology does provide a subsidiary reason. GHK quantify the role of technical progress in the equipment-producing sector by asking by how much the steady-state growth rate of consumption would be reduced if ISTC were the only source of technical progress. By contrast, the growth-accounting tradition estimates the contribution of TFP growth in a particular sector to aggregate TFP growth. This is measured by TFP growth in the sector in question, weighted by the ratio of the sector's gross output to GDP.

An empirical model of household arrears

Working Paper no. 214

John Whitley, Richard Windram and Prudence Cox

There has been a rapid build-up of debt by UK households since the second half of the 1990s, as occurred also in the late 1980s. The ratio of total household debt to disposable income rose to 120% in 2002 Q2, some 10 percentage points above the previous peak in the early 1990s. Unsecured debt has increased from around 16% of total debt in 1990 to around 20% in 2002. A large part of the increase in unsecured debt has been due to growth in credit card borrowing. Despite the growth in both secured and unsecured debt there has been a contrasting difference in the build-up of arrears on different types of borrowing. Credit card arrears of three months have been rising since 1996 but, in contrast, mortgage arrears of six months or more have fallen continuously since 1992.

This paper attempts to explain these differences in the pattern of arrears in terms of the factors accounting for the probability of default on secured and unsecured household loans, and the factors influencing supply of the two types of loans.

Much of the literature uses one of two alternative theories of default to determine the likelihood of going into arrears on a mortgage. The 'equity' theory of default holds that, when households default, they choose to do so voluntarily after a rational analysis of all future costs and benefits associated with continuing or not continuing to meet the obligations of the mortgage. The 'ability-to-pay' theory of default suggests individuals default involuntarily when they are unable to meet current payments. The latter suggests a greater role for flow measures of mortgage repayments. However, the ability-to-pay model can equally be seen as a special case of the equity model where liquidity constraints operate. In general, the literature emphasises the complexity of decisions of borrowers and lenders. There is also a distinction between default and going into arrears. Being in arrears does not necessarily imply an inability to repay debt. All these considerations make it difficult to generate aggregate testable models. Although the empirical analysis in this paper gives some insights into the main influences on arrears, the empirical estimates are essentially reduced-form.

Our empirical model of mortgage arrears provides broad support to the 'ability-to-pay' theory, with mortgage income gearing the most significant explanatory variable. Other significant variables include the unemployment rate, the amount of undrawn equity and the loan to value ratio (LTV) for first-time buyers. Interestingly, the empirical model suggests that mortgage arrears are negatively linked to the loan to value ratio. One possible explanation for this put forward is the effect of second mortgages, which are typically at lower loan to value ratios but tend to be higher risk. Alternatively, it could reflect supply-side behaviour by banks, given that they are more prepared to extend higher loan to value ratios to better credit risks.

There has been relatively little previous work on explaining credit card arrears in aggregate, although there has been extensive work on credit-scoring techniques applied to individual borrowers. Most of the work originates in the United States, using the Survey of Consumer Finances. This is used to identify characteristics associated with more risky borrowers. Other relevant factors include card usage statistics, which provide an insight into the way in which more risky customers use their cards. Time-series models are also available but these have tended to look at defaults rather than arrears. There is evidence, however, that defaults and arrears have moved together.

As for mortgage arrears, the model of credit card arrears is reduced-form rather than derived from an underlying theoretical structure. Availability of data also limits the scope of the empirical analysis. However, the results indicate a strong positive relationship between credit card arrears and household income gearing. In addition, the growth of credit cards is found to be a significant factor, underlining the importance of increased credit card penetration in the United Kingdom in recent years. Unlike the mortgage arrears model, the research does not find a significant effect for unemployment in explaining credit card arrears. Joint tests of the two equations support these findings, although a role for the loan to value ratio is found in explaining credit card arrears but with the opposite sign to that for mortgage arrears. A possible explanation for the opposing signs is that higher LTVs are associated with a better credit risk on mortgage loans, but they might also suggest that households are more likely to be overextended and therefore will build up arrears on credit card debt.

The paper also considers the speed of adjustment within each of the two models. Credit card arrears are found to respond more rapidly than mortgage arrears to shocks from the two equations estimated independently, consistent with anecdotal evidence that individuals tend to default on unsecured debt before secured debt. But when they are considered jointly we find that credit card arrears are a leading indicator of future mortgage arrears. Once this link is taken into account, the underlying speed of adjustment across the two models is found to be very similar.

These equations can be integrated into an overall macroeconomic framework to aid projections of arrears conditional on the macroeconomic environment, and hence permit an analysis of the financial position of UK households.

At the aggregate level, further work might seek to link household sector mortgage arrears to mortgage repossessions and credit card write-offs, and thereby analyse the implications of changes in arrears for the financial position of UK banks. More complete models of the stock/flow relationship of arrears at different durations might improve our understanding of the dynamics between macroeconomic factors and household financial distress. At the disaggregated level, research might usefully consider survey and panel-based sources of data, such as the British Household Panel Survey, to identify those households with a higher risk of default and their characteristics. At the household level, it is likely that changes in individual family financial circumstances (family formation, separation) may be at least as important as aggregate macroeconomic factors.

Measuring total factor productivity for the United Kingdom

By Charlotta Groth, Maria Gutierrez-Domenech and Sylaja Srinivasan of the Bank's Structural Economic Analysis Division.(1)

A good understanding of productivity growth is important for understanding aggregate supply capacity, and so for the conduct of monetary policy. To understand the sources of supply capacity well, it is important to measure output and factor inputs correctly. This article summarises recent and ongoing research at the Bank of England on improved measures of factor inputs. This work explicitly accounts for changes in the quality of these inputs and for the flow of services available from them, as well as for the costs of adjusting the level and utilisation of the inputs over time. This research was presented at a workshop on 'measuring factor inputs' held at the Bank of England in December 2003.

Introduction

The aim of monetary policy is to keep inflation low and stable, in accordance with the target set by the Chancellor. A key influence on inflationary pressure is the balance between the demand for and the economy's capacity to supply goods and services. This capacity depends both on the quantities and qualities of the primary inputs into the production process—capital and labour—and on the efficiency with which they are combined. The latter concept is often referred to as total factor productivity (TFP). A good understanding of past and current productivity growth is thus important for understanding aggregate supply capacity, and so it is relevant for the conduct of monetary policy.

To understand the sources of supply capacity well, it is important to measure output and factor inputs, and therefore productivity, correctly. It is also crucial to recognise and adjust for the changing composition of the aggregate inputs, which may vary over time. This article discusses recent work at the Bank of England on improved measures of factor inputs, which accounts explicitly for changes in their quality and for the flow of services available from them, and for the costs of adjusting the level and utilisation of the inputs over time. These improved factor input estimates can then be used to obtain better measures of total factor productivity growth for the United Kingdom.

The Solow residual

The standard measure of total factor productivity growth is the Solow residual:(2) that part of output growth that cannot be accounted for by the growth of the primary factors of production, ie capital and labour.(3) The Solow residual (z) is calculated by subtracting the growth of the primary inputs (weighted by their respective shares in nominal output) from the growth of output:(4)

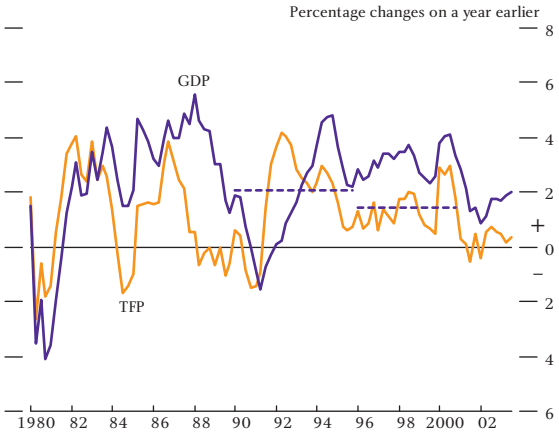
$$z = y - s_k k - s_l l \qquad \textbf{(1)}$$

where y is the growth rate of output, k is the growth rate of capital input, l is the growth rate of labour input and s_k and s_l are the shares of capital and labour in nominal output respectively.

Chart 1 shows a standard measure of the Solow residual for the United Kingdom.(5) The growth rate of TFP is calculated here using aggregate data, where the capital input is a capital stock measure and the labour input is total hours worked.(6) The growth rate appears to be

(1) We would like to thank John Fernald, Steve Nickell, Soledad Nuñez and Nick Oulton for valuable comments. We would also like to thank Pablo Burriel-Llombart and Jerry Jones for supplying us with the quality-adjusted labour series.
(2) Total factor productivity as defined in this article is also referred to in the literature as multi-factor productivity. (See the November 2003 *Bank of England Inflation Report* for some standard multi-factor productivity estimates for the United Kingdom.)
(3) For a 'biography' of total factor productivity, see Hulten (2001).
(4) This is a simplified version of the formula actually used in the empirical calculations. The full formula is given in the appendix in equation **(A.1)**.
(5) The sources for the data underlying the calculations are given in the appendix.
(6) A similar TFP growth measure, but using the number of people in employment as the labour input, is summarised in Table 3.A of the November 2003 *Bank of England Inflation Report*.

Chart 1
Growth of total factor productivity and GDP for the United Kingdom: 1980–2003



procyclical—it is positively correlated with GDP growth.(1) But over and above that, a slowing in the growth rate is noticeable in the second half of the 1990s (relative to the first half), in contrast to the United States, which experienced an increase in TFP growth in the late 1990s. Basu, Fernald, Oulton and Srinivasan (2003) discuss possible reasons for the differing productivity growth patterns in the United States and the United Kingdom.(2)

The Solow residual shown above provides us with just one estimate of total factor productivity growth in the United Kingdom. There are, however, a number of well-known measurement issues that need to be considered. First, capital and labour inputs need to be estimated correctly. For example, the capital measure should reflect the productive services available from the capital stock and needs to reflect factors such as the increased use of ICT capital; and the labour measure should reflect the changing composition and skills of the UK labour force. Second, because the movement of resources between industries also affects aggregate productivity, it is preferable to aggregate industry-level data rather than to use aggregated data directly.(3) Third, the basic Solow residual calculation in equation **(1)** assumes that the factors of production are flexible and fully employed. This may not be the case if there are costs involved in eg hiring and firing or in installing new machines and equipment (usually referred to collectively as adjustment costs). Also, if it is costly to adjust inputs, firms may respond to short-run fluctuations in demand by varying the rates at which their existing capital and labour are utilised. The remainder of this article summarises ongoing Bank of England research on each of these measurement issues and considers their impact on UK TFP growth.(4)

Measuring factor inputs

This section discusses measurement issues relating to the factor inputs used in the TFP calculations.

Capital services

The standard Solow residual is calculated as that part of output growth that cannot be accounted for by growth in capital and labour inputs. The measure of capital that is traditionally used is the stock of capital, which is a measure of economic wealth. As shown in the seminal work by Jorgenson and Griliches (1967), Jorgenson *et al* (1987) and Jorgenson and Stiroh (2000), what is in fact needed to measure productivity accurately is a measure of the flow of services that the capital stock generates. This issue was discussed in an earlier *Quarterly Bulletin* article (Oulton (2001)).

The main difference between a capital stock measure and a capital services measure is the way in which different assets are aggregated together. To create the aggregate stock of capital, different stocks of assets are weighted together by their asset (market) price weights.(5) In the capital services measure, on the other hand, different assets are weighted together by their rental price weights.(6) The rental price is the price that a user of the asset would have to pay to rent the asset for a period of time and, in a competitive market, it will reflect the value of the services which can be derived from the asset. The rental price is related to the price of the asset, but it also takes into account the opportunity cost of holding the asset, the cost of depreciation, and any capital gains or losses (including obsolescence) that are expected to be made by holding the asset over a period of time.

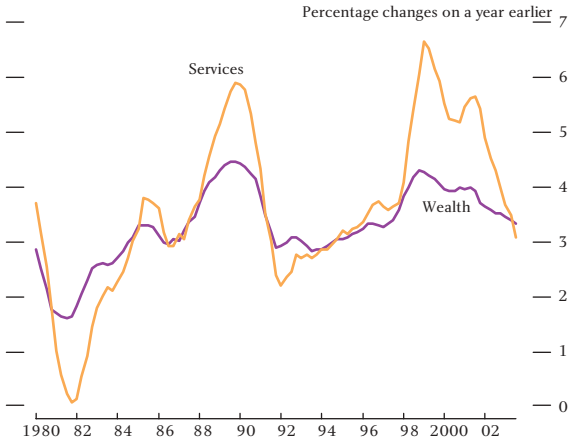
An important implication of using a services rather than a stock measure of capital input is that the services

(1) This is similar to the United States. See Burnside, Eichenbaum and Rebelo (1995) and Basu and Fernald (2000).
(2) They argue that unmeasured investments in intangible organisational capital—associated with the role of ICT as a 'general-purpose technology'—can explain the divergent US and UK productivity performance after 1995.
(3) See Stiroh (2002) and Bosworth and Triplett (2003) for an explanation of these effects.
(4) The focus of this article is on total factor productivity. Clearly, a corresponding labour productivity measure can be calculated.
(5) The asset price weight for each asset is calculated by multiplying the asset price by the asset stock and expressing it as a proportion of aggregate nominal wealth.
(6) The rental price weight for each asset is calculated by multiplying the Hall-Jorgenson user cost of capital for the asset by the asset stock and expressing it as a proportion of aggregate nominal profits.

measure will give more weight to assets for which the rental price is high in relation to the asset price. If the stocks of such assets are also growing more rapidly than those of other types of assets, the services measure of aggregate capital will grow more rapidly than the stock measure of aggregate capital. In recent years ICT assets have precisely had these characteristics: the growth rates of ICT assets have been high compared with those of non-ICT assets and their rental prices are also high in relation to their asset prices.(1) Altogether, this means that the flow of services from capital has recently been growing faster than the stock of capital.(2)

Chart 2 plots the growth rates of a services measure of capital (that accounts separately for ICT assets), against a stock measure of capital (based only on traditional ONS asset classifications: other buildings and structures, transport equipment, other machinery and equipment, intangible fixed assets) for the United Kingdom.(3) The growth of the capital services measure has been much higher than that of the capital stock measure over much of the past five years. This suggests that the Solow residual estimate in Chart 1 (which is based on a capital stock measure) may overestimate underlying total factor productivity growth over that period.

Chart 2
Growth of capital in the United Kingdom: 1980–2003



Quality adjustment of labour input(4)

In order to generate more accurate measures of TFP and aggregate supply, it is also necessary to derive a more accurate measure of aggregate labour input: one that takes into account the quality of labour and allows for changes in its composition over time.

The reason why it is important to adjust for labour quality is that a simple measure of labour input (total hours) disregards the fact that hours of work are not homogeneous: the output they can produce depends on the characteristics of individuals and of jobs. The standard measure of labour input does not capture potential changes in the quality of labour that are linked to changes in, for example, the educational composition of the workforce. For example, even if the amount of labour input (number of people or hours) remained fixed, a shift towards more skilled workers would increase supply capacity.

Determining the quality of labour inputs is not straightforward, since skills are difficult to measure directly. But if we assume that the labour market is competitive, 'quality' ought to be reflected in workers' wages since workers would be paid their marginal product. The disadvantage with this approach, however, is that wages might not be a good proxy for skills if there are significant imperfections in the labour market.

Deriving a better measure of labour inputs which reflects these factors requires dividing the working population into groups, according to characteristics linked to different levels of productivity (eg age, education and gender),(5) and weighting each group's total hours by its productive quality (ie by wages). In practice, the adjusted measure we use is an index (equation **(2)**), aggregating the growth rates of the number of hours of each group and weighting them by the group's contribution to total output:

$$\Delta \ln L_t = \sum_i \left(\frac{s_{i,t} + s_{i,t-1}}{2} \right) \ln \left(\frac{h_{i,t}}{h_{i,t-1}} \right) \qquad \textbf{(2)}$$

where $\Delta \ln L_t$ is the growth in the quality-adjusted labour input, $h_{i,t}$ is the number of hours of group i at time t, $s_{i,t}$ is the share in the wage bill of group i, and the weights in the index are given by the average shares in periods t and $t-1$.

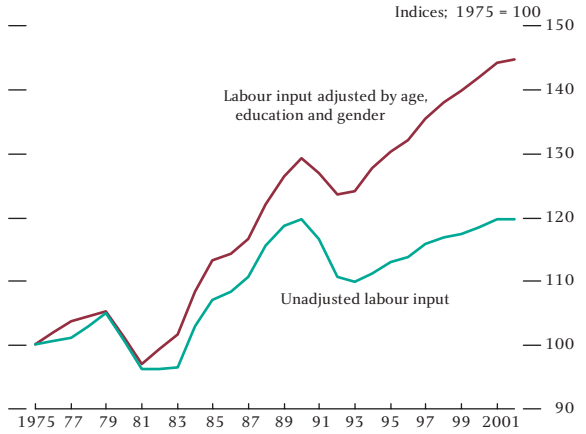
(1) The reason for this is that ICT assets depreciate rapidly. The prices of most ICT assets have also been falling due to rapid technological change. This means that the rental price is high relative to the asset price, since the owner has to be compensated for both depreciation and capital losses.
(2) For details on the calculations of the stock and services measure of aggregate capital for the United Kingdom and the sensitivity of the calculations to various assumptions on the depreciation rate, and investment prices of individual assets see Oulton and Srinivasan (2003a).
(3) Chart 3.9 in the February 2004 *Bank of England Inflation Report* presents the same data for 1993–2003.
(4) This section is based on ongoing research undertaken at the Bank of England.
(5) The different groups are constructed by gender, age (16–24, 25–34, 35–44, 45–54, 55–64 (–59 for females)) and education (other qualifications, O level or equivalent, A level or equivalent, degree or equivalent).

This formulation assumes that firms behave competitively in the labour market, so that the contribution of each group of workers to total output is equal to its share of the wage bill: a group is given a higher weight if its members have a higher wage (higher marginal product reflecting higher quality) or work more hours or both. This implies that the quality-adjusted measure will increase by more than the unadjusted measure if the most productive groups of workers (as reflected in their relative wages) experience greater growth in the number of hours (holding the wage bill shares fixed) and/or if the groups with the highest wages experience an increase in their relative wages (holding growth in the number of hours fixed).

This approach parallels the capital services calculations, where each asset is weighted by its rental price weight: in the adjusted labour input measure, each type of labour is weighted by its share in the wage bill.

