# Some Issues in Inflation Targeting

by

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I would like to thank a number of my colleagues at the Bank of England, in particular Bill Allen, Clive Briault, Spencer Dale, Paul Fisher, Suzanne Hudson, Mervyn King, Charles Nolan, Darren Pain, Vicky Read, Lars Svensson, Paul Tucker, Peter Westaway and John Whitley. I would also like to thank participants at the Konstanz monetary seminar in June 1996 for which this paper was written, in particular my discussant Walter Wasserfallen; and an anonymous referee. Remaining errors are of course my own, as are the views expressed within, which are not necessarily those of the Bank of England.

Issued by the Bank of England, Threadneedle Street, London, EC2R 8AH to which requests for individual copies should be addressed: envelopes should be marked for the attention of the Publications Group (Telephone 0171-601 4030).

Bank of England 1997
ISSN 1368-5562

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## Abstract

This paper discusses some of the operational issues relevant to the implementation of an inflation-targeting regime. In particular it focuses on: whether inflation targeting is 'new'; whether it is potentially destabilising, for example to output; and whether it requires too much knowledge on the part of the authorities. The paper argues that none of these propositions appears in general to be correct.

It goes on to discuss the use of inflation forecasts in general, and inflation probability distributions in particular, in the context of inflation targeting in the United Kingdom. It also discusses the important role greater transparency plays among inflation targeters and discusses some evidence on this. Finally, a preliminary evaluation of inflation targeters' performance to date is given.

# 1 Introduction

This paper is intended as a 'cookbook' of the hows, whys and wherefores of inflation targeting. Of itself, that does not make the paper novel. There are already surveys aplenty: on the genesis of inflation targets (Ammer and Freeman (1995), Haldane (1995a)); on comparisons between inflation targets and alternative monetary regimes (McCallum (1995a), Cukierman (1995)); on the analytics of inflation targeting (Svensson (1996), Cukierman (*op cit*); and on some of the specification issues raised by these regimes (Bank of Canada (1994), Goodhart and Vinals (1994), McCallum (*op cit*), Haldane and Salmon (1995), Yates (1995), Haldane (1997)). Meanwhile, two recent books describe the practical experience of countries operating under an inflation target (Leiderman and Svensson (1995), Haldane (1995b)); and Almeida and Goodhart (1996) provide a comprehensive recent evaluation of the performance to date of inflation-target countries.

Our aims here are more modest and parochial: to describe some of the modalities of inflation targeting as currently operated in the United Kingdom and, to a lesser extent, elsewhere. Duguay and Poloz (1994) conduct a similar exercise for Canada. In doing so, we side-step some of the theoretical - or 'time-consistency' - issues raised by the use of inflation targets and concentrate on the 'engineering' side of policy. Time-consistency issues are important but are amply dealt with elsewhere (*inter alia*, King (1996), Haldane (1995c), Svensson (1995b)). Looked at from an operational angle, the differences between - on the face of it - competing monetary strategies are probably more apparent than real. That said, there are some respects in which inflation targeting does help force some new engineering issues into the open - such as in the use of explicit, probabilistic forecasts in the setting of monetary policy. A number of these issues are explored here, with explicit reference to the United Kingdom.

The paper is set out as follows: sections 2-4 discuss whether inflation targeting is 'new'; whether it is potentially destabilising; and whether it requires too much knowledge on the part of the authorities. Sections 5 and 6 discuss the role of inflation projections in the formulation of UK monetary policy. Sections 7 and 8 discuss whether inflation targeting may be either 'black box' or may destabilise output. Section 9 evaluates the performance of inflation-target countries to date; and Section 10 briefly concludes.

## 2 What is new in inflation targeting?

Because inflation targets are a creation of the 1990s, many view them as a wholly new monetary policy strategy - and, as such, one with a low accrued stock of credibility. That impression was no doubt given weight by the circumstances in which most countries adopted inflation targets. Typically, this came either as a response to an unexpected unhinging of an earlier managed exchange rate regime - as in Finland (Brunila and Lahdenpera (1995), and Sweden (Andersson and Berg (1995), Svensson (1995a)); or as a result of the failure of monetary targeting owing to the vicissitudes of money velocity during the 1970s and 1980s - as, for example, in Canada (Freedman (1994)) and New Zealand (Fischer (1995), McCallum (1995b)); or, in the UK case, as a result of both (Bowen (1995), King (1994)).

