# Quarterly Bulletin

# 2009 Q1 | Volume 49 No. 1





# **Quarterly Bulletin**

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#### Foreword

This edition of the *Quarterly Bulletin* begins with the regular *Markets and operations* report, reviewing recent developments in sterling financial markets and the Bank's official operations. Against the background of a significant and synchronised weakening in international economic activity, market conditions generally remained strained. In particular, bank funding markets became more difficult again reflecting renewed concerns about the scale of potential credit losses and write-downs facing banks. Authorities both at home and abroad have introduced additional measures designed to improve conditions in the financial system and support lending growth.

How prices behave is a key question for policymakers who are setting monetary policy to meet an inflation target. Recent work at the Bank of England uses three large databases of individual price quotes to examine the facts about how often prices change and how much they change by. This is discussed in the article by Philip Bunn and Colin Ellis. Evidence from consumer and producer price data suggests that on average, prices change once every four to five months. Evidence from higher frequency supermarket data suggests that prices change more often than this — once every two weeks. More generally, the work shows that the frequency of price changes varies across different sectors and product groups. The research complements recent work conducted by the Bank of England using survey data, as reported in the 2008 Q4 *Quarterly Bulletin*.

A sustained period of falling prices, deflation, is likely to be the symptom of some underlying shock. Hence, it is important not to confuse the economic costs associated with the circumstances which caused prices to fall, with the costs of deflation *per se*. An important question to address is what additional economic costs deflation *itself* might generate. This is considered in the article by Charlotta Groth and Peter Westaway. Two potentially important costs associated with deflation are debt deflation and downward nominal wage rigidities. But both of these effects are likely to be small for falls in prices that are modest and short-lived. And recent evidence suggests that, to some extent, wages are flexible downwards. A further effect

can arise when sustained periods of deflation limit a central bank's ability to use conventional monetary policy to stabilise the economy. But policymakers have other, more unconventional, options available to them to stimulate the economy.

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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.

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Except where otherwise stated, the source of the data used in charts and tables is the Bank of England or the Office for National Statistics (ONS). All data, apart from financial markets data, are seasonally adjusted.

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# Recent economic and financial developments

# Markets and operations

This article reviews developments in sterling financial markets since the 2008 Q4 *Quarterly Bulletin* up to the end of February 2009. The article also reviews the Bank's official operations during this period.

#### Sterling financial markets(1)

#### Overview

After some improvement following the relatively smooth passing of the year end, bank funding markets reportedly became more difficult again during late January and February. Sterling Libor-OIS spreads widened slightly while interbank term lending remained limited. This seemed to reflect renewed concerns about the scale of potential credit losses and write-downs facing banks, given further falls in global asset prices and the significant and synchronised weakening in international economic activity.

More generally, while conditions across financial markets have improved somewhat since the autumn, overall liquidity conditions have yet to normalise to any significant degree. Contacts cite ongoing balance sheet constraints on financial institutions as an important factor in continued pricing anomalies in various asset markets.

Against that background, and given the prospect of UK CPI inflation falling below target over the medium term, absent further stimulus, the UK Monetary Policy Committee (MPC) reduced Bank Rate further. In addition, the UK authorities announced a series of initiatives to help ensure an adequate supply of credit to households and businesses. These included measures to reduce uncertainty about the adequacy of bank capital by capping the losses on their holdings of risky assets; to facilitate bank funding by means of state guarantees; and initiatives for the Bank to purchase sterling commercial paper, corporate bonds and other securities in order to improve financing conditions in the economy.

These asset purchases were initially to be financed by government borrowing. But on 5 March (after the review period for this article) the MPC announced a second phase of asset purchases, for both private sector and UK government securities, to be financed by central bank reserves. The MPC also reduced Bank Rate to 0.5%.

#### **Recent developments in sterling capital markets** Bank funding markets

Conditions in sterling interbank money markets were reported to have improved slightly through December and early January with few problems over the year end. Indeed, activity increased in the first few days of the new year, as lenders' balance sheet constraints eased somewhat. This was associated with a narrowing in the spread between three-month Libor and overnight index swap (OIS) rates (Chart 1).





Sources: Bloomberg, British Bankers' Association and Bank calculations.

(a) Three-month London interbank offered rate (Libor) spreads over equivalent-maturity OIS rates.

(b) Three-month Libor forward spreads over equivalent-maturity forward OIS rates.

Use of cross-currency swap markets reportedly also became easier compared with strained conditions in late 2008. For example, sterling-US dollar basis swap spreads returned to pre-September 2008 levels by early January (**Chart 2**), indicating that the cost of raising US dollar funding via cross-currency swaps generally fell. Relatedly, contacts reported that some large financial institutions raised US dollar

This article focuses on sterling capital market developments. The data cut-off for this section is 20 February.



#### Chart 2 One-year basis swap spreads

funding and swapped this into other currencies such as euro to take advantage of the basis swap spread.

However during February, Libor-OIS spreads started to widen again and the term structure of forward spreads shifted up slightly (Chart 1). Contacts reported some increased reluctance to lend to banks beyond very short maturities as concerns over the health of banks resurfaced internationally. In particular, with a number of banks reporting large credit losses and write-downs for 2008 Q4, perceptions about bank counterparty risk appeared to pick up again. Consistent with that, premia on UK banks' credit default swaps (CDS) rose, and approached levels reached in October 2008 when fears about system-wide failure were intense (Chart 3).



Chart 3 Major UK banks' CDS premia and equity prices

(a) Average of Barclays, HBOS, HSBC, Lloyds, RBS and Standard Chartered weighted by

market capitalisation. (b) Unweighted average of five-year CDS premia for Barclays, HBOS, HSBC, Lloyds, RBS and Standard Chartered. A mechanical decomposition of the spread between twelve-month Libor and OIS rates, based on banks' CDS premia, correspondingly suggests shows that the portion of the spread attributable to credit premia increased (**Chart 4**).

### Chart 4 Indicative decomposition of the sterling twelve-month Libor-OIS spread<sup>(a)</sup>



Sources: British Bankers' Association, Markit Group Limited and Bank calculations.

(a) See box, 'An indicative decomposition of Libor spreads', Bank of England Quarterly Bulletin, Vol. 47, No. 4, pages 498–99 for further details.

Some of the renewed worries about banks' financial health probably reflected heightened concerns about the adverse feedback from the worsening macroeconomic environment on to banks' balance sheets. Economic activity decelerated sharply in the fourth quarter of 2008 in all the major advanced economies. And, according to Consensus forecasts, growth expectations for both advanced and emerging market economies fell significantly towards the end of 2008 (Chart 5). This weakening in global growth could potentially lead to further losses on banks' domestic and international asset portfolios, including in the United Kingdom.

#### Chart 5 Expected real GDP growth for 2009



Source: Consensus Economics.

Sources: Bloomberg, Markit Group Limited and Bank calculations

<sup>(</sup>a) Simple average of GDP forecasts for Asia Pacific excluding Japan, Eastern Europe and Latin America.

In part at least, some of the rise in banks' CDS premia could be related to concerns among investors about the effect of the possible nationalisation of some UK banks on holders of bank debt securities. Although in the case of both Northern Rock and Bradford & Bingley senior debt holders were protected following Government intervention, investors in other banks remained cautious over the long-term implications for senior debt holders. This uncertainty may have increased the cost of default protection on banks' debt.

Such worries about nationalisation were most apparent in secondary markets for bank equities and subordinated debt securities, the owners of which would be most vulnerable should a bank be taken into public ownership. UK bank equity prices fell further over recent months (Chart 3) and credit spreads on UK banks' junior debt securities widened quite sharply (Chart 6). In contrast, spreads on senior debt drifted only slightly wider, albeit to elevated levels compared with early in 2008.

Chart 6 Secondary market spreads on sterling-denominated senior and subordinated UK bank debt(a)



Sources: JPMorgan Chase and Co. and Bank calculations

- (a) Simple average of secondary market spreads for Barclays, HBOS, HSBC, Lloyds and RBS (b) Tier 1 debt comprises perpetual instruments (that are callable) with non-cumulative cou (ie deferred coupon payments that do not necessarily need to be paid at any point in the future). Holders of Tier 1 debt are subordinate to holders of Lower Tier 2 instruments
- (c) Lower Tier 2 debt comprises dated instruments with cumulative coupons (ie deferred coupons that need to be paid eventually) where holders are subordinate to senior debr debr. holders

(d) Senior debt comprises non-subordinated medium and long-term debt

Banks also rely on other financial institutions such as money market funds (MMFs) to provide funding. Following some withdrawals last autumn, assets under management at MMFs recovered and these supported lending to banks. Indeed, according to contacts, improved sentiment in early January led fund managers to invest some funds at longer maturities. However, MMFs generally remained reluctant to lend significantly at term, preferring instead to maintain liquid portfolios to guard against future redemptions. As a result, the average maturity of their portfolios remained much lower than before the onset of the crisis (Chart 7).

Chart 7 Sterling money market funds: assets under management and weighted-average maturity



Source: iMoneyNet

At longer maturities, volumes of senior debt issuance by UK banks remained heavily dependent upon government debt guarantee schemes. In the United Kingdom, nearly all senior debt issued by UK banks since the previous Bulletin made use of the UK Credit Guarantee Scheme (CGS)<sup>(1)</sup> although the amount of funding raised fell compared with late 2008 (Chart 8). According to contacts, the recent fall in guaranteed issuance could be related in part to the increased number of similar schemes that became fully operational in other countries as well as banks refraining from issuing in the run-up to publishing their annual accounts.

#### Chart 8 UK bank senior debt issuance(a)



Source: Dealogic

(a) Issuance with a value greater than US\$500 million equivalent and original maturity greater than one year (b) Senior debt issued under HM Treasury's Credit Guarantee Scheme

In terms of other bank funding markets, contacts reported that primary sterling residential mortgage-backed securities

(1) For more details of the CGS, see the relevant section of the Debt Management Office website: www.dmo.gov.uk.





(RMBS) markets remained effectively closed, at least for publicly issued securities. In general, contacts did not expect a sustained improvement in market conditions during 2009.

In recognition of the continuing strains in bank funding markets and the likely implications for the availability of credit to households and firms, on 19 January the UK Government announced a series of initiatives to improve market functioning and support lending to the wider economy. These are outlined in the box opposite.

In addition, the Financial Services Authority (FSA) published a statement clarifying its policy towards bank capital ratios, in particular, that capital buffers built up as part of the recent UK bank recapitalisations should allow banks to withstand further losses and facilitate continued lending. Furthermore, it outlined its long-term preference for the regulatory capital regime to incorporate countercyclical measures which lead to banks building up capital buffers in good years which they can draw down during economic downturns.

#### Corporate credit

With banking market capacity much reduced, the Bank's regional Agents reported a general tightening in the terms on bank lending and syndicated loans to companies over the review period. Contacts also commented that firms' credit lines from lenders were under increased scrutiny, in some cases being renegotiated or reduced. As a result, firms reportedly looked to capital markets as a replacement source of funding. Indeed, according to a recent investigation by the Association of Corporate Treasurers, more unrated companies were likely to seek a credit rating in order to access non-bank finance.

Reflecting greater use by firms of capital market finance, primary issuance of investment-grade corporate bonds picked up in recent months (**Chart 10**). The recent announcements of the various government initiatives to support capital market

#### UK Government package to support lending(1)

On 19 January, the Treasury released plans designed to support lending in the UK economy and reinforce the stability of the financial system. Particular measures to be adopted included:

- The extension of the drawdown window of the Credit Guarantee Scheme (CGS) from 9 April 2009 to 31 December 2009. The final maturity date of the scheme remained at 9 April 2014. This extension of the drawdown window will allow banks to access more funding via issuance of CGS debt.
- Plans for the introduction of a guarantee scheme for asset-backed securities (ABS) providing full or partial guarantees for AAA-rated ABS backed by mortgages, corporate and consumer debt.
- The extension of the term of the Bank of England's permanent Discount Window Facility. Specifically, for an additional fee of 25 basis points the Bank would extend the Facility to a term of 364 days in addition to the standard 30-day option. This is designed to meet banks' longer-term liquidity demands.
- The establishment of a new Asset Purchase Facility allowing the Bank of England to purchase up to £50 billion of high-quality private sector assets, including CGS paper, corporate bonds, commercial paper, syndicated loans and a limited range of ABS, financed by the issue of Treasury bills.
- The introduction of an **asset protection scheme**. For a fee, the Treasury would provide protection against the majority of credit losses exceeding a 'first loss' amount, with the participating institution covering the residual exposure, likely to be in the region of 10%. Eligible institutions are UK incorporated deposit takers with more than £25 billion of eligible assets.

Participation in the scheme is conditional on a commitment to increase lending to borrowers and comply with the Financial Services Authority's code of practice on remuneration policies. Eligible assets include corporate and leveraged loans, property loans and structured credit assets. The fee may be paid in cash or the issue of capital instruments; ordinary shares are not likely to qualify.

In addition, and in order to improve conditions in the UK mortgage markets, the UK Government also announced that Northern Rock would no longer actively pursue a policy of rapidly reducing its mortgage book. Rather, the bank would aim to increase mortgage lending by up to £14 billion over the next two years.

For more details of the UK Government package, see www.hm-treasury.gov.uk/press\_05\_09.htm.

Chart 10 Investment-grade corporate bond issuance by UK private non-financial corporations (PNFCs)



Sources: Dealogic and Bank calculations.

financing for UK firms were generally well received. The Bank started its purchases of sterling corporate commercial paper under the Asset Purchase Facility on 13 February and is currently consulting on the purchase of other assets — see page 26 for more details.

Nonetheless, over the review period primary market conditions reportedly remained difficult for lower-rated companies. Moreover, most of the recent primary corporate bond issuance was at relatively short maturities. Specifically, between October 2008 and January 2009, close to 50% of newly issued debt securities were of maturity of five years or less. This compared with an average proportion since 1990 of around 35% (Chart 11). According to contacts, such a shortening in issuance maturities may indicate a reluctance to issue long-term debt at the prevailing wide spreads over government bonds, though it might also have reflected an increased use of capital market funding as a substitute for bank borrowing.



Chart 11 UK PNFC bond issuance by maturity

In secondary markets, sterling investment-grade corporate bond spreads widened further over the review period (Chart 12). But in large part this reflected developments in the financial sector. Spreads on sterling-denominated corporate bonds issued by investment-grade, non-financial companies generally narrowed slightly from January 2009 onwards, although they remained at wide levels.





(a) Option-adjusted spreads.

Given the worsening macroeconomic environment, it seems unlikely that the compensation required by investors in corporate bonds to cover credit risk (both expected losses and uncertainty around such losses) would have fallen recently. Instead, contacts reported a pickup in investor demand for exposure to corporate bonds which could have reduced the required liquidity premia embedded in secondary market corporate bond spreads.

One way to assess the liquidity premia in corporate bond spreads is the so-called CDS-cash basis (the difference between matched-maturity CDS premia and spreads on corporate bonds). An indicative measure shown in **Chart 13** suggests that the basis for non-bank, investment-grade corporate bonds became sharply more negative from the middle of 2007 to the end of 2008 which could be consistent with an increase in liquidity premia in corporate bond spreads. But since the beginning of this year the basis narrowed, at least for the median borrower in the sample.

#### Equities

The recent signs of slightly improved conditions in sterling corporate bond markets, at least for non-financial companies, initially followed a period of modest recovery in equity markets. In the early part of the period UK equity prices generally recovered from the five-year lows reached towards the end of 2008.

<sup>(</sup>a) Lines correspond to three-month moving averages.

Chart 15 Changes in UK equities by sector since

#### Chart 13 Indicative 'basis' between sterling-denominated bond spreads and corresponding CDS premia for non-bank corporates<sup>(a)(b)(c)</sup>



Based on 140 investment-grade sterling bonds issued by non-bank firms. CDS premia less the asset swap spread for the same firm. The maturity of the chosen bond may not necessarily match the maturity of the corresponding CDS as data are typically only

available for five-year CDS. (c) The purple band shows the interquartile range

However, by the end of February most of the end-of-year rally in UK equity prices was unwound and the major UK equity indices approached their earlier lows (Chart 14). Financial stocks experienced the most pronounced falls, related to renewed concerns over the health of banks' balance sheets and business prospects going forward (Chart 15). But the falls in January and February were generally broad-based across different sectors of the UK economy covering both small and large firms.



Sources: Bloomberg and Bank calculations

The recent weakness in UK equity markets might be linked to a perceived deterioration in the prospects for corporate earnings. An increased number of UK corporates cut their 2008 dividends (Chart 16) and reported sizable reductions in their profits. And, while companies' earnings announcements



Sources: Thomson Datastream and Bank calculations

(a) This chart uses the Thomson Datastream index, rather than the FTSE All-Share, in order to provide as detailed a sectoral breakdown as possible

contained few surprises in general, contacts reported that investors' perceptions hardened around continued weak future earnings. Indeed, IBES forecasts of corporate earnings growth for FTSE 100 companies for 2009 were revised down further.





(a) Excluding investment trusts.

Perhaps consistent with less uncertainty about an albeit weak financial outlook for firms, forward-looking measures of equity price volatility derived from options fell since the previous *Bulletin*. At the same time however, the implied probability distribution around future equity prices became more negatively skewed, which could reflect increased investor appetite to insure against further large falls in equity prices (Chart 17). Indeed, contacts noted increased demand from investors to buy 'out of the money' put options on major equity indices (ie options that provide protection against large



Chart 17 FTSE 100 option-implied volatility and skews<sup>(a)(b)</sup>

(a) Calculated from the distribution of returns from three-month option prices.
 (b) A negatively skewed distribution is one for which large negative deviations from the mean are more likely than large positive deviations.

future equity price falls). More generally, capital concerns and reduced risk appetite reportedly made some investors

reluctant to increase their exposure to equities.

Apart from a few large, one-off transactions, primary equity issuance by UK PNFCs remained quite weak over recent months, echoing a global slowdown in equity issuance. Against the background of fairly limited investor demand and restricted underwriting capacity within the banking sector, UK firms reportedly sought to maintain their capital positions and preserve liquidity by reducing share redemptions (including equity buybacks) (Chart 18).

**Chart 18** Equity issuance and repayments by UK PNFCs (all currencies)



#### Short-term interest rates

With global macroeconomic conditions having worsened, alongside direct measures by the UK authorities to help

improve conditions in sterling debt markets, the MPC reduced Bank Rate further. The reduction occurred in three consecutive cuts, of 100 basis points, 50 basis points, and 50 basis points, each of which was in line with market expectations prevailing at the time of the respective decision. The implied path of short-term sterling market interest rates shifted down, and at the end of the review period was consistent with Bank Rate being reduced to 0.5% and remaining at this level during the remainder of 2009 (**Chart 19**). And in fact, on 5 March (after the review period for this article) the MPC reduced Bank Rate again to 0.5%.



Chart 19 Bank Rate and forward market interest rates

(a) Implied forward overnight interest rates derived from sterling overnight index average (SONIA) swaps.

Uncertainty about short-term interest rates, as measured by implied volatility derived from options on interest rate futures, fell in sterling and other currencies since the previous *Bulletin*, but remained elevated. Such options are linked to futures contracts that settle on Libor and consequently it is difficult to infer how much of the moves in implied volatility related to uncertainty about the spread between Libor and policy rates or about policy rates themselves. To the extent that realised interest rate volatilities provide a guide to future perceptions, **Chart 20** suggests that both factors were important. That is, investors became less uncertain about both the outlook for UK policy rates and about the risk premia embedded in Libor.

Implied uncertainty about future Libor could have been affected by expectations about the introduction of monetary policy measures to steer the quantity of reserves. In particular, a decision to begin purchasing a range of financial assets financed by central bank reserves, a process commonly referred to as quantitative easing.

On 5 March (after the review period for this article) the MPC announced its intention to implement an asset purchase programme of  $\pm$ 75 billion financed by the issuance of central bank reserves — see the box on page 26 for more details.