Chart 3 compares indices of unadjusted and adjusted measures of labour input where the adjusted labour input corrects for differences in age, education and gender. It is clear that the measure of labour input is biased downwards if there is no quality adjustment, especially from 1981 onwards.

Chart 3
Labour input: unadjusted and adjusted for quality



The difference between the two indices reflects important changes in labour composition (or quality of hours worked). In particular, changes in the educational composition of the workforce have contributed most to the increase in labour quality. This effect has been driven mainly by the fact that highly educated people have experienced the greatest rise in the number of hours worked over these two decades. Changes in the age distribution have had a small positive impact since young people, who are the least productive in terms of hourly wages, have accounted for a declining share of the workforce. Finally, changes in the gender distribution of the workforce have slightly reduced our measure of labour quality. The latter reflects the fact that more women have joined the workforce, but their wage bill has increased less, partly due to their relative preference for part-time jobs, which have tended to be less well paid per hour than equivalent full-time positions.

Because the adjusted measure of labour input shown in Chart 3 has risen faster than the unadjusted one, a large proportion of what would be considered as TFP growth using raw total hours (ie unadjusted labour input) can actually be attributed to labour input. That is, TFP growth is significantly lower once we allow for changes in labour quality.

There is another dimension of the data that also needs to be considered—namely, that of using disaggregated industry-level data to calculate aggregate productivity growth instead of using aggregate data directly. The following section discusses this issue.

Aggregate TFP growth calculated from industry data

The TFP growth rate shown in Chart 1 is calculated from aggregate data. An alternative aggregate TFP growth rate can be constructed by weighting industry-level TFP growth rates appropriately. As pointed out in Basu, Fernald and Shapiro (2001) and Bosworth and Triplett (2003) the two aggregate measures may not be identical if there are differing returns to scale across industries or heterogeneity across industries in the marginal products of identical factor inputs. It is thus preferable to calculate an aggregate TFP growth measure using industry data, since TFP growth calculated using aggregate data includes the above-mentioned scale and heterogeneity effects. The Bank of England industry data set was developed to address this and other issues. It contains data for 34 industries spanning the whole UK economy, for 1970 to 2000.(1)

Using this data set, the growth rate of aggregate TFP can be calculated by weighting industry-level TFP growth rates, which in turn are calculated using industry-specific gross output, capital services, labour and intermediate inputs measures.

(1) Oulton and Srinivasan (2003b), which is available on request, describe the Bank of England industry data set.

The Bank of England industry data set

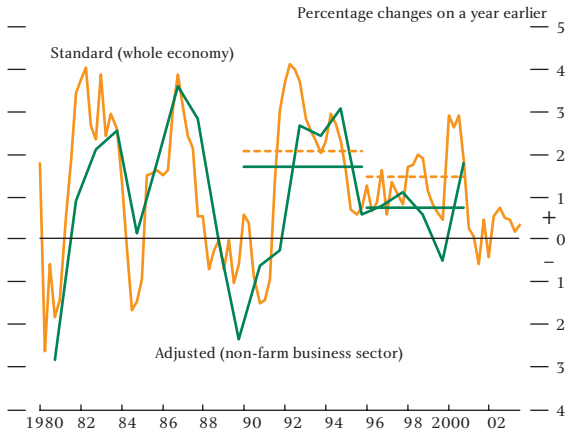
This data set contains data for 34 industries spanning the whole UK economy, for 1970 to 2000. For each industry, there are data on gross output and inputs of capital services, labour and intermediates, in both nominal and real terms. Capital services cover four types of non-ICT assets (structures, plant and machinery, vehicles, and intangibles), and three types of ICT assets (computers, software, and telecommunications equipment). The real intermediate index is a weighted average of domestic purchases from all other industries and from imports. Labour services are measured as hours worked, both including and excluding labour quality adjustment, based on the work discussed above.

The data set is consistent with the official UK National Accounts (as given in the 2002 *Blue Book*, Office for National Statistics (2002)) in both real and nominal terms before the following adjustments were made. To derive series for real ICT investment (and thus ICT capital), US price indices were employed for computers and software, converted to sterling terms, to deflate investment in current prices. The main reason for this is that US price indices are believed to control better for quality, whereas the UK indices do not do so fully. Since technological progress is high for ICT goods, the quality rapidly improves, and US ICT price indices therefore fall at a faster rate than the official UK ones. Also, a large upward adjustment has been made to the official level of software investment.(1)

The approach to ICT has implications for the other variables in the data set. Changing the prices used for measuring real investment in computers and software means that the prices used to measure UK output of these products must also be adjusted. The upward adjustment to nominal software investment raises nominal GDP as measured from the expenditure side. To maintain consistency a corresponding adjustment is made to the income side of the accounts.

(1) This adjustment is discussed in Oulton (2002).

Chart 4
Growth of total factor productivity in the United Kingdom (using disaggregated data, capital services and quality-adjusted labour input): 1980–2003



Source for adjusted (non-farm business sector): Basu, Fernald, Oulton and Srinivasan (2003).

Chart 4 presents an aggregate TFP growth estimate for the non-farm business sector in the United Kingdom. Since the aggregate (for the non-farm business sector) is calculated using a 'bottom-up' approach, the hard to measure government sector and agriculture are easy to exclude. Compared with the 'top-down' aggregate TFP growth measure in Chart 1, the non-farm measure shown in Chart 4 gives quite different point estimates for some years over the 20-year time period.(1) This indicates that there could be some heterogeneity of inputs across industries. However, the overall picture remains broadly similar. The growth rate is still procyclical and there is a slowdown in UK TFP growth in the 1990s, even after moving to a capital services measure, adjusting for labour quality and aggregating from industry-level data.

Adjustment costs and variable rates of utilisation(2)

So far, we have assumed that the factors of production can be adjusted costlessly in response to changes in economic conditions. The framework can, however, be extended to take into account costs of adjustment and variable rates of utilisation.

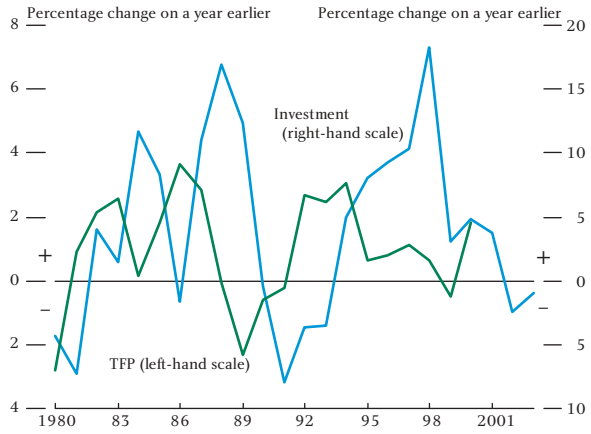
(1) The two lines in Chart 4 must be compared with caution: the standard measure is calculated using data consistent with the 2003 *Blue Book* (Office for National Statistics (2003)) whereas the adjusted measure (using data from the Bank of England industry data set) is calculated using data consistent with the 2002 *Blue Book* (Office for National Statistics (2002)).
(2) This section is based on ongoing research undertaken at the Bank of England.

Capital adjustment costs

The motivation for considering capital adjustment costs is that it may be costly for a firm to increase the amount of capital used for the production of output. One reason for this is that, when firms are investing in new capital, they may need to divert productive resources to installing the new capital rather than producing marketable output. This means that firms are essentially producing two types of products: the final product sold in the market, and the services used within the firm to install new capital. Marketable output may therefore be low during periods of high investment growth, and this would cause a downward bias in estimates of measured productivity growth.

Chart 5 shows the growth rates of business investment (measured in chained volume terms) and total factor productivity.(1) It suggests that there may be a relation between investment and productivity growth: productivity growth slowed during the late 1980s and during the second half of the 1990s, when investment grew rapidly.

Chart 5
Growth of business investment and total factor productivity in the United Kingdom: 1980–2003



Source for TFP: Basu, Fernald, Oulton and Srinivasan (2003).

The measure of productivity growth can be extended to reflect these effects, by defining it as the fraction of output growth that cannot be accounted for by growth in the inputs, where output is defined as the joint product of observed market output and unobserved installation services. Let i be the growth rate of investment and let ϕ denote the (negative) elasticity of output with respect to investment. This measures the percentage change in marketable output that would occur following a percentage increase in investment. The Solow residual calculations can then be amended for adjustment costs—in equation **(1)**, the growth rate of total output (including services to install capital) now equals $y - \phi i$.

The effect on output of installing new capital is not directly observable. But we can estimate it indirectly, by relating the adjustment costs to observable variables. If a firm can adjust capital without incurring any costs, it will always make sure that its productive capital is at its long-run (or normal) level, at which the cost of using one extra unit of capital (given by the rental price of capital) equals the return to one more unit of capital in the production of output. When firms face adjustment costs, the optimal level of capital will still be one at which the cost of installing one more unit of capital equals capital's expected return. But the cost of installing capital now consists of both the rental price and an adjustment cost. And the marginal return to capital consists both of the return in the production of market output and of the contribution to lower adjustment costs in the future. So the optimal level of capital is determined by a dynamic condition, which links current capital to expected future levels of capital. This relation can be used to obtain an estimate of the marginal cost of adjusting capital, from which an estimate of the elasticity of output with respect to investment can be derived.

Ongoing work at the Bank of England focuses on estimating capital adjustment costs for the United Kingdom, for both non-ICT and ICT assets, using the Bank of England industry data set. The results suggest that capital adjustment costs are quantitatively important, and similar in magnitude to those obtained for the United States.(2) We find that, for every 1% increase in investment in aggregate capital, output falls by between 0.02% and 0.04%. If firms invest in traditional non-ICT capital, such as buildings and plant and machinery, output falls by more, while the opposite holds for investment in ICT capital.(3) The net impact on TFP growth, however, also depends on the growth rates of the different types of investment.

These results thus suggest that the standard measure of productivity growth underestimates actual productivity

(1) The TFP measure is the one shown in Chart 4, adjusted for capital services and labour quality, aggregated from industry data.
(2) See for example Shapiro (1986) and Basu, Fernald and Shapiro (2001).
(3) These estimates are based on average elasticities for the sample period (1979 to 2000).

growth in periods of high investment growth. In particular, the slowdown in UK total factor productivity growth in the late 1990s is less pronounced after taking into account capital adjustment costs, compared with the estimate of TFP growth that only adjusts for capital services and quality-adjusted labour services (as shown in Chart 4).

Variable rates of utilisation

If firms face adjustment costs in undertaking new investment and in hiring and firing workers, they may respond to short-run fluctuations in demand by adjusting the intensity with which labour and capital are used. For example, capital can be utilised more intensively by increasing the number of shifts, and labour can be used more intensively by increasing the effort of workers. The Solow residual would in this case overestimate productivity growth in periods when utilisation is growing rapidly, and *vice versa*. This would cause measured productivity to vary positively with the economic cycle, as Chart 1 suggests is in fact the case.

A measure of productivity growth that allows for these effects can be defined as the fraction of output growth that cannot be accounted for by growth in inputs or by growth in the utilisation of these inputs. Define s and e as the growth rates of the utilisation of capital and labour, respectively. Equation **(1)** can now be adjusted to take into account varying rates of utilisation by defining the growth of capital services as $k + s$ and the growth of labour services as $l + e$.(1)

It is not possible to observe the level of utilisation of capital and labour directly; the challenge is again to relate these unobserved variables to something that we can observe. An earlier *Quarterly Bulletin* article by Felices (2003)(2) discussed different approaches to measuring utilisation rates for labour inputs. Here we use an approach that derives links between observed variables and changes in the utilisation rates by using the optimality conditions faced by the firm.(3)

Consider a firm that would like to use more labour. The amount of labour can be thought of as a combination of the number of workers, the number of hours that each worker works, and the effort of each worker. If it is costly to hire more workers, the firm could alternatively consider increasing the number of hours worked, or worker effort. Since the alternative ways of increasing labour tend to come at a cost, it is optimal for the firm to consider all three margins at the same time. This means that the firm makes sure that the cost of a marginal increase in labour is the same irrespective of whether the firm hires more workers, increases the number of hours, or raises effort; when the number of hours is increasing, effort should therefore also be increasing. It should therefore be possible to use observed hours as a proxy for unobserved effort.

Similarly, the utilisation of capital is not observable. But to use capital more intensively, the firm has to use more labour, for example by increasing the number of hours or effort. Moreover, if capital wears out more quickly when utilisation is high, replacement investment should be high when capital utilisation is high. Also, when capital utilisation is rising, the use of intermediate inputs, such as energy inputs, should be increasing. Thus the growth of the number of hours, investment and intermediate inputs could be used as proxies for capital utilisation.

These relationships can be used to obtain an indirect estimate of utilisation. Ongoing work at the Bank of England focuses on this, by relating the growth rates of effort and capital utilisation to the growth rates of the number of hours, investment and intermediate inputs, again using the Bank of England industry data set. Because effort is unobservable, obtaining an appropriate proxy requires careful analysis of the data. For example, as discussed by Felices (2003), there has been a strong downward trend in the number of hours in the United Kingdom, driven by mainly structural factors. So hours worked appear to respond not only to cyclical factors, but also change for structural reasons, and taking this into account properly is important when measuring unobserved utilisation.

Initial results suggest that variations in utilisation of both capital and labour may be important and that, by adjusting for variable utilisation rates, the cyclical pattern in total factor productivity growth can be reduced. This is consistent with findings for the United States, as discussed in Basu, Fernald and Shapiro (2001).

(1) This is a simplified formula since we also need to correct the measure of productivity growth for costs of adjusting the capital stock and costs of changing the number of workers. For the exact formula, see Basu, Fernald and Shapiro (2001).
(2) An alternative approach to modelling and estimating utilisation rates for the United Kingdom is also discussed in Larsen, Neiss and Shortall (2002).
(3) This approach is discussed in Basu and Kimball (1997) and Basu, Fernald and Shapiro (2001).

Conclusions

The Solow residual is defined as that part of output growth that cannot be explained by the growth in the primary inputs. A standard estimate of total factor productivity growth for the United Kingdom appears to be procyclical and shows a lower growth rate in the late 1990s than in the first half of the decade.

There are, however, a number of well known issues related to the measurement of the factor inputs that we need to correct for. This article shows that these improvements in measurement could have a material impact on the estimates of total factor productivity growth. For example, using a services measure of capital input instead of a stock measure reduces estimated TFP growth for the United Kingdom in the late 1990s, since the services measure has grown faster than the stock measure. This difference is mainly due to the contribution of services from ICT capital. Using a quality-adjusted measure of labour input instead of an unadjusted measure also reduces TFP growth, since the quality-adjusted measure of labour input has been growing faster than the unadjusted one. This difference is mainly due to changes in the educational composition of the labour force. In contrast, correcting output growth to take into account costs of adjustment to changes in the level of capital input appears to increase TFP growth in periods of high investment growth, such as the late 1990s.

The net effect of these measurement improvements is complex and varies over time. While the overall picture before and after these corrections remains broadly similar, the point estimates are often different. It appears that, when all these improvements are made, the decline in the growth rate of aggregate total factor productivity in the late 1990s relative to the first half of that decade is reduced but not eliminated. In addition, if both capital and labour inputs are adjusted for differing degrees of utilisation over time, the correlation of total factor productivity growth with GDP growth is reduced.

This richer treatment of input measurement is also helpful in projecting future supply capacity. This is because it enables a higher proportion of capacity growth to be identified with measurable (and so forecastable) inputs rather than with the unidentified sources of growth represented by TFP. But even after taking into account this 'concealed increase in resource expansion' (Abramowitz (1956)), a significant part of output growth remains unexplained by the growth in inputs. Understanding this is the subject of future research.

Appendix

Sources and formula for the data in the charts

The formula used to calculate TFP growth is as follows:

$$z_t = y_t - 0.5^* (s_{k,t} + s_{k,t-1})k_t - 0.5^* (s_{l,t} + s_{l,t-1})l_t \qquad t = 1980, \ldots, 2000 \qquad \textbf{(A.1)}$$

TFP growth is calculated as the residual obtained from subtracting a Törnqvist index of the primary inputs (capital and labour) from the growth rate of output (value added).

When using industry-level data, the formula is modified so that the output measure is gross output, and an extra term $(0.5^*(s_{m,t} + s_{m,t-1})m_t)$ allowing for intermediate inputs (m) is subtracted from the right-hand side of equation **(A.1)**.

Chart 1: The variables used in the TFP calculations are defined as follows:

Output	GDP at factor cost: ONS code YBHH.
Capital	Wealth measure: Variant labelled ONS1 in Oulton and Srinivasan (2003a).
Labour	Total hours: ONS code YBUS.
Share of capital	1 – share of labour.
Share of labour	Assumed to be 0.7.

GDP: GDP at market prices: ONS code ABMM.

Chart 2: See Chart 3.9 of February 2004 *Bank of England Inflation Report*.

Chart 3: Bank of England estimates.

Chart 4: The growth rate of total factor productivity for the non-farm business sector is calculated by weighting industry-level TFP growth rates where the weights are the so-called 'Domar weights'—the share of each industry's gross output in aggregate value added. For each industry, the output measure is gross output, the capital measure is capital services, the labour input measure is total hours (adjusted by aggregate labour quality growth), intermediate inputs are taken into account and the share of each input (capital, labour, intermediate) is calculated as a proportion of nominal gross output.

The industry-level data are from the Bank of England industry data set and are described in Oulton and Srinivasan (2003b). The UK aggregate TFP measure (for the non-farm business sector) is summarised in Table 1 of and described more fully in Basu, Fernald, Oulton and Srinivasan (2003).

Chart 5: Chained volume measure of business investment: ONS code NPEL.

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The Governor's speech[1] at the annual Birmingham Forward/CBI business luncheon

I have always wanted to perform at Villa Park. Now is my chance. Economists at Villa Park are not as unusual a sight as you might think. It is not well known that John Maynard Keynes also came to Villa Park. In September 1913 Keynes was visiting Birmingham and decided to see the match of the day between the two top teams in the country—Aston Villa and Blackburn Rovers. On the following day, Keynes wrote to Duncan Grant:[2]

'There has been some amusement here, but mixed up with a good deal of boredom. Birmingham has a very definite character. I went yesterday with 40,000 other people to one of the peak football matches. The scene was very much as I imagine the Coliseum. The ground is built on the same model—an immense oval rising all round tier above tier in about 50 rows so far as I could count. The crowd maintained a dull roar nearly all the time, rising into a frenzy of excitement and rage when the slightest thing happened. The match was between the two principal 'league' teams of England. The local people were beaten by a team from Lancashire, who had, so I was told, 'the best right wing in England, and the most expensive'.'