But it would be incorrect to overplay the novelty of inflation targeting, for two quite separate reasons. First, history tells us that inflation targeting is not entirely new. The intellectual roots of price targets can be traced back to the last century - to Marshall (1887) and Wicksell (1898). Later, Fisher (1911) and Keynes (1923) both put forward monetary policy schemes which targeted explicitly an index number for prices. So, to take Keynes (1923, page 148):

> '....it would promote confidence and furnish an objective standard of value, if, an official index number having been compiled...to register the price of a standard composite commodity, the authorities were to adopt this composite commodity as their standard of value...prevent[ing] a movement of its price by more than a certain percentage in any direction away from the normal'

Such schemes were the forerunner of Sweden's experiment with an explicit price-level standard during the early part of the 1930s (Jonung (1979)). And such experiments were in turn the intellectual and practical forerunners of price targets today. Of course, one respect in which the debate 'then' and 'now' is different is that then a numerical target for the price level was being advocated, whereas now numerical targets are being set for the rate of change of price levels. There has been what Flemming (1976) calls a 'change of gear' in price expectations in the first and second halves of this century. This raises some interesting issues for the future: for example about the pros and cons of base-drift in the price level, mirroring the 1980s debate on this subject in the context of monetary targets. But these issues are not pursued further here (see Duguay (1994)), Haldane and Salmon (1995) for a discussion).

Second, from an analytical perspective, the differences between inflation targeting and, say, monetary targeting are probably more semantic than economic. After all, both regimes have the same ultimate aim: a specified growth path for nominal magnitudes. And given the transmission lags in monetary policy, both rely on a *forward-looking* inflationary assessment when monetary policy is being set. So the difference between them seems to hinge on the weights each assigns to different information variables when forming this forward-looking inflation assessment.

In *theory*, the differences are acute. Pure monetary targeting is a limiting case of inflation targeting, where the weight attached to monetary variables is unity and that attached to non-monetary variables is zero. Conversely, inflation targeting means using an eclectic mix of information variables, with non-zero weights assigned to both real and monetary magnitudes when forming an inflationary assessment. Pure monetary targeting would, by this taxonomy, simply be inflation targeting with indicator weight restrictions of (0, 1) imposed.

Yet, in *practice*, this distinction and these restrictions are largely hypothetical. Studies of the Bundesbank's reaction function (such as Clarida and Gertler(1995), Muscatelli and Tirelli (1996), Neumann (1995), Schachter and Stokman (1995)) confirm that real as well as monetary variables help to explain its actions over recent years. Indeed, strikingly, actual and expected inflation and output gaps are often found to play a prominent explanatory role with money having, at best, a bit part. There seems to be nothing 'pure' about monetary targeting in practice. Indeed, some have ventured to suggest that monetary targeting is inflation targeting in all but name (Clarida and Gertler (1995), Bernanke and Mihov (1996)). This makes perfect sense since both monetary and non-monetary variables have a role to play in accounting for inflationary dynamics over the policy effectiveness interval - the 18-month to 2-year period over which monetary policy has its maximum effect on inflation (see, eg, Cechetti (1995)).[1] A (0, 1) weighting scheme for indicators in the reaction function is simply not supported by the data.

To offer some illustrative *empirical* evidence on the contribution of real and monetary variables in explaining inflation dynamics, consider some block exogeneity tests and variance decompositions from a four-variable VAR for the United Kingdom comprising: *RPIX* (the price level); import prices

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(1) When discussing the indicators on which the monetary authorities should base their policy decisions, Keynes (1923, page 149) lists:

> 'Actual price movements must of course provide the most important datum; but the state of employment, the volume of production, the effective demand for credit as felt by banks, the rate of interest on investments of various types, the volume of new issues, the flow of cash into circulation, the statistics of foreign trade and the level of the exchanges must all be taken into account'.

(*IMP*); a monthly activity proxy - the unemployment rate (*UN*);[2] and a variety of variables proxying the 'monetary stance' - narrow money (*MO*, VAR 1 in Table A), broad money (*M3*, VAR 2) and nominal interest rates (*INT*, VAR 3). The sample period is January 1975 to December 1995 and the data are monthly.

**Table A**
**Variance decompositions of RPIX inflation**

| VAR 1 | Contributions of (per cent) | | | |
|---|---|---|---|---|
| **Horizon (months)** | ***RPIX*** | ***IMP*** | ***UN*** | ***M0*** |
| 12 | 84 | 10 | 2 | 3 |
| 24 | 61 | 20 | 4 | 16 |
| 36 | 31 | 12 | 26 | 31 |
| 48 | 16 | 6 | 47 | 31 |
| VAR 2 | Contributions of (per cent) | | | |
| **Horizon (months)** | ***RPIX*** | ***IMP*** | ***UN*** | ***M3*** |
| 12 | 76 | 6 | 2 | 16 |
| 24 | 56 | 8 | 15 | 21 |
| 36 | 34 | 6 | 43 | 17 |
| 48 | 23 | 5 | 59 | 13 |
| VAR 3 | Contributions of (per cent) | | | |
| **Horizon (months)** | ***RPIX*** | ***IMP*** | ***UN*** | ***INT*** |
| 12 | 84 | 7 | 15 | 3 |
| 24 | 58 | 12 | 22 | 8 |
| 36 | 35 | 10 | 49 | 6 |
| 48 | 23 | 7 | 62 | 7 |

