
Risk, uncertainty and monetary policy regimes⁽¹⁾

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

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

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

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

It is a pleasure to be here.

As asset/liability managers, you grapple with many of the issues that, from the other side of the fence, confront central bankers as we pursue our mission to maintain monetary and financial system stability. For both of us, risk management is integral to what we do; and, amongst other things, that entails trying to make sense of financial markets. In your case, it includes forming expectations about policymakers' objectives and actions. In our case, it includes trying to decipher whether asset price changes provide a diagnostic on what is going on in the economy, including the credibility of the monetary regime. As capital markets have developed, there has been a richening in the instruments available to you to manage risk, and consequently in the diagnostic indicators available to us. For quite a few years now, most conferences on financial risk management have given centre stage to the use of options in hedging (and taking) risk. Flipping that into the world of central banking, I want to explore whether option prices can shed any light on risks in the current financial environment, including uncertainty about the expected path of monetary policy. I shall also examine

whether the recent changes in the United Kingdom's inflation target have affected uncertainty about the decisions of the Monetary Policy Committee. The conclusions are, I am afraid, far from conclusive, but I hope that they will give you some flavour of how, at the Bank of England, we are trying to apply surveillance and analysis of markets to our core mission.

Environmental risks facing the global financial system

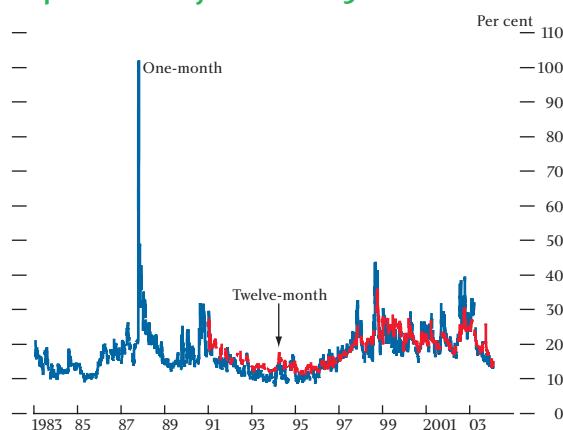
Had we been here this time last year, the centre of our discussion would probably have been risk in the equity and credit markets. Companies on both sides of the Atlantic were still in the middle of adjusting to the excesses of the second half of the 1990s. Reflecting that, equity markets remained highly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

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(2) Member of the Monetary Policy Committee and Executive Director for Markets.

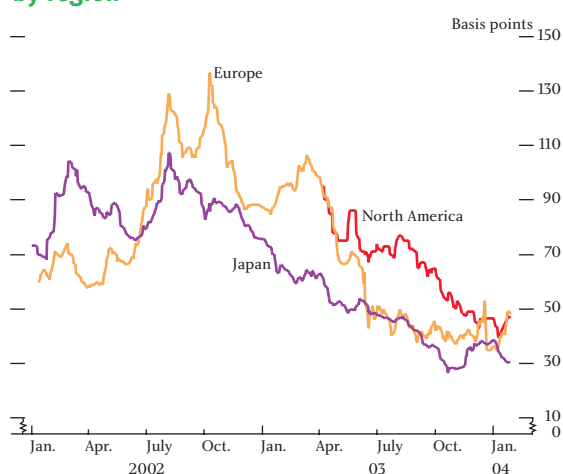
could hardly look more different today. Equities are up over 40% from March 2003 lows; forward-looking measures of equity volatility, derived from option prices, are at or below the averages of the past couple of decades (Chart 1);⁽¹⁾ and credit spreads, across sectors and countries, are low (Chart 2).

Chart 1
Implied volatility of the S&P 500 index



Source: Chicago Mercantile Exchange.

Chart 2
Investment-grade credit default swap indices by region



Source: TRAC-X.