Sadly, as Keynes recorded, Aston Villa lost 3–1 and finished that season as runners-up to Blackburn. It is unclear whether Keynes ever again visited a football ground, and there must be a real possibility that, for him, Villa Park was the sum total of his football experience.

In later years some of Keynes's disciples forgot not only his connection with Villa Park but also his view that price stability was a necessary condition for a successful economy. Tomorrow is the 80th anniversary of the death of Lenin, and it was to Lenin that Keynes attributed the remark: 'The best way to destroy the capitalist system was to debauch the currency. By a continuing process of inflation, governments can confiscate, secretly and unobserved, an important part of the wealth of their citizens.' After doing their best to test this proposition, successive British governments have committed themselves to stable and low inflation. And for the past decade, inflation has ceased to be a dominant consideration in the economic decisions of families and businesses.

That has been achieved by aiming at a symmetrical inflation target. Crucial to the success of such a policy is the ability to anchor inflation expectations on the target. For this to be the case, the target must be clear and well understood. From May 1997 the target was $2^{1}/_{2}$% for RPIX inflation. But in December the Chancellor gave the Monetary Policy Committee a new target for inflation. It is 2% as measured by the Consumer Prices Index or CPI, formerly known as the Harmonised Index of Consumer Prices.

What is this new inflation measure, and how will it affect monetary policy? On the RPIX measure, inflation was at or above target for the whole of last year. In contrast, the CPI measure of inflation was below 2% throughout the same period. Indeed, CPI inflation has been below 2% for all bar three months since May 1997, and it is almost six years since it was last above 2%. How can it be possible for inflation to move from above to below target—just like that? To answer that question, we need to examine how inflation is calculated.

Inflation is measured as the increase in the price of a particular basket of goods and services over the previous twelve months. So there are as many measures of inflation as there are baskets. Since no two people in this room spend their income on exactly the same items, in principle each of you could construct your own measure of inflation. The Office for National Statistics calculates an average inflation measure by weighting together the inflation rates of over 650 different goods

(1) Given in Birmingham on 20 January 2004. This speech can be found on the Bank's web site at www.bankofengland.co.uk/speeches/speech211.pdf.

(2) Unpublished writings of J M Keynes, copyright of the Provost and Scholars of King's College, Cambridge to whom I am grateful for permission to publish this extract. A reference to the letter appeared in Skidelsky, R (1983), *John Maynard Keynes Volume 1: Hopes Betrayed, 1883–1920*, Macmillan, London, page 280. The official attendance on 13 September was 38,575; the Villa scorer was the incomparable Clem Stephenson, who may have lacked pace but whose passes were, according to contemporary observers, 'as sweet as stolen kisses'; and the 'most expensive' right winger for Blackburn Rovers was John 'Jocky' Simpson who cost Blackburn a record fee of £1,850 when he was transferred from Falkirk in 1911.

and services, using as weights the estimated expenditure on each item for a representative household. But where do those prices come from? Each month—on 'Index Day' (either the second or third Tuesday of the month)—around 300 'price collectors' visit a wide range of retail outlets and record the prices charged for 130,000 different items, ranging from small loaves of brown bread to large lawnmowers. Each of these different items will have changed in price by a different amount. A key difference between the CPI and RPIX is how these 130,000 price changes are averaged to give a measure of overall inflation.

RPIX inflation is, for most goods, an arithmetic average of the inflation rates for each item. In contrast, CPI inflation is measured as the increase in the geometric average (the average of the logarithms) of the different prices. That reduces the weight given to those retail outlets where prices are rising the fastest, and allows the overall measure of inflation to take into account the way families are changing their shopping habits away from outlets where prices have been rising relatively rapidly, like traditional high-street stores, towards those where they have been rising relatively slowly, like newer more heavily discounted stores. For that reason, the formula used to calculate CPI inflation is superior to the formula used in RPIX. Arcane though it may sound, the 'formula' effect reduces estimated inflation in Britain by about half a percentage point a year.

In this respect, the difference between RPIX and CPI inflation as a measure of the economic temperature of the economy is rather like the difference between Fahrenheit and Centigrade as a measure of physical temperature. In both cases moving from one measure to another changes the number without there having been any change in the temperature itself. Because the temperature—whether physical or economic—is independent of the particular measure, then the implications for decisions which depend on temperature—whether of farmers deciding on when to harvest their crops and then how to price them or the Monetary Policy Committee deciding on when to change interest rates—are unaffected by the measure used, provided the conversion is calculated correctly. Hence the switch to a new CPI target has in itself no implications for monetary policy. But just as changing from Fahrenheit to Centigrade has not proved easy for those who had become used to the old measure, so it will take time for us all to adjust to the new inflation measure.

Unfortunately, there is an additional complication. Unlike the translation between Fahrenheit and Centigrade, the difference between RPIX and CPI inflation does vary with the economic temperature. That is because the 'formula' effect is not the only difference between the two measures. RPIX includes both house prices and Council Tax. Those items are omitted from the basket of goods and services used to construct the CPI. So when house prices are rising faster than prices in general, as has been the case in recent years, RPIX exceeds CPI inflation by more than the half a percentage point represented by the 'formula' effect. Over the past 15 years, when data have been collected on both measures, RPIX has exceeded CPI inflation by about three quarters of a percentage point. It is possible to argue, therefore, that moving from a target of 2.5% for RPIX inflation to one of 2% for CPI inflation represents a small increase in the long-run effective target. But no reasonable person could describe a symmetric target of 2% as inconsistent with price stability, defined as a state of affairs in which inflation does not materially affect economic decisions by families and businesses.

Of greater significance than the average difference between the two measures in the long run is the observation that the gap between them varies over time, often quite widely, in line with changes in the temperature of the economy in general and house prices in particular. At present the difference between the two measures is unusually large. It peaked at 1.7 percentage points in June, since when it has narrowed to 1.3 percentage points in December, but remains well above the 0.5 percentage points change in the inflation target. So the change in target gives the impression that inflation has moved from above to below target. Does this mean that monetary policy in the coming months will need to be looser under the new target than it was with the old target? The answer is no. The large difference between the two measures of inflation at present can mostly be explained by house price inflation. It is unlikely that house prices will continue to rise at their recent pace for much longer. We have already seen some slowing since the peak in 2002, and the Monetary Policy Committee judges that a reasonable central view is that house price inflation is likely to subside over the next two years or so. The gap between RPIX and CPI inflation is, therefore, likely to narrow to around half a percentage point over that period. So the change in the target is unlikely to have any material impact on the decisions of the Monetary Policy Committee in the near future. And our decision to leave

interest rates unchanged in January reflected that view. Although house prices do not enter the CPI directly, the Committee will continue to monitor the housing market as carefully as before in order to assess the implications for the inflation outlook resulting from changes in the balance between nominal demand and supply and in the exchange rate.

Equally, economic decisions made by businesses and individuals over the next year or so should be unaffected by the change in the target. If the degree of underlying inflationary pressure remains unchanged, and there is no difference in the stance of monetary policy, then the rates of increase of wages, earnings and prices that are consistent with the new target are no different from those which were compatible with the old target. In other words, wage bargaining should be unaffected by the switch in inflation target—as should price setting by firms. Of course, the new target will make clearer how much of an increase in money earnings represents a real rise in living standards—a pay increase of 2½% that was described as a 'cost of living' rise under RPIX will now be shown by the CPI as a ½% increase in real pay, even though no individual price has changed. The MPC will still need to monitor carefully developments in the labour market in case they signal a change in costs that might threaten the target in future.

In Jane Austen's *Emma*, the awful Mrs Elton, wife of the parson, dismisses the newly arrived family in the village with the words: 'They came from Birmingham. … One has not great hopes from Birmingham. I always say there is something direful in the sound.' But Birmingham and the manufacturing industries with which it has always been so closely associated have changed. Nowhere symbolises this metamorphosis better than Villa Park. Since Keynes's visit, Villa Park has changed from a 19th century Coliseum into a magnificent 21st century stadium, focusing on quality rather than sheer numbers. Manufacturing industry has also shifted its focus from traditional products valued by weight to high value-added products. But the case for price stability, which Keynes made so forcefully, is unchanged, as is the commitment of the Monetary Policy Committee to meet the inflation target—new or old.

Inflation targeting—achievement and challenges

In this speech,[1] *Rachel Lomax, Deputy Governor responsible for monetary policy, reviews the improvement in economic performance associated with inflation targeting, and explains why this approach to monetary policy works well. She argues that while monetary policy has become 'a less melodramatic affair', today's policy makers face substantial challenges in three key areas: assessing current developments, effective communication, and understanding future trends. She concludes that an open approach to uncertainty and disagreement has underpinned the MPC's credibility, and increased its ability to respond to changing circumstances.*

Ladies and Gentlemen, it is a great pleasure to be here in Bristol tonight.

Bristol and the Bank go back a long way. Our Agent in the South West, the late Michael Knight, was a founding member of this Society. And nearly two centuries ago—in 1827 to be exact—Bristol was one of the first branches that the Bank established outside London. Not that it was plain sailing. The Bank's first Agent in Bristol, Mr John May, resigned after only a few years complaining of the unhealthy situation of the branch premises, situated as they were next to the City Poor House and a pool of stagnant water, at risk of cholera and—this was the time of the great Reform Bill—riots and fire. By these standards, our present Agent, Kevin Butler, has no grounds for complaint.

My subject tonight is a more recent episode in our economic history: the improvement in economic performance associated with the adoption of inflation targets just over a decade ago. I will look first at why this approach to monetary policy seems to work, and then consider what challenges remain for policy makers.

Historical overview

One of the more dramatic developments in the final decades of the past century was the sharp fall in inflation worldwide. This remarkable phenomenon brought inflation almost everywhere to levels not seen for the best part of 50 years. Set against the long sweep of history, it is the 1970s and 1980s that now stand out—as a major, but time limited, episode of high global inflation.[2] In the United Kingdom, the period since 1992 has seen a shift to low and stable inflation combined with sustained economic growth, and steadily falling unemployment. Slightly miraculous as these developments may still seem to the generation that came of age during the Great Inflation of the 1970s—remember 'stagflation'?—the happy fact is that for anyone in their mid-30s, low inflation, steady growth and low interest rates are the norm.

Success has many parents, and the trend to low inflation is no exception. But there is a broad consensus that better monetary policies run by more independent and more open central banks can claim a significant share of the credit. The Short History of Twentieth Century Monetary Policy goes roughly as follows. For the first time since the collapse of Bretton Woods—arguably since the Gold Standard—after decades of unhappy experiments with fine tuning, incomes policies and monetary targets, buffeted by the explosive growth of financial markets and often misled by economic dogma, governments have finally found an approach to monetary policy that seems to work. And it works by setting clear limits on the role of governments themselves.

This is of course a caricature. But it is certainly true that the 1990s were a period of considerable reform and

(1) Given to the Bristol Society at the University of the West of England, Bristol, on 18 February 2004. I would like to thank Jens Larsen for research support and Luca Benati, Melissa Davey, John Power and Sally Srinivasan, whose work I have drawn on extensively. I have also benefited from comments from many colleagues at the Bank, especially Peter Andrews, Charlie Bean, James Proudman and John Keyworth. The views expressed here are mine, and do not necessarily reflect those of the Bank of England or the Monetary Policy Committee. This speech can be found on the Bank's web site at www.bankofengland.co.uk/speeches/speech215.pdf.

(2) See Rogoff, K (2003), *Globalization and global disinflation*, paper prepared for the Federal Reserve Bank of Kansas City conference on 'Monetary policy and uncertainty: adapting to a changing economy'.

innovation in central banks across the world; many new central banks were established and many established central banks were given greater independence from their governments, often in exchange for a clear commitment to meet specific targets for inflation. From the time when we left the Exchange Rate Mechanism in 1992, the United Kingdom has led this wave of change. Looking back, the adoption of formal inflation targets in 1992 marks a decisive break with the past.

The other key date is 1997, when the Bank of England was granted operational independence; the institutional framework then put in place entrenched and enhanced the credibility of inflation targeting, and has been widely admired. Moreover, in the United Kingdom, as in many other inflation targeting countries, a track record of success, built up over more than a decade, has progressively reinforced the credibility of these targets. As a result, people and firms have increasingly come to expect inflation to stay close to the official target—a belief that itself helps to keep it there.

Clearly the world has changed. For sure, there is still much we do not understand, both about the ebbing of global inflationary pressures over the past decade and about the impact of low inflation on the way that people behave. And there have been crises, such as the Stock Market Crash and 11 September. By past standards, though, modern monetary policy is a less melodramatic affair.

Has policy making become easier? I do not think so, though I suspect it looks that way. But let me give a fuller answer by setting out how the present approach to setting interest rates works and outlining some of today's challenges.

The policy framework

I shall start with inflation targeting as it has been implemented in the United Kingdom since 1997.

The institutional framework is set out in some detail in the 1998 Bank of England Act. This is extremely clear, both about the aims of monetary policy and about the respective roles of the Government and the Bank. On the one hand, the Bank of England is required to set interest rates so as 'to maintain price stability and subject to that to support the economic policy of HM Government, including its objectives for growth and employment.' On the other, the Government is required to specify what its economic objectives are, including what is meant by price stability. The remit of the Monetary Policy Committee (MPC) must be set out in writing at least annually and it must be published.

The remit has always had important elements of flexibility. For example, while the MPC is directed to aim for the target 'at all times' and to treat deviations from target symmetrically, it is not expected to react mechanically. Instead, if inflation deviates from target by more than 1 percentage point, the Governor is required to write to the Chancellor explaining the circumstances and setting out what action the MPC considers necessary to return to target. No letter has been written so far, but only because circumstances have not warranted it.

There is an explicit understanding that operational independence must be accompanied by transparency and clear accountability to Parliament and the general public, as well as to Government. The Bank's forecasts are published in the quarterly *Inflation Report*, the minutes of MPC meetings are published within two weeks, and the nine members of the MPC appear regularly in front of Parliamentary committees, as well as undertaking between them some 50–60 regional visits a year to different parts of the United Kingdom.

The Committee has a distinctly individualistic bias, in contrast to the consensus seeking traditions of many other central banks. It includes four external members who are appointed for their expertise, not as representatives of interest groups; and all members are individually accountable for their votes, which are made public with the minutes. Both the markets and the press take a keen interest in the pattern of voting, and members will often find a way to explain their thinking in more detail.

All this adds up to a powerful set of incentives for members of the MPC to focus on maintaining price stability; to pay attention to all relevant information; to weigh up the risks; to take timely decisions; and to explain them clearly. Moreover, clarity about the aims of policy and the transparency of the decision-taking process give the MPC significant scope to influence the longer-term interest rates set by the market.

It is a far cry from previous policy regimes, when the main players faced very different incentives. Prior to 1997 the key decision makers were politicians, who both set objectives for monetary policy and took responsibility for the technical judgments needed to

meet them. Politicians can rarely afford the luxury of focusing on one objective to the exclusion of all others. Attempts to win credibility by constraining their discretion, notably through setting monetary targets, were a fairly comprehensive failure.

Interest rate decisions have been the subject of some famous tussles between Number 10 and Number 11 Downing Street under successive Governments. Here is Chancellor Denis Healey, writing in his memoirs(1) about a spat with the Prime Minister of the day:

'At this time my own relations with Jim were shaken by an incident just after the Party Conference. On October 6 I had asked him to let me raise interest rates by another 2 per cent to the then unprecedented level of 15 per cent…He refused. I said I wanted to take the matter to Cabinet that morning. 'All right' he replied 'but I will not support you.' Nevertheless I insisted…'

In the event this did not prove necessary: Callaghan backed down, leading Healey to comment wryly:

'This was the only time I have ever used the threat of resignation to get my way.'

The new framework has taken the politics out of interest rate decisions without sacrificing democratic accountability or oversimplifying the policy process. It is an elegant institutional solution to the lengthy debate between those who favoured untrammelled discretion and those who advocated rules (such as monetary targets); one, moreover, that manages to respect the constitutional priorities of a parliamentary system.

Achievements

Performance over the six years since the Bank became independent has been impressive. Against the target of 2.5% for RPIX inflation, which ran from 1997 until December 2003, the average was 2.4%. For 68 out of the 79 months, inflation was within 0.5 percentage points of the target—below it for 42 months, above it for 30, and on target for the remaining seven. Notwithstanding the Stock Market Crash and the slowdown in world activity, the UK economy has continued to grow steadily and employment has remained strong.

On a longer-term view, the decade of inflation targeting since 1992 looks remarkably stable by post-war standards.(2) The recent slowdown has been exceptionally mild compared with all previous slowdowns since the beginning of the 1970s, and since 1992 growth in both real GDP and consumer spending has also been significantly less volatile, with 46 quarters of positive growth, and no significant downturn in consumption since mid-1994. Prior to the 1970s, recessions were virtually absent, but real GDP was much more volatile than it has been in the past decade.

Of course, better monetary policy and low inflation are only part of this story. It matters that monetary policy has been supported by fiscal discipline. Just as important are the many labour and product market reforms that, over a long period of time, have given us a more flexible and competitive economy, which is capable of adapting quickly to sudden change without prolonged periods of unemployment and underutilised capacity.

Attitudes towards inflation

American economist Alan Blinder once said: 'Price stability is when ordinary people stop talking and worrying about inflation.' Has low inflation entered our bloodstream yet? This is a hard one but there are some clues.

Expectations about future inflation seem to have fallen steadily over the past decade and are now clustered around the Bank's target. This is supported by survey evidence, including surveys of trade union officials, and evidence drawn from financial market prices. A recent Bank of England survey of the general public(3) pointed to interesting, though small, differences across age groups, with younger people expecting lower inflation on average than their parents. When it comes to inflation, people have very long memories.

The evidence also suggests that firms and wage bargainers are now more disposed to expect inflation to revert to target if something happens to throw it off course: in that sense inflationary expectations are better anchored. This should make the task of policy makers easier. After all, if wage bargainers and firms themselves act as if the Bank will take action to offset any potential disturbance to inflation, the need for the Bank itself to

(1) Healey, D (1989), *The time of my life*, Michael Joseph, London.
(2) Benati, L (2004), 'Investigating inflation persistence across monetary regimes', *Bank of England Working Paper*, forthcoming.
(3) Lombardelli, C and Saleheen, J (2003), 'Public expectations of UK inflation', *Bank of England Quarterly Bulletin*, Autumn, pages 281–90.

actually change interest rates will be that much less. This, in a nutshell, is the intuitive reason why a credible policy regime should help to produce more stability in output as well as inflation.