Chart 20 Six-month sterling interest rate volatility



Sources: Bloomberg, British Bankers' Association, Euronext.liffe and Bank calculations

(a) Inferred from options on Libor futures.(b) Twenty-day rolling variance of daily changes

#### Long-term interest rates

Expectations of an increase in gilt purchases by the Bank due to its asset purchase programme may have been one factor behind the recent fall in longer-term gilt yields. But gilt yields and implied forward rates were quite variable through the period (**Chart 21**) suggesting other factors were probably also at work.

Chart 21 Sterling five-year interest rates and inflation five years forward<sup>(a)</sup>



(a) Derived from the Bank's government liability curves

According to contacts, strong demand for government securities in December, in the wake of the turmoil in banking markets in Autumn 2008, helped push gilt prices higher and yields lower, although subsequently this effect may have unwound somewhat. Contacts also noted that gilt yields were affected by speculation about prospective revisions to UK liquidity regulations for banks (see page 18), as well as expectations of increased government bond issuance to finance commercial bank rescues and fiscal stimulus packages. One possible way to gauge the impact on yields of changes in the demand and supply for gilts is to consider moves in interest rate swap spreads — the difference between swap rates and gilt yields of similar maturities. More specifically, decomposing the fifteen-year sterling swap spread into the spread between Libor and OIS rates and the spread between OIS and gilt yields, indicates that the recent swings in swap spreads were largely accounted for by movements in the gilt yield relative to the expected path of the overnight rate (Chart 22).





Since OIS are derivative instruments settling on an overnight interest rate and involve no exchange of cash at the inception of the trade, credit and liquidity risk premia in OIS rates should be small. As a result, for the most part developments in OIS-gilt yield spreads seem likely to have reflected changes in the perceived scarcity value (ie liquidity premia) attached to gilts.<sup>(1)</sup>

Of course, investors could have demanded greater compensation to cover the, albeit remote, potential for default on gilts. That could also have pushed up gilt yields relative to swap rates. And indeed, the CDS premia on UK government debt rose noticeably over the past few months continuing a trend since the autumn (Chart 23).

However, contacts reported that sovereign CDS are typically thinly traded, and hence their premia can be significantly affected by liquidity conditions. Moreover, contacts suggest that participants do not typically trade sovereign CDS with a view that countries will default, given the potential for governments ultimately to monetise their debt. Rather they tend to use sovereign CDS principally as a way to hedge

Sources: Bloomberg and Bank calculations

<sup>(1)</sup> For a fuller discussion of the potential impact of liquidity in government bond markets on secured borrowing rates see the box, 'Why have secured funding spreads increased recently?', on page 260 of the 2008 Q3 *Quarterly Bulletin*.





their exposure to potential movements in government bond spreads.

More generally, long-term sterling swap spreads have been persistently negative since October 2008 — that is government bond yields were above similar maturity swap rates. This is difficult to rationalise with financial markets working efficiently since swap rates would normally include an extra premium to compensate investors for the risk of a systemic failure of the banking sector.

As explained in the box on pages 16–17, negative swap spreads are one example of various pricing anomalies in financial markets that have yet to normalise. Given these sorts of pricing anomalies in fixed-income markets, it remains more difficult than normal to draw firm conclusions about investors' perceptions of fundamental influences on the prices of government bonds and associated derivatives.

In principle, increased government borrowing would tend to push up long-term real interest rates, to the extent that planned savings in the private sector did not increase commensurately. In fact, long-term sterling real forward rates derived from yields on index-linked gilts ended the period lower and remained at relatively low levels (Chart 21).

In contrast, long-term inflation forwards (derived from the difference between yields on conventional and index-linked gilts) ended the period slightly higher although they drifted down a little over the past month (**Chart 21**). To some extent the prospect of quantitative easing, and in particular uncertainty about when the associated injection of central bank reserves would, if appropriate, ultimately be withdrawn, might have led investors to revise upwards their expectations of long-run expectations and/or the required compensation for uncertainty about future inflation (ie inflation risk premia). But survey evidence indicated that expectations of long-term inflation were broadly unchanged and indeed were lower than in the middle of 2008.

#### Foreign exchange

The sterling effective exchange rate index (ERI) depreciated by around 4% since the previous *Bulletin*, reflecting declines against all of the major currencies and continuing the general drift down in the external value of sterling since late 2007 (Chart 24).

# Chart 24 Cumulative changes in sterling exchange rates since 2 January 2008





However, survey measures provided only limited support for the view that investors' long-term expectations for sterling have fallen significantly. The latest long-term Consensus Economics forecast for sterling, although a little lower compared with October 2008, was similar to its level in June 2007 (Chart 25). Similarly, the latest Bank of America/Merrill Lynch survey of fund managers indicated that for the first time since the survey began in 2002 respondents believed sterling to be undervalued (Chart 26).

Chart 25 Actual and Consensus expectations for the sterling effective exchange rate index  ${}^{\rm (a)}$ 



Sources: Bank of England and Consensus Economics

(a) Expectations for the sterling ERI are derived from bilateral US dollar, euro and yen exchange rates, weighted by UK trade shares in 2006.
(b) Dates refer to the publication date of the Consensus Economics survey of forecasts.

Chart 26 Net balance of fund managers who believed sterling to be overvalued



Contacts instead suggested that the recent weakness in sterling can at least in part be attributed to worsening perceptions about the near-term prospects for the UK economy and corresponding expectations for UK interest rates. Perhaps consistent with that, the pace of decline in the value of sterling would appear to have slowed over recent months — and indeed sterling appreciated by around 9% against the euro since the beginning of 2009 — as the deteriorating outlook for economic activity spread internationally.

By the end of February, developments in relative interest rates, as indicated by movements in international yield curves, could account for most of the depreciation in sterling since the previous *Bulletin*. But they did not appear to explain the pattern of changes through the period (**Chart 27**). This suggests that other factors may also have been influential.

**Chart 27** Implied contribution of interest rate 'news' to cumulative change in sterling ERI since previous *Bulletin*<sup>(a)</sup>



Sources: Bank of England and Bloomberg.

(a) For more information on the analytics required to isolate the impact of interest rate 'news' on exchange rates, see Brigden, A, Martin, B and Salmon, C (1997), 'Decomposing exchange rate movements according to the uncovered interest rate parity condition', Bank of England Quarterly Bulletin, November, pages 377–89. One alternative explanation for the continued fall in sterling could be that investors required greater compensation to bear the risk associated with holding sterling-denominated assets, perhaps because of increased concerns about risks to the UK economic outlook. Consistent with that, estimates of currency risk premia, based on combining information on interest rate differentials and surveys of forecasts for exchange rates, indicated that sterling risk premia continued to rise over recent months (Chart 28).





(a) Risk premia estimate the expected rate of return required by foreign investors to invest in a domestic risk-free asset, over the foreign risk-free rate of return. A positive risk premium implies that the currency is expected to appreciate relative to the path implied by the interest rate differential.

More generally, uncertainty surrounding sterling exchange rates remained elevated. This was reflected in the width of the implied probability distribution of future levels of sterling, derived from option prices (Chart 29).



Chart 29 One-year unconditional sterling ERI probability distribution<sup>(a)</sup>

(a) Probability of the sterling ERI being within ±0.5 index points of any given level. For example, on 20 February 2009 the probability of the ERI being at 78.8 (between 78.3 and 79.3) in one year's time was around 4%. For details of how this probability distribution is constructed see the box on pages 130–31 of the Summer 2006 Quarterly Bulletin.

Sources: Reuters and Bank calculations.

#### Pricing anomalies in financial markets

In theory, the prices of different assets which provide equivalent discounted cash flows should be the same. If not, there could be 'pure' arbitrage opportunities; that is, with no risk, investors could pursue strategies guaranteed to earn a profit or at least not make a loss. And the actions of investors seeking to exploit such opportunities should eliminate the price differentials.

This box reviews some recent examples where market prices might seem to imply apparent arbitrage opportunities. Their persistence suggests that, in practice, there are explicit and implicit costs involved in taking advantage of pricing differentials. These costs may weaken the relationship between prices of assets with similar cash flows, and hence give rise to asset pricing anomalies that would not usually exist.

If there are arbitrage opportunities that are not exploited and asset prices depart from their underlying or 'fundamental' value, there is no guarantee that the price allows investors to make consistent inferences about the expected pay-offs.

#### **Current examples**

The financial crisis has given rise to a number of such pricing anomalies. Examples include negative spreads between long-term swap rates and gilt yields of similar maturities (**Chart A**); wide spreads between domestic funding rates and the cost of raising foreign currency and swapping it into domestic currency (**Chart B**); spreads between forward rates implied by spot Libor rates of differing maturities relative to those embedded in forward rate agreements (**Chart C**); and the higher compensation for exposure to credit risk through corporate bonds relative to credit default swaps (the so-called CDS-cash basis) (**Chart 13** on page 11).

Take the case of interest rate swap spreads (**Chart A**). In the absence of market imperfections, swap rates should equal yields on gilts of similar maturities plus an extra premium to compensate investors for the risk of a systemic failure of the banking sector.<sup>(1)</sup> As a result, swap spreads are typically positive — historically the average fifteen-year sterling swap spread has been around +50 basis points.

At face value, negative swap spreads represent a profitable trading opportunity. To try to profit from this spread an investor could purchase a long-term government bond, say a fifteen-year bond yielding an annual interest rate of 5%, and simultaneously enter into an interest rate swap, paying a fixed rate, say 4.8% per annum, over the same maturity, to lock in a profit. Specifically, the investor can finance the bond purchase by borrowing funds secured against the value of the bond at six-month repo rates and rolling over this financing every six months. Provided the payments on this secured borrowing are less than the floating-rate payments received on the swap (ie six-month unsecured Libor, reset every six months for the following fifteen years), the investor would hope to earn at least the fixed-rate differential of 20 basis points per annum.

Chart A Fifteen-year sterling-denominated gilt yields, swap rates and their spread<sup>(a)</sup>



Sources: Bloomberg and Bank calculations.

(a) Dashed line represents the average spreads between sterling-denominated gilt yields and swap rates from January 1998 to February 2009.

Chart B Three-month sterling Libor and implied interest rates from foreign exchange forwards<sup>(a)</sup>



Sources: Bloomberg, Reuters and Bank calculations

(a) For more details of the calculation of implied interest rates from foreign exchange forwards, see 2008 Q2 Quarterly Bulletin, page 134, Chart 26 and BIS Quarterly Review March 2008, pages 73–86.

Similar arguments could be applied to the other pricing anomalies identified above. For example, a bank should be indifferent to borrowing at domestic Libor rates versus borrowing at a foreign Libor rate and entering into an FX forward contract to swap the proceeds into domestic currency (**Chart B**), especially as reporting banks in Libor panels for the main currencies are very similar so the default risk embedded in different Libors should be comparable. And an investor trying to exploit the negative CDS-cash basis could borrow funds to buy the corporate bond and simultaneously buy default protection on the underlying bond in the CDS market.

**Chart C** Spreads between sterling implied forward rates from Libors and forward rate agreements (FRAs)<sup>(a)</sup>

- Three months, three months
- Three months, six months



Sources: Bloomberg, British Bankers' Association and Bank calculations.

(a) Five-day moving averages of the spread between three-month Libor, x months forward (inferred from spot Libors) and the equivalent-maturity forward rate agreement. For each of the lines, x refers to three, six or nine months.

#### Why have they persisted?

Normally these sorts of pricing anomalies would not be expected to have persisted. But there are a number of features of the current conjuncture that may have prevented investors from taking advantage of such mispricing. One factor might be funding/credit constraints. In theory, the complete elimination of arbitrage opportunities assumes that market participants can access limitless capital. But credit constraints might mean investors are limited in their ability to borrow funds in order to exploit an opportunity to a sufficient scale to remove pricing differentials.

Credit constraints may manifest themselves in the quantity and/or price of credit available. Constraints on the quantity of capital available for trading purposes could mean that market participants are simply unable to exploit the price differentials. For example, consider an investor trying to exploit the negative CDS-cash basis by borrowing funds to buy the corporate bond and simultaneously buy default protection on the bond in the CDS market. Borrowing funds and purchasing the bond would tend to expand the investor's balance sheet, and hence potentially increase leverage, relative to simply taking a position in CDS markets (which are derivatives and require less upfront capital investment). This could represent a 'barrier to arbitrage' and could in turn give rise to a liquidity premium in corporate bond yields.

Similarly, increases in the price of credit could result in higher transaction costs for investors, as reflected in wider bid-ask spreads. This would increase the 'costs of arbitrage', such that the trading opportunity might only be profitable if the pricing anomaly is sufficiently wide to cover the increased cost.

Investor risk aversion might also offer a partial explanation behind some of the recent anomalies. 'Pure' arbitrage should not be affected by investors' attitude to risk since these opportunities enable the investor to guarantee a profit or at least break even. However, in most cases the different assets are not perfect substitutes for each other and as such there may only be approximate arbitrage opportunities that offer a large potential profit at little risk (but could generate losses in some circumstances). For example, in the case of negative interest rate swap spreads, investors may be unwilling to take on the financing risk (ie the possibility that the secured rate may be above the unsecured rate). Similarly, if market participants have become more uncertain about counterparty risks (ie the uncertainty about whether the counterparty will be able to honour its side of a commitment), that might have made them more reluctant to put on trades to exploit the pricing anomaly. This might perhaps be because they perceive the risks to have become unquantifiable (ie an example of so-called Knightian uncertainty).

Moreover, even if a trade is guaranteed to generate a return on maturity, it could nonetheless present significant mark-to-market risks in the interim. Most investors have to value their positions over time based on prevailing market prices. A fall in the value of the position could impact the investors' balance sheet via collateral or margin calls from counterparties. And if the investor was forced to sell the position prior to maturity there is a risk that this could result in a loss, particularly if the underlying assets were relatively illiquid. As a result, investors (particularly leveraged investors who might be expected to be especially active in these types of trade) may be reluctant at times to exploit the opportunities that exist.

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See Cortes, F (2006), 'Understanding the term structure of swap spreads', Bank of England Quarterly Bulletin, Spring, pages 45–56.

#### Developments in market structure

#### UK foreign exchange turnover survey

Results of the October 2008 Foreign Exchange Joint Standing Committee (FXJSC) survey were published on 27 January. The survey showed that foreign exchange turnover in London declined in October 2008 compared with April 2008. This was the first six-month fall in overall turnover published by the FXJSC since the survey started in 2004.

Average daily turnover recorded in the October 2008 survey was \$1,679 billion, 8% lower than the April 2008 survey, although it remained 21% higher than in October 2007 (**Chart 30**). Some of the fall in turnover reflected the strength of the US dollar in October — taking account of that currency effect, turnover fell by just over 1%. According to contacts, turnover continued to fall in November and December.

### Chart 30 UK foreign exchange daily average turnover by instrument



Source: London Foreign Exchange Joint Standing Committee.

In terms of instruments, the reported fall in turnover in the October survey was more than accounted for by a 23% fall in foreign exchange swap activity. This reflected the ongoing strains in international money markets. In contrast, turnover for spot and outright forward instruments continued to rise.

Turnover in all major currencies fell in the six months to October, except for the Japanese yen and euro (Chart 31). Turnover in sterling fell by 7% in October from April. Notably, US dollar turnover dropped 11% over the same period.

#### Proposed new liquidity standards for UK banks

The FSA published its consultation paper on strengthening liquidity standards for UK banks on 4 December 2008. At the

### Chart 31 UK foreign exchange daily average turnover by currency



core of the proposed regime is a requirement on banks to assess how much liquidity they would potentially need under stress conditions. Based on the results of those stress tests, the FSA plans to impose quantitative requirements that aim to constrain the amount of liquidity risk each bank can take. They will also require banks to hold a buffer of the highest-quality liquid assets comprising essentially of high-quality government bonds.

Alongside these *quantitative* measures, the FSA proposed a strengthened *qualitative* framework for liquidity risk management, with an increased focus on firms' stress testing and contingency funding plans. This is based on recently agreed international liquidity standards, in particular the Basel Committee on Banking Supervision's Principles for Sound Liquidity Risk Management and Supervision.

The consultation period closed on 4 March 2009. The FSA hopes to introduce new rules by the summer of 2009.

#### Bank of England official operations

#### Sterling monetary framework

On 5 March, the MPC announced that Bank Rate would be reduced by 0.5 percentage points to 0.5%, and that the Bank would undertake a programme of asset purchases of £75 billion financed by the issuance of central bank reserves. Part of that sum would finance the Bank's programme of private sector asset purchases through the Asset Purchase Facility (APF) intended to improve the functioning of corporate credit markets. But in order to meet the MPC's objective for total asset purchases, it was announced that the Bank would also buy medium and long-term conventional gilts in the secondary market. This section covers the three full reserves maintenance periods from 6 November to 4 February prior to this announcement. The subsequent changes to the sterling monetary framework are described in the box on page 26.

#### Maintaining short-dated interest rates in line with **Bank Rate**

#### **Reserves targets**

In normal circumstances, the Bank seeks to maintain overnight interest rates in line with Bank Rate ensuring a net supply of reserves in line with the banking system's demand, as reflected in targets chosen by the banks themselves. Aggregate reserves targets increased by £0.4 billion to £37.7 billion in November, and increased again to £44.6 billion in December as reserves scheme participants continued to set higher targets to help manage unexpected liquidity or payment shocks around the end of the year. Aggregate reserves targets were subsequently reduced to £40.4 billion in January. Reserves targets remained high relative to their average since the launch of the reserves scheme in May 2006 (Chart 32).





#### Reserves target ranges

Reserves balances are usually remunerated at Bank Rate within a range around each bank's individual reserves target. This range was ±40% for the October maintenance period. The Bank reduced the range to ±20% for the November maintenance period. It subsequently reduced the range to ±10% with effect from the December maintenance period (Chart 33).

#### Open market operations

By operating at a variety of maturities, in normal circumstances the Bank gives itself the flexibility to adjust the supply of reserves as needed without unnecessary 'churn' in its short-term repo open market operations (OMOs). Long-term financing is provided by means of long-term repo OMOs at three, six, nine and twelve-month maturities and by means of gilt-purchase OMOs.

#### Chart 33 Aggregate reserves targets and reserves provision

- Range within which reserves remunerated
- Additional provision resulting from uncovered OMO drains
- Additional provision
- Reserves provision to meet aggregate targets



The Bank offered to provide reserves in long-term repo OMOs, according to its published monthly schedule, in each of the three maintenance periods. In addition, the Bank continued to provide liquidity insurance via extended-collateral long-term repo OMOs at a three-month maturity (described further below). Repo operations at six, nine and twelve-month maturities were offered against routine OMO collateral. In the operation held in December no bids were received for the nine months and twelve-months OMOs. Other operations were fully covered (Table A).

Over the review period, the Bank conducted two gilt-purchase OMOs, on 24 November 2008 and 26 January 2009. Both operations were fully covered (Table B).

Long-term repo and bond purchase OMOs provide reserves for the maintenance period in which they are settled and for all subsequent maintenance periods until maturity. Weekly and fine-tuning OMOs offer the greatest flexibility for adjusting the Bank's net supply of reserves.

Since October 2008, reserves provided in extended-collateral long-term OMOs have increased substantially (Chart 34). Since then, the Bank has ceased to lend in its weekly short-term OMOs and has instead sought to drain reserves.

It has done this via offers to sell one-week Bank of England sterling bills (Bank bills),<sup>(1)</sup> in order to leave reserves banks with sufficient reserves, in aggregate, to meet their combined targets.

<sup>(1)</sup> For the use of central bank bills in the implementation of monetary policy see the box on page 377 of the 'Markets and operations' article in the 2008 Q4 Quarterly Bulletin.