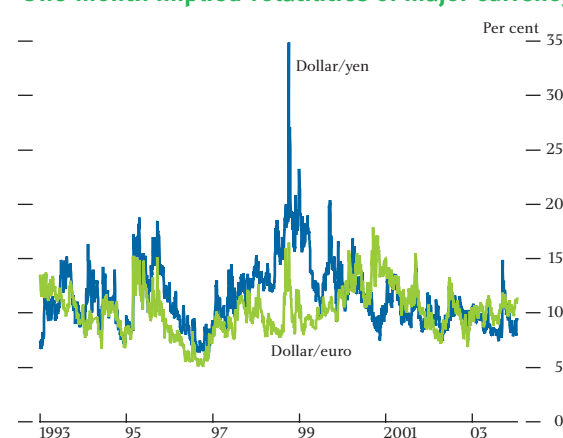
Perceptions of reduced credit risk owe much to the steps taken by many large corporates to strengthen balance sheets, for example by extending debt maturities. Monetary policy has not been incidental to this. As well as sustaining household spending, low interest rates—and, notably in dollar markets, the expectation over the past year or so that official rates would remain low for some time—have facilitated corporate sector balance

sheet strengthening by reducing yields on long-maturity bonds. And demand for corporate debt instruments has been strong in an environment of low *ex-ante* nominal returns on government bonds—part of a wider ‘search for yield’ highlighted by the Bank⁽²⁾ and others. Indeed, it cannot be ruled out that the tightening in credit spreads may have overshot.

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

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

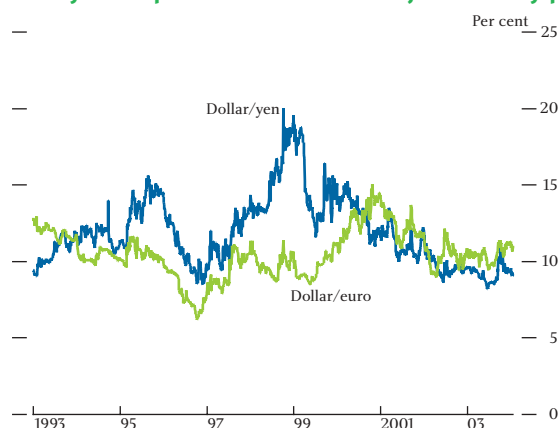
Chart 3
One-month implied volatilities of major currency pairs



Source: UBS.

- (1) The comparison depends on whether the sharp spikes in implied volatility that accompanied the 1987 crash, the recent boom/bust etc are omitted in calculating the average. I prefer to omit them when thinking about whether or not current equity implied volatility is unusually low.
- (2) See, for example, the June 2003 (pages 11, and 15–17) and December 2003 (pages 13, and 17–18) issues of the Bank's *Financial Stability Review* for a discussion of this.

Chart 4
One-year implied volatilities of major currency pairs



Source: UBS.

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

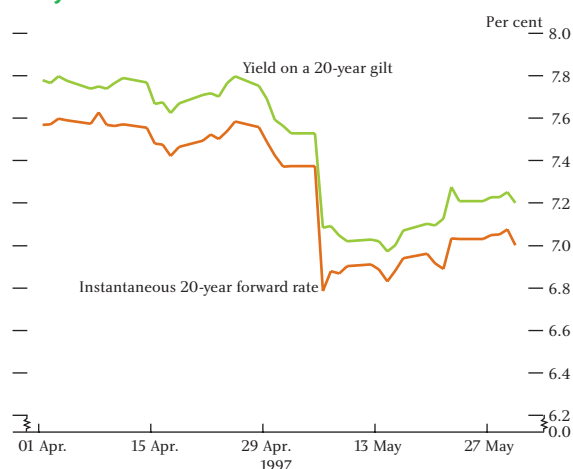
Options-based measures of monetary credibility