Challenges

Inflation is low, expectations are well anchored, and the real economy works better as a result. These achievements are important and they were hard won. We must not take them for granted. But nor can we live in the past. So what are today's challenges? I see these in three main areas: assessing current economic developments; effective communication; and understanding the new trends that will shape the future.

(i) Assessing current developments

Broadly speaking, the task for the MPC is to control inflationary pressure by ensuring that the level of aggregate demand in the economy is more or less in line with aggregate supply. The first and most basic challenge comes in translating this deceptively simple idea into practice.

It is hard enough to estimate how fast demand is growing now from incomplete, preliminary or just plain puzzling information. It is harder still, and even more important, to look ahead over the two or three-year horizon relevant to setting interest rates. But that is only part of the story. The rate at which demand can be allowed to rise without leading to an upturn in inflation depends both on how much spare capacity there is in the economy now and on factors that determine the future growth in supply, such as productivity and labour availability. And finally, we need to consider what effect our own actions will have on longer-term interest rates and through them on the wider economy.

Inflation targeting provides a credible framework within which these complicated issues can be properly considered. That is important, but it does not change the need to make judgments, or even make the judgments any easier. Data get revised; models oversimplify; forecasts are fallible. It is essential to invest in state of the art techniques; indeed the Bank has just introduced a new macroeconomic model. But progress depends just as much on recognising all the uncertainties and allowing for them in a systematic way.

The monthly interest rate decision requires a complex assessment of all the evidence. We need to be both sceptical and open minded, if we are to avoid major error: sceptical when it comes to interpreting the data, but alert for signs that we may be getting it wrong. The decision to raise rates in February, while inflation was still well below the new target, reflected a top-line view that inflationary pressures were likely to build over the next couple of years. While this has been the emerging picture for some months now, we have been surprised by a number of developments pointing in different directions, which have needed careful evaluation—notably, the resilience of household spending and the strength of the exchange rate. We have also had an opportunity to reconsider earlier judgments, especially about the amount of spare capacity and the likely growth in potential supply. That is the nature of the exercise.

March will be another month. There can be no foregone conclusions when it comes to setting interest rates. Every month I may have a fairly well-developed view not just about this month's interest rates, but about where interest rates are likely to need to go in the future, to achieve the inflation target. But that view may—indeed should—change in the light of new information, better research, another set of forecasts, perhaps a different view of the risks. In that sense every month is a fresh decision. What does not change is what we are trying to achieve. This clarity about aims is what gives us the flexibility to learn, so important if we are to avoid major error.

(ii) Effective communication

Maintaining this clarity through effective communication is critical. The MPC aims to be as open and straightforward as possible. Sometimes this involves lengthy explanations of rather arcane issues. A recent example is the change in the inflation target. As you probably know, in January the Chancellor has just replaced the inflation target of 2.5%, as measured by the RPIX, by a 2% target as measured by the new CPI. We have used speeches, Parliamentary appearances and short articles to set out as clearly as possible the nature of this worthwhile, but essentially technical, change in order to underline one simple message: that the change in target in no way weakens the commitment to price stability, and indeed has no material implications for monetary policy.

It has been harder work to explain our thinking about the altogether more newsworthy subject of the strong growth in household spending, and its relationship with escalating house prices and household debt. Bad

memories of boom and bust in the late 1980s and early 1990s get in the way of more nuanced explanations which try to reflect how the world has changed in the past decade. The truth is that the present situation is rife with uncertainties. For example, while it is not difficult to think of reasons why the level of house prices relative to income might have risen significantly in recent years, at no less than 40% above their long run average, current levels definitely stretch the imagination. Are people behaving rationally? Hard to say—individuals are notoriously prone to overoptimism about their own prospects, but it is not obviously misguided to base decisions on a view of the future that reflects the record of macroeconomic stability I described earlier. What clearly is irrational is to assume that current rates of house price inflation will continue indefinitely.

It has also been a challenge to explain how house price inflation and borrowing fit within an inflation targeting framework. One commentator has claimed that they are 'the targets that dare not speak their name'. This is not so. True, the Committee has debated endlessly how far a strong housing market can explain the resilience of household spending, and the risk that a sharp correction in house prices will dent consumer confidence and administer a nasty deflationary shock. Inevitably such questions do not have clear cut answers—for example, the relationship between house prices and consumer spending, never well defined, has shown tantalising signs of weakening over the past few years.

But the message we have tried to get across is that house prices and borrowing are part of the wide range of evidence we review monthly in assessing the outlook for inflation. They have also been important in shaping our view of the balance of risks. They do not have a special role, as targets, in driving interest rate decisions.

(iii) Understanding future trends

Let me come to my final set of challenges: understanding the new forces that are shaping the future. This is what successful businesses have to do, and we need to share their insights. There is an important role here for the Bank's regional Agents. Their most valuable input to the MPC can be the stories that illuminate their regular surveys of their 8,000 contacts around the country, bringing to mind Nobel prize-winner George Stigler's quip that 'the plural of anecdote is data.'

Let me give you an example. Since 1996 the National Accounts have painted a picture of a boom in household spending, with the volume of personal consumption growing by 3¾% a year on average, compared with real GDP growth of 2¾%. But for the past couple of years at least, the Bank's Agents have been talking about a much tougher world 'out there', with demanding shoppers on a ceaseless 'search for value' using new technology to search out bargains as well as to make purchases, driving an endless round of discounting across a wide range of consumer goods.

It is a fact that in *value* terms, the growth in household spending has been slowing since the middle of 2000. Much of the strength in the volume of consumption reflects lower prices which have boosted consumers' spending power, for given incomes. Since 1998 the price of durables has fallen by 14%, while the price of other goods and services has continued to rise. The falls have been spread across a range of categories, including cars, clothing and sports goods, though the fall has been particularly marked in IT/audio visual goods. So it is not surprising that spending on durables accounts for virtually all the growth in the volume of consumption—an average of over 8% a year compared with around 2% for other goods and services.

The interesting questions are why this has happened, how far it will go and how long it will last.

We know that the United Kingdom's terms of trade have improved substantially since the mid-1990s, as the price of our imports has fallen more than the price of our exports, boosting domestic spending power. But this seems to be partly an IT story, much of it concentrated in capital rather than consumer goods; and lower prices may be related to exchange rate changes, which could be temporary.

Clearly new technology is playing an increasing part in helping consumers to search out bargains as well as to make purchases. While the total value of on-line sales remains relatively small, it is clearly growing very rapidly. Comprehensive data are still hard to come by, but one source suggests that on-line sales have risen more than tenfold over the past four years. Several recent reports have pointed to a sharp acceleration in the second half of last year, as the habit of e-shopping spreads. Structural changes within the retail sector are also part of the story. High-street retailers are facing stiff competition from the major supermarket groups across a wider range of products.

What is driving these changes? No doubt there are many factors at work, but I find the Agents' picture of an increasingly demanding consumer quite thought provoking. We live in a consumer society, and shopping, in one form or another, is what many people do much of the time; helped by technology, why would they not learn to do it rather well? And indeed one of the benefits of low inflation is that price signals carry more information, making price comparisons worthwhile.

Understanding what is happening is relevant to monetary policy. To the extent that a fierce competitive struggle is squeezing retail margins, it is likely to affect the short-run outlook for inflation. While such a squeeze will not have an effect on inflation in the longer term, it could herald a lasting improvement in productivity across the sector as a whole.

This brings me to my final issue: whether productivity in the United Kingdom will accelerate as it seemingly has in the United States.(1) Since 1995 the growth of US productivity has doubled and the improvement has been sustained through the Stock Market Crash. This is directly relevant to current thinking about US monetary policy. If faster productivity growth has indeed helped to create a high level of spare capacity and contributed to a higher growth in underlying supply, holding interest rates at historically low levels for some time should not add to inflationary pressures, even if demand grows rapidly. This is a key reason why the Fed believes it can be 'patient' in raising interest rates.

The US evidence does seem to suggest that productivity has accelerated and that ICT has played a substantial role in raising productivity in non ICT sectors. This answers one puzzle, neatly posed by US economist Robert Solow when he commented that 'You can see computers everywhere but in the productivity statistics.' But it also raises the equally interesting question of why no such acceleration has yet been detected in the United Kingdom (or continental Europe) despite huge ICT investment in the late 1990s.

The possible answers to this question cover the full range from the pessimistic—it is never going to happen because there are institutional and other barriers to realising the benefits of ICT, in the shape of regulations, planning restrictions, or restrictive labour practices—to the optimistic—it will definitely happen given time, but the lags are long and variable.

The truth is, of course, that we do not really know, despite much research both in the United States, here and elsewhere. For what it is worth, I take it as read that realising the benefits from investment in ICT is about much more than buying kit. As anyone who has ever run a business knows, investment in ICT must be accompanied by changes in the way the job is done. Managing change is a notoriously costly and disruptive business. So some temporary slowdown in productivity growth in the wake of heavy investment in ICT is not surprising.

If that is right, the questions for monetary policy makers become harder: namely, when, where and by how much will productivity growth eventually pick up? What is the likely impact on potential supply? As it happens, the projections in the February *Inflation Report* do project a pickup in supply over the next few years, but that reflects improved labour availability rather than an assumption that there is an ICT-led productivity miracle in the making. But we could easily be wrong. Given recent experience, there is clearly some risk of undue pessimism, though it has to be said that past policy errors have more often been the result of too much optimism. One thing is for sure: we cannot afford to sit back and wait for the data to tell us the answer. By the time we have that degree of certainty policy will have moved on. So productivity will remain a key issue for us over the coming years.

Conclusion

That brings me to my final challenge for policy makers: how to handle uncertainty in taking and presenting policy decisions.

The MPC has met this challenge head on from the beginning. Within the discipline imposed by a shared inflation target, the Committee has been very open, both about uncertainty and about the disagreement that is likely to go with it. Published MPC forecasts have explored rather than glossed over risks and uncertainties. The individual accountability of MPC members reduces the incentive to search for consensus. MPC members have always voiced their different views in public, and while this is not without risk to the clarity of

(1) Basu, S, Fernald, J G, Oulton, N and Srinivasan, S (2003), 'The case of missing productivity growth: or, does information technology explain why productivity accelerated in the United States but not the United Kingdom?', forthcoming in Gertler, M and Rogoff, K (eds), *NBER Macroeconomics Annual 2003*, Vol. 18, MIT Press. Available from the NBER web site: www.nber.org/books/macro18/.

the message, and has occasionally led to an uncomfortable personalising of decisions, I see it as an inherent part of the system, not a quirk of particular personalities.

The big prize is long-term credibility, and nowadays there is no credibility without openness. This is what gives the present framework the flexibility to respond to changing circumstances, and allows members of the MPC to change their minds in the light of experience. And in an uncertain world this openness to learning is a pre-condition for success under any policy regime.

Risk, uncertainty and monetary policy regimes[1]

In this speech, Paul Tucker[2] explores how option prices can shed light on the risks in the current financial environment, including uncertainty about the expected path of monetary policy.

Although monetary policy may have become more credible, there is evidence of greater uncertainty at present about the path of nominal interest rates, especially in the United States. When official rates are materially away from their 'neutral' level, there may be uncertainty, not only about future shocks, but also about how, absent shocks, the central bank will return to 'neutral'.

In the United Kingdom, there have been few periods over the short life of the MPC when policy has proceeded to unwind its response to past shocks and so return towards 'neutral' along a smooth path. So there have been few opportunities to observe how the MPC would choose to do so.

Above and beyond this, however, market uncertainty seems not to have been influenced by the change in the Government's inflation target.

It is a pleasure to be here.

As asset/liability managers, you grapple with many of the issues that, from the other side of the fence, confront central bankers as we pursue our mission to maintain monetary and financial system stability. For both of us, risk management is integral to what we do; and, amongst other things, that entails trying to make sense of financial markets. In your case, it includes forming expectations about policymakers' objectives and actions. In our case, it includes trying to decipher whether asset price changes provide a diagnostic on what is going on in the economy, including the credibility of the monetary regime. As capital markets have developed, there has been a richening in the instruments available to you to manage risk, and consequently in the diagnostic indicators available to us. For quite a few years now, most conferences on financial risk management have given centre stage to the use of options in hedging (and taking) risk. Flipping that into the world of central banking, I want to explore whether options prices can shed any light on risks in the current financial environment, including uncertainty about the expected path of monetary policy. I shall also examine whether the recent changes in the United Kingdom's inflation target have affected uncertainty about the decisions of the Monetary Policy Committee. The conclusions are, I am afraid, far from conclusive, but I hope that they will give you some flavour of how, at the Bank of England, we are trying to apply surveillance and analysis of markets to our core mission.

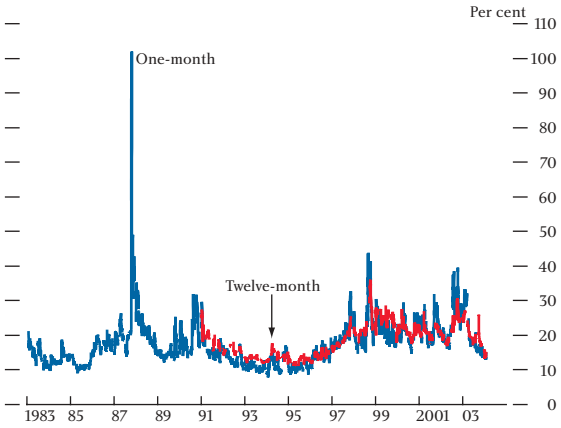
Environmental risks facing the global financial system

Had we been here this time last year, the centre of our discussion would probably have been risk in the equity and credit markets. Companies on both sides of the Atlantic were still in the middle of adjusting to the excesses of the second half of the 1990s. Reflecting that, equity markets remained highly volatile and credit spreads elevated, including for some parts of the international banking system. The heightened sense of fragility worryingly apparent during September-October 2002 had passed. But uncertainty about war and about the prospects for macroeconomic growth—and so about the value of corporate sector debt and equity—remained high. At least as judged by asset prices, things

(1) A version of this speech was delivered to the UK Asset and Liability Management Association on 29 January 2004. With many thanks to Niki Anderson, Peter Andrews, Rob Scammell, Fergal Shortall and Peter Westaway; and to Sandra Bannister for secretarial support. The views expressed are those of the author and do not necessarily reflect those of either the Bank of England or other members of the Monetary Policy Committee.
(2) Member of the Monetary Policy Committee and Executive Director for Markets.

could hardly look more different today. Equities are up over 40% from March 2003 lows; forward-looking measures of equity volatility, derived from option prices, are at or below the averages of the past couple of decades (Chart 1);[1] and credit spreads, across sectors and countries, are low (Chart 2).

Chart 1
Implied volatility of the S&P 500 index



Source: Chicago Mercantile Exchange.

Chart 2
Investment-grade credit default swap indices by region

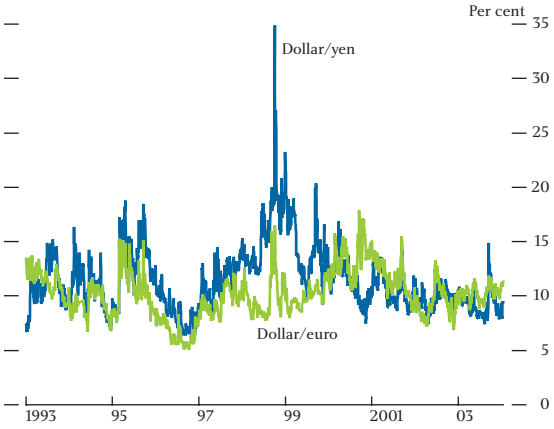
Source: TRAC-X.

Perceptions of reduced credit risk owe much to the steps taken by many large corporates to strengthen balance sheets, for example by extending debt maturities. Monetary policy has not been incidental to this. As well as sustaining household spending, low interest rates—and, notably in dollar markets, the expectation over the past year or so that official rates would remain low for some time—have facilitated corporate sector balance sheet strengthening by reducing yields on long-maturity bonds. And demand for corporate debt instruments has been strong in an environment of low *ex-ante* nominal returns on government bonds—part of a wider 'search for yield' highlighted by the Bank[2] and others. Indeed, it cannot be ruled out that the tightening in credit spreads may have overshot.

But, currently at least, the greater uncertainties concern the future paths of global interest rates and exchange rates. The Bank has therefore gone to some trouble in recent *Financial Stability Reviews* to stress that, notwithstanding improvements over the past year or so, the environment for financial firms is not hazard-free. That has also been the message from our network of market contacts around the world.

The story on exchange rates is at least superficially clear, and the background does not need spelling out here: a large and persistent US current account deficit, subdued domestic demand in the euro area, intervention by Asian central banks to build up their foreign exchange reserves and/or hold down their currencies, etc. What is, perhaps, surprising is that options-based indicators of uncertainty about exchange rates have not risen much as global imbalances have accumulated over recent years (Charts 3 and 4). One possible explanation for this is that, as part of the 'search for yield' I referred to, writers of options may be prepared to take increased risk in order to receive the premium income—in other words, the degree of uncertainty felt by market participants may not be fully apparent in options prices. Another

Chart 3
One-month implied volatilities of major currency pairs

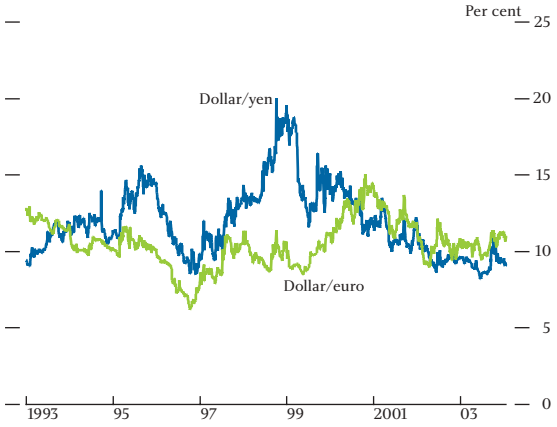


Source: UBS.

(1) The comparison depends on whether the sharp spikes in implied volatility that accompanied the 1987 crash, the recent boom/bust etc are omitted in calculating the average. I prefer to omit them when thinking about whether or not current equity implied volatility is unusually low.

(2) See, for example, the June 2003 (pages 11, and 15–17) and December 2003 (pages 13, and 17–18) issues of the Bank's *Financial Stability Review* for a discussion of this.