Table B Issue Department gilt-purchase OMOs

#### Table A Long-term repo operations

|                                      | Six-month | Nine-month | Twelve-month |
|--------------------------------------|-----------|------------|--------------|
| 18 November 2008                     |           |            |              |
| On offer (£ millions)                | 750       | 400        | 200          |
| Cover                                | 2.73      | 3.13       | 3.00         |
| Weighted average rate <sup>(a)</sup> | 1.800     | 1.870      | 1.925        |
| Highest accepted rate <sup>(a)</sup> | 1.890     | 1.890      | 1.940        |
| Lowest accepted rate <sup>(a)</sup>  | 1.720     | 1.850      | 1.910        |
| Tail <sup>(b)</sup>                  | 8.00      | 2.00       | 1.50         |
| 16 December 2008                     |           |            |              |
| On offer (£ millions)                | 750       | 400        | 200          |
| Cover                                | 0.93      | 0.00       | 0.00         |
| Weighted average rate <sup>(a)</sup> | 1.114     | 0.000      | 0.000        |
| Highest accepted rate <sup>(a)</sup> | 1.212     | 0.000      | 0.000        |
| Lowest accepted rate <sup>(a)</sup>  | 1.050     | 0.000      | 0.000        |
| Tail <sup>(b)</sup>                  | 6.00      | 0.00       | 0.00         |
| 20 January 2009                      |           |            |              |
| On offer (£ millions)                | 750       | 400        | 200          |
| Cover                                | 2.15      | 2.39       | 3.08         |
| Weighted average rate <sup>(a)</sup> | 0.880     | 0.912      | 0.990        |
| Highest accepted rate <sup>(a)</sup> | 0.900     | 0.950      | 0.990        |
| Lowest accepted rate <sup>(a)</sup>  | 0.850     | 0.820      | 0.990        |
| Tail <sup>(b)</sup>                  | 3.00      | 9.20       | 0.00         |

(a) Per cent.

(b) The yield tail measures, in basis points, the difference between the weighted average accepted rate and the lowest accepted rate.

# Chart 34 Factors affecting the supply of reserves (maintenance period averages)



In the November maintenance period, the offers to sell Bank bills on a weekly basis were not fully taken up (Chart 35). The Bank adjusted the amount of bills offered for sale each week in light of its forecast for autonomous factors in the coming week together with any reserves which were not drained in previous operations in the maintenance period. For the maintenance period as a whole, more reserves were supplied (net) than banks required to meet their aggregate targets (Chart 33). However, the range around targets within which the Bank remunerated reserves was sufficiently wide for all of these reserves to be remunerated at Bank Rate.

|                                   | Amount<br>purchased<br>(£ millions) | Sector<br>cover<br>ratio | Weighted<br>average<br>accepted<br>price | Highest<br>accepted<br>price | Lowest<br>accepted<br>price | Tail <sup>(a)</sup> |
|-----------------------------------|-------------------------------------|--------------------------|--|------------------------------|-----------------------------|---------------------|
| 24 November                       | 2008                                |                          |  |                              |                             |                     |
| Short                             |                                     | 2.48                     |  |                              |                             |                     |
| UKT 5%<br>07/09/14                | 83.09                               |                          | 108.810                                  | 108.860                      | 108.723                     | 0.050               |
| UKT 8%<br>07/12/15                | 136.89                              |                          | 125.400                                  | 125.430                      | 125.390                     | 0.030               |
| Medium                            |                                     | 3.61                     |  |                              |                             |                     |
| UKT 4.75%<br>07/03/20             | 125.99                              |                          | 104.840                                  | 104.847                      | 104.840                     | 0.007               |
| Long                              |                                     | 1.98                     |  |                              |                             |                     |
| UKT 5%<br>07/03/25                | 45.91                               |                          | 105.668                                  | 105.700                      | 105.587                     | 0.032               |
| UKT 6%<br>07/12/28                | 45.91                               |                          | 118.973                                  | 119.050                      | 118.913                     | 0.077               |
| Total<br>purchased <sup>(b)</sup> | 437.79                              |                          |  |                              |                             |                     |
| 26 January 20                     | 09                                  |                          |  |                              |                             |                     |
| Short                             |                                     | 3.28                     |  |                              |                             |                     |
| UKT 4.75%<br>07/09/15             | 105.89                              |                          | 108.671                                  | 108.690                      | 108.664                     | 0.019               |
| UKT 8%<br>07/12/15                | 64.08                               |                          | 127.297                                  | 127.371                      | 127.280                     | 0.074               |
| Medium                            |                                     | 2.82                     |  |                              |                             |                     |
| UKT 8%<br>07/06/21                | 133.93                              |                          | 138.978                                  | 138.989                      | 138.970                     | 0.011               |
| Long                              |                                     | 4.98                     |  |                              |                             |                     |
| UKT 5%<br>07/03/25                | 47.99                               |                          | 105.148                                  | 105.148                      | 105.120                     | 0.032               |
| UKT 6%<br>07/12/28                | 47.95                               |                          | 117.554                                  | 117.554                      | 117.540                     | 0.026               |
| Total purchased <sup>(b)</sup>    | 399.84                              |                          |  |                              |                             |                     |

(a) The tail measures the difference between the highest accepted price and the weighted average accepted price.

(b) Figures may not sum to total due to rounding.

In December, Euroclear UK & Ireland announced that with effect from 10 December 2008 Bank bills could be included in the CREST delivery-by-value (DBV) category 'unstripped British government debt' (UBG) and could therefore be delivered using this category within CREST, including, where eligible, in the Bank's operations under the sterling monetary framework.<sup>(1)</sup> The UBG category is the main basket used by market participants in gilt repo transactions. Since their inclusion within the UBG DBV category, the Bank's counterparties indicated that they became a more attractive asset to hold; and as a result, cover in operations to sell Bank bills increased (Chart 35).

Delivery-by-value allows CREST members to borrow or lend cash against a package of securities overnight, which are automatically selected and delivered at the end of the day and unwound the following morning.

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# Chart 35 Size of short-term draining OMOs and short-term cover ratio<sup>(a)</sup>

Counterparties continued to make use of the ability to place funds with the Bank via the Operational Standing Facilities. Use of the deposit facility, where banks deposited funds at 25 basis points below Bank Rate, naturally tended to coincide with periods when short-dated market interest rates were below Bank Rate. During the November, December and January maintenance periods daily usage by banks averaged £5.3 billion, £5.4 billion and £1.3 billion respectively. Use of the deposit facility had the effect of draining reserves. There was no use of the lending facility during the period under review.

The Bank held routine overnight fine-tuning OMOs at the end of each maintenance period.

On 29 December, HM Treasury refinanced the loans that the Bank had made to the Financial Services Compensation Scheme (FSCS) and to Bradford & Bingley. To fund this refinancing, HM Treasury borrowed temporarily from the Bank using the 'Ways and Means' facility, the UK central government's overdraft facility with the Bank (**Chart 34**). HM Treasury intends to repay this Ways and Means borrowing during the spring of 2009. The original loan to the FSCS was an 'autonomous factor' increasing the size of the Bank's bill sale OMOs needed to achieve the reserves target. The repayment of this Ways and Means borrowing will have the opposite effect.

#### OMOs over the year end

In order to provide greater assurance to banks in managing their liquidity positions over the year end, the Bank announced on 19 December 2008 that it intended to vary its schedule of weekly draining OMOs. Rather than offering a single weekly OMO spanning the year end, two short-term operations with different maturities were conducted on 24 December 2008. In addition, further operations were conducted on 31 December 2008 and on 2 January 2009 (Chart 36).

# Chart 36 Amounts outstanding in short-term drain operations around the year end



#### Short-dated interest rates

Secured sterling overnight market interest rates tended to trade a little below Bank Rate during the period under review and were less volatile than during the October maintenance period (**Chart 37**). During the November maintenance period, when overnight market interest rates traded a little further below Bank Rate, reserves banks in aggregate held more reserves than were required to meet their targets. In the December and January maintenance periods, when reserves were in line with targets, market rates tended to trade close to Bank Rate (**Chart 38**).



Chart 37 Spread to Bank Rate of secured sterling

Sources: BrokerTec and Bank calculations

Banks might usually be expected to charge a premium for the credit risk associated with unsecured interbank lending compared to a secured transaction of the same maturity.

Chart 38 Folded cumulative distribution<sup>(a)</sup> of spread of sterling secured overnight interest rate (trade weighted) to Bank Rate



Sources: BrokerTec and Bank calculations.

(a) Distribution of the spread between overnight interest rate at end-of-day and the official interest rate. The distributions are folded at the medians to that cumulative probabilities for values above (below) the median are indicated by the right-hand (left-hand) scale.

However, overnight secured interest rates have for most of the period under review been higher than equivalent unsecured interest rates (Chart 39).



Sources: BrokerTec and Bank calculations

The relatively low level of unsecured overnight interest rates compared to policy rates has been a global phenomenon (Chart 40). As discussed in previous *Bulletins*, fragmentation of money markets might explain why market participants were not utilising the unsecured market to finance secured lending in sufficient size to arbitrage away any 'risk-less' spread.

# Reducing the cost of disruption to the liquidity and payment services supplied by commercial banks

The second objective of the Bank's market operations is to reduce the cost of disruptions to the liquidity and payments services supplied by commercial banks. The Bank does this by **Chart 40** Folded cumulative distribution<sup>(a)</sup> of spread of international unsecured overnight interest rates to official interest rates for period 6 Nov. 2008–4 Feb. 2009



(a) Distribution of the spread between overnight interest rate at end-of-day and the official interest rate. The distributions are folded at the median so that cumulative probabilities for values above (below) the median are indicated by the right-hand (left-hand) scale.

balancing the provision of liquidity insurance against the costs of creating incentives for banks to take greater risks, and subject to the need to control the risk to its balance sheet.

In addition to the provision of reserves accounts, the Bank provides liquidity insurance in a number of ways. Within the sterling monetary framework, these include extended-collateral long-term repo OMOs and the Discount Window Facility described below. In addition, as described in the subsequent section, operations outside the sterling monetary framework, including US dollar repo operations and the Special Liquidity Scheme, have also been employed.

#### Extended-collateral long-term repo operations

Extended-collateral three-month long-term repo OMOs continued to be conducted on a weekly basis up until 18 November 2008, with £20 billion offered in each operation during the period under review. Following an announcement on 14 November 2008, the Bank reduced the frequency of these operations from weekly to twice-monthly. The Bank announced on 2 February 2009 that it would continue to hold these operations twice-monthly up to and including the scheduled long-term repo operation on 14 April 2009.

The results of these operations are shown in **Table C**. Cover in these operations has been variable.

#### Discount Window Facility (DWF)

In October 2008 the Bank introduced a DWF as part of the framework for its operations in the sterling money markets. The DWF is a permanent facility to provide liquidity insurance to the banking system. It allows eligible banks and building societies to borrow gilts against a wide range of collateral. In recognition of the continued stresses in financial markets, the Bank announced on 19 January 2009 that, for an additional fee

Chart 39 Spread between secured and unsecured sterling overnight interest rates

#### Table C Extended-collateral three-month long-term repo operations

#### 11 November 2008

| On offer (£ millions)<br>Cover<br>Weighted average rate <sup>(a)</sup><br>Lowest accepted rate <sup>(a)</sup><br>Tail <sup>(b)</sup> | 20,000<br>0.55<br>2.567<br>2.440<br>13.00 |  |
|--|---|--|
| 18 November 2008   |   |  |
| On offer (£ millions)<br>Cover<br>Weighted average rate <sup>(a)</sup><br>Lowest accepted rate <sup>(a)</sup><br>Tail <sup>(b)</sup> | 20,000<br>0.36<br>2.198<br>1.890<br>31.00 |  |
| 2 December 2008  |   |  |
| On offer (£ millions)<br>Cover<br>Weighted average rate <sup>(a)</sup><br>Lowest accepted rate <sup>(a)</sup><br>Tail <sup>(b)</sup> | 20,000<br>0.68<br>1.740<br>1.410<br>33.00 |  |
| 16 December 2008   |   |  |
| On offer (£ millions)<br>Cover<br>Weighted average rate <sup>(a)</sup><br>Lowest accepted rate <sup>(a)</sup><br>Tail <sup>(b)</sup> | 20,000<br>0.85<br>1.634<br>1.430<br>20.00 |  |
| 6 January 2009   |   |  |
| On offer (£ millions)<br>Cover<br>Weighted average rate <sup>(a)</sup><br>Lowest accepted rate <sup>(a)</sup><br>Tail <sup>(b)</sup> | 20,000<br>1.24<br>1.070<br>1.010<br>6.00  |  |
| 20 January 2009  |   |  |
| On offer (£ millions)<br>Cover<br>Weighted average rate <sup>(a)</sup><br>Lowest accepted rate <sup>(a)</sup><br>Tail <sup>(b)</sup> | 20,000<br>1.61<br>1.205<br>0.951<br>25.00 |  |
| 3 February 2009  |   |  |
| On offer (£ millions)<br>Cover<br>Weighted average rate <sup>(a)</sup><br>Lowest accepted rate <sup>(a)</sup><br>Tail <sup>(b)</sup> | 20,000<br>1.73<br>1.018<br>0.803<br>0.22  |  |

(a) Per cent.(b) The yield tail measures, in basis points, the difference between the weighted average accepted rate and the lowest accepted rate

of 25 basis points, it would permit drawing from the DWF with a term of 364 days in addition to the standard option to draw for 30 days.

There is a consequential change to the arrangements for publication of the use of the DWF. The average aggregate daily value of gilts lent under the DWF with an initial maturity of 30 days or less during each calendar quarter will continue to be published on the first Tuesday following the final working day of the following calendar quarter. The average aggregate daily value of gilts lent with an initial maturity of more than 30 days during each calendar quarter will be published on the first Tuesday following the final working day of the calendar quarter five quarters ahead.

#### Other market operations

#### US dollar repo operations

In co-operation with other central banks, since 18 September 2008, the Bank has offered dollar financing to financial institutions funded by a swap with the Federal Reserve. Dollar financing is currently offered at one-week, one-month and three-month maturities. The profile of the stock of dollar financing is shown in Chart 41.



Chart 41 US dollar repo: stock outstanding by maturity<sup>(a)</sup>

(a) Stock outstanding is shown from settlement date

To address continued pressures in global US dollar funding markets it was announced on 3 February 2009 that swap lines between the Federal Reserve and other central banks had been extended to 30 October 2009. In the United Kingdom, there has been declining participation in the US dollar repo operations recently. The Bank will continue to conduct US dollar repo operations, including its weekly tenders, as long as necessary but will keep them under review in the light of market conditions.

#### Special Liquidity Scheme (SLS)

As previously announced the drawdown period for the SLS closed on 30 January 2009. Although the drawdown window to access the SLS has closed, the Scheme will remain in place for three years, thereby providing participating institutions with continuing liquidity support and certainty. The box on page 25 provides further details on the usage of the SLS.

#### Asset Purchase Facility

On 19 January 2009, HM Treasury authorised the Bank to purchase up to £50 billion of high-quality private sector assets under an Asset Purchase Facility (APF). The initial aim of the Facility was to help improve financing conditions for companies.

The following sterling assets were initially announced as eligible for purchase: commercial paper, corporate bonds, paper issued under the Credit Guarantee Scheme, syndicated loans and asset-backed securities created in viable securitisation structures.

The Bank, on 13 February, launched a Commercial Paper Facility to enable the purchase of investment-grade sterling-denominated commercial paper (CP) issued by companies that make a material contribution to economic activity in the United Kingdom. CP would be purchased both at issuance and in the secondary market, subject to a minimum spread. This could channel funds directly to parts of the corporate sector while also underpinning secondary market activity and helping to enlarge the private issuance market, and so removing obstacles to corporate access to capital markets. Over the first three weeks of operation the total amount purchased, in terms of the amount paid to the sellers, was £985 million.

Until the announcements made on 5 March noted above, the APF was financed by the issuance of Treasury bills by the Debt Management Office so that asset purchases under the Facility would not affect the level of reserves. Subsequent changes to the APF are described in the box on page 26.

#### The Bank's foreign currency reserves

There have been no significant developments in the Bank's holdings of foreign exchange reserves over the review period. The reserves comprised around £2.5 billion of assets at the end of the review period. These are funded by two \$2 billion three-year issues, under the Bank's programme of annual bond issuance, which commenced in March 2007. The third bond issue in the programme, due in March 2009, will complete the transition process to a portfolio of approximately \$6 billion of foreign exchange reserves.

#### Facilitating the provision of payment services

In May 2008, as previously reported, the Bank ceased to be a direct member of TARGET, the euro-area wholesale payments system. Prior to this, to facilitate UK participation in TARGET, the Bank held euro-denominated assets that were lent out each day by the Bank to generate intraday liquidity. These assets were funded by a series of Euro Notes. The final such note, for €3 billion nominal, matured on 27 January 2009.

#### Capital portfolio

The Bank holds an investment portfolio that is approximately the same size as its capital and reserves (net of equity holdings, eg in the BIS and ECB, and the Bank's physical assets) together with aggregate cash ratio deposits. They are invested in a portfolio of sterling-denominated securities. Securities purchased by the Bank for this portfolio are normally held to maturity; nevertheless sales may be made from time to time, reflecting for example, risk management, liquidity management or changes in investment policy.

The bond portfolio currently includes around £3 billion of gilts and £1 billion of other debt securities. Purchases are generally made each month, with purchase details announced in advance on the Bank's wire service pages. Over the current review period, gilt purchases were made in accordance with the quarterly announcements on 1 October 2008 and 2 January 2009: £20 million each in November and January.

#### **Special Liquidity Scheme**

On 21 April 2008, the Bank of England launched the Special Liquidity Scheme (SLS) to improve the liquidity position of the banking system. The Scheme was designed to finance part of the overhang of illiquid assets on banks' balance sheets by allowing banks and building societies to swap for up to three years some of their legacy illiquid assets for UK Treasury bills. The drawdown period for the SLS closed on 30 January 2009, and data about its use was published on 3 February.

#### Usage of the Scheme

Thirty two banks and building societies accessed the Scheme. In aggregate, those firms accounted for over 80% of the combined sterling balance sheets of the financial institutions eligible to use the Scheme.

The Bank announced that Treasury bills with a face value of approximately  $\pounds$ 185 billion had been lent under the Scheme. Given its scale, the Scheme is indemnified by HM Treasury, but is designed to control the risk of potential losses. Banks will need, at all times, to provide the Bank of England with securities of significantly greater value than the Treasury bills they have received.

Most of the securities held by the Bank as collateral in the Scheme have been residential mortgage-backed securities or covered bonds secured on pools of residential mortgages. As at 30 January 2009, the total nominal 'par' value of this collateral amounted to approximately £287 billion. The Bank's valuation of those securities at that time was approximately £242 billion, an effective discount to par of about 16%.

#### Valuation and haircuts

Securities are valued by the Bank using observed market prices that are independent and routinely available publicly. The Bank reserves the right to use its own calculated prices, including where such independent market prices are unavailable. Those calculated prices are designed to deliver valuations taking account of securities' contracted cash flows and yields of comparable securities, but not individual loan-by-loan analysis of portfolios. To account for the risk that a calculated price is an over-estimate of what a market price would have been had it existed, an additional haircut is added.

Haircuts are designed to protect against the risk of loss in the event of a counterparty defaulting, and are therefore set taking into account uncertainty about possible valuations of the Bank's collateral, including in the event of default.

#### The Scheme after the close of the drawdown window

Although the drawdown window to access the SLS has closed, the Scheme will remain in place for three years. During this

time, if the haircut-adjusted value of the collateral were to fall, the counterparties would need to provide more securities, or return some of the Treasury bills. And if their assets pledged as security were to be down-rated, the counterparties would need to replace them with alternative, highly rated assets.

The SLS has served its purpose in relation to the overhang of illiquid assets on balance sheets up to the end of 2007 and continues to provide participating institutions with liquidity support and certainty. But financing conditions have remained difficult for banks and building societies, and further measures have been introduced by the Bank and HM Treasury to improve bank financing and credit conditions in the economy more widely (see box on page 9).