Block exogeneity tests (not reported) indicated a strong role for both the real and monetary variables in accounting for inflationary dynamics, each being admissible at at least the 5% significance level, and often at much higher levels of significance. We can get some feel for the temporal dynamic effects of these variables upon RPIX by looking at variance decompositions. These are shown in Table A at four horizons - 12, 24, 36 and 48 months.[3] The general pattern is of inflationary inertia - lagged inflation - being the dominant inflationary influence over the first year or so. Import prices also have their strongest effect over the shorter run - somewhere between one and two years out. Activity variables kick in strongly over the medium term - between, say, two and four years out; while the monetary variables typically bring up the rear, though their effect can also be strong - dominant, in fact -

(2) Using industrial production - a noisier monthly activity series - gave less clear but similar results.

(3) The ordering is as in Table A: inflation; import prices; activity; and the monetary variables.

over longer horizons. These conclusions are broadly consistent with the findings of Lougani and Swagel (1995) in a VAR-based study of inflationary dynamics in the OECD. Although classical monetary forces assert themselves over the long run, both real and monetary factors remain central to explaining inflationary dynamics over medium-term horizons.[4] Taken together, this evidence suggests that non-monetary variables have a well-defined role to play in accounting for inflationary dynamics over the policy effectiveness interval. That would argue persuasively for their inclusion - implicitly or explicitly - in the reaction function of any central bank seeking price stability. Again, the restrictions implied by a (0, 1) indicator-weighting scheme are not justified by the data.

*Theoretical* support for choosing a mix of information variables is stronger still. It is well-known that the optimal feedback rule combines a diversified set of information variables (Friedman (1975)). Inflation targeting, by using such a diversified mix, can be seen as an attempt to mimic this optimal feedback rule.[5] This approach could in principle come across as confusing and random. It may appear, for example, that the monetary authorities are assigning indicators different weight at different times; that they are picking and choosing as they see fit. But according to control theory, such behaviour is simply the optimal response to the wide range of shocks affecting the medium-term inflation profile. The rule itself - if not the implications for policy - are invariant to the particular realisation of shocks. Far from being random, such a 'case-by-case' approach is entirely in keeping with what control theory would tell us was optimal.

By contrast, feeding back from a single indicator - be it money, the exchange rate or whatever - is to restrict arbitrarily and unnecessarily the arguments entering the feedback rule. Because that means discarding information useful for predicting future inflation, it can never be optimal in a control theory sense.[6] Of course, given the flexible way in which monetary targeting has operated in practice, this drawback of intermediate targeting need not be decisive. It is these considerations that ultimately lead King (1996) to propose a 'fundamental equivalence theorem' between all intermediate targeting strategies - both in theory and in practice. So while inflation targeting may sound new, in fact much of what it comprises should be familiar enough from history or from existing monetary regimes.

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(4) These responses are also consistent with the temporal patterns from the Bank's forecasting model.

(5) Svensson (1996) shows that forward-looking inflation targeting secures the minimum variance of inflation.

(6) See, again, Svensson (1996).

## 3 The forward-looking nature of inflation targeting

The most common early criticism of inflation targeting was that it was backward-looking; that, by feeding back from *actual* inflation, monetary policy was 'driving the economy by looking out of the rear-view mirror'. Described in this way, such a strategy does indeed sound like a recipe for disaster, failing as it does to take account of the transmission lag between the enactment of monetary policy and its ultimate impact on prices. In Keynes' (1923) words: '...if we wait until a price movement is actually afoot before applying remedial measures, we may be too late'. Certainly, if actual inflation is the long and variable tail on the end of the monetary policy dog, then a policy of chasing one's tail is, at best, thankless and, at worst, destabilising. And the monetary policy equivalent of chasing one's tail is to generate - possibly destabilising - inflationary cycles. An analytical example of such behaviour is given below.

In practice, this view of inflation targeting is misconceived. The monetary authorities in inflation-target countries feed back from *expected*, rather than actual, inflation. For example, in the United Kingdom the Bank of England publishes in its *Inflation Report* an inflation projection up to two years ahead - the period at which monetary policy has its maximum marginal impact. This projection, and in particular any deviation between this projection and the inflation target, then forms the basis of the Bank's monetary policy decisions.[7] A similar procedure is used at the Bank of Canada,[8] the Reserve Bank of New Zealand, and elsewhere. In effect, what occurs among inflation-targeting central banks is inflation *forecast* targeting, with the forecast taking the role of feedback variable.[9] In this way, the lags embedded in the monetary transmission process are explicitly recognised in the setting of today's monetary policy.