Chart 4
One-year implied volatilities of major currency pairs



Source: UBS.

possible explanation, emphasised by some market contacts, may be that market participants believe that central banks will smooth any correction in exchange rates. I suppose that projecting such talismanic powers onto the central banking community might just be flattering, but it is certainly not comforting, and we had better guard against its becoming intoxicating.

Options-based measures of monetary credibility

By contrast, there should be a somewhat more straightforward connection between uncertainty about nominal interest rates and perceptions of central bank policies—depending on the monetary regime, including the perceived probability of regime change.

The level of short-term nominal rates expected in, say, 10–20 years' time can be broken down into the expected steady-state level of real interest rates, the rate of inflation expected to prevail then, plus risk premia.(1) Whereas, in the real world of sticky prices, the monetary authority has a big influence over the level of short-maturity real interest rates, it has none over long-term real rates, which are determined by such things as the trend rate of productivity growth, the rate at which households discount their future welfare etc. In other words, uncertainty about the risk-free real component of long bond yields should not be sensitive to views on the monetary regime. By contrast, the credibility and nature of the monetary regime will have a direct impact on both the rate of inflation expected to prevail in the future and on how confident or uncertain people feel about their expectations.

Thus, it is widely remarked that conventional gilt yields—and, more to the point, long-maturity nominal forward rates—edged down during the first half of the 1990s, as the inflation-targeting regime introduced in 1992 accumulated credibility; and that they then stepped down, by around 50 basis points, when the current government announced Bank of England independence on 6 May 1997 (Chart 5). In other words, medium-term inflation expectations fell to a level that has been more or less in line with the target for inflation—a vital measure of credibility.

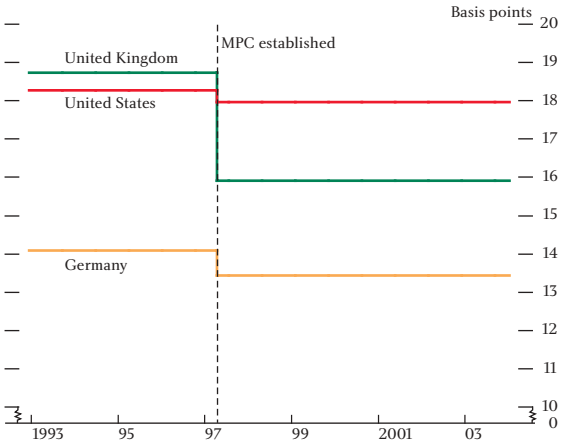
Chart 5
20-year interest rates

Credibility should also entail that month-by-month policy decisions do not reveal information about the central bank's objectives, since in a credible regime they would not be altering. Under a regime lacking credibility, by contrast, one would expect long-term nominal interest rates to change as and when interest rate changes were perceived as shedding light on policymakers' objectives. So, other things being equal, an increase in credibility might be accompanied by lower volatility in long-term forward rates following policy changes.(2) Rather than exploring volatility following official interest rate changes, Chart 6 shows that the volatility(3) of long-maturity sterling forward rates has declined since 1997.

Historical volatility is, by definition, backward looking, and could be affected by a whole range of transient influences on yields. Less familiar but, crucially, forward-looking indicators of credibility can in principle be derived from option prices because greater uncertainty will, other things being equal, raise the value

(1) For ease of exposition, I ignore risk premia for much of this presentation.
(2) This proposition was explored in Haldane, A and Read, V (1999), 'Monetary policy and the yield curve', *Bank of England Quarterly Bulletin*, May, pages 171–76.
(3) Measured in basis points rather than per cent.

Chart 6
Average historical volatility(a) of ten-year forward rates



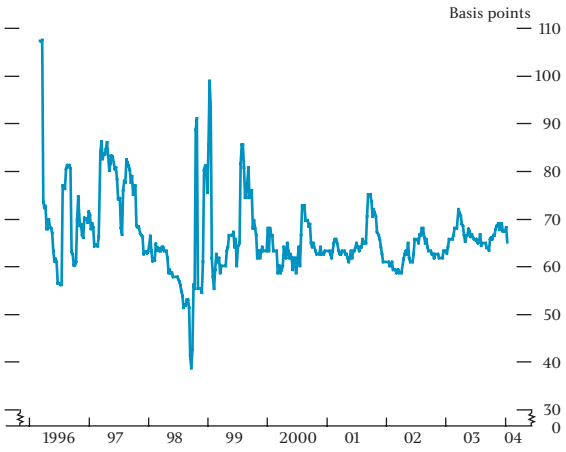
(a) Three-month standard deviation.

of an option. In consequence, estimates of the implied future volatility of financial assets can be backed out from option prices.(1)

In a monetary regime with low credibility, one would expect there to be a lot of uncertainty about the rate of inflation, and thus about the level of short-term interest rates, over the medium to long term. So there would also be a lot of uncertainty about future yields on long-maturity nominal bonds. If one wanted to buy insurance on future nominal bond yields, the premium would be higher than in a credible monetary regime. This can be specified a bit more precisely. Insurance policies last for different periods. So do options: one can buy options with different periods to expiry (three months, one year, five years, ten years etc) on interest rates of different maturities (one month, six months, one year, five years, ten years, 20 years etc).(2) In a low-credibility monetary regime,(3) I would expect uncertainty about the level of interest rates—both short-maturity rates and longer-maturity yields—to be particularly high over long horizons as market participants would not have much of a clue about what the monetary authority would do over a period of many years. To be concrete, I would expect a shift from a low-credibility monetary regime to a credible regime to be accompanied by a fall in the implied volatility of long-term options on interest rates.

Has that happened in the United Kingdom? Unfortunately, we do not have time series for long-term options going back beyond 1996. Chart 7,(4) showing implied volatility on an option with ten years to expiry on 20-year swap rates, is suggestive of a fall since 1996–97, but it is not conclusive. A longer time series is available for options with three months to expiry on entering into ten-year swaps—going back to early 1993, when the credibility of the inflation-targeting regime was plausibly still in doubt (Chart 8). On this measure, implied volatility averaged 120 basis points up to May 1997 but has averaged 88 basis points since then. The time series is, though, dominated by spikes in early 1994, Autumn 1998 and Spring 1999, corresponding to particular instances of short-lived volatility in global fixed-income markets. It is not surprising that sudden shocks or crises like the LTCM crisis in October 1998 should temporarily raise uncertainty about bond yields, since the shock would persist for a while as investors, intermediaries and others adjusted their risk exposures. The spikes do not, therefore, provide evidence of fluctuations in monetary credibility. On that view, one would expect the historical volatility of implied volatility

Chart 7
Implied volatility of a ten-year option on a 20-year swap



Source: JPMorgan Chase.

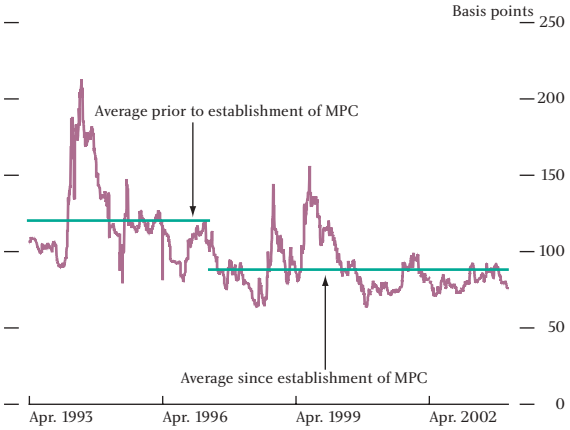
(1) Implied volatility, based on the Black-Scholes option-pricing formula, is commonly interpreted as a measure of the expected standard deviation of the return on the underlying asset over the life of the option. Implied volatility is, therefore, usually reported as a percentage.

(2) The data in this paper are from options on swaps, known as 'swaptions': see the box on page 24 of the June 2002 *Financial Stability Review*. A swap is a financial contract where the counterparties exchange a Libor-based floating-rate stream of payments for a fixed-rate stream of payments (at the 'swap rate'). Swaps and swaptions are traded in over-the-counter (OTC) markets. The options used in this paper are 'European' options, which can be exercised only at the terminal date and not before; the analogy with insurance is more exact for 'American' options, which can be exercised at any time but are less frequently traded in OTC fixed-income markets.

(3) This is ignoring extreme circumstances like hyperinflation when there would effectively be zero credibility and things could only get better over the long run.

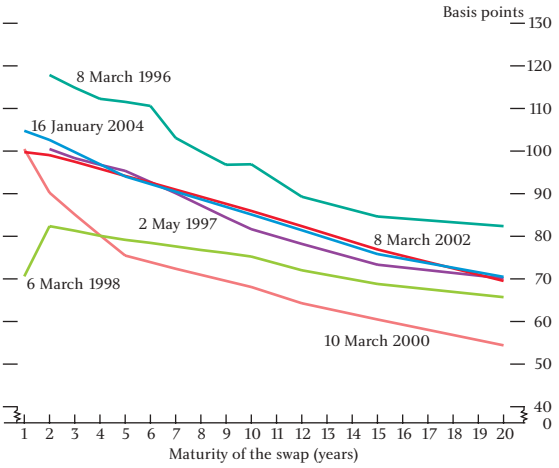
(4) This chart and the others show implied volatility in terms of basis points of yield. If, for reasonable levels of interest rates, the size of any change in interest rates by the central bank is unrelated to the level of rates, implied volatility measured in basis points is a better indicator of uncertainty than a percentage measure.

Chart 8
Implied volatility of a three-month option on a ten-year swap



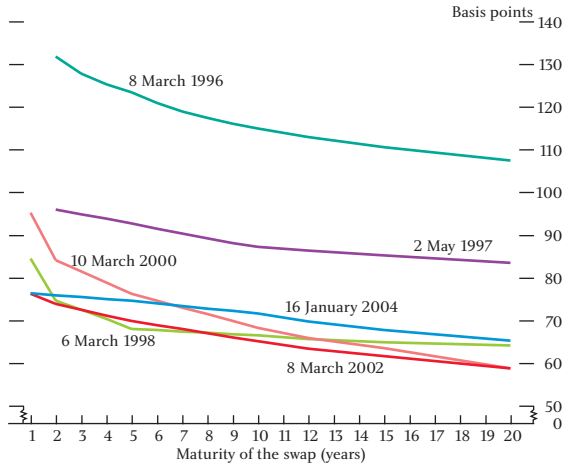
Source: Barclays Capital.

Chart 9
Term structure of implied volatility of ten-year option on dollar swaps of various maturities



Source: JPMorgan Chase.

Chart 10
Term structure of implied volatility of ten-year option on sterling swaps of various maturities



Source: JPMorgan Chase.

to be greater on short-expiry options than on long-expiry options on interest rates. Unfortunately, that merely underlines that a longer time series of long-maturity swaption implied volatility is needed to assess robustly whether or not inflation targeting has reduced uncertainty about UK interest rates. Ideally, one would like data going back to the 1980s or even the 1970s, but the swaptions market did not exist then!

Fortunately, I think one can perhaps get a little more out of the available data. This turns on intuitions about what one would expect the term structure of implied volatility to look like in a credible regime. First, for an option with a long time to expiry, I suggest that one would expect the degree of uncertainty about the level of short-term interest rates to be slightly higher than that about yields on longer-term bonds.(1) The former will reflect the possibility that at the time of an option's expiry, say ten years ahead, the official interest rate might be a little above or below its steady-state level because the central bank may be responding to a shock then, whereas a longer-term yield will average out cyclical fluctuations in short rates over the life of the bond. In a regime lacking credibility, however, the long yield would not be pinned down and so there would be more uncertainty about it. Charts 9 and 10 show that, for an option with ten years to expiry, the term structure of implied volatility does slope downwards for both dollar and sterling interest rates.

Second, in a credible regime, I would expect that the degree of uncertainty about the path of interest rates over a relatively short period (say three months) would typically vary according to the maturity of the interest rate. I would guess that the market's uncertainty would typically be fairly low about the very near-term path of short-term interest rates as the market would usually believe that the central bank was likely to set rates in a fairly narrow range over its next few meetings, particularly if it usually moved in steps of, say, 25 basis points. But I would expect that there would be somewhat greater uncertainty about the path of interest rates out to, say, two to three years, during which policymakers would be responding to unforeseen cyclical developments in the economy or unwinding their response to past cyclical shocks—news about the economic outlook or about the central bank's thinking

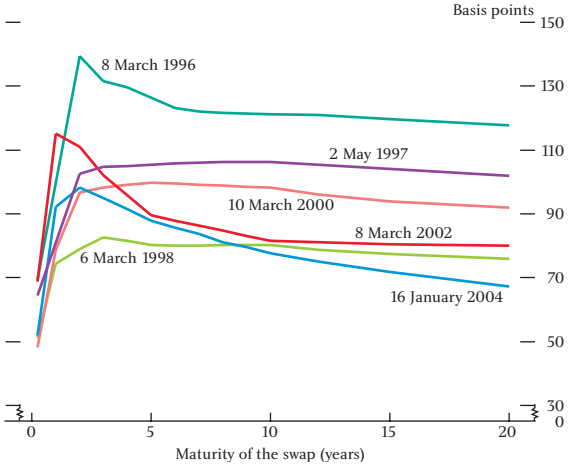
(1) The discussion here is about yields, not about forward rates. For a long-expiry option, the term structure of implied volatility on forward rates would plausibly be flat.

about the outlook could emerge over the life of the option. And, finally, I would expect that, on average,(1) near-term uncertainty would be lower again about long-maturity yields because they are influenced less by the business cycle than short-term interest rates—provided that the market was confident that there was a low probability of any near-term changes to the monetary regime. So, my guess is that the implied volatility on a short-term option across the term structure of interest rates would have a shape similar to that shown in Chart 11.

Chart 11
Hypothetical implied volatility of short-term option on swaps of various maturities

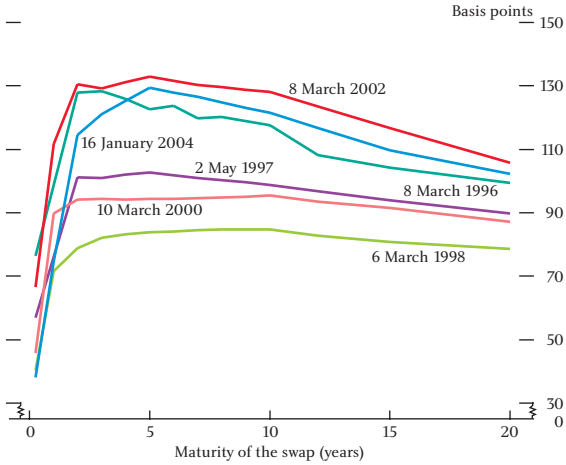
Does it look like that for the United Kingdom? Chart 12 suggests that broadly speaking it does, but with the implied volatility curve occasionally flattish beyond two to three years. The same is true of the dollar and euro/DM markets (Charts 13 and 14).(2)

Chart 12
Implied volatility of three-month option on sterling swaps of various maturities



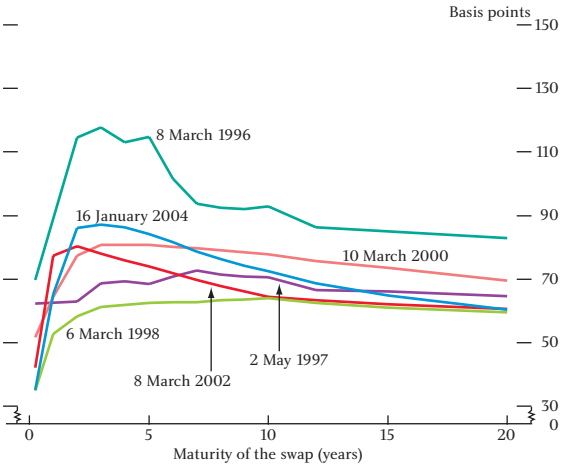
Source: JPMorgan Chase.

Chart 13
Implied volatility of three-month option on dollar swaps of various maturities



Source: JPMorgan Chase.

Chart 14
Implied volatility of three-month option on euro swaps of various maturities



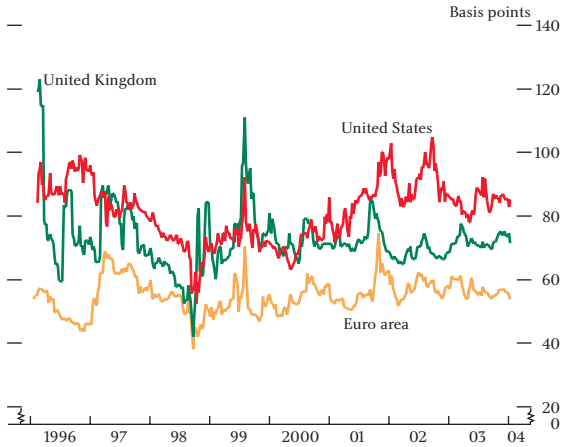
Source: JPMorgan Chase.

The US regime has, of course, been credible for much longer than the relatively new UK regime; as has the euro-area regime if it is regarded as continuous with the predecessor Bundesbank regime for the Deutsche mark. Is that apparent from time series for long-term options on long-term yields? Chart 15 shows a time series going back to early 1996—not really long enough to support robust conclusions.

Perhaps the most striking feature of this proxy measure of longer-horizon uncertainty about long-term yields is that dollar interest rate implied volatility is consistently higher than euro interest rate implied volatility, and has also been higher than sterling interest rate implied volatility over the past few years. This is a puzzle.

(1) I say 'on average' because, over any particular period, near-term volatility may be affected by financial market disturbances, such as the LTCM crisis.
(2) Deutsche mark denominated swaps are used for the period before 1999.

Chart 15
Implied volatility of a ten-year option on a ten-year swap



Source: JPMorgan Chase.

Various possible explanations come to mind. The first is that, absent an explicit inflation target, the market may conceivably be more uncertain about future average inflation in the United States. A second possible explanation is that uncertainty about long-maturity yields may have risen given debates a few months ago about the possibility of official purchases of US government bonds as part of 'unconventional' monetary policy if the 'zero bound' for the official rate were to be hit—although the wedge between dollar and 'euro' implied volatility goes back at least to the mid-1990s. A third possible explanation arises from the distinctive features of the US mortgage market: namely, that households have an option to repay mortgages early, which they will exercise when mortgage yields fall below the rate on their existing mortgage.(1) In their efforts to buy insurance against their prepayment risk exposure, holders of mortgage-backed securities and others may bid up the price of options on medium to long-term rates, given that there are few natural suppliers of the insurance in an environment where there is a structural imbalance between the financial system, which is short the option, and the household sector, which is long. If so, derived implied volatility plausibly exaggerates the degree of uncertainty that market participants in fact have about long-term dollar nominal interest rates.