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

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

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

Chart 5
20-year interest rates



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

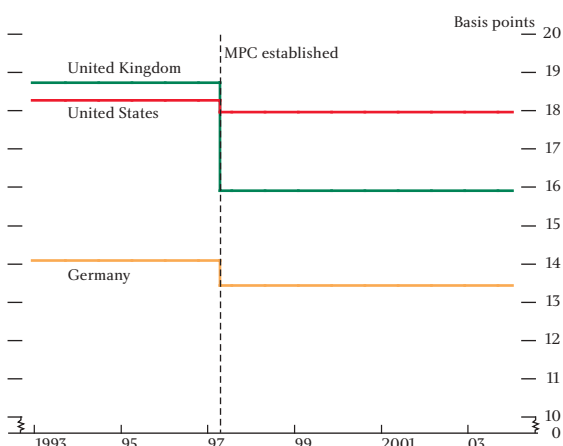
Historical volatility is, by definition, backward looking, and could be affected by a whole range of transient influences on yields. Less familiar but, crucially, forward-looking indicators of credibility can in principle be derived from option prices because greater uncertainty will, other things being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

(1) For ease of exposition, I ignore risk premia for much of this presentation.

(2) This proposition was explored in Haldane, A and Read, V (1999), 'Monetary policy and the yield curve', *Bank of England Quarterly Bulletin*, May, pages 171–76.

(3) Measured in basis points rather than per cent.

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



(a) Three-month standard deviation.

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

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

be accompanied by a fall in the implied volatility of long-term options on interest rates.

Has that happened in the United Kingdom?

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

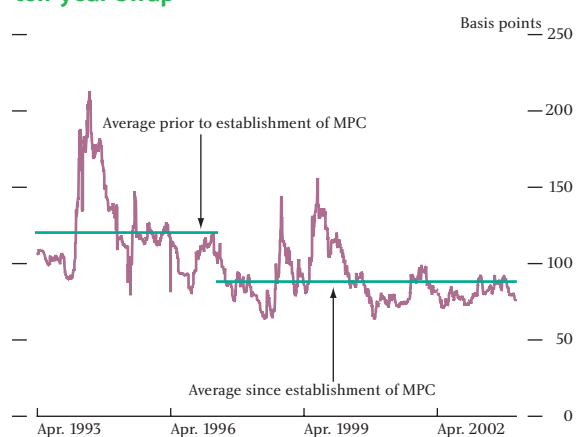
Chart 7
Implied volatility of a ten-year option on a 20-year swap



Source: JPMorgan Chase.

- (1) Implied volatility, based on the Black-Scholes option-pricing formula, is commonly interpreted as a measure of the expected standard deviation of the return on the underlying asset over the life of the option. Implied volatility is, therefore, usually reported as a percentage.
- (2) The data in this paper are from options on swaps, known as 'swaptions': see the box on page 24 of the June 2002 *Financial Stability Review*. A swap is a financial contract where the counterparties exchange a Libor-based floating-rate stream of payments for a fixed-rate stream of payments (at the 'swap rate'). Swaps and swaptions are traded in over-the-counter (OTC) markets. The options used in this paper are 'European' options, which can be exercised only at the terminal date and not before; the analogy with insurance is more exact for 'American' options, which can be exercised at any time but are less frequently traded in OTC fixed-income markets.
- (3) This is ignoring extreme circumstances like hyperinflation when there would effectively be zero credibility and things could only get better over the long run.
- (4) This chart and the others show implied volatility in terms of basis points of yield. If, for reasonable levels of interest rates, the size of any change in interest rates by the central bank is unrelated to the level of rates, implied volatility measured in basis points is a better indicator of uncertainty than a percentage measure.

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



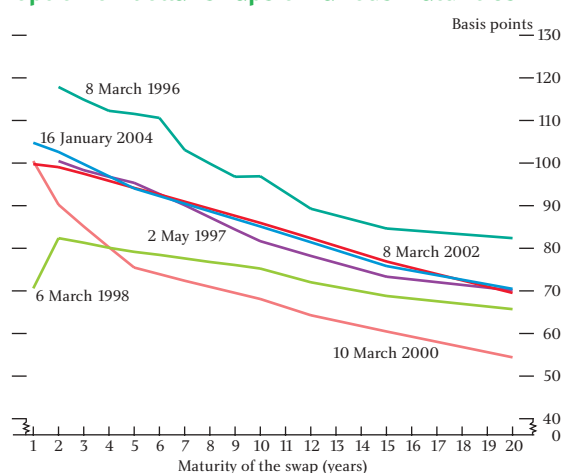
Source: Barclays Capital.