This type of policy-setting behaviour can be captured in the *forward-looking feedback* monetary policy rule:

$$i_t = \gamma\ (E_t\ \pi_{t+j} - \pi^*) \qquad \textbf{(1)}$$

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(7) And in the period prior to the Bank's operational independence formed the basis of the Bank's advice to the Chancellor.

(8) Where they solve the dual of this problem: for the path of monetary conditions (weighted interest and exchange rate movements) consistent with meeting inflation objectives (Longworth and Freedman (1994)).

(9) Again, see Svensson (1996).

where $i_t$ denotes the policy instrument, $\pi_t$ is inflation, $E_t$ is the expectations operator conditional on information at time $t$ and earlier, $\pi^*$ is the inflation target, $\gamma$ is a (positive) feedback parameter and $j$ is the targeting horizon, determined by, among other things, the length of the monetary transmission lag. As we discuss in Sections 4 and 5, $E_t\,\pi_{t+j}$ is best thought of as the entire probability distribution of future inflation outcomes, rather than as a single point expectation.[10]

Consider a simple two-equation model of the economy:

$$\pi_t = E_t\,\pi_{t+1} + \psi\, y_{t-1} + u_t \qquad \textbf{(2)}$$
$$y_t = -\beta(i_t - E_t\,\pi_{t+1}) \qquad \textbf{(3)}$$

where $y_t$ denotes real output, $i_t$ are nominal interest rates, $u_t$ is a white-noise inflation shock and $\psi$ and $\beta$ are positive coefficients. **(2)** is a standard expectational Phillips curve. **(3)** is a conventional aggregate demand relation. For simplicity and without loss of generality we: (a) specify **(2)** and **(3)** in terms of deviations from equilibrium - that is, we partial out the natural rate of output from the right-hand side of **(2)** and the left-hand side of **(3)**, and specify no 'core' rate of inflation in **(2)**;[11] (b) consider only one shock - coming from the supply side, $u_t$ - but equally could have added aggregate demand shocks to **(3)**; and (c) normalise $\psi$ to unity and omit any inflationary inertia in **(2)**. So this is a standard aggregate demand/aggregate supply model. Note that there are explicit lags in monetary transmission. Yesterday's output growth affects inflation today.[12] It is these transmission lags which justify an explicit role for forward-looking monetary policy.

To close the model we need a monetary policy rule. Consider first a rule which involves no feedback, but which holds the nominal interest rate constant at $i^*$. The solution for inflation is then:

$$\pi_t = E_t\,\pi_{t+1} - \beta i^* + \beta E_{t-1}\,\pi_t + u_t \qquad \textbf{(4)}$$

the (forward) root of which is unstable under rational expectations. The intuition here is classic Wicksell. Imagine that real interest rates are initially at their 'natural' rate. A positive inflation shock, $u_t$, occurs which raises

(10) In which case $E_t$ defines subjective rather than mathematical expectations, in the sense described below.

(11) Equation **(1)** is also written in the form of a deviation from equilibrium nominal interest rates.

(12) Equally, we could have embedded lags in the aggregate demand curve, **(3)**. See Svensson (1996) for such a model.

inflation and lowers the real rate of interest. The below-equilibrium real interest rate then stokes up further inflationary pressures, lowering the real rate of interest further. This process continues in a cumulative fashion. In the absence of a nominal interest rate adjustment, an explosive inflationary or deflationary spiral is set off - entirely in keeping with Wicksell's cumulative process.

Consider next the solution for inflation with the forward-looking feedback rule **(1)** in place:

$$\pi_t = E_t \pi_{t+1} + \beta\gamma\pi^* - \beta(\gamma - 1) E_{t-1} \pi_t + u_t \qquad \textbf{(5)}$$

Under rational expectations, the forward root is now stable for $\gamma > 1$.[13] Again the intuition is straightforward. To get inflation back to equilibrium following a positive shock, real interest rates need to be *raised* above their natural rate temporarily. That, in turn, means adjusting nominal interest rates by *more than* any inflation shock - hence $\gamma > 1$.