# The Asset Purchase Facility and changes to the sterling monetary framework

On 19 January 2009, HM Treasury authorised the Bank to purchase up to £50 billion of high-quality private sector assets under an Asset Purchase Facility (APF). The initial aim of the Facility was to improve the functioning of corporate credit markets. The APF also provided a framework for the Monetary Policy Committee (MPC) to undertake asset purchases for monetary policy purposes.<sup>(1)</sup>

An exchange of letters between the Governor and the Chancellor, dated 17 February and 3 March respectively, was published on 5 March. The MPC will use the APF for monetary policy purposes by financing asset purchases using central bank reserves. To that end, the range of eligible assets will include UK government debt purchased in the secondary market as well as certain private sector assets. Purchases of up to £150 billion were authorised, of which it was specified that up to £50 billion should be used to purchase private sector assets.

Within that framework, as well as announcing on 5 March that Bank Rate would be reduced by 0.5 percentage points to 0.5%, the MPC announced that the Bank would undertake a programme of asset purchases of £75 billion financed by the issuance of central bank reserves. Part of that sum would finance the Bank's programme of private sector asset purchases through the APF. But in order to meet the MPC's objective for total asset purchases, it was announced that the Bank would also buy medium and long-term conventional gilts in the secondary markets. The MPC noted that at its future meetings, it would monitor the effectiveness of the purchase programme in boosting the supply of money and credit, and in due course raising the rate of growth of nominal spending, adjusting the speed and scale of purchases as appropriate.

In a Market Notice issued on 5 March, the Bank announced that it would purchase gilts in reserve auctions, normally twice weekly. The Chancellor's letter to the Governor confirmed that the government's debt issuance strategy would not be altered as a result of the asset purchase transactions undertaken by the Bank for monetary policy purpose.

#### Changes to the sterling monetary framework

As a consequence of the MPC's decision, in a Market Notice issued on 5 March, the Bank announced a number of changes to the sterling monetary framework. With effect from the maintenance period starting on 5 March, until further notice, all reserves balances held by reserves banks would be remunerated at Bank Rate. The usual system in which reserves banks choose monthly reserves targets that they have to achieve on average over the maintenance period was suspended.

The Bank also announced that if Bank Rate was 0.5% or below, the rate paid on the Operational Standing Deposit Facility would be zero; the rate charged on the Operational Standing Lending Facility would continue to be set 25 basis points above Bank Rate.

The Bank would continue to provide liquidity insurance to the banking system, and inject reserves, by holding extended-collateral, and routine, long-term repo open market operations (OMOs) on the schedule previously announced.

In respect of the level of reserves, the Bank announced that broadly, its operational approach would be to ensure that the net supply of reserves was around the aggregate level of reserves targets initially set by reserves scheme participants for the maintenance period starting on 5 March, plus the amount of reserves injected via the purchase of assets acquired as authorised by the MPC. In order to achieve that, the Bank would continue for the time being to hold weekly OMOs to drain reserves injected via extended-collateral long-term repo operations by issuing one-week Bank of England sterling bills. Henceforth, these bills would normally be issued on a variable-rate basis. Short-term lending operations would remain available for use if necessary. For as long as reserves averaging was suspended, the Bank said it would not conduct a routine fine-tuning OMO on the final day of the maintenance period.

The use of asset purchases for monetary policy purposes was discussed in the February 2009 Inflation Report, pages 44–45.

# Research and analysis

PROMISE

# Price-setting behaviour in the United Kingdom: a microdata approach

By Philip Bunn of the Bank's Structural Economic Analysis Division and Colin Ellis of the Bank's Monetary Analysis Division.<sup>(1)</sup>

This article discusses recent work at the Bank of England using large databases of individual price quotes to investigate price dynamics in the United Kingdom. Understanding the dynamics of prices is important for policymakers concerned with meeting an inflation target. Based on price quotes underlying ONS aggregate price indices, consumer prices changed, on average, once every five months between 1996 and 2006, while producer prices changed once every four months between 2003 and 2007. Higher frequency supermarket price data covering the period from 2005 to 2008 suggest that prices change more often than this. There are considerable differences in the behaviour of prices between different types of products: for example, goods prices change more often than services prices. The individual price-level data are not clearly supportive of any one theory of price-setting.

#### Introduction

This article summarises the key findings from recent research work at the Bank of England which examines price-setting behaviour in the United Kingdom using large databases of individual price quotes — often referred to as 'microdata'. This research complements other recent work at the Bank of England using survey data, as discussed in the 2008 Q4 *Quarterly Bulletin* (see Greenslade and Parker (2008)).

How prices behave is a key question for policymakers who are setting monetary policy to meet an inflation target. If prices take time to adjust, this allows changes in monetary policy to affect real economic activity via changes in real interest rates and monetary aggregates, at least in the short term. Understanding more about price dynamics is important in judging what the appropriate monetary policy response is to developments in the economy.

The Bank of England targets an annual inflation rate in the consumer prices index (CPI) of 2% a year. Given that this aggregate price index is a weighted sum of individual prices, changes in those individual prices can have important implications for both the overall price level and for relative prices within the aggregate. So learning more about how often individual prices change and how much they change by is important for monetary policy makers.

Prices might be sticky, or slow to adjust, because of the presence of constraints, often referred to as 'nominal

rigidities'. Economic models typically include some type of mechanism to incorporate these nominal rigidities. A number of mechanisms have been proposed. These can be categorised under two main headings: 'time-dependent' and 'state-dependent' pricing models.

In a time-dependent model, the probability of a price change depends only on the time since the previous change. A simple example proposed by Calvo (1983), assumes homogeneous firms have a constant probability of changing their price in each period. Alternative time-dependent models include 'staggered contracts' in which prices are fixed for the duration of a contract but contracts overlap in that they do not all start and end at the same time (Taylor (1980)). In a state-dependent model, the decision to change prices depends on the state of the economy and the market faced by the firm. Firms are typically assumed to face a cost to adjusting their prices. Examples of these costs include fixed costs of changing price — so-called 'menu costs' (Mankiw (1985)), or a disutility associated with making large price changes if firms fear that making such changes may upset their customers (Rotemberg (1982)). Examining how actual prices behave may help to shed light on which of these theoretical models are more relevant to the real world.

The work described in this article uses three large databases of individual prices to examine the facts about how often prices

This work was completed while Colin Ellis was employed at the Bank of England. He now works at Daiwa Securities SMBC.

#### The ONS Virtual Microdata Laboratory (VML)

The ONS collects a large amount of data to produce statistics about all aspects of the economy and society. The microdata that underlie many of the aggregate statistics produced by the ONS are a potentially valuable resource to researchers. But because of the confidentiality issues relating to information collected about individual people or firms it is not possible to make this type of data widely available. The Virtual Microdata Laboratory (VML) was launched in January 2004 with the aim of allowing researchers access to data while also maintaining confidentiality and security. Initially only business survey data were available, but the number of data sets stored in the VML has expanded considerably since then. The microdata that underlie the consumer and producer price indices used in this article were first made accessible via the VML in late 2007. The VML is located on ONS premises and allows no data or results to be taken into or out of the laboratory directly by researchers. There is no access to the outside world via email or the internet for those working in the laboratory and all outputs have to be cleared by ONS staff before they are released to researchers to ensure they contain no confidential information. Access is only granted for a valid statistical purpose and all researchers are given training and vetted. The VML has been used by over 400 trained researchers from a variety of backgrounds since its inception. These include members of ONS staff, academics and researchers from a range of government departments and other institutions such as the Bank of England. Ritchie (2008) provides further details and summarises work carried out in the VML.

change and how much they change by. Two of these micro-level data sets are produced by the ONS and they underlie the consumer and producer price indices.<sup>(1)</sup> Both of these data sets have been made available for the first time for use in research work. The third is a database of UK supermarket price quotes or so-called 'scanner data' from the point of sale. Past studies in this field for other countries have used both price quotes underlying official inflation measures (see Bils and Klenow (2004), Dhyne *et al* (2005)) and scanner data (Chevalier *et al* (2000), Kehoe and Midrigan (2007)). But there is no such previous work for the United Kingdom using either approach. The research described in this article attempts to fill this gap in the literature.

Investigating how individual prices behave using large databases of price quotes addresses similar issues to the recent Bank of England pricing survey discussed in the 2008 Q4 Quarterly Bulletin. Both approaches have their relative merits. The microdata analysis has the advantage of using much larger data sets to establish the facts about how a broader range of prices actually behave. The largest micro data set discussed in this article contains over 11 million observations, whereas the survey is based on around 700 responses. The databases of individual price data also enable the examination of how prices behave at different points in time rather than just in one particular period. But surveys can be used to ask firms about why they change their prices and how they respond to different events, as well as gathering information about how often prices typically change. Using surveys, it is also possible to ask firms how often they review their price as well as how often they change their price. Later in the article the results from these two approaches are compared.

The remainder of the article is structured as follows. First it describes the three data sets in a little more detail. It then

summarises the results, starting off by discussing how often prices change before looking at whether the likelihood of a price change varies over time. This is followed by some analysis of the size of price changes and the relationship between the frequency and size of price changes.

#### The data

#### **Consumer price data**

On the second or third Tuesday of every month, the ONS collects data on the prices of individual consumer goods and services. These raw data are then weighted together and aggregated to form the monthly CPI. The ONS makes the microdata underlying the CPI available to researchers via its Virtual Microdata Laboratory (VML). The box above describes the VML in more detail.

The sample for consumer prices used in this article is very large — it includes just over 11 million price quotes recorded between 1996 and 2006, covering 600,000 different items. The same individual items are not present in all periods since the sample is regularly updated to ensure it remains representative. Only the locally collected data that make up the CPI — where ONS price collectors go into shops and record selling prices — were available. A set of centrally collected data — where the ONS collects national prices from particular companies — were not readily available. The locally collected data make up around two thirds of the aggregate CPI by weight. The box on page 30 describes how the microdata were used to estimate how often prices change.

<sup>(1)</sup> This work contains statistical data from ONS which is Crown copyright and reproduced with the permission of the controller of HMSO and Queen's Printer for Scotland. The use of the ONS statistical data in this work does not imply the endorsement of the ONS in relation to the interpretation or analysis of the statistical data. This work uses research data sets which may not exactly reproduce National Statistics aggregates.

#### Estimating how often prices change

Estimates of how often consumer prices and producer prices change were calculated using the microdata underlying these series. The data provided by the ONS contain identifiers that classify an individual price quote according to its exact product type, date of collection and the location in which the price was collected. Using these identifiers, a time series of price quotes for each individual item was constructed. This was then used to identify whether a price change occurred for each item in a particular month of the data. The results were aggregated across the sample to calculate how many prices changed in that month. Each individual price quote was then weighted to calculate an average figure for that month. The weights used were the weights of each individual item within either the locally collected part of CPI or the overall PPI. The CPI weights are based on expenditure, while the PPI weights are based on sales.

The ONS collects larger samples of price quotes for some groups of products where it believes that it is necessary to produce a reliable estimate of the average price, for example where there is a lot of diversity within a product group. Weighting the ONS data avoids biasing the results towards these types of products, making them more representative of the prices faced by the average consumer or charged by producers.

Similar techniques were used to estimate how often supermarket prices change. Here the weights used were based on sales. The data were heavily weighted towards fresh products (57% of the sample) so results are reported both including and excluding these items.

#### Producer price data

The ONS collects and aggregates data on producer prices each month in a similar manner to consumer prices — although one notable difference is that producer prices are gathered by asking firms about their 'average' prices over the month rather than the price on a single day.

The producer price data examined are individual manufacturing output price quotes, which are aggregated together by the ONS to form producer prices indices (PPIs). The sample includes around 430,000 individual producer price quotes collected between 2003 and 2007, covering approximately 18,000 products and 9,000 firms. On average, around 7,000 prices a month are collected.

Producer prices are those charged by firms actually producing goods rather than the prices charged by retailers selling the goods to consumers. Examining producer prices allows for an analysis of how prices behave at an earlier point in the supply chain.

#### Supermarket price data

Although being able to examine the price quotes underlying the official inflation data is very useful, these are not the only microdata available. This analysis also examines prices recorded at the point of sale — scanner-level data. While these data may be less comprehensive than price data compiled by national statistical offices, they have a much higher frequency of observation. Prices used to calculate inflation indices are typically only collected once a month. They therefore give no indication about what happens to prices within each month. If prices change from week to week, this volatility will be automatically removed from the monthly data. A database of weekly scanner data from supermarkets in Great Britain was kindly made available to the Bank by market research company, Nielsen.<sup>(1)</sup> This particular anonymised data set included data from 230 supermarket stores located throughout Great Britain, covering the country's largest retailers. Just over 280 distinct products were included in the data set; but as not all stores stock all products, some products appear intermittently. The individual products were chosen both with consideration to data availability, and to try to get a broad range of different types of goods. The data set covers three years of sales on a weekly frequency, from February 2005 to February 2008. In all, there were approximately 51/2 million individual price quotes, or roughly 35,000 different price observations each week. The data are average prices for each week. This means that temporary changes in prices, such as special promotions or selling damaged goods more cheaply, were captured by the data.

#### How often do prices change?

**Table A** summarises how often prices change in the three data sets. On average, 19% of consumer prices change each month. This implies an average duration between price changes of approximately five months. Around 7% of the price quotes in the UK consumer price data are identified as either being temporarily discounted sale prices or prices recovering from a sale in the previous month.<sup>(2)</sup> Excluding

<sup>(1)</sup> Nielsen is a market research company that provides clients with analysis of sales trends and promotional impacts. To provide this service they collect data from a nationwide network of Electronic Point of Sale (EPoS) checkout scanners which represent sales at 65.000 supermarket and convenience stores in Great Britain.

represent sales at 65,000 supermarket and convenience stores in Great Britain.
 (2) Sale prices are identified by ONS price collectors as temporary price reductions where the item is likely to be available at the normal price in the future. Sale prices are only recorded as sales if they are available to everybody: therefore money-off coupons and loyalty card discount are excluded. Prices are not adjusted for temporary increases in quantities or multi-buy offers.

these observations relating to sales, the proportion of consumer prices changing each month falls to 15%. Consumer goods prices change more often than the prices of services, an average of 24% of goods prices change each month compared to only 9% for services. The results suggest that UK consumer prices change slightly more often than in the euro area, where 15% of prices were found to change each month (Dhyne *et al* (2005)). But UK consumer prices appear to change less often than in the United States, where around 26% of prices are estimated to change each month (Bils and Klenow (2004)). These cross-country comparisons are all made using results that include sale prices.

#### Table A How often do prices change?(a)

| Price measure                                   | Sample                 | Percentage<br>of prices<br>changing | Implied<br>duration<br>between price<br>changes |
|---|------------------------|-------------------------------------|---|
| Monthly CPI microdata <sup>(b)</sup>            | 1996 to 2006           | 19% a month                         | 5.3 months                                      |
| CPI goods                                       | 1996 to 2006           | 24% a month                         | 4.2 months                                      |
| CPI services                                    | 1996 to 2006           | 9% a month                          | 11.1 months                                     |
| All items excluding temporary discounts         | 1996 to 2006           | 15% a month                         | 6.7 months                                      |
| Monthly PPI microdata                           | 2003 to 2007           | 26% a month                         | 3.8 months                                      |
| Weekly supermarket data                         | Feb. 2005 to Feb. 2008 | 60% a week                          | 1.7 weeks                                       |
| Excluding fresh products                        | Feb. 2005 to Feb. 2008 | 40% a week                          | 2.5 weeks                                       |
| Excluding fresh products<br>and price reversals | Feb. 2005 to Feb. 2008 | 27% a week                          | 3.7 weeks                                       |

Sources: Nielsen, ONS and Bank calculations.

(a) All figures are weighted. See the box on page 30 for further details on how the percentage of prices changing was calculated.
 (b) Locally collected data only.

(b) Locally collected data only.

Overall, the producer price results are similar to the findings on CPI goods prices. The PPI only covers goods prices, so a more natural comparison is with CPI goods rather than the whole of CPI, which also includes services. On average, 26% of producer prices change each month, which compares to 24% of consumer goods prices. The finding that prices charged by goods producers change with similar frequency to those charged for retail goods suggests that few pricing frictions exist between the production and retail sectors in the United Kingdom.

Approximately a quarter of UK producer prices changing each month is consistent with evidence from the United States where a similar proportion of producer prices were found to change each month (Nakamura and Steinsson (2007)). However, it implies that UK producer prices may be a little more flexible than in the euro area where only 21% of producer prices are estimated to change each month (Vermeulen *et al* (2007)).

Weekly supermarket prices appear to change much more frequently than is implied from analysing the prices used in

the construction of the CPI and PPI indices.<sup>(1)</sup> The data suggest that, excluding fresh products, about 40% of prices change each week, or the average duration of prices is around two and a half weeks. The sample was heavily weighted to fresh products (57% of the sample), whose prices change frequently, so excluding these products may give a better read on underlying price flexibility. This is a lower duration than the CPI retail goods data, but of course this is based on higher frequency data. There are a number of possible explanations for this result. The first is that the weekly supermarket data are picking up large numbers of temporary promotions that are not captured in the monthly CPI data. Excluding all price changes that are direct reversals of the previous change — a proxy for temporary promotions — the share of prices changing each week (excluding fresh products) falls to 27%. Second, the supermarket sample is predominantly food items, and food products within the CPI change price slightly more frequently than the average for all products (Chart 1). Third, the CPI data cover prices from a much wider range of shops than just large supermarkets and price-setting behaviour may not be the same among all types of retailers. Nevertheless, the high levels of flexibility observed in the weekly scanner data suggest that UK prices may change more often than in the monthly ONS microdata because, by construction, the most prices can change in the ONS micro data sets is once a month.

# Chart 1 Percentage of UK consumer prices that change each month by component (1996–2006)<sup>(a)</sup>



Sources: ONS and Bank calculations.

(a) Uses locally collected data only.

#### Comparison with price-setting survey

There are some similarities between these results based on microdata and those from the recent Bank of England price-setting survey (Greenslade and Parker (2008)). A common result across the microdata work and the price-setting survey is that consumer goods prices change more frequently than services prices. The price-setting survey

<sup>(1)</sup> Due to the terms associated with accessing the data it was not possible to identify prices collected in supermarkets explicitly within the CPI microdata. See the box on page 29 for further details.

found that the median service sector firm changes price once a year, which is consistent with the average of eleven months between changes in CPI services prices from the microdata.

There are also some differences between the microdata and the survey results. The survey found that on average retailers change price once a month, compared with just over four months for CPI goods prices based on the microdata, and less than one month for the supermarket data.<sup>(1)</sup> And the producer price microdata suggest that UK manufacturing firms change prices more frequently (once every four months) than is suggested by the price-setting survey, which found that the average manufacturing firm only changes price annually.

#### Price changes across sectors and product groups

As noted above, consumer goods prices change more often than services prices. But there are also differences in how often prices change within these categories (**Chart 1**). In particular, the prices of energy items, predominately petrol in the locally collected CPI microdata, change the most frequently.<sup>(2)</sup> The evidence of heterogeneity is also clear in the supermarket data (**Chart 2**) and in the producer price data (**Chart 3**). In the supermarket data the prices of fresh products (which also have the largest weight) change the most often, and in the producer price data, energy products change price the most frequently (as in the consumer price data).

Chart 2 Percentage of UK supermarket prices that change each week by product category (2005–08)



Sources: Nielsen and Bank calculations

For producer prices, those sectors that use a high proportion of primary inputs — agriculture, metals and energy — tend to exhibit higher frequencies of price change than average (the magenta bars in **Chart 3**). The prices of these commoditised inputs typically can change on a daily basis, and this appears to be reflected in companies' output prices. The only sector with a very high proportion of prices changing each month that uses less primary inputs is recycling. Although the inputs to this industry come from across the economy, the output is a type of commodity and therefore output prices charged will be closely linked to prices in commodity markets. The Chart 3 Percentage of producer prices that change each month by industry  $(2003-07)^{(a)}$ 



Sources: ONS and Bank calculations

(a) The magenta bars are industries which have more than 25% of inputs from agriculture, energy extraction and supply, iron, steel and non-ferrous metals.

relationship between commodity-related input prices and output prices is consistent with the Bank's price-setting survey (Greenslade and Parker (2008)), which found increases in raw material prices to be the second most important driver (after increases in labour costs) of price increases.