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

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

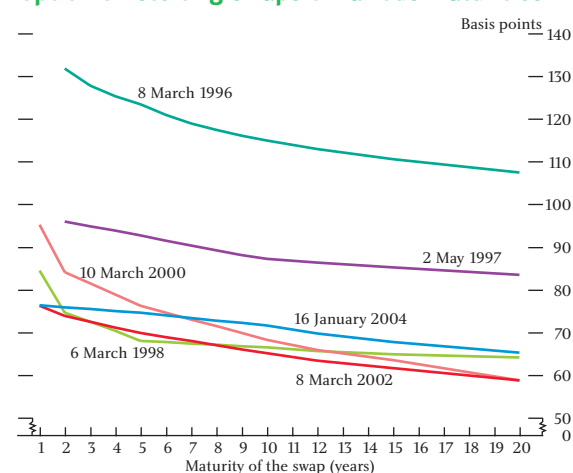
Second, in a credible regime, I would expect that the degree of uncertainty about the path of interest rates

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



Source: JPMorgan Chase.

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



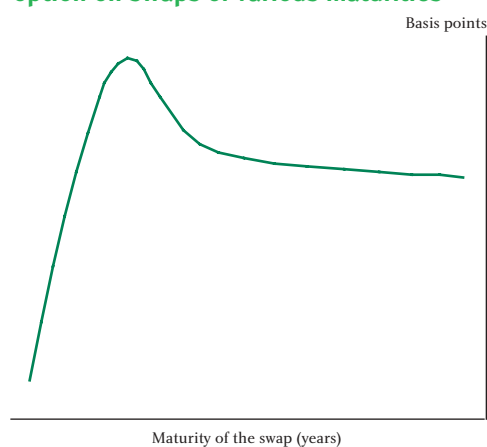
Source: JPMorgan Chase.

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

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

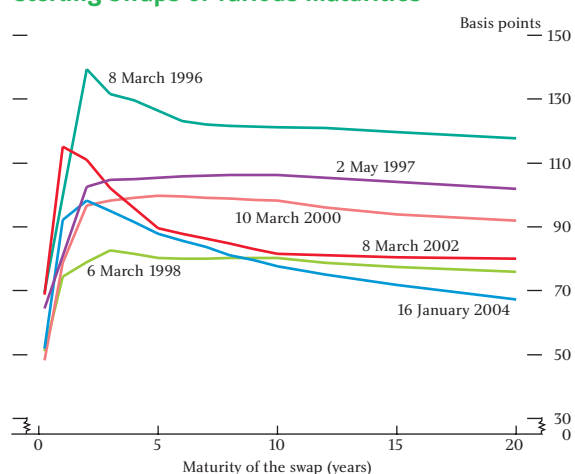
about the outlook could emerge over the life of the option. And, finally, I would expect that, on average,⁽¹⁾ near-term uncertainty would be lower again about long-maturity yields because they are influenced less by the business cycle than short-term interest rates—provided that the market was confident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