As a third case, consider now a 'chasing your tail' policy feeding back from *current* inflation:

$$i_t = \gamma (\pi_t - \pi^*) \qquad \textbf{(6)}$$

$$\pi_t = E_t \pi_{t+1} - \beta\gamma \pi_{t-1} + \beta E_{t-1} \pi_t + \beta\gamma\pi^* + u_t \qquad \textbf{(7)}$$

where **(7)** is the reduced form for inflation, given **(6)**. We can solve this second-order expectational difference equation formally using the method of undetermined coefficients.[14] Guessing a solution in the (minimum number of) predetermined state variables:

$$\pi_t = \varphi_0 + \varphi_1 \pi_{t-1} + \varphi_2 u_t \qquad \textbf{(8)}$$

Running the expectations operator through **(8)** gives us expressions for $E_t \pi_{t+1}$ and $E_{t-1} \pi_t$, thus:

$$E_t \pi_{t+1} = \varphi_0 + \varphi_1 \pi_t \qquad \textbf{(9)}$$

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(13) This can be shown formally using the method of undetermined coefficients, as illustrated below.

(14) Though the intuition underlying the result is straightforward given that **(7)** is a higher-order difference equation than **(5)**.

Using **(7)-(9)** and equating coefficients gives us the following undetermined coefficient constraints:

$$\varphi_0 = \beta\gamma\pi^* + \varphi_0\varphi_1 + \varphi_0 (1 + \beta) \quad \textbf{(10)}$$

$$\varphi_1 = \varphi_1^2 + \beta\varphi_0 - \beta\gamma \quad \textbf{(11)}$$

$$\varphi_2 = 1 + \varphi_1\varphi_2 \quad \textbf{(12)}$$

From **(8)**, the key stability constraint is **(11)** which has the solution:

$$\varphi_1 = \frac{1 \pm \sqrt{(1 + 4\beta\gamma(1+\beta)^{-2})}}{2(1+\beta)^{-1}} \quad \textbf{(13)}$$

As we would expect, this second-order system has two roots. Following McCallum (1983), we choose the root which rules out 'bubble' solutions; that is, the value of **(13)** that gives $\varphi_1 = 0$ whenever $\beta = 0$. This is the negative root. Evaluating **(13)** then tells us that $\varphi_1$ will be unambiguously negative. But $\varphi_1 < 0$ in **(8)** means that inflation will be oscillatory. A 'chasing your tail' feedback rule will itself generate inflationary cycles - and the larger the feedback, the larger these cycles. Indeed, at high values of $\gamma$, these oscillations could become explosive. Clark, Laxton and Rose (1995) conduct some empirical simulations of rules similar to **(1)** and **(6)**. They find that the myopic rule, **(6)**, results in greater cyclical output swings than the forward-looking rule, **(1)**, which mirrors our analytical finding here.[15]

These results tell us two things. First, about the dangers of following a purely backward-looking inflation rule. Following a backward-looking inflation rule risks introducing a further dynamic into the inflation process, rather than subtracting one from it. Monetary policy needs to be forward-looking if it is not to be destabilising, with the degree of forward-lookingness dictated by the transmission lag. Second, even a forward-looking inflation rule may require a prompt and proactive policy response to secure inflation stability.[16]

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(15) Few other empirical studies have tackled this forward-looking versus backward-looking policy rule issue, most tending to deal with myopic policy rules (*inter alia*, the contributions in Bryant, Hooper and Mann (1993), and Haldane and Salmon (1995)). As a result, such studies probably unfairly disadvantage inflation targeting in comparison with alternative policy rules in counterfactual simulations.

(16) Though, following Brainard (1967), adding uncertainty to the parameters of the model might lower the optimal speed of policy adjustment.

## 4 Information requirements of inflation targeting

Because inflation targeting involves feeding back from the expectation of future inflation, it clearly requires the central bank to form a view of the whole monetary transmission process. In equations **(2)** and **(3)**, monetary transmission is fully summarised in the aggregate demand ($\beta$) and aggregate supply ($\psi$) parameters, which therefore appear in the inflation reduced form. But in practice a macromodel will embody multiple parameters of interest. If these parameters were poorly understood and uncertain - which in practice, of course, they are - that could pose problems for a policy rule such as **(1)**.