# Does the probability of price changes vary over time?

It is interesting to look at how the likelihood of price changes varies over time to give some idea as to how sensitive the results are to the time period used, and to help shed light on whether time-dependent pricing models provide a good explanation of how prices are set. In its simplest form, a time-dependent model implies the probability of a price change is the same in each period. There are two ways to explore the predictions of this model in the data. The first is to look at the frequency of price changes in different periods. The second is to draw so-called 'hazard functions' which plot the probability of a price change against the time elapsed since the previous change.

#### Frequency of price changes over time

It is well known that there is seasonal variation in prices. That is clear in the microdata: for example, more consumer prices change in January than in any other month of the year as firms reduce prices as part of the January sales. Excluding all sale prices, consumer prices are most likely to change in April. That could reflect changes in duty and/or firms changing prices to

<sup>(1)</sup> Supermarkets are not explicitly identified in the pricing survey.

<sup>(2)</sup> The sample of energy prices is mainly made up of petrol and diesel price quotes. Household gas and electricity prices are collected centrally by the ONS and are not therefore part of the locally collected data used here.

coincide with the start of a new financial year. Producer prices are also most likely to change in January and April. Consumer and producer prices appear to change least often in November and December.

The average share of consumer prices changing each month varies between 16% and 22% in different years of the sample. For producer prices, the annual average proportion of prices changing each month ranges between 24% and 28%. In the CPI microdata, which spans the longest time period of the three data sets (1996 to 2006), there is some evidence of a correlation between the average share of prices increasing each month and the aggregate inflation rate they underlie (**Chart 4**).<sup>(1)</sup> However, there is no sign of a relationship between inflation and the share of prices decreasing.<sup>(2)</sup> Similar relationships hold for producer prices, albeit over a shorter time horizon. The share of supermarket prices changing each week also varies over time.

Chart 4 Annual average percentage of UK consumer prices that change each month and CPI inflation rates



Sources: ONS and Bank calculations.

The variation in the frequency of price changes over time is not consistent with the predictions of a simple time-dependent pricing model.

#### Hazard functions

Hazard functions show how the probability of a price change depends on the time elapsed since the previous price change. Consumer goods prices are most likely to change in the month after they previously changed (Chart 5), and the probability of a price change falls as more time passes since the price last changed. The spike at one month may in part be picking up temporary price promotions. However, the hazard function for consumer services prices looks very different: it is broadly flat with a notable spike at twelve months — suggestive of annual price reviews. The hazard function for producer goods prices has a large spike at one month and slopes downwards, broadly matching the consumer goods price data, although the one major difference is that it also has a spike at twelve months.

In the supermarket price data, the probability of a price changing is very high if that price also changed in the previous week (**Chart 6**). After the first week, the probability of a price change then declines. The shape of the supermarket price hazard function is broadly similar to that for the CPI goods data except that prices change on a much more regular basis.

Chart 5 Consumer and producer price hazard functions



Sources: ONS and Bank calculations.



Chart 6 Supermarket price hazard function

Sources: Nielsen and Bank calculations.

A simple time-dependent pricing model would suggest a broadly flat hazard function, implying that the probability of a price change depends only on when the price last changed. The downward-sloping hazard function for goods would appear to be inconsistent with that model. The hazard functions for each of the goods components all have a similar downward slope, but it is also possible that the decreasing hazard functions could result from aggregating heterogeneous price-setters within components (Álvarez *et al* (2005)). The hazard function for services is relatively constant in each period except for an additional annual pricing review for some

<sup>(1)</sup> The correlation coefficient is 0.6.

<sup>(2)</sup> The correlation coefficient is 0.0 to 1 decimal place.

firms, which is more consistent with a time-dependent pricing model.

#### How large are price changes?

Analysing the size of price changes provides further information about how individual prices behave. It may also be useful to help determine whether firms face costs in adjusting their prices, as is assumed in some state-dependent pricing theories. Few small price changes might suggest that fixed costs of price adjustment — or menu costs — are important. By contrast, if firms face disutility from making large price changes that would suggest the majority of price changes should be small. And studying the distribution of price changes may also help to shed light on the extent of downward nominal rigidities - constraints which prevent firms from reducing prices — in product markets. The existence of such rigidities would be consistent with there being few falls in prices, particularly small falls.

Across all three data sets the median price change is an increase of between 0% and 2%. For each data set, the distribution of the size of price changes around the central estimates is wide with a number of large price changes (Chart 7). But the distribution is not uniform: there are a significant number of price changes that are relatively small and close to zero.



- Supermarket prices
- PPI (goods)



Sources: Nielsen, ONS and Bank calculations

(a) Price changes for each distribution are grouped into 1 percentage point intervals. The lines

join up the data points for each interval. The distribution only includes observations where the price changes. The sample periods used are not the same for each data set. The CPI data cover 1996 to 2006, PPI uses 2003 to 2007 data and the supermarket data cover 2005 to 2008.

The proportion of small price changes is particularly high for producer prices. There have tended to be more increases and fewer decreases in consumer services prices than in goods prices, but that may just reflect higher rates of services price inflation over the sample period. The distribution of the size

of supermarket price changes looks broadly similar to the distribution of the size of consumer goods price changes. However, there is a higher proportion of smaller price falls in the supermarket data. This might suggest that temporary promotions — where price changes are likely to be relatively large — cannot fully explain why weekly supermarket prices appear to change so much more frequently than CPI goods prices. It could also reflect using average prices in the supermarket data where short-term price reductions, for example to sell off stock approaching its sell-by date, could explain some of the small changes in supermarket prices. This is relevant for fresh products which make up a significant proportion of the sample.

State-dependent pricing models typically assume that firms face a small fixed cost to adjusting their prices or face a disutility associated with making large price changes. The large number of relatively small price changes that occur in all data sets imply that small fixed costs of price adjustment may not be important for many firms. Also, the significant number of large price changes that are present in the data are not consistent with those firms receiving disutility from making large price changes. The evidence suggests state-dependent pricing models may not explain price-setting behaviour in the majority of firms.

#### Evidence on the extent of downward nominal rigidities

Over a period where inflation rates have been positive it is reasonable to expect there to be more price increases than decreases (as is shown in Chart 4 for consumer prices). But the data still show a large share of price changes are price cuts. Around 40% of all CPI and PPI price changes were decreases, while price falls account for 50% of price changes in the supermarket data. Excluding the effects of temporary sales, approximately 35% of all consumer price changes were still price cuts. The large share of price changes that are price falls and the large proportion of price cuts that are smaller than 5%, suggests there is limited evidence to support the presence of downward nominal rigidities in product markets in the United Kingdom.

#### Is there a relationship between the frequency and size of price changes?

Having examined the frequency and magnitude of price changes separately, this section considers linkages between the two. If prices can be set in each period there is no reason to expect price changes to be larger if more time has passed since the price last changed. But if some constraint exists which only allows or incentivises firms to set prices at infrequent intervals, there is more scope for a firm's actual price to differ from its optimal price as the duration since the previous price change increases. Examples of such constraints might include contracts of fixed length or costs of price adjustment.

# Chart 8 Size of price changes and duration since the previous price change $^{\rm (a)(b)}$

🔶 CPI





Consumer prices that change more frequently tend to do so by less (Chart 8). This relationship is particularly strong for services prices.

This relationship between the frequency and magnitude of price changes also holds in the producer price data, at least for periods of up to one year. Beyond one year the producer price sample size is much smaller which makes it more difficult to test this hypothesis. However, in the supermarket price data prices that change less frequently do not tend to change by more. This may be related to prices changing much more frequently in the weekly supermarket data, which means price durations tend to be short in this data.

#### Conclusion

Pricing rigidities are an important part of the monetary transmission mechanism. Understanding more about how prices behave can shed light on the nature of these rigidities and can help policymakers determine how best to set monetary policy to achieve the inflation target. This article has summarised the evidence on the behaviour of individual prices in the United Kingdom. Price quotes underlying both the ONS consumer and producer price indices were used alongside a data set of more frequent weekly price data from supermarkets. Evidence from the ONS microdata implies that consumer prices changed, on average, once every five months between 1996 and 2006, while producer prices changed once every four months between 2003 and 2007. Higher frequency supermarket data, which cover the period between 2005 and 2008, suggest that prices change more often than this.

In all data sets there are clear differences between the proportions of prices changing in different sectors. Consumer goods prices change more frequently than services prices. Producer prices change more frequently for goods that use a high proportion of commodities as raw material inputs. The distribution of the size of price changes is wide, but a large number of price changes are relatively small.

The Bank of England price-setting survey described in the 2008 Q4 *Quarterly Bulletin* found that firms use both time and state-dependent pricing rules. The results presented in this article are also not clearly supportive of any one pricing theory. Indeed, the heterogeneity in pricing behaviour across sectors implies that there may not be a single theory that can explain how all prices are determined.

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# Deflation

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This article provides a brief review of issues relating to deflation. It explains what is meant by deflation, examines the historical experience and investigates what costs might be associated with deflationary episodes. It suggests that the adverse effects of deflation can be exaggerated by confusing the effects of the underlying shock with the effects of deflation *per se*. The costs of deflation itself are most likely to be associated with debt deflation and downward rigidities in money wages. By learning from previous episodes, it argues that deflationary episodes can be short-lived and less costly if policy responds promptly and decisively, employing the full range of conventional and unconventional monetary policy instruments.

#### Introduction

#### Context

Deflation is sometimes used to describe any fall in the general level of prices (as measured in the United Kingdom by the consumer prices index (CPI), retail prices index (RPI) or the GDP deflator), however short-lived. A more economically significant phenomenon, however, would be a sustained period of negative inflation.

It is widely recognised by policymakers, academics and city commentators that periods of deflation can have adverse consequences. Indeed, the persistent deflationary episodes that occurred in the United Kingdom and other developed economies during the late 1920s and early 1930s were associated with depressed economic conditions. But it is useful to acknowledge that the adverse economic outcomes that often accompany deflationary episodes may not have been entirely caused by the experience of deflation itself but rather by the circumstances that caused inflation to fall into negative territory. So an important question this article will address is the extent to which deflation *per se* makes matters worse.

In fact, not all deflationary episodes have been associated with depressed conditions. Deflations have arisen, for example, when the supply potential of the economy has been boosted by a series of beneficial shocks but prices have fallen because the supply of money did not expand sufficiently to meet the higher demand. But deflation has also resulted when the economy has been subject to an adverse demand shock which has driven demand below capacity, causing unemployment to rise. With an inappropriate policy response in the past, this has also caused inflation to fall for a sustained period.<sup>(1)</sup> In both types of situation, deflation might have been avoided if policymakers had acted to stimulate nominal demand as necessary. This is an important lesson for policymakers in current circumstances.

This article examines how the costs associated with inflation and deflation respectively might differ and whether the behaviour of the economy changes significantly when prices fall rather than rise. Of course, in the context of the UK regime of inflation targeting, any sustained departure in the rate of inflation below the target of 2% is costly since this will tend to create uncertainty for firms and households and will potentially dislodge long-run inflation expectations away from the target. This article takes these important costs as given and does not consider them further. This article sets out to clarify whether a period of falling prices might impose additional costs on the economy. In any case, the Monetary Policy Committee's (MPC's) central projection in the February 2009 Inflation Report was for its target measure, annual CPI inflation, to remain above zero throughout the forecast horizon. And the MPC will take the necessary steps to bring inflation back to target by making changes to monetary policy so that any deviation from target is short-lived and less costly.

One important feature of deflationary episodes is that they increase the likelihood that nominal interest rates will be driven down towards the zero bound, as discussed later.

To distinguish between the different underlying shocks Bordo and Filardo (2004) refer to 'good', 'bad' and 'ugly deflations'.

In these circumstances, a range of alternative monetary policy instruments is available to central banks to allow them to loosen the stance of monetary policy. Such measures are discussed in more detail in King (2009), the February 2009 MPC minutes and the February 2009 *Inflation Report*. Indeed, the MPC voted on 5 March 2009 to undertake a programme of asset purchases (along with a cut in Bank Rate of 0.5 percentage points) worth £75 billion financed by the issuance of central bank reserves. These issues are beyond the scope of this article and will not be evaluated here.

The structure of this article is as follows. The rest of this introductory section defines deflation and describes the historical experience in the United Kingdom and elsewhere. It then goes on to examine the different ways that falling prices might potentially magnify or modify the economic costs of a given economic situation and then finally concludes.

#### Definitions

Although deflation if often loosely referred to as any period where prices are falling, deflation as an economic phenomenon is more conventionally defined as a persistent fall in the general level of prices (such as CPI, RPI or the GDP deflator). A short period of falling prices is generally considered less likely to be a cause for concern. So for example, in the United Kingdom, the twelve-month inflation rate of RPI was negative for the occasional month in 1959 and 1960 but this is not considered a period of deflation in an economic sense. And in the coming months, the RPI is likely to fall temporarily, mainly reflecting reduced mortgage interest payments (see February Inflation Report, Section 4.1, page 30). As Chart 1 shows, these brief periods of falling prices can be contrasted with periods of genuine deflation, for example that between 1923 and 1933, when prices fell more or less continuously.





(a) Long-run UK annual RPI inflation (monthly frequency)

A generalised fall in the price of a particular class of goods is not considered to be a case of deflation either so long as this is a relative price fall offset by correspondingly greater increases in the prices of other goods. So for example, in the United Kingdom, the inflation rate of goods in the CPI basket was almost always negative between 1999 and 2005, their prices falling by up to around 2% per annum. But the overall level of CPI inflation mostly stayed between 1% and 2% during that period, as service price inflation averaged around 4% (Chart 2).<sup>(1)</sup>

#### Chart 2 UK consumer prices index<sup>(a)</sup>



(a) Annual CPI inflation (monthly frequency).

It is also important to distinguish between periods of deflation, when the level of prices is falling, and those of disinflation, when the rate of increase of the price level is falling. In the post-war period in the United Kingdom, disinflation most notably characterised the period from the mid-1970s to 1992, when CPI inflation fell from above 20% to 2% as policymakers successfully reduced inflation. This article will note that although many of the costs of deflation are quite distinct from those of disinflation, some effects are similar, for example in how unanticipated changes in inflation transfer wealth from debtors to creditors (as will be explained in more detail later).

Of course, in discussing whether or not the economy is experiencing deflation, it is important to remember that general indices of prices are not uniquely defined. Since the RPI and CPI are different price indices measuring somewhat different baskets of goods and services, there may be times when one is falling, perhaps temporarily, and one is increasing, so the question of whether an economy is in a state of deflation may not at times be clear-cut. Of course, if many of the general price indices are falling, as was the case in Japan between 1999 and 2005, then it is more likely that deflation is genuinely occurring.

#### **Historical experience**

From a historical perspective, deflation is not uncommon. Chart 3 shows a smoothed measure of UK consumer price

<sup>(1)</sup> Indeed, within the CPI basket, it is normal for the prices of many items to be falling, reflecting demand and supply conditions in those markets. In December 2008, for example, around a fifth of the prices in the CPI basket (weighted by expenditure shares) were lower than a year earlier.

#### Chart 3 UK consumer prices<sup>(a)</sup>



Source: The Composite Price Index, ONS.

(a) Five-year moving average of annual consumer price inflation. From 1947, the index is the RPI, 1870–1946 the index is the consumption deflator. Prior to 1870 various indices are used.

inflation from 1800 to 2008. Prices were almost as likely to fall as to rise over the period 1800–1914, when average annual inflation was close to zero. But since the Second World War (WWII), annual inflation has averaged around 7%, and on an annual basis prices have not fallen in a single year. Data for other industrialised countries look similar.

In part, prices declined during the 19th and the early part of the 20th century because of the constraints imposed by the Gold Standard. Under this regime, money was freely converted into gold at a set price so the supply of money was linked to the size of a country's gold reserves. When the world's gold supply could not keep pace with the growing supply capacity of the world economy, this frequently led to periods of falling prices (IMF (2003)). Since this was often caused by an increased supply of goods and services and not by a shortfall of demand, the resulting deflation was benign.

The Gold Standard was abandoned by many countries, including the United Kingdom, during the First World War whereupon prices tended to rise. But after the war, many countries aimed at restoring the Gold Standard at the pre-war parity, which required prices to fall back. For this reason, the immediate post-war period was characterised by an initial policy-induced deflation across the industrialised world.<sup>(1)</sup> In fact, since the return to the Gold Standard was preannounced in many countries, prices were often expected to fall.<sup>(2)</sup> This helped contribute to an environment with relatively flexible prices and nominal wages. Even so, numerous countries suffered large contractions in economic activity.

By 1925, many countries had managed to return to the Gold Standard. Since then, prices fell at a modest rate across much of the industrialised world until 1929, while output grew steadily.<sup>(3)</sup> This deflation is likely to have been the consequence of beneficial developments reflecting the increased ability of the economies to provide goods and services.<sup>(4)</sup> For example, there was a renewal of international trade and strong growth in new high-tech industries producing goods such as telephones, radios and automobiles. But the global deflation that took place between 1929 and the mid-1930s was much more malign, characterised by sharp declines in real output and quickly falling prices.<sup>(5)</sup> It has been argued that the downturn was initially caused by tight monetary policy in the United States and transmitted to the rest of the world via the fixed exchange rates that were part of the Gold Standard.<sup>(6)</sup> Indeed, countries that left the Gold Standard, including the United Kingdom in 1931, typically performed better than those that remained.

Since WWII, there have been few episodes of deflation in the United Kingdom or elsewhere. Perhaps the most notable episode was in Japan, where consumer prices fell by an average of 0.5% per year between 1999 and 2005. This mild deflation was prompted by an unwinding of inflated asset prices associated with a crisis in the Japanese banking system and as other commentators have suggested, an insufficient policy response (see Bernanke (2000) and Kuttner and Posen (2001)). This resulted in a protracted decade-long period of low growth.

Overall, one clear lesson can be drawn from previous deflationary episodes in the United Kingdom and internationally. The economic costs associated with deflationary episodes are primarily determined by the underlying shocks which cause prices to fall in the first place. What is unclear from this simple narrative, however, is whether the fact that prices were falling itself made the costs of deflation any greater by impairing the functioning of the economy. In particular, if falling prices created additional costs, then policymakers would need to take this into account when setting policy. The next section of this article examines this question in more detail.

#### Costs of deflation

So how does the behaviour of the economy change when prices are falling rather than rising? Briault (1995) provides an exhaustive examination of the costs of inflation, but the focus here is to understand how the nature of those costs might be different under deflation. To reiterate, the intention here is not to examine the overall economic cost of deflationary episodes since, as noted above, this will depend on why the economy has fallen into a deflationary state. Rather, the aim is to

<sup>(1)</sup> Demobilisation could have contributed to the severity of the recession in addition to

policy. (2) Capie and Wood (2004) and Fregert and Jonung (2004).

<sup>(3)</sup> One exception was the United Kingdom, where high interest rates and sluggish growth prevailed throughout the 1920s. Some argue that this reflected attempts to protect the chosen parity with the Gold Standard or the effect of labour market reforms (Cole and Ohanian (2001)).

<sup>(4)</sup> For this argument, see Bordo and Filardo (2004).

<sup>(5)</sup> See, for example, Bernanke (1995).

<sup>(6)</sup> See, for example, discussions in IMF (2003) and Mundell (2000).

examine whether deflation *per se* has additional costs and whether it changes the way that the economy behaves.