There are potential distortions in other swaptions markets too. Contacts suggest that the prices of both sterling and euro-denominated swaptions have at times been pushed higher by long-term savings institutions, such as insurance companies, buying hedges against their having guaranteed minimum nominal returns on savings products. Sometimes such distortions can be quite persistent.

Uncertainty and the current conjuncture

Shorter-maturity options are probably more liquid and so, on the whole, may give clearer readings of uncertainty about the near-term path of policy, to which I now turn. As I said earlier, the economic recovery under way in the United States and Europe has been promoted by low official interest rates. Short-term real rates have been negative in the United States, around zero in the euro area and, although slightly higher, below most estimates of 'neutral' in the United Kingdom.(2)

The counterpart to this is the debate in the market about the path central banks will take back towards 'neutral' if, as widely expected, economic recovery is sustained and spare capacity is gradually put back to use, putting upward pressure on inflation. In dollar interest rate markets in particular, commentators and financial firms' risk managers wonder about the possibility, if and when the FOMC eventually raises its rate, of revisiting the fairly extraordinary bond market volatility of late July/early August last year. A suggestion made then was that, although exceptional, the realised volatility was probably lower than it would have been had the FOMC's rate moved, as it did when the episode of heightened volatility in 1994 was triggered. On this view, while holders of mortgage-backed securities were heavy sellers of fixed-rate instruments last summer in order to stay in line with their asset/liability duration mismatch targets, other financial firms maintained long positions that continued to enjoy positive carry, given that official rates were unchanged and were expected to remain so for some while. The suggestion was, therefore, that volatility could be exacerbated by the management of those risk exposures as expectations about the timing and extent of any FOMC changes ebb and flow.

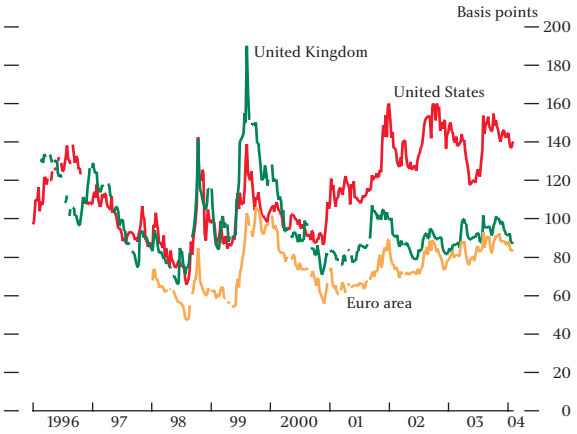
Judging by the market debate about so-called 'exit strategies', uncertainty about the path of policy over the next few years is especially pronounced in the United States. An argument can, I think, be made that there is likely to be moderately greater uncertainty about the

(1) I discussed this in a speech to the Leeds Financial Services Initiative in August 2003, reprinted in the Autumn *Quarterly Bulletin*, pages 366–78. See also the box on page 22 of the Bank's December 2003 *Financial Stability Review* and pages 70–71 of the June 2002 *Review*.

(2) The concept of a neutral, or natural, interest rate goes back to Wicksell's *Interest and Prices* (1898) and *Lectures on political economy, volume II: money* (1906).

path of the policy rate when it starts off materially away from (above or below) neutral than when it is broadly around neutral and the economy is otherwise on its steady-state path. In the latter case, uncertainty about the policy rate will broadly stem from uncertainty about the pattern of shocks that could hit the economy and so elicit a policy response. But where policy is materially away from neutral, there is plausibly not only that uncertainty about future shocks but also uncertainty about how, absent shocks, the central bank would return to neutral. This is assuming that the market is not so well informed about the central bank's reaction function that it is confident about the path back to the neutral range. So, in terms of the options-based diagnostics I deployed earlier, the argument would be that implied volatility on, say, a six-month option on, say, five-year bond yields would be greater when policy was materially away from neutral. If so, one might expect that to be apparent in dollar interest rate markets at present. It does, in fact, seem that implied volatility on short-term dollar interest rates has risen over the past few years relative to both euro and sterling rates (Chart 16), although it cannot be ruled out that that owes something to mortgage convexity hedging.

Chart 16
Implied volatility of a six-month option on a five-year swap



Source: JPMorgan Chase.

What about the United Kingdom? The recent position here has been that if the economy proceeds along the path implied by our November 2003 *Inflation Report* projections, the MPC's repo rate will need gradually to rise to keep inflation in line with the target. This important point was reported in the minutes of our December and January meetings. I was one of the members who emphasised it, in those terms.

While not completely uncharted territory, over the short life of the MPC there have been few periods when policy has proceeded to unwind its response to past shocks and so return the official rate towards 'neutral' along a smooth path. *Ex post*, over the past six years, another shock has always come along first. In the months that followed independence in May 1997, the MPC was initially raising rates to catch up with the implications for the inflation outlook of earlier positive shocks to aggregate demand; the repo rate reached 7.5% in June 1998. During late 1998 and early 1999, when that tightening was being unwound, monetary conditions had to be eased to ensure that they were accommodative in the face of the disturbances to global confidence following the Russian and LTCM crises and a further increase in sterling's exchange rate; the repo rate reached 5% in June 1999. Domestic demand soon recovered and policy moved to restrain growth again following unexpected labour market strength and rapid increases in consumption. But equity market falls from Spring 2001 and the slowdown in the global economy, exacerbated by 9/11, required once again an accommodative stance. (The focus, throughout, was firmly on the outlook for inflation.) The significance for my remarks today is that there have been few opportunities for market participants and others to observe how the MPC would choose to return rates back to around 'neutral'.

I have wondered whether the conjuncture in dollar interest rate markets and elsewhere has been behind some of the commentary about central bank communication over recent months. Statements about the future course of policy can in theory aid the market and the formation of expectations in the economy more generally. But the key here is to be clear that any such steers are unavoidably conditional on the current outlook based on current data etc. As conditions change, expectations of future policy settings would change, and so therefore would the message. Capturing an inherently state-contingent proposition in elegant prose is not easy. The MPC's communication effort is, in consequence, focused on the minutes of our monthly meetings, lengthy background analysis in the quarterly *Inflation Report*, and our quarterly projections for output growth and inflation, which are very explicitly conditional on current economic circumstances. We publish those projections on two bases: unchanged official interest rates and the market interest rate curve. Market participants and others can observe any differences between them.

Interpretation of the MPC's recent analysis has, perhaps, been complicated slightly by a degree of ambiguity in the term 'gradual' when we have referred to gradual rises in rates if the economy recovers as projected. The first, most obvious and, to my mind, most important sense of 'gradual' in this context is simply that, other things being equal, I would expect us to reduce the degree of stimulus to demand broadly in line with reductions in spare capacity in the economy and any consequent increases in inflationary pressures looking ahead. The second—and quite different—sense of 'gradual' is a term of art referring to the proposition that if the impact of policy changes on the economy has become more uncertain, then policymakers should move in smaller steps than would otherwise be optimal.(1) At present, the suggestion has been that the increase in household indebtedness may have increased uncertainty about how interest rate changes will affect the economy, and so the MPC should proceed cautiously. Since, other things being equal, I would expect us to move back towards 'neutral' gradually (in the first sense), I am not sure that any 'gradualism' of the second variety would be easy to detect.(2)

The change in the United Kingdom's inflation target: has it increased uncertainty about monetary policy?

Communication is also the main challenge for us given the change in the United Kingdom's inflation target. Having flagged the possibility last June, the Chancellor of the Exchequer announced on 10 December that the United Kingdom's inflation target was changing from 2.5% on the RPIX measure to 2% on the new Consumer Prices Index (CPI). What does this mean?

There are quite a few changes.(3) Some goods and services are treated slightly differently in the two indices (eg new cars, insurance). The weights given to elements of the basket differ too: for example, RPIX does not take into account the spending patterns of the 4% of private households with the highest incomes, whereas the CPI does. But the two most important changes are to coverage, and to the formula for calculating the inflation rate for bundles of similar goods. Unlike RPIX, the CPI does not include housing depreciation and Council Tax. And the inflation rate for some categories of goods is calculated via an arithmetic mean in RPIX but by a geometric mean in the CPI.(4)

Both these changes affect the rate of increase of the CPI relative to RPIX. The so-called 'formula effect' reduces the measured rate of inflation, as a geometric mean is always less than (or equal to) an arithmetic mean. On average over recent years, the formula effect has been worth around $^1/_2$ a percentage point. That $^1/_2$ is not fixed. It has varied from month to month over the 15 years for which we have data, but the range around $^1/_2$ has been fairly narrow.(5) It is reasonable to assume that it will continue to make the annual rate of increase in the CPI about $^1/_2$ a percentage point lower than in RPIX.

The coverage effects are slightly different. The 'housing depreciation' element of RPIX is proportional to a (lagged) measure of house price inflation. Other things being equal, it would therefore be expected to rise at around the rate of nominal earnings over the medium term—somewhat faster than the average of other goods and services in the RPIX index. Looking back, Council Taxes have also risen faster than the rest of the index over recent years, although looking forward it is harder to project a medium to long-run relationship.

So over the long run, one would perhaps expect the difference between the rates of increase of the two indices to be slightly more than $^1/_2$ a percentage point—the difference between the two targets. A number of commentators seem to expect that the difference will average around $^3/_4$ of a percentage point over the long term, but with considerable uncertainty around this estimate.

(1) This is often referred to as 'Brainard uncertainty' as described in Brainard, W (1967), 'Uncertainty and the effectiveness of policy', *American Economic Review*, Vol. 57, pages 411–25. See also Batini, N, Martin, B and Salmon, C (1999), 'Monetary policy and uncertainty', *Bank of England Quarterly Bulletin*, May, pages 183–89.

(2) In principle, any Brainard-type 'gradualism' or 'caution', which can be an important consideration in monetary policy, may be easier to detect when policy moves away from neutral (and the economy away from its steady-state path) in the face of a shock, as in those circumstances the initial policy response might be smaller than would otherwise be optimal and be followed by further policy moves in the same direction. In practice, most central banks' policy settings seem generally to exhibit such autocorrelation, so it is difficult to know whether or not 'Brainard uncertainty' plays a role. See Goodhart, C (1996), 'Why do monetary authorities smooth interest rates?', *LSE Financial Markets Group special paper*, No. 81, for more on this.

(3) For more detail, see Roe, D and Fenwick, D (2004), 'The new inflation target: the statistical perspective', *Economic Trends*, January.

(4) Broadly, this means that, for goods and services that do not have individual weights in the index, whereas in the RPIX the inflation rate of *n* goods is the sum of the individual inflation rates divided by *n*, in the CPI it is the *n*th root of the product of the *n* inflation rates.

(5) Over the period since 1995 the size of the formula effect has ranged between 0.4 and 0.7 percentage points.

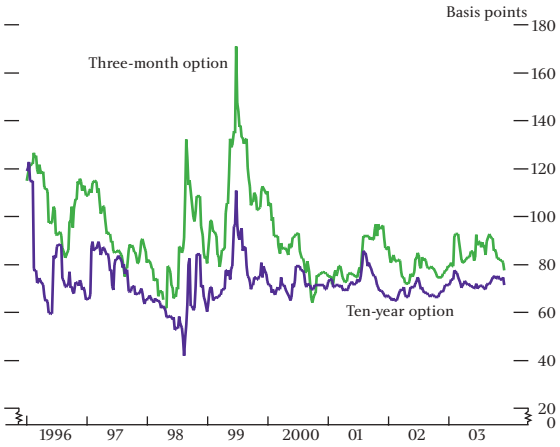
Significance of the new inflation target for the monetary regime

The changes have therefore raised the following questions. Do they imply a loosening of monetary policy? Do they amount to a regime change? Are they material to the near-term path of the MPC's policy settings? Do they have implications for asset prices?

Do the changes entail a 'loosening' of monetary policy? I think the fairly widespread references to a 'loosening' are misleading, and therefore unfortunate. If—as it happens, a big 'if'—it were certain that the difference between the two measures was, say, ¾ of a percentage point (and that there was no change in agents' views of the true, unobservable rate of inflation that they care about), then the effect of reducing the target by 0.5 percentage points would be to increase the steady-state (ie long-term) nominal rate of economic expansion by around ¼ of a percentage point. The notion that this would be a 'loosening' of monetary policy harks back to the language used when thinking about monetary conditions in terms of monetary aggregates. For unchanged velocity of money, the steady-state rate of growth of the monetary aggregates would increase by around ¼ of a percentage point. This would have no effect on the real economy over the long run. Most important, provided the change was credible, it would not entail what, in today's world, is generally called a loosening of monetary policy, ie that short-term real interest rates would be lower. It simply means that, other things being equal, medium to long-term inflation expectations would be very slightly higher.

Do the changes entail a regime change? No. Even if one assumed that the changes definitely entailed an increase in steady-state inflation of around ¼ percentage point, it would hardly amount to a regime change. The regime is to achieve price stability. And it really cannot be argued that the new target of 2% CPI inflation is inconsistent with price stability. A difference of around ¼ percentage point would be immaterial in terms of the welfare costs of anticipated inflation.(1) And, returning to the diagnostics I used earlier, there is no evidence from option prices that the changes have increased uncertainty about long-term nominal interest rates—over either short or long horizons. If anything, short-horizon uncertainty about long-term nominal interest rates seems to have edged down very recently (Chart 17). That there has not been a rise in long-horizon uncertainty is hardly surprising: over a period of a decade or so, adjustments would have been made to the RPI, as part of the ONS's work programme, that could have an effect of that modest size. And changes could conceivably be made to the CPI—for example, the introduction of a measure of housing costs, which Eurostat is studying—that might reduce any differences of coverage between CPI and RPIX.

Chart 17
Implied volatility of different options on a ten-year swap

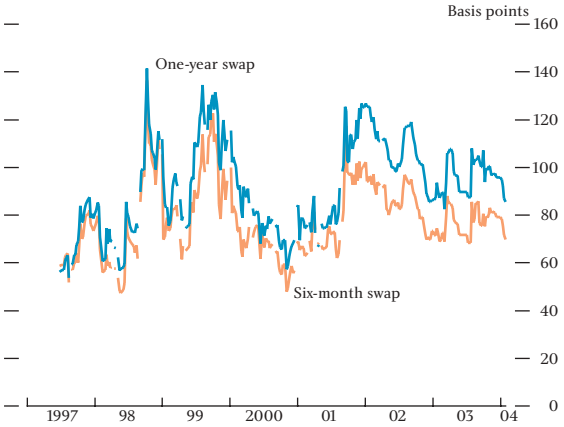


Are the changes material to the Committee's near-term decisions? The answer to this depends on the outlook for the prices of the items included in the RPIX but not CPI. Over the past few years, house prices have been rising much faster than normal, so the wedge between annual RPIX and CPI inflation has been unusually large: it peaked in May 2003 at 1.7 percentage points, compared with an average of around ¾ of a percentage point since 1989, when the CPI was first compiled. The Committee's recent view has been that house price inflation is most likely gradually to moderate over the next couple of years—to below its steady-state rate and below the rate of general price inflation for a while. In consequence, the CPI/RPIX inflation wedge is likely to narrow to below what would be expected on average over the longer term. On that basis, projections for CPI and RPIX inflation would, therefore, be pretty similar relative to the respective targets. That will make the explanation of policy settings easier, since the change in target should not make much difference to the MPC's decisions on interest rates over the next few months. Again, this is

(1) One of the principal works in this area is Lucas, R (2000), 'Inflation and welfare', *Econometrica*, Vol. 68. No. 2, pages 247–74. See also Sinclair, P (2003), 'The optimal rate of inflation: an academic perspective', *Bank of England Quarterly Bulletin*, Autumn, pages 343–51.

backed up by Chart 18, which shows that the level of uncertainty about the near-term path of policy is not at all unusual and has, in fact, edged down recently.

Chart 18
Implied volatility of three-month options on swaps of various maturities



The new inflation target and asset prices

Do the changes have any implications for asset prices? I rather doubt it, but it is worth making the analysis clear, as the change does perhaps usefully highlight some subtleties in how indexed gilt yields should be interpreted as a proxy of risk-free real rates.

The relevant element of the changes in this context is the switch from arithmetic to geometric averaging described above. This is a better way of measuring changes in the cost of living for the 'average' household, as it is more sensitive to the fact that people shop around, and so shift the pattern of their spending to shops where prices are rising less rapidly than elsewhere.(1) In consequence, the so-called formula effect of around ½ a percentage point—and the accompanying reduction in the inflation target of 0.5 percentage points—is indicative that the rise in the cost of living has over the years been around ½ a percentage point lower per year than measured by RPIX. As the Governor recently observed,(2) 'the new target will make clearer …. [that] a pay increase of 2½% that was described as a 'cost of living' rise under RPIX will now be shown by the CPI as a ½% increase in real pay ….'

The same nominal/real split carries across to asset prices, and in particular to bond yields. As stated earlier, long-term nominal interest rates comprise the steady-state real interest rate plus the expected inflation rate (plus risk premia). The switch from an RPIX target of 2.5% to a CPI target of 2% will make clearer, assuming credibility, that medium to long-term expectations of cost-of-living increases should be around 2% not 2½%, and that the remaining component of medium to long-maturity nominal yields represents a real return. Provided investors have understood that RPIX has overstated cost-of-living increases by around ½ a percentage point on average, there are no implications for asset prices.

For bond market participants, a wrinkle arises from the design of inflation-indexed gilts (IGs). The coupons on IGs, which of course are paid in money, are indexed to RPI.(3) Because the RPI plausibly overstates cost-of-living increases, the RPI uplift on IGs overcompensates investors for cost-of-living increases: part of the uplift—on average around ½ a percentage point—represents a real return. The required real rate of return to an investor in IGs is delivered via a combination of the conventionally calculated (IG) yield plus an expected real return from the RPI uplift. In other words, conventionally calculated IG yields are not necessarily the best measure of the risk-free interest rate, which is used as a benchmark for real returns from other, riskier assets such as equities, property etc. The 'measuring rod' needs to be adjusted for the bias in RPI/RPIX as a gauge of cost-of-living increases.