But, in practice, any *feedback* rule requires the authorities to form a view about the monetary transmission process. Otherwise there is no way for the authorities to gauge how their actions will affect inflationary dynamics - the final objective - since these depend on all the parameters in the reduced form of the model. An understanding of the transmission process needs to underpin any monetary policy decision, irrespective of whether these actions are based upon tomorrow's, today's or yesterday's data. For example, consider a monetary feedback rule:

$$i_t = \theta\,(m_t - m^*) \qquad \textbf{(14)}$$

where we assume current-period money (growth) outturns, $m_t$, are observable, $m^*$ is the monetary target and $\theta$ is a positive coefficient. Consider also the money demand function:

$$m_t = \pi_t + y_t - \lambda i_t + \upsilon_t \qquad \textbf{(15)}$$

which is unit income elastic, homogenous in prices (here inflation) and is subject to money demand shocks, $\upsilon_t$. Using **(2)**, **(3)**, **(14)** and **(15)** gives us a solution for inflation:

$$\pi_t = E_t\,\pi_{t+1} + \delta\,E_{t-1}\,\pi_t - \delta\xi\,[\pi_{t-1} - m^* + \upsilon_{t-1}] + u_t \qquad \textbf{(16)}$$

where $\delta \equiv \beta/(1+\beta\xi)$ and $\xi \equiv (\theta^{-1} + \lambda)$. Comparing **(16)** with **(5)**, it is clear that the inflation-stabilisation problem - the choice of feedback parameter $\theta$ - is made no easier by adherence to the money feedback rule, **(14)**. Inflation dynamics still depend on the full reduced form of the model, inclusive of the policy rule. Indeed, the inflation-control problem for the central bank could be made more acute if velocity shocks, $\upsilon_t$, are significant, since these are no longer fully accommodated under money targeting. Monetary targeting also clearly places a strong reliance on knowledge of the interest elasticity of money demand. This is one of the less well-specified behavioural parameters in macroeconomics; and is apt to be affected by financial liberalisation. So the informational demands of a monetary feedback rule are never less than under inflation targeting. The policy-maker certainly cannot abdicate responsibility for understanding the monetary transmission mechanism by following such a rule.

As for the stability of a money feedback rule, we can solve **(16)** using the same method as earlier. This gives us a restriction on $\varphi_1$:

$$\varphi_1 = \frac{1 \pm \sqrt{(1 + 4\,\delta\xi\,(1 - \delta)^{-2})}}{2\,(1 - \delta)^{-1}} \qquad \textbf{(17)}$$

which is again likely to generate oscillatory cycles, for the same reasons as the current-inflation feedback rule.

Of course, if money outturns today were a *perfect* predictor of inflation tomorrow, then the situation would be different. But this is hardly a likely outcome (Table A). And even if it were, then the rule **(1)** would simply collapse into **(14)**, and monetary and inflation targeting would have an exact correspondence. **(1)** nests **(14)** as a special case. An inflation-forecasting feedback rule encompasses a money feedback rule. Svensson (1996) provides a formalisation of this point, illustrating that in general money-growth targeting will imply greater inflation variability than inflation targeting.

## 5 Forecasting inflation at the Bank of England

Inflation targeting requires the authorities to form a conditional inflation forecast before policy choices can be decided. That is immediately problematic given the difficulties involved in accurately forecasting the future path of almost any variable of macroeconomic interest. Friedman (1959) articulated very neatly this policy-setting dilemma in a world in which monetary transmission lags were long, variable and immutable:

> ‘[My] proposal to increase the money stock at a fixed rate month in and month out is certainly simple. Surely, you will say, it would be better to ‘lean against the wind’, rather than stand straight upright whichever way the wind is blowing. We seldom in fact know which way the economic wind is blowing until several months after the event, yet to be effective, we need to know which way the wind is going to be blowing when the measures we take now will be effective, itself a variable date that may be half a year or a year or two years from now.

Leaning today against next year's wind is hardly an easy task in the present state of meteorology' (Friedman, 1959, page 93).

This meteorological analogy is particularly apposite - for inflation forecasting and weather forecasting have much in common. Both amount to decision-making under uncertainty. Both are subject to periodic shocks - for every torrential downpour there is an equivalent terms-of-trade or indirect tax shock. But most importantly, both are essential to effective planning. News of an impending tornado would prompt actions today to batten down the hatches. Likewise, news of an impending inflationary hurricane ought to prompt monetary policy actions today to batten down demand and inflationary expectations. In both cases, decision-making is improved by releasing forecast information - however imperfect - and acting on it pre-emptively.

Neither science is perfect. Just as a weather forecaster cannot be certain that the temperature tomorrow will be exactly 18°, an economic forecaster cannot be certain that inflation next year will be exactly 3%. Those uncertainties call for a *probabilistic* assessment of the risks and margins of error around forecasts. This is the direction that inflation forecasting - and monetary policy-making more generally - has recently taken at the Bank of England. The intermediate variable of monetary policy can be thought of as the entire probability distribution of future inflation outcomes. As discussed in the next section, this allows explicitly probabilistic statements to be made about the future path of inflation, in an exactly analogous way to the presentation of the weather forecast.