The potential costs associated with deflation can be divided into five broad categories, many of which are interrelated:

- · menu costs and taxation effects;
- consumption postponement;
- downward nominal rigidities;
- debt deflation; and
- · the impact of the zero interest rate bound.

#### Menu costs and taxation effects

Any form of price adjustment is potentially costly since firms face 'menu costs'. These partly relate to the physical cost of altering price lists (although technological advances such as the internet may be tending to reduce these). But they are also incurred by firms who find it costly to recalculate the optimal price continually in an environment of changing prices. And consumers face costs in deducing whether such changes are specific to particular goods or reflect a change in the overall price level. However, all these costs will be present whether prices are rising or falling, so if this were the only criterion, zero inflation would be the ideal.

Friedman (1969) highlighted one potential benefit of deflation. This relates to the fact that holders of cash receive no interest payments. The cost of holding money can be thought of as the income lost from not depositing it in a bank account, where it would yield a return equal to the nominal interest rate. As long as the nominal interest rate is positive, holding money is costly. For this reason, people tend to hold too little money compared to what they would optimally like to hold.<sup>(1)</sup> In other words, a positive nominal interest rate distorts money holdings. Friedman therefore proposed that the nominal interest rate should be set to zero, in which case the cost of holding money would be zero. Since the nominal interest rate equals the real interest rate adjusted for expected inflation, and because, on average, the real interest rate tends to be positive, to deliver an average nominal interest rate of zero, inflation would need to be persistently negative. So from this perspective, deflation could be good. It is important to note, though, that Friedman's proposition holds only under very special conditions. And Sinclair (2003) showed that various imperfections in the economy make it likely that a small positive rate of inflation is beneficial.

Another way to think about this is that the interest rate can be seen as a tax on holders of money. This tax gives revenues so-called 'seigniorage' — to the government. And this tax distortion is only eliminated when there is the right amount of deflation to offset the real interest rate.<sup>(2)</sup>

Deflation has other implications for the tax system as well. In most countries, including the United Kingdom, the tax system

is not fully indexed to inflation; *ceteris paribus*, effective tax rates will tend to be higher with inflation and lower with deflation.<sup>(3)</sup>

Bakhshi *et al* (1997) calculated the benefits to households and businesses arising from a fall in UK inflation from 4% to 2% per year, suggesting that the benefits arising from the seigniorage and tax effects would be small, amounting to around 0.2% of GDP per year. It is possible that a further fall from a small positive to a small negative rate of inflation would bring some additional benefits from these effects, but it is also likely that some of the other costs associated with deflation could outweigh any benefits. This article now turns to these other costs.

#### **Consumption postponement**

One commonly cited fear associated with deflation is that if prices are expected to fall, consumers will defer purchases until goods are cheaper, amplifying any slowdown in aggregate demand. While superficially convincing, this argument is flawed at least in its simplest form. That is because the timing of purchases by consumers will be determined not only by their inherent preference for consuming now rather than later, but importantly also by the real rate of interest that they face, ie the nominal interest rate adjusted for expected inflation. For a given level of nominal interest rates, if inflation turns negative this will tend to raise real rates and indeed cause consumers to postpone spending; they will prefer to earn more interest on their savings and spend later. But typically policymakers would cut nominal interest rates in response to weaker prospects in aggregate inflation, as the MPC has done over the recent past. For real interest rates to fall to encourage consumers to spend more, nominal interest rates would have to be cut by more than the fall in inflation.<sup>(4)</sup> But as inflation falls towards zero and then below, it becomes more likely that interest rates will hit the zero bound. This means that the consumption-postponement cost associated with deflation may be present but is simply part of the wider issue of the costs associated with hitting the zero interest rate bound, as discussed later. But the MPC has other more unconventional tools that it can use to loosen the stance of monetary policy and ensure the inflation target is met.

#### Downward nominal rigidities

One important asymmetry in the economy is that it may be difficult for businesses to reduce money wages when economic conditions warrant such falls, either because the conditions facing the firm are very depressed or because aggregate prices are falling. If this were the case, a period of deflation could

In perfect markets, the price of any good or service should equal the cost of producing it. Because the cost of physically producing money is negligible, the welfare distortions from money holdings will only be eliminated when the nominal interest rate is zero.

<sup>(2)</sup> Seigniorage will be positive as long as the nominal interest rate is positive.

<sup>(3)</sup> For a discussion about this, see Bakhshi et al (1997).

<sup>(4)</sup> This is known as the Taylor principle, originally described in Taylor (1993).

have adverse consequences, with unemployment higher than it would otherwise be. This is a potential cost of deflation.

If aggregate prices were to fall, and nominal wages fell by the same amount, the purchasing power of money wages would be maintained. But employees may suffer from money illusion — the tendency to focus on the nominal, rather than the real, value of money and this may make it difficult to cut nominal wages. If they do suffer from money illusion, they may be unwilling to accept a pay cut, since they incorrectly believe that doing so will reduce their ability to buy goods and services.<sup>(1)</sup>

It is important to remember that, even if aggregate prices fall, there may be no need for nominal wages to fall. Over the medium term, money wages would be expected to rise in line with labour productivity — the amount of output produced per worker — plus the rate of inflation. Over the past 30 years, UK labour productivity has risen by around 2% per year on average. This suggests that even if prices were to fall at a modest rate, there would not necessarily be a need for aggregate nominal wages to be cut. But because some sectors are more likely to be affected by a downturn than others, it is still possible that wage cuts would be needed in those sectors. And if employees were resistant to such wage cuts, then unemployment would likely be higher than otherwise.

Is there any evidence for downward rigidity in money wages? Previous studies of individual firms have suggested that in the past employers have usually been prepared to cut nominal wages, and employees are prepared to accept them, only when firms face severe problems.<sup>(2)</sup> Historical data typically show an asymmetry in the distribution of wage changes for individuals; a larger proportion of individuals have received wage increases than wage cuts, and wages have remained unchanged for a significant number of individuals.<sup>(3)</sup> This has often been interpreted as evidence for downward rigidity in nominal wages.<sup>(4)</sup>

But it is important to recognise that most of this evidence has come from periods when inflation has been positive — in which case a cut in the nominal wage is certainly associated with a fall in the real wage. And even if employers found it difficult to cut the nominal wage, there may be other ways to cut down on labour costs: non-wage benefits and bonuses could be cut, and firms may avoid customary wage increases due to merit and seniority. Firms could also hire new workers on wages below those paid to existing workers.

More recent data, also discussed in the box on page 33 of the February 2009 *Inflation Report*, show that the proportion of freezes in pay settlements in 2008 H2 was about twice that in 2008 H1, but the number of pay cuts remained very small. Nevertheless, with a sharp slowdown in growth forecast, a recent British Chambers of Commerce survey does suggest that about 10% of companies plan to implement nominal pay cuts in 2009. This suggests that nominal wages may be more flexible downwards in the current conjuncture than they have previously been.

#### **Debt deflation**

Another frequently cited cost associated with deflation relates to the implications of falling prices for firms and households who have entered into debt contracts fixed in nominal terms. With such contracts, falling prices will increase the real debt burden for borrowers in terms of the principal repayments and the ongoing interest payments (for fixed-rate loans at least).<sup>(5)</sup>

This is known as the debt deflation mechanism, first articulated in detail by Fisher (1932, 1933).<sup>(6)</sup> And there is empirical evidence to suggest that this channel has been important: during the global downturn of the late 1980s and early 1990s, the most severe recessions occurred in those countries which had previously experienced the largest increases in debt (see King (1994)).

The key element to the debt deflation channel is the transfer of wealth from debtors to creditors caused by an unexpected fall in inflation.<sup>(7)</sup> Since debtors are likely to have a higher propensity to consume than creditors, demand is likely to fall. For this mechanism to matter, the fall in inflation must be unexpected relative to when the debt contract was entered into; so for example, if inflation were to fall unexpectedly by 2% for two years, the real debt burden on existing nominal contracts would necessarily be 4% higher. To the extent that borrowers are committed to fixed interest rate payments on their loans, then the burden of real interest payments will be correspondingly greater too; in the United Kingdom, some 40% of mortgages are on a fixed-rate basis.<sup>(8)</sup> And real interest payments would also increase if nominal interest rates did not fall in line with inflation either because policy is prevented from doing so (as discussed in the next section) or because banks increased their lending margins. There is some evidence that this has been happening recently in the United Kingdom (see pages 13–16 of the February 2009 Inflation Report).

It could also be difficult for businesses to reduce wages because of institutional reasons, for example the national minimum wage, which prevents wage cuts for workers that are paid at this level.

<sup>(2)</sup> Akerlof et al (1996) discuss this type of evidence.

<sup>(3)</sup> For the United Kingdom, see Barwell and Schweitzer (2007), Schweitzer (2007), Smith (2000) and Smith (2006).

<sup>(4)</sup> Downward rigid nominal wages could also be helpful in tending to prevent runaway deflation, as noted by Akerlof *et al* (1996). IMF (2003) argue that this effect helped contain the extent of Japanese deflation in the 1990s.

<sup>(5)</sup> For floating-rate loans, the real burden will depend on how nominal interest rates move relative to inflation.

<sup>(6)</sup> Fisher's ideas are closely related to earlier work by Veblen (1904), contemporaneous analysis by Schumpeter (1934) and more recent work by Minsky (1977). For a comparative evaluation of these contributions, see Raines and Leathers (2008).

<sup>(7)</sup> Tobin (1980) was the first to emphasise this channel, subsequently elaborated in King (1994).

<sup>(8)</sup> Bernanke (2000) attempted to illustrate the likely impact of the unexpected deflation experienced by Japanese borrowers taking out a ten-year loan in 1997. He calculated that the real debt burden would have been some 20% higher by the time the loan matured.

Although the debt deflation mechanism is usually emphasised in the context of deflationary episodes, in fact an unexpected fall in inflation from 10% to 5% is comparable in its effect to a fall from 2% to -3%. So in principle, this aspect of debt deflation is not specific to periods when inflation is negative. Nevertheless, there are some features of unexpected deflation which do suggest that such an episode may have a more marked effect when prices are actually falling. If the deflationary episode has been caused by an adverse shock to demand, this is likely to be associated with falling output and higher unemployment, making the debt burden even more difficult to service. Furthermore, these economic circumstances are often also associated with a sharp fall in asset values (ie a fall in asset prices relative to general prices).<sup>(1)</sup> And if this degrades the value of the collateral on which the loan is secured, this could magnify the effect of the initial shock as firms and households become more likely to default. These conditions can also have deleterious implications for financial institutions holding bad loans with a substantially lower recovery value, prompting them to cut back on their lending to rebuild their balance sheets.<sup>(2)</sup>

In fact, this configuration of falling asset prices and depressed economic conditions in the face of an adverse demand shock is consistent with recent and prospective macroeconomic developments in the United Kingdom and internationally, as described in the February 2009 *Inflation Report*. These influences help to explain the fall in growth and inflation over the forecast horizon while uncertainty surrounding the strength of these effects motivates some of the downside risks to that projection. Notably, these effects are present despite the fact that deflation itself was not expected in the central projection in the February 2009 *Inflation Report*. This serves to emphasise the point that many of the costs typically associated with debt deflation are not caused by falling aggregate prices themselves.

One other feature of the adverse effects associated with debt deflation is that they can be viewed as 'transitional effects'; if deflation was expected to persist for a prolonged period, firms and households would likely adjust to an environment of falling prices and nominal debt contracts would likely be redesigned to reflect this new expectation. But in the context of the inflation-targeting regime in the United Kingdom, this is less relevant since policy will be set to ensure that inflation is returned to its target level.

Overall, the debt deflation channel is likely to imply that deflationary episodes will tend to be associated with higher costs compared to a situation where there is low and predictable inflation. But it is likely that high costs are only truly incurred when deflation is accompanied by sharply falling asset prices and depressed economic conditions. The effect of a low level of deflation alone may not be enough to have serious consequences via this channel. For example, in describing the Japanese experience of the 1990s, Posen (2006) argues that the feed-back from deflation on to the debt burden and then back into deflation and the real economy was limited in magnitude.

#### The impact of the zero interest rate bound

The final set of potential costs associated with deflationary episodes relates to the increased possibility that interest rates will be driven down to the zero bound.<sup>(3)</sup> Unlike the other costs considered so far, these are not necessarily incurred when deflation occurs; it will depend on whether the deflationary episode actually causes policymakers to want to bring nominal interest rates down to zero. This matters because nominal interest rates cannot fall below zero even if the central bank wished to loosen monetary conditions further; no one would be prepared to lend money at negative interest rates because they could always earn a better return by holding cash.<sup>(4)</sup> Instead, the central bank will use so-called 'unconventional' monetary policy measures to stimulate the economy (see King (2009)). Indeed, the MPC voted in March 2009 to use these more unconventional policy instruments.<sup>(5)</sup>

Whether this situation would actually be costly in practice would depend on the relative effectiveness of the other monetary policy instruments available to the central bank compared to the conventional interest rate instrument in providing an appropriate countercyclical response. Possible options are discussed in more detail in King (2009).

#### Conclusions

This article has explained how the economic costs of deflationary episodes will be largely determined by the underlying circumstances which have caused prices to fall. If deflation has occurred because of beneficial supply shocks, the economic costs may be much less than if deflation has arisen because of an adverse demand shock.

But this conclusion does not tell us whether the experience of falling prices, *per se*, makes the deflationary episode more costly. The association of the 1930s' deflationary episode in the United Kingdom with a deep depression has led many commentators to demonise deflation, but it is important not to confuse the effects of the underlying shock (for example a credit crunch) with the effects of deflation itself.

(5) www.bankofengland.co.uk/publications/news/2009/019.htm.

<sup>(1)</sup> Falling commodity prices alongside asset prices sometimes exacerbated this effect. For example, during the Great Depression in the 1930s, large falls in the price of agricultural products caused many farmers into liquidation, especially in the United States.

<sup>(2)</sup> These effects on bank lending are known respectively as the credit channel and the bank capital channel.

<sup>(3)</sup> In practice, the effective lower bound on interest rates may be slightly above zero, partly for operational reasons relating to money markets, partly due to the impairment of the banking sector transmission mechanism at low levels of interest rates.

<sup>(4)</sup> Yates (2003) discusses circumstances when it might be possible to charge a negative interest rate on money.

Consequently, the main purpose of this article is to examine whether the cost of deflationary episodes is made worse by the fact that prices are falling. This article has examined the different costs associated with deflation and how they might change our view of the monetary transmission mechanism.

Some theoretical work suggests that mild deflation might actually enhance welfare, as originally argued by Friedman. But other distortions are likely to overturn that theoretical result.

Another source of distortion associated with deflation relates to the possible existence of downwardly rigid money wages. During a deflationary episode, this might prevent the labour market adjusting in the conventional manner and could potentially exaggerate the unemployment consequences of adverse demand shocks. But very recent evidence tends to suggest that money wages are flexible downwards to some extent in the United Kingdom in the face of the current downturn. However, it is too early to conclude that there would be no effect from this potential distortion.

Another important mechanism associated with deflation is that of 'debt deflation'. Debt deflation might magnify adverse shocks as unexpectedly lower inflation increases the burden of debt fixed in nominal terms, especially if this is accompanied by even greater real falls in asset prices. In practice, the effects of falling asset prices and lower incomes are likely to be more costly than falling prices themselves.

Deflation also increases the chance of interest rates reaching the zero bound. Once at the zero bound, monetary policy loses its ability to affect the economy in a conventional manner by cutting interest rates countercyclically in response to a deflationary shock. But other monetary policy tools are available to stimulate the economy as necessary (as discussed in King (2009)). Indeed, the MPC voted in March 2009 to use these more unconventional policy instruments.

To understand how to respond to a potential deflationary episode, it is crucial to learn the lessons of history from previous episodes in the United Kingdom and abroad. Perhaps the most important insight from such analysis is that the costs of previous deflationary episodes have been exacerbated by inappropriate policy responses, or by constraints imposed by existing policy regimes, in particular the Gold Standard. But if policy responds sufficiently promptly and decisively employing the full range of conventional and unconventional monetary policy instruments, deflationary episodes should be short-lived.

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# A no-arbitrage structural vector autoregressive model of the UK yield curve

#### Summary of Working Paper no. 357 Iryna Kaminska

Monetary policy makers control short-term interest rates. But long-term rates are no less important, since they influence borrowing costs and aggregate demand in the economy. Thus understanding the behaviour of the whole spectrum of interest rates (the 'yield curve') is crucial.

While yield curve dynamics have been extensively studied in statistics and finance, these studies abstract from the macroeconomic drivers of yield curve movements. The contribution of this paper is to link the term structure of nominal interest rates to the wider economy, by assuming that all risks affecting the pricing behaviour of agents are related to the underlying ('structural') macroeconomic shocks. This approach allows us to enrich financial models of the yield curve with macroeconomic theory, and thus to narrow the existing gap between financial and macroeconomic models.

Thus the paper builds upon and extends two strands of research: previous work on the finance approach to yield curves; and empirical macroeconomic modelling. At the nexus of these two strands, a yield curve model is presented that relates fundamental macroeconomic shocks identified from a macroeconometric model to the bond pricing behaviour of the economic agents. This is in contrast to standard finance models, in which agents are concerned with non-structural risks, which are not directly interpretable. The combination of the macroeconometric and financial models helps us to achieve several goals. Primarily, we are able to model the yield curve across maturities and across time jointly with the macroeconomic dynamics, explaining 'term premia' which describe how rates at longer maturities are related to short rates. Additionally, replacing purely statistical factors by macroeconomic variables simplifies the estimation of highly parametrised financial models.

As an application, three underlying shocks to the UK economy are studied, and their roles in determining the term structure of UK nominal interest rates examined. The approach has two steps. First, aggregate supply, aggregate demand and monetary policy shocks are identified from a three-variable model based on the output gap, inflation and short-term interest rate. Second, the shocks' effects on the nominal yield curve are analysed with the help of a term structure model of interest rates.

The results can be summarised as follows. Demand and supply shocks have different effects on the yield curve. Both supply and demand shocks drive short-term interest rates, whereas demand shocks dominate long-term interest rates. Both demand and supply shocks affect the slope of the yield curve positively on impact. This result confirms previous findings that the slope of the yield curve and economic activity are linked. Finally, the monetary policy shock affects the whole yield curve, with the effect decreasing with maturity.

The results are broadly consistent with the dynamics of yields implied by previous work in empirical macroeconomics. The advantage of the approach is that we are able to decompose long-term interest rates into expected short-term rates and term premia. The results show that the short end of the yield curve moves due to changes in expectations, while movements in the long end are due to the term premia dynamics.

Although the model performs well overall, it does not fit the long end of the yield curve well over the most recent sample, which suggests that including additional macroeconomic variables and shocks might improve the simple model.

# Understanding the real rate conundrum: an application of no-arbitrage finance models to the UK real yield curve

#### Summary of Working Paper no. 358 Michael Joyce, Iryna Kaminska and Peter Lildholdt

Long-term interest rates in the major international bond markets fell sharply during 2004 and 2005, at the same time as US policy rates were rising. This phenomenon was famously described as a 'conundrum' by Alan Greenspan the Federal Reserve Chairman at the time. But it was arguably the decline in international real rates (interest rates adjusted for inflation) which was more unusual. And by the end of 2007, although real (and nominal) rates had recovered slightly in the United States and euro area, long real rates in the United Kingdom remained at recent historical lows.

Understanding the causes of low long real rates matters for monetary policy makers, not least because different explanations have correspondingly different implications for monetary conditions. If, for example, low real rates are due to lower investor risk aversion, the response of monetary policy may differ from the scenario where they reflect expectations of weaker long-term growth. There are also implications regarding the risks of long rates reverting to more normal, higher levels. For example, if low long real rates reflect a temporary rather than a permanent shock, there is a greater risk of a sharp upward adjustment in borrowing rates, which would be disruptive for the real economy.