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



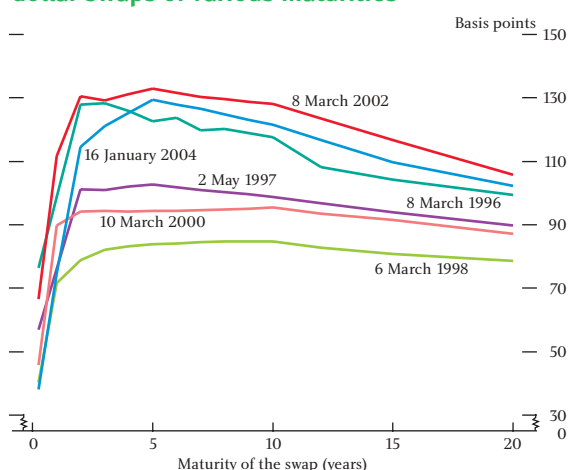
Does it look like that for the United Kingdom? Chart 12 suggests that broadly speaking it does, but with the implied volatility curve occasionally flattish beyond two to three years. The same is true of the dollar and euro/DM markets (Charts 13 and 14).⁽²⁾

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



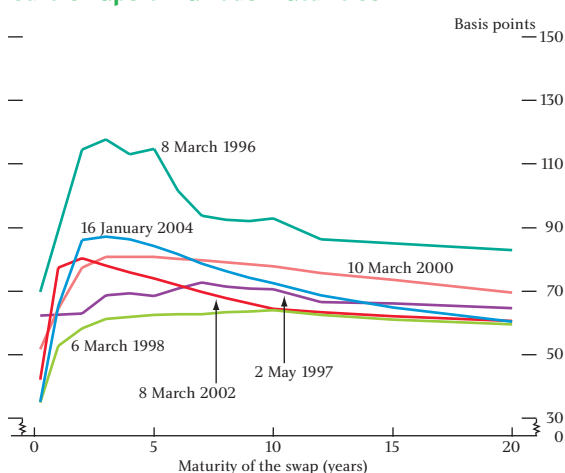
Source: JPMorgan Chase.

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



Source: JPMorgan Chase.

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



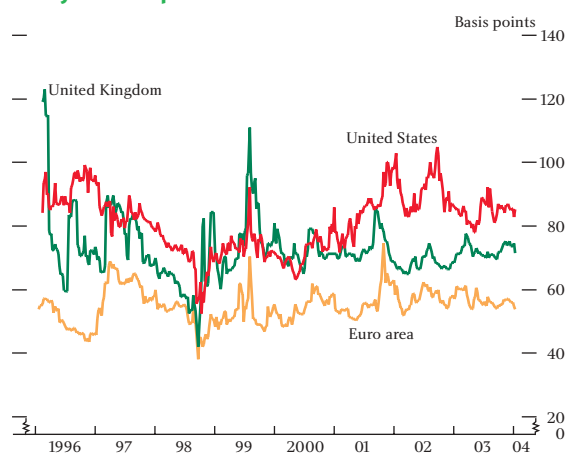
Source: JPMorgan Chase.

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

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

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

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



Source: JPMorgan Chase.

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

There are potential distortions in other swaptions markets too. Contacts suggest that the prices of both sterling and euro-denominated swaptions have at times been pushed higher by long-term savings institutions,

such as insurance companies, buying hedges against their having guaranteed minimum nominal returns on savings products. Sometimes such distortions can be quite persistent.

Uncertainty and the current conjuncture

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

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

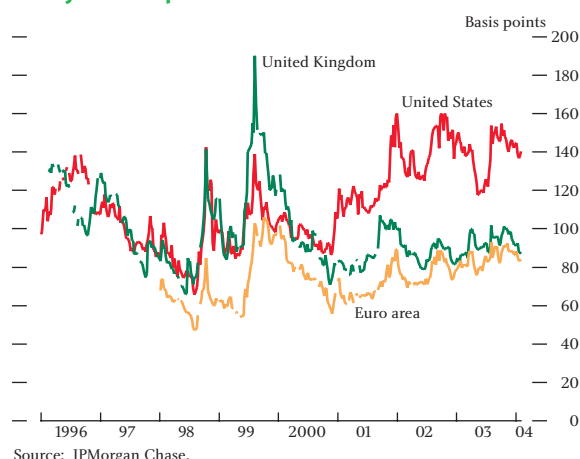
Judging by the market debate about so-called 'exit strategies', uncertainty about the path of policy over the next few years is especially pronounced in the United States. An argument can, I think, be made that there is likely to be moderately greater uncertainty about the