The Bank produces two inflation projections, both of which until recently appeared in its quarterly *Inflation Report:* a short-run projection, covering the next three months; and a medium-term projection covering the period up to two years ahead.[17] The short-term projection provides a benchmark against which the Bank can assess the inflationary 'news' over the quarter. The short-run projection is constructed using Kalman filter techniques. It is influenced by a combination of inflationary inertia, seasonality and a set of 'off-model' information, such as known forthcoming changes to excise duties or other taxes and prices.

The medium-term projection is based on a small, structural macro model, which is similar in many respects to a flex-price IS-LM model. The model contains around 18 behavioural equations and is described in greater detail in Dhar, Fisher, Holland and Pain (1995). Stripped down to its bare bones, the

(17) The February 1996 *Report* for the first time did not publish a short-term inflation projection, with attention focusing on the Bank's medium-term projection.

reduced form for inflation (aggregate supply) and aggregate demand implied by the model is:

$$\pi_t = \alpha(L)\ \pi_t + \beta(L)\ \Delta w_t + \chi\ (y - y^*)_{t-1} + \delta(L)\ x_t + \varphi\ E_t\ (\pi_{t+j}) + \varepsilon_t^{\ 1} \quad \textbf{(18)}$$

$$y_t = y^* + \gamma\ (i_t - \pi_t) + \eta(L)\ f_t + \phi(L)\ y_t^{\ o} + \mu(L)\ q_t + \xi(L)\ we_t + \varepsilon_t^{\ 2} \quad \textbf{(19)}$$

where $w_t$ are wages; $y^*$ is potential output; $x_t$ is a vector of exogenous variables (eg, import price inflation); $i_t$ are nominal interest rates; $f_t$ defines fiscal policy; $y_t^{\ o}$ is overseas output; $we_t$ is wealth; and $q_t$ is the real exchange rate. So the reduced form of inflation, **(18)**, is essentially an expectational Phillips curve.(18) This is vertical in the long run. But it is responsive to cost pressures over the short run (through $\alpha$, $\beta$ and $\delta$), whether external (through import price inflation) or internal (through wages); and to demand pressures - the 'output gap' - wealth and hence monetary policy (via $\chi$, $\gamma$ and $\xi$) over the medium term. This temporal sequencing within the inflation process is similar to that found from the unrestricted VARs earlier on.

The price expectations term in **(18)** encompasses a range of 'off-model' information. These are variables which are not easily incorporated into a structural model such as **(18)-(19)**, but which nonetheless offer useful information on future prices - whether the central expectation of future inflation or the probability distribution around it. Surveys of various sorts - of inflation expectations, of industrialists' expectations and intentions and of views expressed to the Bank's Agents around the United Kingdom - are one such piece of information. The money and credit aggregates are another. The links from money and credit to activity and inflation in the forecasting model are often indirect, for example working through wealth. Treating them as an 'off-model' - expectational - influence on the forecast helps to give them a more direct role.

Inflation expectations inferred from the yield curve are another 'off-model' indicator. Monetary policy does not feed back in any mechanical way from market inflation expectations. Such an approach may leave the inflation rate undetermined (see Woodford (1994) for a formalisation of this point). It would also fall foul of what Samuelson recently called the 'monkey in the mirror' syndrome: central banks (the monkeys) believing that signals from the yield curve (their own reflection) are providing them with new information. But inflation expectations can provide a useful metric of, among other things, monetary policy credibility - of the extent to which agents

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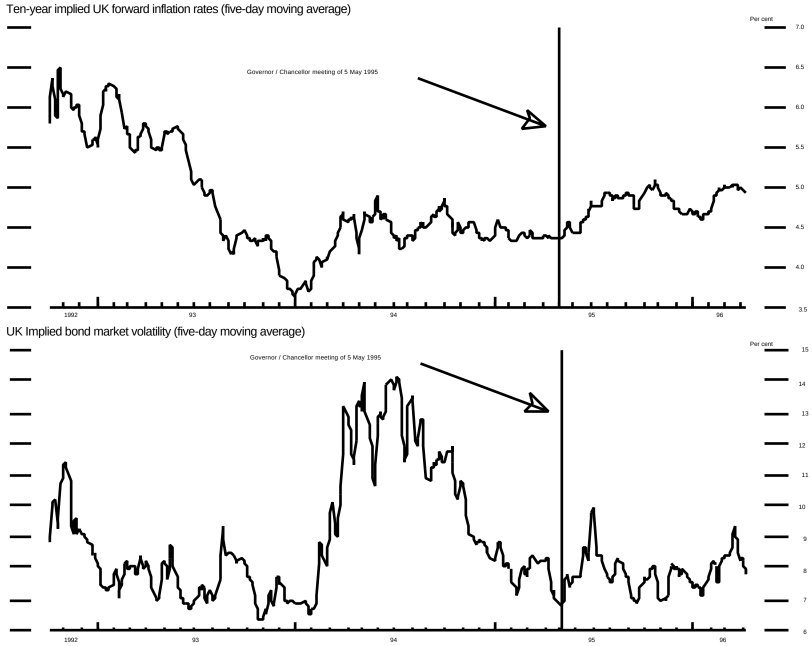
(18) Longworth and Freedman (1995) report a similar inflation reduced-form from the Bank of Canada's forecasting model.

believe that stated inflation objectives will be realised, or of the risks which agents attach to these objectives not being met.