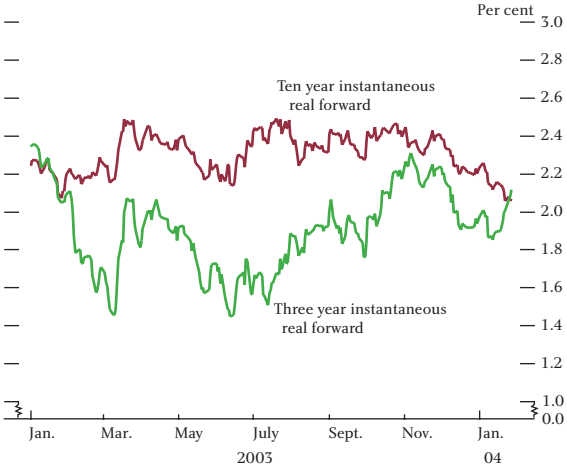
Is it conceivable that investors would have been awakened to this for the first time by the change in the inflation target? I doubt it, but it is worth conducting a thought experiment on the implications for bond yields if, hypothetically, that were the case. In those circumstances, assuming that their view of 'true' steady-state real rates was unchanged, IG prices would rise and conventionally calculated IG yields fall—by roughly ½ a percentage point. Likewise, under these assumptions, long nominal forward rates would be expected to fall too. On waking up to the 'formula effect', these hypothetical investors would realise that nominal rates had been overcompensating for inflation—by around ½ a percentage point on average. Separately, on an assumption that investors demand a return on nominal bonds that compensates for expected increases in the prices of items that are included in RPIX but not

(1) A geometric mean gives relatively more weight to goods whose prices increase more slowly, thus capturing some of this substitution effect.
(2) In a speech on 20 January 2004 to the annual Birmingham Forward/CBI business luncheon, Birmingham, reproduced on pages 74–76 of this *Bulletin*.
(3) In what follows, it is assumed that RPI and RPIX inflation are on average the same in the long run.

the CPI (housing depreciation etc), nominal forward rates would be slightly higher than otherwise. As discussed earlier, market commentators seem to think that that may for the time being be worth roughly 1/4 of a percentage point or so. In summary, on the demanding assumptions made here, observed medium to long-term forward IG yields would fall by around 1/2 a percentage point, nominal yields by around 1/4 of a percentage point, and derived inflation expectations would rise by around 1/4 of a percentage point.

Index-linked yields have, as it happens, fallen quite sharply since December: by around 30 basis points at ten years. This seems not to be explained entirely by falls in short-maturity rates reflecting an altered view of the path of monetary policy: long-maturity real forward rates have fallen too (Chart 19). These moves have taken real forward rates slightly outside their 'trading range' in the year leading up to the Chancellor's initial statement (measured by one standard deviation either side of the mean rate over the period). Likewise, derived inflation expectations have risen too, but not unusually so at longer maturities compared with the path of the year to last June (Charts 20 and 21).

Chart 19
Real forward interest rates as derived from index-linked gilts



There are, however, persuasive reasons for thinking that asset prices have not been affected by the change in the target. First, the yields on dollar and euro inflation-indexed bonds have also fallen over the past few months implying that the fall in IG yields since December is not due to local factors (Chart 22). Second, the existence of inflation-indexed government bonds elsewhere—the United States, France, etc—

Chart 20
Real forward interest rate curve relative to June 2002–June 2003 trading range

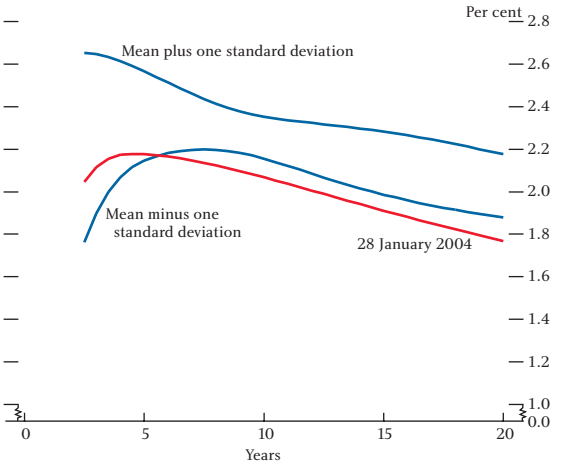


Chart 21
Forward break-even inflation rates relative to June 2002–June 2003 trading range

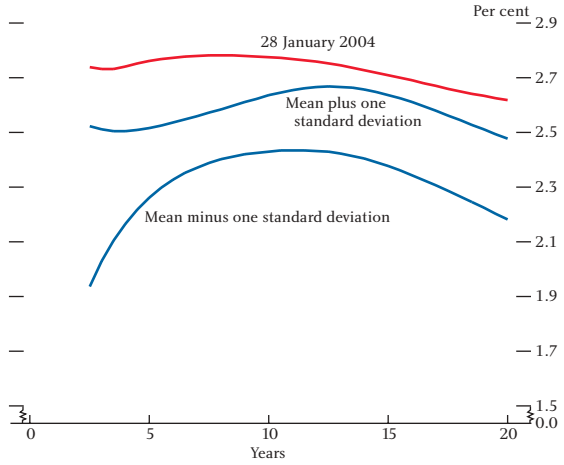


Chart 22
International ten-year real yields

should have sensitised investors to the significance of the details of the price indices used for the inflation uplift and so to how well, or not, they capture changes in the cost of living—especially since the 1996 Boskin report on possible biases in the US consumer price index.(1) In the same vein, because IGs are uplifted by RPI rather than RPIX there has often been a short-term wedge between the RPIX measure of inflation and the index applied to IG payments. So investors in UK indexed gilts should be used to thinking about, and adjusting for, the details of price indices.

Third, a persistent mistake about the nominal/real split delivered by an RPI-based uplift would have entailed *ex-post* real returns on IGs exceeding the *ex-ante* return. I suppose that it is just about conceivable that the difference would be too small to notice. And it is possible that institutional investors holding IGs to match RPI-indexed liabilities would not be sensitive to this. But it does not seem likely that the analytical firepower deployed in today's global capital markets would have missed it.

So the point I want to emphasise is simply that care needs to be taken in interpreting conventionally calculated indexed gilt yields as a measure of risk-free rates.

For people generally, the key point is that no price index precisely captures the cost of living for individual people or households in the economy, as we each consume different baskets of goods and services. Changing the price index does not alter anyone's cost of living. Communicating this is vital.

As is communicating that the switch in the target is not material in the crucial sense that a target of 2% on the CPI measure and 2½% on the RPIX measure are both consistent with price stability. At present, CPI inflation is below our 2% target, whereas RPIX inflation is above our old target of 2½%. But that does not have material implications for the near-term path of policy because, as I discussed earlier, the MPC expects the wedge between the two measures of inflation to narrow on the basis of our view that house prices will decelerate over the next year or so. That is not to say that, over the long run, policy will always be identical under the CPI target to what it would have been under the RPIX target—we set policy on a month-by-month basis. But it does underline that the transition can be smooth. Consistent with this, bond options suggest that the change in the inflation target has not affected uncertainty about the near-term path of policy or the credibility of the regime.

Summary

A credible monetary regime requires that households, firms and financial markets believe that the central bank will do what it says. For inflation targeters, a key indicator is therefore whether medium to long-run inflation expectations are in line with the target. In the United Kingdom, they have been since the mid-1990s. But I do not think a regime could reasonably be described as credible, or inflation expectations as anchored, if the central expectation was that the central bank would stick to its target but with considerable uncertainty about whether it would do so. This is no idle matter: well anchored expectations enable the central bank to offset shocks to the economy more effectively, since the shocks themselves have less effect on inflation expectations and the central bank's responses do not raise questions about the regime.

Yields on bonds do not give us a handle on uncertainty. Bond options, whose prices reflect uncertainty, can in principle do so. I have tried to show today that option-based measures of uncertainty about future nominal interest rates in the United Kingdom are consistent with gains in credibility during the 1990s, and exhibit similar characteristics to indicators for the United States and continental Europe, where monetary policy has been credible for rather longer. Robust conclusions cannot, I have stressed, be reached from the data/charts I have deployed. Longer runs of data are needed to explore these issues thoroughly; and it is necessary to aim off for possible illiquidity—and so for time-varying risk premia—in the swaptions market. But I do believe that it is a potentially fruitful area for enquiry. And I trust that I have explained some of the ways in which, in pursuing our monetary and financial stability mission, central banks now monitor these markets for information on perceptions of policy and for indicators of risk taking or hedging.

(1) Boskin, M *et al* (1996), *Towards a more accurate measure of the cost of living*, final report to the Senate Finance Committee, 4 December.

E-commerce and the foreign exchange market—have the promises been met?

In this speech,[1] *Paul Fisher, Head of the Bank's Foreign Exchange Division and Chair of the Foreign Exchange Joint Standing Committee, surveys the continuing impact of technology on trading in the foreign exchange market. Criteria are suggested for evaluating the impact of new developments on the effectiveness and efficiency of the market, and some of the benefits and risks are assessed against these criteria. The speech concludes by noting that the codes of conduct which govern foreign exchange markets around the world will need to keep pace with the issues arising from the use of new technology.*

It is a pleasure to be invited to address you this morning as the first keynote speaker at this, the fourth Annual Foreign Exchange Markets Summit. In tackling the issues surrounding the benefits of e-commerce this morning I am going to be wearing two closely related hats.

First, as Head of the Foreign Exchange Division at the Bank of England, I am interested in the developments in the foreign exchange market as they affect our own operations: these include management of the United Kingdom's foreign exchange reserves, with assets totalling some $45 billion and management of the foreign-currency elements of the Bank of England's balance sheet with assets totalling around $20 billion. More importantly, as a central banker, I am interested in how developments in the foreign exchange market affect the Bank's core responsibilities for monetary and financial stability and our role in promoting the effectiveness of financial markets.

My second hat—which is, as I said, closely related—is as Chairman of the Foreign Exchange Joint Standing Committee (or FXJSC).

For those of you who do not know much about the FXJSC and its work, a short history may be helpful. This is not a total digression from the topic of this talk—you will see that, in the past, the FXJSC has spent a great deal of time considering the impact of technology on the foreign exchange market and that e-commerce in particular is very much a current topic of interest.

The FXJSC was formed in the Autumn of 1973 as an initiative of both the banks and the broking community: specifically it was set up at the request of what was then called the Foreign Exchange Committee (FEC—a powerful group representing the banking community) and the Foreign Exchange and Currency Deposit Brokers' Association (the FECDBA). These two organisations were engaged in some rather difficult negotiations over a wide range of issues, not least the rate of brokerage which was then negotiated centrally for the market as a whole. The FXJSC was established to intermediate between the banks and the brokers, with the Bank taking the chair and providing the secretary.

Throughout its 30 years of life the FXJSC has been heavily involved in drafting or influencing the code of conduct for transactions in the wholesale market in foreign exchange and that is now the bread and butter of the Committee's work. As an over-the-counter, professional market, foreign exchange has always been regulated by a code of conduct rather than legally enforced supervision. Until the late 1980s these codes were published in the form of a letter to market participants from the chair of the FEC. The details of those regimes need not bother us today, but I briefly offer you the following list covering the past 35 years or so which may jog some memories:

1967–75	'the (Mr) Stirling letter'
1975–88	'the O'Brien letter(s)/regime'
1988–2001	'the London Code of Conduct'
2001–to date	'the Non-Investment Products Code' known as the NIPs code.

(1) Given at the fourth Annual Foreign Exchange Markets Summit, on 19 January 2004. I am grateful to many colleagues at the Bank for comments and suggestions. In particular I would like to thank Alexander Flatner for providing vital background research. Any views expressed in this speech are those of the speaker and not necessarily those of the Bank of England. This speech can be found on the Bank's web site at www.bankofengland.co.uk/speeches/speech210.pdf.

Today, one of the prime responsibilities of the FXJSC is to review and maintain the NIPs code on behalf of the wholesale foreign exchange market in London. This initiative came out of the creation of the Financial Services Authority which took on the Bank of England's supervisory and regulatory functions. But it was agreed that the foreign exchange market should continue to be subject to a code of conduct and the foreign exchange part of that code would be devised, published and maintained by the FXJSC in consultation with other market groups (the NIPs code also covers the bullion market and wholesale money market).

The Committee now consists of some 25 members including heads of foreign exchange trading from 16 banks (formally chosen for their market knowledge and experience, not to represent their institutions), 3 representatives of the broking community including the Wholesale Markets Brokers' Association (WMBA), trade associations such as the Association of Corporate Treasurers and the British Bankers' Association. The Committee continues to be supported by the Bank through the Chair and Secretary and, importantly, its meetings are also attended by the FSA. Internationally the Committee has established good contacts with seven committees in other centres: New York, Tokyo, Frankfurt, Canada, Singapore, Hong Kong and Australia. But London remains the largest foreign exchange market centre in the world. The latest BIS triennial survey showed that some 32% of transactions in the global market were priced in London: twice the number in the next-largest centre (New York).

In addition to reviewing the NIPs code, the Committee has always kept a watchful eye on developments in the structure of the foreign exchange market, especially those related to technological innovations in the market.

Going back through the files the following technology-related issues have attracted the attention of the Committee:

- Tape-recording systems (1976).
- Reuters Mark I and Mark II dealing systems (1977 onwards).
- 'Squawk boxes' (1979).
- London's telecoms infrastructure (1980).
- Telex confirmation and automated confirmation systems (1980–84).
- Relocation of back offices overseas (1994).
- Herstatt risk, the Allsopp report (1996), Continuous Linked Settlement.
- Internet trading (1996 and onwards).
- Y2K (1998 and 1999).

All of these issues have been considered in terms of their impact on the market and how it operates. E-commerce in the foreign exchange market has been a regular discussion topic in the past two years with two separate subcommittee reports. The latest can be found on the Bank's internet site(1) but a version is also available in the *Bank of England Quarterly Bulletin*(2) and I believe that the conference organisers have kindly made that available in your packs.

The work of the Committee has therefore been of great help, not only to me with my central banking hat on, but also when, at events such as these, I am asked to try to answer the question posed in the title of my speech, which I will now try to do, albeit from my own perspectives.

Efficient and effective markets—for any good or service or financial product—are essential to the economic welfare of society. I hope I do not need to elaborate to this audience that free, competitive markets are a key mechanism in ensuring that resources are efficiently allocated between competing ends in our society. The foreign exchange market is absolutely central to this process on a global scale. An efficient foreign exchange market allows, of course, for goods and services to be traded internationally. More importantly in the context of this conference, it facilitates the cross-border trading of other financial instruments—equities, bonds, credit derivatives etc—thus contributing to the efficient allocation of capital internationally. As a general principle, the more efficient and effective the foreign exchange market is in this function, the greater should be economic welfare in the global economy as a whole.

The key question for this speech is whether new technology has delivered many benefits and, from my perspectives, that means how it has affected the efficiency and effectiveness of the market. I am going to take a pretty broad view of new technology to include the following: electronic broking in the interbank market, single-bank e-portals, multi-bank e-portals, and some of the related developments such as prime

(1) See www.bankofengland.co.uk/qb/qb030208.pdf.
(2) See Foreign Exchange Joint Standing Committee e-commerce subgroup report (2003), *Bank of England Quarterly Bulletin*, Summer, pages 235–39.

brokerage and white labelling. Although only some of these can strictly be called e-commerce, they are actually all intimately related. I also want to say something about Continuous Linked Settlement.

To address these issues I am going to set out some of the key criteria that might be used to evaluate any market development. There is no unique or definitive approach to this that I am aware of, but my personal list certainly includes: liquidity, transactions costs, operational risk, market risk management, settlement risk and market integrity.

First, liquidity: a key question is whether any market development improves liquidity. To be clear, what I mean is the ability to trade in significant size on demand without substantially moving the price against the trader.

Transactions costs: the investment in new technology should naturally reduce cost per transaction. I do not include in this the cost of 'failed trades'—that comes next—or the capital costs. What I mean is simply the physical systems cost of processing. That includes the cost to end-users—or the buy-side if you prefer—and for that group, the transactions costs include the profits being earned by the intermediary. As the market gets more efficient and more competitive, bid/offer spreads should narrow and the price for the end-user should get closer and closer to that in the interbank market. For constant risk, that should represent an improvement in economic welfare.

Operational risk: given that the majority of foreign exchange trading is in relatively simple products, the 'failure' rates that people have mentioned to me privately can be surprisingly high. By a failed trade I mean, for example, disputed trades or non-matching trade confirmations or other settlement errors. The costs of clearing up such problems can be significant and the FXJSC used to spend a lot of time and effort in helping to resolve disputes. I also include under operational risk the disruption to the market caused by system crashes.

Market risk management: the monitoring, analysis and management of risk in financial markets is still very much a growth industry. Developments in trading and settlement systems can help make risk management more effective, eg by speeding up the passing of deal information to the risk manager or providing more or better quality information.

Settlement risk: in particular the so-called Herstatt risk, which is the probability of a counterparty defaulting at a point when one leg of a foreign exchange trade has been paid but the corresponding payment by the defaulting counterparty has not been received. Reducing this form of settlement risk has been a key objective for central banks for at least the past ten years. I also include under this heading the more prosaic risk arising from inappropriate legal agreements. A particular problem is caused by the proliferation of very similar names but different legal entities within a single corporate structure.

Market integrity: I mean by this the protection of confidential information about clients, the quoting of true market prices, the absence of fraud or other criminal activity etc. This is a subject which all trading operations have to be constantly alert to, in order to protect both themselves and their clients.

I am sure that many of you here could add to this list or provide me with a better classification scheme, but let us see whether this one captures the benefits and risks. I should stress that most of what I am about to say is based on what I or colleagues hear in discussion with those of you in the industry.

Considering the interbank electronic systems first, these are hardly new with Reuters having been around for over 20 years—but it is obvious they remain absolutely key in underpinning the e-commerce platforms and so they are worthy of a few thoughts here. I think it is clear that EBS and Reuters have become very impressive liquidity 'pools'. The number of transactions on both systems has been steadily rising in recent years, despite continued consolidation in the interbank market generally, and, although liquidity is sometimes concentrated, for example around fix times, there has been little evidence of significant price-gapping even when trading is hectic. Overall, these systems seem to have delivered clear benefits to the interbank market.

The counterpart to the efficiency of these systems is just how dependent on them the industry has become. The volumes being traded every day are huge—EBS alone averages some $90–$100 billion a day and up to 700 trades a minute. When there are systems or external communications problems—as happened a few times just recently with EBS and in Autumn 2002 on Reuters—the disruption, even from a few seconds of broken links or a period of slow running, can be quite

significant. These events also serve as a timely reminder of how much the market relies on the robustness of the surrounding telecommunications infrastructure—which was really the cause of EBS's problems—not just the resilience of the systems themselves. The market may be fortunate that it has two such systems operating in a competitive fashion, with either being able to take over the business of the other should that be necessary.