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

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

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

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



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

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

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

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

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

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

There are quite a few changes.⁽³⁾ Some goods and services are treated slightly differently in the two indices (eg new cars, insurance). The weights given to elements of the basket differ too: for example, RPIX does not take into account the spending patterns of the 4% of private

households with the highest incomes, whereas the CPI does. But the two most important changes are to coverage, and to the formula for calculating the inflation rate for bundles of similar goods. Unlike RPIX, the CPI does not include housing depreciation and Council Tax. And the inflation rate for some categories of goods is calculated via an arithmetic mean in RPIX but by a geometric mean in the CPI.⁽⁴⁾

Both these changes affect the rate of increase of the CPI relative to RPIX. The so-called 'formula effect' reduces the measured rate of inflation, as a geometric mean is always less than (or equal to) an arithmetic mean. On average over recent years, the formula effect has been worth around $\frac{1}{2}$ a percentage point. That $\frac{1}{2}$ is not fixed. It has varied from month to month over the 15 years for which we have data, but the range around $\frac{1}{2}$ has been fairly narrow.⁽⁵⁾ It is reasonable to assume that it will continue to make the annual rate of increase in the CPI about $\frac{1}{2}$ a percentage point lower than in RPIX.

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

So over the long run, one would perhaps expect the difference between the rates of increase of the two indices to be slightly more than $\frac{1}{2}$ a percentage point—the difference between the two targets. A number of commentators seem to expect that the difference will average around $\frac{3}{4}$ of a percentage point over the long term, but with considerable uncertainty around this estimate.

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

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

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

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

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

Significance of the new inflation target for the monetary regime

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

Do the changes entail a 'loosening' of monetary policy? I think the fairly widespread references to a 'loosening' are misleading, and therefore unfortunate. If—as it happens, a big 'if'—it were certain that the difference between the two measures was, say, $\frac{3}{4}$ of a percentage point (and that there was no change in agents' views of the true, unobservable rate of inflation that they care about), then the effect of reducing the target by 0.5 percentage points would be to increase the steady-state (ie long-term) nominal rate of economic expansion by around $\frac{1}{4}$ of a percentage point. The notion that this would be a 'loosening' of monetary policy harks back to the language used when thinking about monetary conditions in terms of monetary aggregates. For unchanged velocity of money, the steady-state rate of growth of the monetary aggregates would increase by around $\frac{1}{4}$ of a percentage point. This would have no effect on the real economy over the long run. Most important, provided the change was credible, it would not entail what, in today's world, is generally called a loosening of monetary policy, ie that short-term real interest rates would be lower. It simply means that, other things being equal, medium to long-term inflation expectations would be very slightly higher.

Do the changes entail a regime change? No. Even if one assumed that the changes definitely entailed an increase in steady-state inflation of around $\frac{1}{4}$ percentage point, it would hardly amount to a regime change. The regime is to achieve price stability. And it really cannot be argued that the new target of 2% CPI inflation is inconsistent with price stability. A difference of around $\frac{1}{4}$ percentage point would be immaterial in terms of the welfare costs of anticipated inflation.⁽¹⁾ And, returning to the diagnostics I used earlier, there is no evidence from option prices that the changes have increased uncertainty about long-term nominal interest rates—over either short or long horizons. If anything, short-horizon uncertainty about long-term nominal interest rates seems to have edged down very recently

(Chart 17). That there has not been a rise in long-horizon uncertainty is hardly surprising: over a period of a decade or so, adjustments would have been made to the RPI, as part of the ONS's work programme, that could have an effect of that modest size. And changes could conceivably be made to the CPI—for example, the introduction of a measure of housing costs, which Eurostat is studying—that might reduce any differences of coverage between CPI and RPIX.