A large number of potential explanations for the conundrum have been put forward. Some have emphasised the role of saving and investment: either high global saving (the so-called Asian 'saving glut') or low investment (particularly in the industrialised countries). Others have focused on looser monetary policy or 'excess liquidity'. Other explanations have related the conundrum to lower risk premia (the amount by which the market rewards the holders of more risky assets). This may have reflected perceptions of greater macroeconomic stability, or the so-called 'search for yield', which could have driven up the demand for riskier but higher yielding assets. And search for yield itself has been seen by some as a possible consequence of excess liquidity, which has depressed nominal risk-free rates and increased investors' demand for risky assets to meet their nominal return aspirations. Finally, other explanations have focused on the role of imbalances between market demand and supply, arising from either large portfolio inflows into bonds from Asian central banks or strong demand from pension funds. Each of

these explanations has some plausibility and it is probably fair to say that no firm consensus has yet emerged on which was the most important. But the fact that the fall in long nominal interest rates during the conundrum period mainly reflected a decline in long real rates, as opposed to lower inflation compensation, suggests that understanding the behaviour of real rates may be particularly fruitful.

In this paper, we try to shed light on what accounts for the phenomenon of low long real rates, by estimating several empirical models of the term structure of real interest rates, derived from UK government index-linked bonds. We adopt a standard 'finance' approach to modelling the real term structure, based on the assumption that there are no risk-free profits to be made by trading between different government bonds (in other words, there are no arbitrage opportunities). Importantly, the assumption of no arbitrage enables us to decompose forward real rates into expectations of future short (ie risk-free) real rates and forward real term premia in a theoretically consistent way.

Although we find some evidence that long-horizon risk-free real rates of interest have declined, the results from the models we examine suggest that reductions in term premia played the more important role in explaining the decline in UK long real rates over the 2004–05 period. This could be consistent with both the search for yield/excess liquidity explanation of the conundrum or heavy demand for index-linked bonds by institutional investors and central banks, although the global nature of the conundrum inclines us to put more weight on the former explanation. More recently, however, it seems likely that real rates have been depressed by a 'flight to quality' from risky assets triggered by the sub-prime crisis in the United States. Taking our results at face value would suggest that there are risks that real rates may rise in the future, as they currently remain below the long-run equilibrium levels implied by our models. But it should be borne in mind that there are a number of caveats with our analysis. In particular, the model set-up does not directly allow for structural changes in the level of the long-run equilibrium real interest rate, and the estimates themselves may be less reliable as a result of the relatively short data sample available.

### Globalisation, import prices and inflation dynamics

#### Summary of Working Paper no. 359 Chris Peacock and Ursel Baumann

The past two decades saw a marked fall in inflation across the globe, also associated with a rise in stability more generally. This stability is currently less obvious, as the major economies are experiencing a set of shocks that may mean that this benign period will eventually be judged to be one of only temporary respite from a more normal level of macroeconomic volatility. Whether this is the case or not, there may be important lessons to be learned from recent experience, and this paper examines the role that globalisation, and in particular rising imports and competition from low-cost countries, may have played in exerting downward pressure on global prices over that period of stability (specifically, we examine the periods from 1965 and 1985 until early 2007).

While theory tells us that the level of inflation is ultimately determined by monetary policy and its effectiveness in anchoring long-term inflation expectations, globalisation has certainly engendered a marked decline in the relative price of imported to domestically produced goods. In the short run, this may also have had an impact on inflation by lowering production costs, if firms were able to substitute between domestic and imported inputs to production. Stronger competitive pressures may also have had an impact on dampening inflation by making it harder for firms to raise their prices in the face of increased cost pressures. Explaining the dynamics of inflation in the light of increased global integration is thus high up on the agenda of policymakers.

Several recent papers have sought directly to analyse the impact of an increase in import openness or competitive pressures on inflation in an empirical framework by employing a 'reduced-form' approach, which conflates separate,

fundamental, relationships into a single empirical vehicle. This approach has two main drawbacks. First, it is difficult to link back the finding of lower relative prices in more-open sectors to aggregate inflation. Second, the estimates cannot tell us which underlying economic mechanisms are driving the relationship between globalisation and inflation. Consequently, in this paper a structural model of inflation dynamics — a New Keynesian Phillips Curve (NKPC) — is employed which allows us better to examine the impact of globalisation on inflation. The role of globalisation is modelled via the inclusion of intermediate imports in firms' production functions, and the results compared to those from a simpler closed-economy version of the model. This framework provides evidence on two questions. First, does the inclusion of import prices in firms' marginal costs (the cost of producing an extra unit of output) provide a relatively better in-sample fit of post-war inflation dynamics in the United Kingdom, United States and Japan than a model where marginal costs reflect labour costs alone? Second, is the weight on import prices in marginal costs now larger than it was prior to the most recent period of globalisation that has been evident since the mid-1980s?

Overall, the results suggest that import prices do help explain movements in inflation. In particular, NKPC models that allow for import prices to enter into firms' costs outperform closed-economy models in sample. However, they also suggest that the influence of import prices has generally remained constant across the whole sample period, with perhaps only the United Kingdom providing some evidence that import prices have become more important in firms' marginal costs.

## Extracting inflation expectations and inflation risk premia from the term structure: a joint model of the UK nominal and real yield curves

Summary of Working Paper no. 360 Michael Joyce, Peter Lildholdt and Steffen Sorensen

The nominal and real interest rates implied by government conventional and index-linked bonds of different maturities (ie the term structure of nominal and real interest rates) can potentially provide monetary policy makers with a great deal of information about financial market expectations of both future interest rates and inflation. The nominal and real term structures embody market expectations of future nominal and real interest rates respectively, while the difference between the two — the inflation term structure — embodies information about inflation expectations. Extracting this information, however, is complicated by the fact that the interest rate term structure may also reflect inflation risk premia (the compensation investors require for holding nominal bonds given the risk of unexpected inflation) and real term premia (the compensation investors require for the risk of unexpected future real interest rate movements).

In this paper we formulate and estimate a joint model of the UK nominal and real term structures, which enables us to decompose nominal forward interest rates into expected real policy (risk-free) rates, expected inflation, real term premia and inflation risk premia. The model is based on the assumption of no arbitrage, which implies that there are no risk-free profits to be made by trading combinations of nominal or real bonds. A necessary condition for this assumption to hold is that investors price nominal and real bonds consistently, so that for example the real interest rate priced into nominal bonds is the same as the real rate priced into index-linked bonds. To help identify inflation expectations, we also incorporate survey expectations of longer-term inflation, although the structure does not

constrain model expectations to equal the survey expectations period by period. The model is estimated using monthly data since October 1992, to enable us to analyse the dynamics of the term structure over the period that the UK monetary authorities have had an explicit inflation target.

Our analysis suggests there has been a marked fall in both expected longer-term inflation and inflation risk premia since the Bank of England was granted operational independence for setting interest rates. Moreover, in May 1997 — the month that independence was announced — we find a significant fall in both, suggesting that this institutional change was important relative to other influences. More recently, we find that the unusually low level of long real forward interest rates since 2004 (the bond yield 'conundrum') reflects a decline in real term premia, although a significant proportion remains unexplained. The relative inability of the model to fit long-dated real forwards during much of the recent period may reflect strong pension fund demand for index-linked bonds. And our analysis suggests that these special factors affecting the index-linked market may also partly explain the increase in long-term inflation forward rates since the middle of 2005, with long-term inflation expectations changing only modestly over this period, according to the model.

While more structural models are needed to analyse more carefully the economics behind the determinants of term premia and expected risk-free interest rates, our model-implied decompositions nevertheless add insights on which components have accounted for changes in short, medium and long-term forward interest rates since 1992.

# Why do risk premia vary over time? A theoretical investigation under habit formation

#### Summary of Working Paper no. 361 Bianca De Paoli and Pawel Zabczyk

Risky assets, such as stocks, tend to yield higher returns than safer assets, such as bonds. This difference in returns reflects the fact that investors require extra compensation (or a 'premium') for bearing risk. Evidence suggests that the size of this risk premium depends on whether the economy is in a period of stagnation or prosperity. In particular, investors require higher premia during economic slowdowns than during booms. This empirical regularity has been termed 'premium countercyclicality', and accounting for it in a theoretical framework is the focus of this paper.

We assume that investors form 'consumption habits'. That is, they get used to a certain reference level of consumption, which, much like real-life habits, is allowed to change over time. Allowing for habits has two main implications. First, it means that good times correspond to periods when actual consumption is high *relative* to this reference level. Second, it implies that in those good times, agents tend to be less averse to bearing risk (ie risk aversion is countercyclical). Our first, somewhat surprising, finding is that it is possible for more risk-averse agents to demand lower compensation for bearing risk. The remainder of the paper then analyses why this is the case and highlights conditions which guarantee that risk premia fall in good times and increase in bad times — as found in the data.

We first demonstrate that investors' assessment of future prospects is crucial in determining the behaviour of premia. We then show how the interplay of different model parameters, such as the speed with which investors change their habits or the persistence of shocks affecting the economy, jointly influence investors' assessment of the future. We prove that, in our simple model, to generate countercyclical risk premia, shocks to economic conditions have to be long-lasting, and consumption habits have to adjust slowly to these shocks.

To understand the intuition behind this result, consider a bad shock which pushes down the level of consumption. If the shock is temporary and households very quickly change their habits, then next period they will be used to a lower level of consumption, while actual consumption will tend to revert back to its previous (higher) level. Hence, households hit by the negative shock have every reason to expect consumption next period to be high relative to the benchmark.

Accordingly, even though risk aversion increases as a result of the bad shock, prospects of *good times* ahead make agents take on more risk and actually lead to a compression of premia. This is why temporary shocks and quickly adjusting habits translate into procyclical risk premia.

We then extend our analysis and investigate the likely behaviour of risk premia given more complicated dynamics of consumption, similar to those that might arise in modern macroeconomic models (and, arguably, in the data which they attempt to fit). A typical feature of these models is that they produce a 'hump-shaped' response of consumption to shocks. That is, following a bad shock, consumption will initially be expected to fall before recovering. As a result, bad shocks can lead to a reduction in risk-taking and an increase in risk premia, even if habits adjust quickly. Thus, under this specification, the conditions for countercyclical premia become less stringent. This result suggests that features which help generate humpshaped consumption responses are likely to generate more realistic risk premium behaviour.

### Output costs of sovereign crises: some empirical estimates

#### Summary of Working Paper no. 362 Bianca De Paoli, Glenn Hoggarth and Victoria Saporta

There have been many financial crises over the past 30 years especially in emerging market economies (EMEs). Crises have either hit the banking sector, the currency, the government or all three. This has spawned a large volume of empirical studies that have attempted to predict these types of crises. In recent years, there have also been a number of studies that have quantified the costs associated with banking and currency crises but there have been very few on the costs of sovereign debt crises. This is surprising especially given that some debt crises have had a broader impact on the global financial system such as the Latin American debt crisis in the early 1980s and the more recent Russian sovereign debt crisis ten years ago which culminated in the bail out of LTCM. This paper seeks to help fill this gap by assessing the impact on output of 40 sovereign debt crises since the 1970s.

In order to calculate the impact on output during periods of debt crises an estimate of what output would have been in the absence of crisis is needed. Two methods are adopted to measure this output counterfactual. The first method uses a relatively simple (Hodrick-Prescott) time trend of the country's GDP growth before the crisis. The second method involves estimating a model that, aside from the debt crisis itself, explains output growth (per head) by the ratio of investment to GDP, the ratio of government consumption to GDP, inflation, the degree of trade openness and a measure of political stability. This procedure should give a more precise measure of the counterfactual growth rate, since it controls for other factors that may affect output growth during the period of the sovereign crisis. As a check on the robustness of the results, the path of output during these sovereign crisis periods was compared to that for similar countries that at the time did not have sovereign crises. Nonetheless, given the difficulty in distinguishing between the loss in output due to the sovereign crisis itself — the cost of sovereign crisis — from the loss caused by the economic event that triggered the crisis in the first place, perhaps more weight should be attached to the relative costs of different types of crises.

The results suggest that, on all methods, debt crisis periods are associated with large output losses — falls in output relative to the counterfactual — of at least 5% per annum — and last a long time — on average for about ten years. Sovereign crises also rarely occur in isolation. More often than not they are associated with banking and/or currency crises. Moreover, it is the potent cocktail of triple crises that are found to have the biggest output losses.

Given that governments in EMEs, unlike in developed countries, have in the past often defaulted at relatively low levels of external debt these results emphasise the importance for EMEs of adopting sound macroeconomic policies and structural reforms to avoid unsustainable debt positions in the first place. In fact, since the new millennium, many EMEs have improved their policy frameworks and made progress in reducing the amount of government debt owed to foreigners while also lengthening the maturity of their debts. But total government debt, including that owed to domestic residents, remains high in a number of EMEs. Governments are also often reliant for debt financing on their domestic banks. This makes some EME banks vulnerable to sovereign weakness and potentially vice versa if governments bail out weak banking systems. Moreover, improvements in debt positions over the past decade were helped by the unusually benign external conditions including strong world GDP growth, low inflation and interest rates. The external environment is now significantly less favourable and so it is important that EMEs do not allow their fiscal positions to deteriorate markedly.

Once in a crisis, annual output losses are found to increase the longer that countries stay in arrears or take to restructure their debts. There is also some evidence that countries that restructure their debts face lower output losses than those that do not. This is consistent with the recent policy emphasis on the importance of market-based policy initiatives aimed at improving the speed and efficiency of debtor-creditor restructuring.

# Speeches

PROMISE

### Bank of England speeches

A short summary of speeches made by Bank personnel since publication of the previous *Bulletin* are listed below.

# What should be done about rising unemployment in the United Kingdom?

David Blanchflower, Monetary Policy Committee member, February 2009.

www.bankofengland.co.uk/publications/speeches/2009/ speech379.pdf

In this speech, David Blanchflower explained that while monetary and fiscal policy could stimulate the economy in the short term, the medium-term prospects for growth relied on a healthy financial sector to channel savings into the most productive investments. One risk to the economic outlook was that large increases in unemployment, coupled with negative equity in the housing market, could lead to rising arrears and defaults on mortgage loans. This scenario would imply further profit losses for banks. To help mitigate this risk any fiscal stimulus should be concentrated on sustaining employment and raising the human capital of the young, rather than being focused on large-scale, costly training schemes that had been ineffective in the past.

#### Monetary policy and the current recession

Andrew Sentance, Monetary Policy Committee member, February 2009.

www.bankofengland.co.uk/publications/speeches/2009/ speech378.pdf

In this speech, Andrew Sentance described the characteristics of the current recession and how it compared with previous UK recessions. He noted that although this recession is unusual in being driven by a global financial crisis there are familiar patterns in the components of demand and the sectors of the economy which are being affected. He went on to discuss the main challenges for monetary policy in the current economic climate. Risks to inflation were skewed to the downside but lower interest rates and a competitive pound should help to support the UK economy over the course of the year. Quantitative easing would also provide an additional tool to limit the downward pressures on demand. Consequently, monetary policy could continue to make a substantial contribution to economic stability over both the short and long term provided it remained focused on price stability. Seven lessons from the last three years Sir John Gieve, Deputy Governor, February 2009.

www.bankofengland.co.uk/publications/speeches/2009/ speech377.pdf

In his final speech as Deputy Governor, John Gieve looked back at the period of Great Stability and described seven lessons from his time at the Bank of England. First, he believed regulators should have a say in banks' risk management, as the recent crisis has shown that banks relied too heavily on flawed systems. Second, he outlined the gaps that existed in the United Kingdom's arrangements for resolving failing banks. He welcomed the new arrangements established by the Banking Act which bridge those gaps. Third, he noted that international co-operation and co-ordination procedures for resolving cross-border institutions were lacking and needed improvement. Fourth, he argued that the current generation of macroeconomic models used by central banks have drawbacks that need to be addressed. Fifth, he proposed that it may be less costly to avoid a bubble forming in financial markets than simply 'mopping up' after the crash. Sixth, he believed that central banks should adopt an 'intelligent approach to inflation targeting' to counter asset price booms and credit expansion. His final lesson was that the authorities require another instrument to stabilise the economy. He considered what form the instrument could take and who should be in charge of it.

# Opening remarks for an LSE panel on the global economic crisis: meeting the challenge

Timothy Besley, Monetary Policy Committee member, February 2009.

www.bankofengland.co.uk/publications/speeches/2009/ speech376.pdf

In this speech, Professor Tim Besley described the three main elements of the policy responses to the downturn. The first is a series of measures aimed at limiting directly the fallout from the financial crisis — including efforts to improve liquidity in financial markets, to recapitalise banks and to limit the impact of their 'difficult to value' assets on their lending activity. The second is the loosening of monetary policy — mainly so far by lowering official policy rates. Third, there have been fiscal policy responses, which are geared towards supporting demand in the face of weakening private investment spending and softening household demand. Professor Besley concluded that direct measures to prevent a sharper-than-desirable credit contraction should be understood and evaluated against the background of clearly defined policy objectives. The inflation-targeting framework with independent decisions by the MPC remains in his view a sound structure for monetary policy in the United Kingdom.

#### The economic outlook

Charles Bean, Deputy Governor, February 2009.

www.bankofengland.co.uk/publications/speeches/2009/ speech375.pdf

In this speech, Charles Bean described how the crisis in the financial sector caused the current recession. He highlighted the importance of the shock from the collapse of Lehman Brothers in triggering a worldwide collapse in credit availability and confidence. Although the near-term outlook remains weak, he argued there are grounds for believing conditions would improve later in the year because of the stimulus from large cuts in Bank Rate, the large depreciation of sterling and the various measures implemented to support the banking system. He concluded by arguing the case for an additional policy instrument to curtail excessive exuberance in the financial sector.

#### Why banks failed the stress test

Andrew Haldane, Executive Director for Financial Stability, February 2009.

www.bankofengland.co.uk/publications/speeches/2009/ speech374.pdf

In this speech, Andrew Haldane diagnosed some of the market failures in stress-testing practices highlighted by the financial crisis of the past 18 months. These roughly fall into three categories: disaster myopia, network externalities and misaligned incentives. He then went on to propose a five-point plan for improving stress-testing practices going forward to address these weaknesses. These measures involved better specification and regular evaluation of stress scenarios, including their second-round effects; plus a greater degree of engagement between risk managers and senior management and between financial firms and the authorities. They would also involve much greater public transparency about risk metrics and accompanying management actions.

Macroeconomic policy responses in the United Kingdom? David Blanchflower, Monetary Policy Committee member, January 2009.

www.bankofengland.co.uk/publications/speeches/2009/ speech373.pdf

In this speech, David Blanchflower described that a range of survey measures of UK economic activity had fallen to historic lows and the outlook for the global economy had deteriorated significantly. In past recessions, forecasts for economic activity had failed to anticipate the duration of the downturn. And past episodes of financial crises had been associated with particularly severe declines in output. Hence, UK economic activity was likely to contract further. As the degree of spare capacity within the economy increased there was a risk annual CPI inflation could fall below zero. Recently announced fiscal and monetary policy initiatives would provide an effective stimulus to the economy, but further policy action was required.

# The Governor's speech to the CBI Dinner, Nottingham, at the East Midlands Conference Centre

Mervyn King, Governor, January 2009.

www.bankofengland.co.uk/publications/speeches/2009/ speech372.pdf

In this speech, the Governor argued that the crisis — driven by the build-up of global imbalances and the explosion in the financial system — pointed to the need to create a new policy instrument to limit the build-up of debt. Bank Rate should be used for its traditional task of targeting inflation, rather than being diverted to try to control financial imbalances. The Governor pointed to a 'paradox of policy', where almost any policy measure that was desirable in the short run was diametrically opposite to the direction policy would need to take in the long run. In the short run spending must be encouraged to support the economy, but in the long term we would need to save more as a nation. Similarly banks should be encouraged to run down their capital now to enable them to absorb losses while continuing to lend, but in the long run they would need more capital. That suggested a need for clear policy frameworks to guide the policy response. In the area of monetary policy that framework is provided by the inflation target. With Bank Rate already very low, the MPC were preparing for the possibility that they may need to consider a range of unconventional measures to meet their remit. Those would need to be carefully designed.