Feeds from the interbank systems have, of course, become the main pricing source for most of the e-trading portals. So the latter will be affected by any disruption in the interbank market. We have—very occasionally I would stress—heard some reports of banks having to shut down their pricing feeds to the e-portals because those feeds were generating off-market prices. Like much new technology that people come to depend on in everyday life, the benefits are huge, but it is when those benefits are made unavailable—even temporarily—that they are really appreciated!

The single and multi-bank portals have been continuing to battle it out for market share. If, in 2002, the talk was all about the multi-bank portals—with the lead contenders benefiting from reducing numbers and each of the main platforms finding their niche in the market—2003 may well come to be seen as the year that single-bank portals came of age. I cannot be specific because of commercial sensitivity, but we have had reports of single-bank e-trading platforms now handling the vast majority of customer tickets within a firm and the largest share by value, with just the resulting net position and the very biggest tickets worked by dealers through the market in the traditional way. These systems are still developing and growing and the market-leading systems that invest in the best technology are almost certainly gaining market share.

The choice between multi and single-bank platforms is itself complicated. Some end-users who use multi-bank systems like the price transparency and the audit trail that they provide. Others prefer the relationship with a single bank across a wide range of products.

The fineness of pricing on the e-portals means that end-users are benefiting from close to interbank market prices and this is creating a greater sense of transparency in the market which would generally be welcomed. Of course there is a corresponding risk: that very transparency and ease of access could attract the inexperienced or unwary user and those who offer such platforms must take some responsibility for how they are used and by whom.

Both single and multi-bank portals appear able to generate a more flexible market, for example by opening up the door to multi-product and hence cross-market trading. But it is clear that there is quite a long way to go yet before the full potential is realised. Most of the systems, for example, are still based on 'Request for Quote'—although there are now a growing number of systems that offer prices that can be hit, and this seems to be more popular with end-users. And the cross-market functionality of existing systems is usually quite limited, although gradually expanding.

Another innovation made possible by these e-commerce systems is the use of 'intelligent' software—a bit like on-board computers in Formula one cars. Flow analysis has been used to generate trading signals for banks' own accounts for a number of years and the next step is likely to be automating the trading process in response to these signals.

Because these e-trading solutions can be implemented flexibly for individual customers and do not require special terminals they have the advantage of being relatively easily connected to internal systems. Some well-known corporates have used this to their advantage to enhance their straight-through-processing: reducing costs and operational risk and, in the process, improving management information and risk management more generally.

One of the features of the current market structure is that prices are still determined largely in the interbank market. We have heard of two closely related issues here. The first is the potential for a circularity problem: market-makers typically offer prices and then lay off their risks in the interbank market. The growing liquidity available in the e-portals could perhaps start to attract some activity away from the interbank market, affecting the liquidity that feeds most of the e-portals in the first place. This does not appear to have become a live problem as yet but it is a widely recognised concern. What does appear to be a live issue is the magnification of liquidity. We hear examples of prices on EBS or Reuters that are good for, say, $10 million being fed into, say, three portals for the same size at the same rate meaning that $40 million is potentially being quoted for. This could mean that liquidity is being underpriced systematically: the existence of many systems being fed

from one price source could be a risk for the banks, while the buy-side could find liquidity somewhat fractured. However, I suspect that these risks will provide the motivation for change and possibly further natural selection and so I expect any such concerns to be temporary.

My general conclusion is that, despite these risks, both single and multi-bank portals have contributed substantial benefits, leading to a more efficient and effective market, especially for the buy-side.

Prime brokerage and white labelling have been two of the hot topics over the past year, depending in large part on the growth of the e-commerce systems. Both deliver clear benefits to the provider and the user. White labelling allows the larger banks to earn revenue streams to set against the largely fixed cost of their e-trading systems—which must promote greater investment and further efficiency gains at least in the most successful systems. The smaller banks effectively outsource their technology, getting the advantage of high-quality systems at a reduced cost, the benefits of which they can pass on to their customers. The smaller bank can also take price feeds from the larger bank, although I understand that an element of choice is usually available as to whether to take prices for all or only some currency pairs and there can be reciprocal arrangements in pricing, for example for an exotic currency in which the smaller bank specialises.

As long as there remain a sufficient number of systems to ensure competition, the advantages of economies of scale from white labelling are fairly clear. Interestingly, the effects on industry consolidation may be less clear-cut than one first imagines—the smaller banks may be able to use the outsourced systems and liquidity to help retain their markets with, for example, the smaller or more specialised clients.

Prime brokerage generates a similar gain in respect of the more efficient use of balance sheets and credit, again earning the larger banks a revenue stream, while reducing costs for the fund managers or smaller banks and others who are the main users of such arrangements. What are the risks here? In both white labelling and prime brokerage, there is a distancing of the end-user from the direct supplier of liquidity and credit respectively. The supplier banks must ask themselves: are they pricing liquidity and credit too cheaply? Are they really sure they know what risks they are exposed to? If something goes wrong with white-labelled technology, who is going to take responsibility (think of Railtrack and the carriers). Is there a concentration of liquidity and credit risk that is going unnoticed? Who has the incentive to carry out checks to 'know your customer'?

The final development I want to say something about is Continuous Linked Settlement (CLS). A major milestone in risk reduction in the foreign exchange market, this initiative is fast becoming a market standard. Unlike the other technology improvements, CLS has slightly increased direct transactions costs in order to reduce settlement risk significantly. I have also heard that the use of CLS has quite significantly reduced the number of settlement errors and the savings from this, as well as the reduction of Herstatt risk, must be set against the direct costs.

On the other hand, the rapid take-up of CLS also creates a new risk due to the possible single point of failure. On the one occasion when there was a significant glitch last year the consequences created a problem of some scale: the subsequent smooth clean-up operation, however, did much to demonstrate sound contingency arrangements. Resilience clearly needs to be a watchword for any system that becomes part of the market infrastructure and I know the CLS management takes this very seriously. Despite the residual or new risks, CLS must be regarded as a major step forward in the market.

I have not said much about market integrity. Initial fears about internet security seem to have been largely overcome but I cannot help thinking that new technology of any sort will always have plus and minus points. On the positive side, automated systems allow quicker, fuller and better quality management information and more complex security features which should help to keep the market clean as well as efficient. On the other hand, the opportunities to exploit technology to help wrong-doing tend to rise proportionately. To take me back to my starting point, I see it as essential that codes of conduct for foreign exchange trading are kept up to speed with new technology and that is one reason why the FXJSC and the other market practices committees overseas must keep their eyes on the e-commerce ball.

Bank of England speeches

Speeches made by Bank personnel since publication of the previous *Bulletin* are listed below.

Inflation targeting—achievement and challenges.
Speech by Rachel Lomax, Deputy Governor, to the Bristol Society at the University of the West of England, Bristol on 18 February 2004. www.bankofengland.co.uk/speeches/speech215.pdf. Reproduced on pages 77–83 of this *Bulletin*.

Risk, uncertainty and monetary policy regimes.
Speech by Paul Tucker, Executive Director and member of the Monetary Policy Committee, at the UK Asset and Liability Management Association in Egham, Surrey on 29 January 2004. www.bankofengland.co.uk/speeches/speech214.pdf. Reproduced on pages 84–96 of this *Bulletin*.

Panel on EU/US Cooperation.
Opening remarks by Mervyn King, Governor, at the Advancing Enterprise Conference, Queen Elizabeth II Conference Centre in London on 26 January 2004. www.bankofengland.co.uk/speeches/speech213.pdf.

Financial stability oversight, past and present.
Speech by Sir Andrew Large, Deputy Governor, at the London School of Economics on 22 January 2004. www.bankofengland.co.uk/speeches/speech212.pdf.

Annual Birmingham Forward/CBI business luncheon.
Speech by Mervyn King, Governor, at Aston Villa Football Club in Birmingham on 20 January 2004. www.bankofengland.co.uk/speeches/speech211.pdf. Reproduced on pages 74–76 of this *Bulletin*.

E-commerce and the foreign exchange market—have the promises been met?
Speech by Paul Fisher, Head of Foreign Exchange Division, and Chair, Foreign Exchange Joint Standing Committee, at the fourth Annual Foreign Exchange Markets Summit on 19 January 2004. www.bankofengland.co.uk/speeches/speech210.pdf. Reproduced on pages 97–101 of this *Bulletin*.

The institutions of monetary policy—The Ely Lecture 2004.
Lecture by Mervyn King, Governor, at the American Economic Association Annual Meeting, San Diego on 4 January 2004. www.bankofengland.co.uk/speeches/speech208.pdf.

Comments made on 3 January 2004 by Mervyn King, Governor.
Remarks made in a panel discussion on Alan Greenspan's speech on Risk and Uncertainty in Monetary Policy, given at the American Economic Association Annual Meeting, San Diego on 3 January 2004. www.bankofengland.co.uk/speeches/speech209.pdf.

Asset prices, monetary policy and financial stability: a central banker's view.
Speech by Charles Bean, Chief Economist and member of the Monetary Policy Committee, at the American Economic Association Annual Meeting, San Diego on 3 January 2004.
(This paper is a shortened version of that previously given in Basel, Switzerland on 29 March 2003 and New South Wales, Australia on 19 August 2003.) www.bankofengland.co.uk/speeches/speech207.pdf.

Contents of recent Quarterly Bulletins

The articles and speeches that have been published recently in the *Quarterly Bulletin* are listed below. Articles from November 1998 onwards are available on the Bank's web site at www.bankofengland.co.uk/qbcontents/index.html.

Articles and speeches (indicated S)

Winter 2001

The external balance sheet of the United Kingdom: implications for financial stability
Public sector debt: end-March 2001
The foreign exchange and over-the-counter derivatives markets in the United Kingdom
The Bank's contacts with the money, repo and stock lending markets
The formulation of monetary policy at the Bank of England
Credit channel effects in the monetary transmission mechanism
Financial effects on corporate investment in UK business cycles
Why house prices matter
The prospects for the UK and world economies (S)
Maintaining financial stability in a rapidly changing world: some threats and opportunities (S)
Monetary policy: addressing the uncertainties (S)
Economic imbalances and UK monetary policy (S)
Do we have a new economy? (S)

Spring 2002

The London Foreign Exchange Joint Standing Committee: a review of 2001
Provision of finance to smaller quoted companies: some evidence from survey responses and liaison meetings
Explaining trends in UK business investment
Building a real-time database for GDP(E)
Electronic trading in wholesale financial markets: its wider impact and policy issues
Analysts' earnings forecasts and equity valuations
On market-based measures of inflation expectations
Equity wealth and consumption—the experience of Germany, France and Italy in an international context
Monetary policy, the global economy and prospects for the United Kingdom (S)
Three questions and a forecast (S)
Twenty-first century markets (S)
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Financial stability and the United Kingdom's external balance sheet
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UK monetary policy in a changing world (S)
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Asset pricing and the housing market
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Risk, uncertainty and monetary policy regimes(S)
E-commerce and the foreign exchange market—have the promises been met?(S)

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 web site www.bankofengland.co.uk/publications.

Working papers

Working papers are free of charge; a complete list is available from the address below. An up-to-date list of working papers is also maintained on the Bank of England's web site at www.bankofengland.co.uk/wp/index.html, where abstracts of all papers may be found. Papers published since January 1997 are available in full, in PDF.

No.	Title	Author
198	Non-interest income and total income stability *(August 2003)*	Rosie Smith Christos Staikouras Geoffrey Wood
199	Credit risk diversification: evidence from the eurobond market *(September 2003)*	Simone Varotto
200	Estimating real interest rates for the United Kingdom *(September 2003)*	Jens Larsen Ben May James Talbot
201	Debt maturity structure with pre-emptive creditors *(September 2003)*	Prasanna Gai Hyun Song Shin
202	Credit spreads on sterling corporate bonds and the term structure of UK interest rates *(October 2003)*	Jeremy Leake
203	Analytics of sovereign debt restructuring *(October 2003)*	Andrew G Haldane Adrian Penalver Victoria Saporta Hyun Song Shin
204	The dynamics of consumers' expenditure: the UK consumption ECM redux *(November 2003)*	Emilio Fernandez-Corugedo Simon Price Andrew Blake
205	Empirical determinants of emerging market economies' sovereign bond spreads *(November 2003)*	Gianluigi Ferrucci
206	The rise in US household debt: assessing its causes and sustainability *(November 2003)*	Sebastian Barnes Garry Young
207	A quantitative framework for commercial property and its relationship to the analysis of the financial stability of the corporate sector *(November 2003)*	John Whitley Richard Windram
208	A matching model of non-employment and wage pressure *(December 2003)*	Andrew Brigden Jonathan Thomas
209	Settlement bank behaviour and throughput rules in an RTGS payment system with collateralised intraday credit *(December 2003)*	Simon Buckle Erin Campbell
210	Company accounts based modelling of business failures and the implications for financial stability *(December 2003)*	Philip Bunn Victoria Redwood
211	An empirical analysis of the dynamic relationship between investment-grade bonds and credit default swaps *(February 2004)*	Roberto Blanco Simon Brennan Ian W Marsh
212	Crisis spillovers in emerging market economies: interlinkages, vulnerabilities and investor behaviour *(February 2004)*	Michael Chui Simon Hall Ashley Taylor
213	Investment-specific technological change and growth accounting *(February 2004)*	Nicholas Oulton
214	An empirical model of household arrears *(March 2004)*	John Whitley Richard Windram Prudence Cox

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 web site at www.bankofengland.co.uk/mpc/extmpcpaper0000n.pdf (where n refers to the paper number). The following papers have been published recently.

No.	Title	Author
9	The pricing behaviour of UK firms *(April 2002)*	Nicoletta Batini Brian Jackson Stephen Nickell
10	Macroeconomic policy rules in theory and in practice *(October 2002)*	Christopher Allsopp
11	The exchange rate and inflation in the UK *(October 2002)*	Amit Kara Edward Nelson
12	Measuring the UK short-run NAIRU *(April 2003)*	Nicoletta Batini Jennifer Greenslade
13	UK consumers' habits *(May 2003)*	Ryan Banerjee Nicoletta Batini

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.

From 2004 *Bankstats* will continue to be published monthly on the Internet but paper copies will be available on a twice-yearly basis. Paper copies will be published for the January and July editions in hard copy on Monday 2 February 2004 and Friday 30 July 2004 respectively. The price per annum in the United Kingdom will be £40, or £20 per copy. *Bankstats* is available on a monthly basis free of charge from the Bank's web site at: www.bankofengland.co.uk/mfsd/latest.htm.

Further details are available from: Daxa Khilosia, Monetary and Financial Statistics Division, Bank of England: telephone 020 7601 5353; fax 020 7601 3208; e-mail daxa.khilosia@bankofengland.co.uk.

The following articles have been published in recent issues of *Monetary and Financial Statistics*. They may also be found on the Bank of England's web site at www.bankofengland.co.uk/mfsd/030901/aug03articles.htm.

Title	Author	Month of issue	Page numbers
Historical comparison of seasonally adjusted series using GLAS and X-12-ARIMA	Martin Daines	January	9–13
Change of seasonal adjustment method to X-12-ARIMA	John Thorp	January	4–8
Public sector net debt: end-March 2003	Paul Burton	January	1–3

Financial Stability Review

The *Financial Stability Review* is published twice a year, in June and December. Its purpose is to encourage informed debate on financial stability; survey potential risks to financial stability; and analyse ways to promote and maintain a stable financial system. 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. It is available from Financial Stability Review, Bank of England HO-3, Threadneedle Street, London, EC2R 8AH and on the Bank's web site at: www.bankofengland.co.uk/fsr/index.htm.

Practical issues arising from the euro

This is a series of booklets providing a London perspective on the development of euro-denominated financial markets and the supporting financial infrastructure, and describing the planning and preparation for possible future UK entry. Recent editions have focused on the completion of the transition from the former national currencies to the euro in early 2002, and the lessons that may be drawn from it. Copies are available from Public Enquiries Group, Bank of England, Threadneedle Street, London, EC2R 8AH and on the Bank's web site at: www.bankofengland.co.uk/euro/piq.htm.

Economic models at the Bank of England

The *Economic models at the Bank of England* book, published in April 1999, contains details of the economic modelling tools that help the Monetary Policy Committee in its work. The price of the book is £10.00. An update was published in September 2000 and is available free of charge.

Quarterly Bulletin

The *Quarterly Bulletin* provides regular commentary on market developments and UK monetary policy operations. It also contains research and analysis and reports on a wide range of topical economic and financial issues, both domestic and international.

Back issues of the *Quarterly Bulletin* from 1981 are available for sale. Summary pages of the *Bulletin* from February 1994, giving a brief description of each of the articles, are available on the Bank's web site at: www.bankofengland.co.uk/bulletin/index.html.

The *Bulletin* is also available from ProQuest Information and Learning: enquiries from customers in Japan and North and South America should be addressed to ProQuest Information and Learning, 300 North Zeeb Road, Ann Arbor, Michigan 48106, United States of America; customers from all other countries should apply to The Quorum, Barnwell Road, Cambridge, CB5 8SW, telephone 01223 215512.

An index of the *Quarterly Bulletin* is also available to customers free of charge. It is produced annually, and lists alphabetically terms used in the *Bulletin* and articles written by named authors.

Bound volumes of the *Quarterly Bulletin* (in reprint form for the period 1960–85) can be obtained from Schmidt Periodicals GmbH, Ortsteil Dettendorf, D-83075 Bad Feilnbach, Germany, at a price of €105 per volume or €2,510 per set.

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 over the following two years.

The *Report* starts with an overview of economic developments; this is followed by six sections:

- analysis of money and asset prices;
- analysis of demand;
- analysis of output and supply;
- analysis of costs and prices;
- summary of monetary policy during the quarter; and
- assessment of the medium-term inflation prospects and risks.

The minutes of the meetings of the Bank's Monetary Policy Committee (previously published as part of the *Inflation Report*) now appear as a separate publication on the same day as the *Report*.

Publication dates

Copies of the *Quarterly Bulletin* and *Inflation Report* can be bought separately, or as a combined package for a discounted rate. Current prices are shown overleaf. Publication dates for 2004 are as follows:

Quarterly Bulletin		*Inflation Report*	
Spring	19 March	February	11 February
Summer	18 June	May	12 May
Autumn	24 September	August	11 August
Winter	17 December	November	10 November

Quarterly Bulletin and *Inflation Report* subscription details

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