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

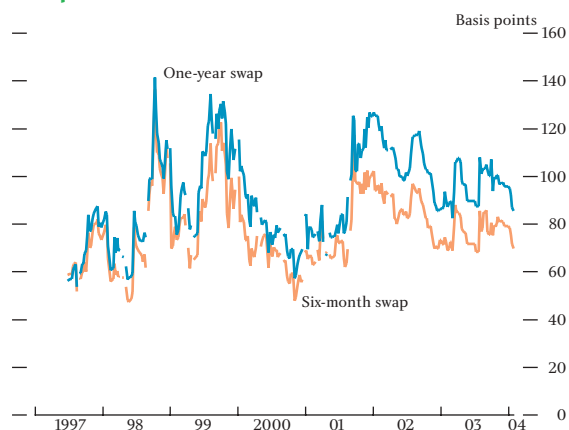


Are the changes material to the Committee's near-term decisions? The answer to this depends on the outlook for the prices of the items included in the RPIX but not CPI. Over the past few years, house prices have been rising much faster than normal, so the wedge between annual RPIX and CPI inflation has been unusually large: it peaked in May 2003 at 1.7 percentage points, compared with an average of around $\frac{3}{4}$ of a percentage point since 1989, when the CPI was first compiled. The Committee's recent view has been that house price inflation is most likely gradually to moderate over the next couple of years—to below its steady-state rate and below the rate of general price inflation for a while. In consequence, the CPI/RPIX inflation wedge is likely to narrow to below what would be expected on average over the longer term. On that basis, projections for CPI and RPIX inflation would, therefore, be pretty similar relative to the respective targets. That will make the explanation of policy settings easier, since the change in target should not make much difference to the MPC's decisions on interest rates over the next few months. Again, this is

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

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

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



The new inflation target and asset prices

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

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

The same nominal/real split carries across to asset prices, and in particular to bond yields. As stated

earlier, long-term nominal interest rates comprise the steady-state real interest rate plus the expected inflation rate (plus risk premia). The switch from an RPIX target of 2.5% to a CPI target of 2% will make clearer, assuming credibility, that medium to long-term expectations of cost-of-living increases should be around 2% not $2\frac{1}{2}\%$, and that the remaining component of medium to long-maturity nominal yields represents a real return. Provided investors have understood that RPIX has overstated cost-of-living increases by around $\frac{1}{2}$ a percentage point on average, there are no implications for asset prices.

For bond market participants, a wrinkle arises from the design of inflation-indexed gilts (IGs). The coupons on IGs, which of course are paid in money, are indexed to RPI.⁽³⁾ Because the RPI plausibly overstates cost-of-living increases, the RPI uplift on IGs overcompensates investors for cost-of-living increases: part of the uplift—on average around $\frac{1}{2}$ a percentage point—represents a real return. The required real rate of return to an investor in IGs is delivered via a combination of the conventionally calculated (IG) yield plus an expected real return from the RPI uplift. In other words, conventionally calculated IG yields are not necessarily the best measure of the risk-free interest rate, which is used as a benchmark for real returns from other, riskier assets such as equities, property etc. The 'measuring rod' needs to be adjusted for the bias in RPI/RPIX as a gauge of cost-of-living increases.

Is it conceivable that investors would have been awakened to this for the first time by the change in the inflation target? I doubt it, but it is worth conducting a thought experiment on the implications for bond yields if, hypothetically, that were the case. In those circumstances, assuming that their view of 'true' steady-state real rates was unchanged, IG prices would rise and conventionally calculated IG yields fall—by roughly $\frac{1}{2}$ a percentage point. Likewise, under these assumptions, long nominal forward rates would be expected to fall too. On waking up to the 'formula effect', these hypothetical investors would realise that nominal rates had been overcompensating for inflation—by around $\frac{1}{2}$ a percentage point on average. Separately, on an assumption that investors demand a return on nominal bonds that compensates for expected increases in the prices of items that are included in RPIX but not

(1) A geometric mean gives relatively more weight to goods whose prices increase more slowly, thus capturing some of this substitution effect.