#### Economic prospects and the policy challenge

Sir John Gieve, Deputy Governor, January 2009.

www.bankofengland.co.uk/publications/speeches/2009/ speech371.pdf

In this speech, John Gieve described the economic situation and the challenges for policy. The current recession was unusual, compared with previous post-war recessions, in that it was not preceded by a boom in output growth leading to rising price inflation. But there had been a sharp rise in household and corporate indebtedness associated with a surge in many asset prices. When losses emerged in the US sub-prime market, this ricocheted through the global financial system, eventually leading to a collapse in confidence across the world. In the United Kingdom there had been a sharp and broad-based weakening in activity reflecting a squeeze on credit, lower confidence, and falling external demand. Past policy measures — lower interest rates and looser fiscal policy — combined with a lower exchange rate would have a growing effect on the economy in the short term by stimulating demand. Though in the medium term, we needed to see higher saving rates, less leverage in the financial sector and higher net exports. It would also be necessary to supplement monetary policy action with measures directly focused on banking and financial markets.

The current downturn — a bust without a boom? Andrew Sentance, Monetary Policy Committee member, December 2008.

www.bankofengland.co.uk/publications/speeches/2008/ speech370.pdf

In this speech, Andrew Sentance discussed how the current downturn was different from other post-war recessions which had been preceded by an inflationary boom. Instead, the current cycle looked similar to those that occurred before the First World War which had been driven by financial and commodity booms. Dr Sentance offered three policy conclusions. First, the two-way interactions between the financial system and the macroeconomy need to be better understood. Second, better policy instruments for maintaining the stability of the financial system, and avoiding financial booms, need to be developed. Third, the inflationary consequences of strong demand growth may have been masked, perhaps by the inflation of a financial bubble or because of globalisation. This suggested that the future growth of supply potential may be lower than previously thought.

# Appendices

PROMISE

### 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 website at:

www.bankofengland/publications/quarterlybulletin/index.htm.

#### Articles and speeches

Speeches are indicated by (S)

#### Summer 2006

- House prices and consumer spending
- Investing in inventories
- Cost-benefit analysis of monetary and financial statistics
- Public attitudes to inflation
- The Centre for Central Banking Studies
- A review of the work of the London Foreign Exchange Joint Standing Committee in 2005
- Uncertainty, the implementation of monetary policy, and the management of risk (S)
- Reflections on operating inflation targeting (S)
- Cost pressures and the UK inflation outlook (S)
- The UK current account deficit and all that (S)
- A shift in the balance of risks (S)
- What do we now know about currency unions? (S)

#### 2006 Q3

- The UK international investment position
- Costs of sovereign default
- UK export performance by industry
- The Governor's speech in Edinburgh, Scotland (S)
- The Governor's speech at the Mansion House (S)
- Stability and change (S)
- Financial system risks in the United Kingdom (S)

#### 2006 Q4

- The economic characteristics of immigrants and their impact on supply
- Recent developments in sterling inflation-linked markets
- The state of British household finances: results from the 2006 NMG Research survey
- Measuring market sector activity in the United Kingdom
- The Governor's speech at the Great Hall, Winchester (S)
- Trusting in money: from Kirkcaldy to the MPC (S)
- The Governor's speech to the Black Country business awards dinner (S)
- International monetary stability can the IMF make a difference? (S)
- The puzzle of UK business investment (S)
- Hedge funds and financial stability (S)

- Practical issues in preparing for cross-border financial crises
   (S)
- Reflections on my first four votes on the MPC (S)
- Prudential regulation, risk management and systemic stability (S)
- Globalisation and inflation (S)

#### 2007 Q1

- The Monetary Policy Committee of the Bank of England: ten years on
- The macroeconomic impact of globalisation: theory and evidence
- The macroeconomic impact of international migration
- Potential employment in the UK economy
- The role of household debt and balance sheets in the monetary transmission mechanism
- Gauging capacity pressures within businesses
- Through the looking glass: reform of the international institutions (S)
- The Governor's speech to the Birmingham Chamber of Commerce Annual Banquet (S)
- Perspectives on current monetary policy (S)
- The MPC comes of age (S)
- Pricing for perfection (S)
- Risks to the commercial property market and financial stability (S)
- Macro, asset price, and financial system uncertainties (S)
- The impact of the recent migration from Eastern Europe on the UK economy (S)
- Inflation and the supply side of the UK economy (S)
- Inflation and the service sector (S)
- Recent developments in the UK labour market (S)

#### 2007 Q2

- Public attitudes to inflation and interest rates
- National saving
- Understanding investment better: insights from recent research
- Financial globalisation, external balance sheets and economic adjustment
- A review of the work of the London Foreign Exchange Joint Standing Committee in 2006
- The MPC ten years on (S)
- The City's growth: the crest of a wave or swimming with the stream? (S)
- The changing pattern of savings: implications for growth and inflation (S)
- Interest rate changes too many or too few? (S)
- A perspective on recent monetary and financial system developments (S)

 Recent developments in the UK economy: the economics of walking about (S)

#### 2007 Q3

- Extracting a better signal from uncertain data
- Interpreting movements in broad money
- The Bank of England Credit Conditions Survey
- Proposals to modify the measurement of broad money in the United Kingdom: a user consultation
- The Governor's speech to CBI Wales/CBI Cymru, Cardiff (S)
- The Governor's speech at the Mansion House (S)
- London, money and the UK economy (S)
- Uncertainty, policy and financial markets (S)
- Central banking and political economy: the example of the United Kingdom's Monetary Policy Committee (S)
- Promoting financial system resilience in modern global capital markets: some issues (S)
- UK monetary policy: good for business? (S)
- Consumption and interest rates (S)

#### 2007 Q4

- Household debt and spending: results from the 2007 NMG Research survey
- The macroeconomic impact of higher energy prices on the UK economy
- Decomposing corporate bond spreads
- The foreign exchange and over-the-counter derivatives markets in the United Kingdom
- The Governor's speech in Northern Ireland (S)
- Current monetary policy issues (S)
- The global economy and UK inflation (S)
- Trends in European labour markets and preferences over unemployment and inflation (S)
- Fear, unemployment and migration (S)
- Risk, uncertainty and monetary policy (S)
- New markets and new demands: challenges for central banks in the wholesale market infrastructure (S)
- A tale of two shocks: global challenges for UK monetary policy (S)

#### 2008 Q1

- Capital inflows into EMEs since the millennium: risks and the potential impact of a reversal
- Recent developments in portfolio insurance
- The Agents' scores: a review
- The impact of low-cost economies on UK import prices
- The Society of Business Economists' survey on MPC communications
- The Governor's speech in Bristol (S)
- The impact of the financial market disruption on the UK economy (S)
- The return of the credit cycle: old lessons in new markets (S)
- Money and credit: banking and the macroeconomy (S)
- Financial markets and household consumption (S)

#### 2008 Q2

- Public attitudes to inflation and interest rates
- Recent advances in extracting policy-relevant information from market interest rates
- How do mark-ups vary with demand?
- On the sources of macroeconomic stability
- A review of the work of the London Foreign Exchange Joint Standing Committee in 2007
- Sovereign wealth funds and global imbalances (S)
- Monetary policy and the financial system (S)
- Inflation and the global economy (S)
- Does sterling still matter for monetary policy? (S)
- Strengthening regimes for controlling liquidity risk: some lessons from the recent turmoil (S)
- Inflation, expectations and monetary policy (S)

#### 2008 Q3

- Market expectations of future Bank Rate
- Globalisation, import prices and inflation: how reliable are the 'tailwinds'?
- How has globalisation affected inflation dynamics in the United Kingdom?
- The economics of global output gap measures
- Banking and the Bank of England (S)
- The Governor's speech at the Mansion House (S)
- A tale of two cycles (S)
- The financial cycle and the UK economy (S)
- The credit crisis: lessons from a protracted 'peacetime' (S)
- Financial innovation: what have we learnt? (S)
- Global inflation: how big a threat? (S)
- Remarks on 'Making monetary policy by committee' (S)

#### 2008 Q4

- The financial position of British households: evidence from the 2008 NMG Research survey
- Understanding dwellings investment
- Price-setting behaviour in the United Kingdom
- Monetary Policy Roundtable

#### 2009 Q1

- Price-setting behaviour in the United Kingdom: a microdata approach
- Deflation

### Bank of England publications

The Bank of England publishes information on all aspects of its work in many formats. Listed below are some of the main Bank of England publications. For a full list, please refer to our website:

www.bankofengland.co.uk/publications/index.htm.

#### Working papers

An up-to-date list of working papers is maintained on the Bank of England's website at:

www.bankofengland.co.uk/publications/workingpapers/ index.htm

where abstracts of all papers may be found. Papers published since January 1997 are available in full, in portable document format (PDF).

No. 349 Dealing with country diversity: challenges for the IMF credit union model (May 2008) Gregor Irwin, Adrian Penalver, Chris Salmon and Ashley Taylor

No. 350 Investigating the structural stability of the Phillips curve relationship (May 2008) Jan J J Groen and Haroon Mumtaz

No. 351 The cyclicality of mark-ups and profit margins for the United Kingdom: some new evidence (August 2008) *Clare Macallan, Stephen Millard and Miles Parker* 

No. 352 An agent-based model of payment systems (August 2008) Marco Galbiati and Kimmo Soramäki

No. 353 The conduct of global monetary policy and domestic stability (August 2008) Andrew P Blake and Bojan Markovic

No. 354 Estimating the determinants of capital flows to emerging market economies: a maximum likelihood disequilibrium approach (November 2008) *Guillermo Felices and Bjorn-Erik Orskaug* 

No. 355 The network topology of CHAPS Sterling (November 2008) *Christopher Becher, Stephen Millard and Kimmo Soramäki* 

No. 356 Measuring monetary policy expectations from financial market instruments (November 2008) *Michael Joyce, Jonathan Relleen and Steffen Sorensen* 

No. 357 A no-arbitrage structural vector autoregressive model of the UK yield curve (December 2008) *Iryna Kaminska* 

No. 358 Understanding the real rate conundrum: an application of no-arbitrage finance models to the UK real yield curve (December 2008) *Michael Joyce, Iryna Kaminska and Peter Lildholdt* 

No. 359 Globalisation, import prices and inflation dynamics (December 2008) *Chris Peacock and Ursel Baumann* 

No. 360 Extracting inflation expectations and inflation risk premia from the term structure: a joint model of the UK nominal and real yield curves (February 2009) *Michael Joyce, Peter Lildholdt and Steffen Sorensen* 

No. 361 Why do risk premia vary over time? A theoretical investigation under habit formation (February 2009) *Bianca De Paoli and Pawel Zabczyk* 

No. 362 Output costs of sovereign crises: some empirical estimates (February 2009) Bianca De Paoli, Glenn Hoggarth and Victoria Saporta

#### External MPC Unit discussion papers

The MPC Unit discussion paper series reports on research carried out by, or under supervision of, the external members of the Monetary Policy Committee. Papers are available from the Bank's website at:

www.bankofengland.co.uk/publications/externalmpcpapers/ index.htm.

The following papers have been published recently:

No. 24 The causal relationship between inflation and inflation expectations in the United Kingdom (July 2008) *Roger Kelly* 

No. 25 Household external finance and consumption (October 2008) *Timothy Besley, Neil Meads and Paolo Surico* 

No. 26 Monetary policies and low-frequency manifestations of the quantity theory (December 2008) *Thomas J Sargent and Paolo Surico* 

#### **Monetary and Financial Statistics**

Monetary and Financial Statistics (Bankstats) contains detailed information on money and lending, monetary and financial institutions' balance sheets, banks' income and expenditure, analyses of bank deposits and lending, external business of banks, public sector debt, money markets, issues of securities, financial derivatives, interest and exchange rates, explanatory notes to tables and occasional related articles.

*Bankstats* is published on a monthly basis, free of charge, on the Bank's website at:

www.bankofengland.co.uk/statistics/ms/current/index.htm.

Following user consultation, printed editions of *Bankstats*, which were previously published twice a year in January and July, have been discontinued since July 2006.

Further details are available from: Leslie Lambert, Monetary and Financial Statistics Division, Bank of England: telephone 020 7601 4544; fax 020 7601 3208; email leslie.lambert@bankofengland.co.uk.

Articles that have been published in recent issues of *Monetary and Financial Statistics* can also be found on the Bank's website at:

www.bankofengland.co.uk/statistics/ms/articles.htm.

#### **Financial Stability Report**

The *Financial Stability Report* is published twice a year in April and October. 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 at a charge, from Publications Group, Bank of England, Threadneedle Street, London, EC2R 8AH and on the Bank's website at:

www.bankofengland.co.uk/publications/fsr/index.htm.

#### **Payment Systems Oversight Report**

The *Payment Systems Oversight Report* provides an account of how the Bank is discharging its responsibility for oversight of

UK payment systems. Published annually, the Oversight Report sets out the Bank's assessment of key systems against the benchmark standards for payment system risk management provided by the internationally adopted Core Principles for Systemically Important Payment Systems, as well as current issues and priorities in reducing systemic risk in payment systems. Copies are available on the Bank's website at:

www.bankofengland.co.uk/publications/psor/index.htm.

#### Handbooks in central banking

The series of *Handbooks in central banking* provide concise, balanced and accessible overviews of key central banking topics. The *Handbooks* have been developed from study materials, research and training carried out by the Bank's Centre for Central Banking Studies (CCBS). The *Handbooks* are therefore targeted primarily at central bankers, but are likely to be of interest to all those interested in the various technical and analytical aspects of central banking. The series also includes lecture and research publications, which are aimed at the more specialist reader. All the *Handbooks* are available via the Bank's website at:

www.bankofengland.co.uk/education/ccbs/handbooks/ index.htm.

# The framework for the Bank of England's operations in the sterling money markets (the 'Red Book')

The 'Red Book' describes the Bank of England's framework for its operations in the sterling money markets, which is designed to implement the interest rate decisions of the Monetary Policy Committee while meeting the liquidity needs, and so contributing to the stability of, the banking system as a whole. It also sets out the Bank's specific objectives for the framework, and how it delivers those objectives. The framework was introduced in May 2006. The 'Red Book' is available at:

www.bankofengland.co.uk/markets/money/publications/ redbookjan08.pdf.

#### The Bank of England Quarterly Model

*The Bank of England Quarterly Model*, published in January 2005, contains details of the new macroeconomic model developed for use in preparing the Monetary Policy Committee's quarterly economic projections, together with a commentary on the motivation for the new model and the economic modelling approaches underlying it.

www.bankofengland.co.uk/publications/other/beqm/ index.htm.

# Cost-benefit analysis of monetary and financial statistics

The handbook describes a cost-benefit analysis (CBA) framework that has been developed within the Bank to ensure a fair balance between the benefits derived from good-quality statistics and the costs that are borne by reporting banks. Although CBA is a well-established approach in other contexts, it has not often been applied to statistical provision, so techniques have had to be adapted for application to the Bank's monetary and financial statistics. The handbook also discusses how the application of CBA has enabled cuts in both the amount and the complexity of information that is required from reporting banks.

www.bankofengland.co.uk/statistics/about/cba.htm.

#### **Credit Conditions Survey**

As part of its mission to maintain monetary stability and financial stability, the Bank needs to understand trends and developments in credit conditions. This survey for bank and non-bank lenders is an input to this work. Lenders are asked about the past three months and the coming three months. The survey covers secured and unsecured lending to households and small businesses; and lending to non-financial corporations, and to non-bank financial firms.

www.bankofengland.co.uk/publications/other/monetary/ creditconditions.htm.

#### **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.

Summary pages of the *Bulletin* from February 1994, giving a brief description of each of the articles, are available on the Bank's website at:

www.bankofengland.co.uk/publications/quarterlybulletin/ index.htm.

Individual articles from May 1994 are also available at the same address.

Bound volumes of the *Quarterly Bulletin* (in reprint form for the period 1960–2004) can be obtained from Schmidt Periodicals GmbH, Ortsteil Dettendorf, D-83075 Bad Feilnbach, Germany, at a price of  $\notin$ 4,100 per complete 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 *Inflation Report* is available at:

www.bankofengland.co.uk/publications/inflationreport/ index.htm.

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

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

#### **Publication dates**

Copies of the *Quarterly Bulletin, Inflation Report* and *Financial Stability Report* can be bought separately, or as combined packages for a discounted rate. Current prices are shown overleaf. Publication dates for 2009 are as follows:

#### Quarterly Bulletin

| Q1 | 16 March     |
|----|--------------|
| Q2 | 15 June      |
| Q3 | 21 September |
| Q4 | 14 December  |

#### Inflation Report

| February | 11 February |
|----------|-------------|
| May      | 13 May      |
| August   | 12 August   |
| November | 11 November |

#### Financial Stability Report

April October

#### Quarterly Bulletin, Inflation Report and Financial Stability Report subscription details

Copies of the *Quarterly Bulletin* (*QB*), *Inflation Report* (*IR*) and *Financial Stability Report* (*FSR*) can be bought separately, or as combined packages for a discounted rate. Subscriptions for a full year are also available at a discount. The prices are set out below:

| Destination                                      | 2009                                 |                      |                    |                   |                   |             |
|--|--------------------------------------|----------------------|--------------------|-------------------|-------------------|-------------|
|  | <i>QB, IR</i> and <i>FSR</i> package | QB and IR<br>package | IR and FSR package | <i>QB</i><br>only | <i>IR</i><br>only | FSR<br>only |
| United Kingdom                                   |                                      |                      |                    |                   |                   |             |
| First class/collection <sup>(1)</sup>            | £31.50                               | £27.00               | £13.50             | £21.00            | £10.50            | £5.25       |
| Students/schools<br>(concessionary rate UK only) | £10.50                               | £9.00                | £4.50              | £7.00             | £3.50             | £1.75       |
| Academics<br>(concessionary rate UK only)        | £21.00                               | £18.00               | £9.00              | £14.00            | £7.00             | £3.50       |
| Rest of Europe                                   |                                      |                      |                    |                   |                   |             |
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| Surface mail                                     | £38.50                               | £33.00               | £17.00             | £25.00            | £13.00            | £6.50       |
| Air mail   | £50.00                               | £43.00               | £21.50             | £34.00            | £17.00            | £8.50       |

(1) Subscribers who wish to collect their copy (copies) of the Bulletin, Inflation Report and/or Financial Stability Report may make arrangements to do so by writing to the address given below. Copies will be available to personal callers at the Bank from 10.30 am on the day of issue and from 8.30 am on the following day.

Readers who wish to become **regular subscribers**, or who wish to purchase single copies, should send to the Bank, at the address given below, the appropriate remittance, payable to the Bank of England, together with full address details, including the name or position of recipients in companies or institutions. If you wish to pay by **Visa**, **MasterCard**, **Maestro** or **Delta**, please telephone +44 (0)2076014030. Existing subscribers will be invited to renew their subscriptions automatically. Copies can also be obtained over the counter at the Bank's front entrance.

The **concessionary** rates for the *Quarterly Bulletin, Inflation Report* and *Financial Stability Report* are noted above in *italics*. Academics at UK institutions of further and higher education are entitled to a concessionary rate. They should apply on their institution's notepaper, giving details of their current post. **Students and secondary schools** in the United Kingdom are also entitled to a concessionary rate. Requests for concessionary copies should be accompanied by an explanatory letter; students should provide details of their course and the institution at which they are studying.

These publications are available from Publications Group, Bank of England, Threadneedle Street, London, EC2R 8AH; telephone +44 (0)20 7601 4030; fax +44 (0)20 7601 3298; email mapublications@bankofengland.co.uk or fsr\_enquiries@bankofengland.co.uk.

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