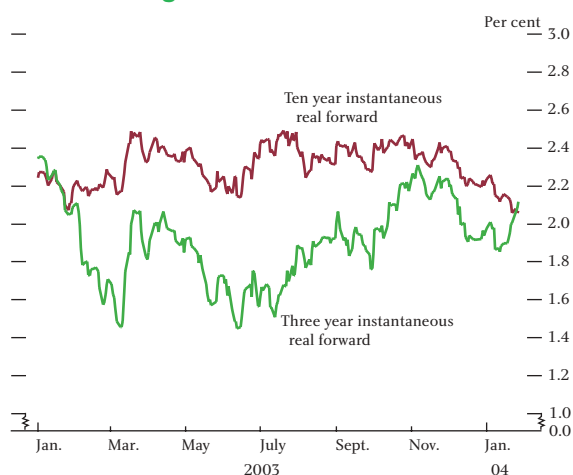
(2) In a speech on 20 January 2004 to the annual Birmingham Forward/CBI business luncheon, Birmingham, reproduced on pages 74–76 of this *Bulletin*.

(3) In what follows, it is assumed that RPI and RPIX inflation are on average the same in the long run.

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

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

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



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

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

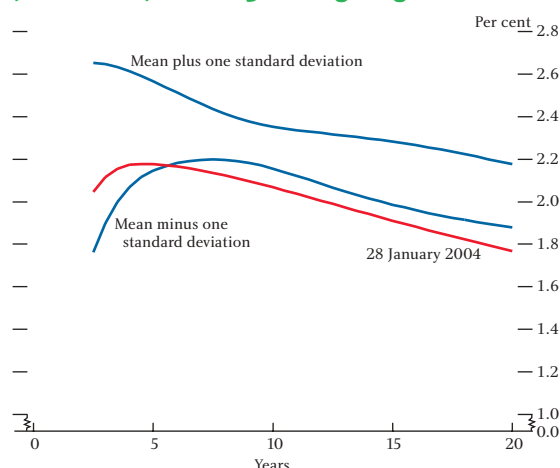


Chart 21
Forward break-even inflation rates relative to June 2002–June 2003 trading range

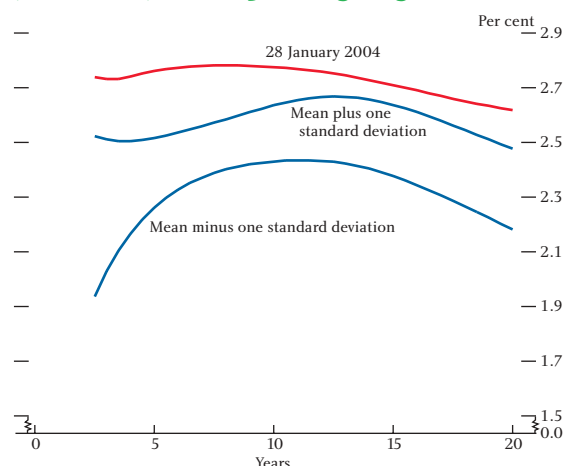


Chart 22
International ten-year real yields



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

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

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

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

As is communicating that the switch in the target is not material in the crucial sense that a target of 2% on the CPI measure and 2½% on the RPIX measure are both consistent with price stability. At present, CPI inflation is below our 2% target, whereas RPIX inflation is above our old target of 2½%. But that does not have material implications for the near-term path of policy because, as I discussed earlier, the MPC expects the wedge between the two measures of inflation to narrow on the basis of our view that house prices will decelerate over the next year or so. That is not to say that, over the long run,

policy will always be identical under the CPI target to what it would have been under the RPIX target—we set policy on a month-by-month basis. But it does underline that the transition can be smooth. Consistent with this, bond options suggest that the change in the inflation target has not affected uncertainty about the near-term path of policy or the credibility of the regime.

Summary

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

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

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