For example, in May 1995 the Governor of the Bank of England and the Chancellor of the Exchequer disagreed on monetary policy. The latter's view - not to raise interest rates - prevailed.[19] It was interesting to observe the response of measured longer-run inflation expectations immediately following this event.[20] They rose steadily for several months afterwards - perhaps an indication of policy credibility having been dented (see Chart 1). That sort of information is worth knowing even if, ultimately, it is not the sort of 'news' you would want actively to respond to with monetary policy.

Chart 1
Ten-year implied UK forward inflation rates (five-day moving average)

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(19) This was in the period prior to the Bank's operational independence.
(20) Inflation expectations are proxied here by the ten-year forward inflation rate, derived from the difference between the nominal and index-linked yields curves in the United Kingdom. See Deacon and Derry (1994).

The general point here is that the Bank's published inflation projection is not a mechanical extrapolation from a single macro model. Rather, it draws upon a much wider and richer set of information variables - quantitative and qualitative, real and monetary. Indeed, increasingly the Bank's published projection is also drawing on a wider set of models, as well as information variables. For example, four of the largest inflation shocks which the United Kingdom has encountered since it began targeting inflation are: the rise in input prices in the second half of 1994 and the beginning of 1995; sterling's depreciation in the first half of 1995; the rise in broad monetary growth from 1995 onwards; and the appreciation of sterling during 1996/97. In each case, detailed sectoral models complemented the information from the Bank's medium-term forecasting model. So in the case of the input price rise, the Bank drew upon VAR models to assess the historical supply chain linkages between input prices, output prices and, ultimately, retail prices. Likewise, for the exchange rate shocks in 1995 and in 1996/97, the Bank drew upon a small analytical - calibrated Dornbusch - model to pin down the potential causes of the exchange rate movement and to back out their inflationary implications; it also used structural VAR models (Astley and Garrett (1996)). For the recent money supply shock, the Bank has drawn upon separately estimated sectoral money demand functions to gauge the source and size of potential inflationary risks (see Thomas (1996)).

This eclectic approach to the use of models mirrors the approach when using indicators (Whitley (1997)). Using a 'portfolio' of models offers insurance against model uncertainties. Diversification applies as much to policy-makers when choosing among uncertain indicators and macro models as it does to investors when choosing among uncertain securities and asset-pricing models.

Finally, to turn **(18)-(19)** into an inflation projection we need to make some assumptions about the paths of the exogenous variables. These are threefold:

(a) *fiscal policy*: the projection assumes the same nominal control total for spending as assumed in the Government's annual Financial Statement and Budget Report. The implied real spending profiles are not necessarily the same, as the Bank uses its own forecast of the GDP deflator;

(b) *overseas output and interest rates*: outcomes for the major six economies are fixed using VAR models, external forecast information (eg, OECD, IMF) *etc;* and

(c) *monetary policy*: the forecast assumes unchanged nominal interest rates over the forecast horizon.

The last assumption is by far the most contentious. The thinking behind it is as much expositional as analytical. Analytically, for example, there is the familiar Sargent and Wallace (1975) problem that constant nominal interest rates may well leave the long-run price level indeterminate - a point also illustrated in the model of equations **(1)-(4)**.[21] The assumption also of course means that there is a potential bias in the published projections: because forward-looking agents may make pricing decisions today using quite different expected interest rate assumptions to the ones used in the Bank's forecast; because existing market interest rates, on which agents are basing borrowing and lending decisions, are also different to these assumptions; and because, in practice, interest rates *are* likely to change over the two-year forecast horizon, thereby explicitly invalidating the forecast's assumptions.

Against this, the constant interest rate assumption is useful in helping the Bank decide on the appropriate *direction* for future interest rate moves; it provides a clear-cut benchmark against which to evaluate the current policy stance.[22] It is also easier presentationally, and more transparent, to publish a forecast under this assumption than to run an explicit reaction function - which is subjective and unlikely to be widely agreed upon; or to draw an 'ideal' (inflation-target consistent) interest rate profile - which is unlikely to be unique or riskless. In fact, when the Bank conducts policy simulations it will typically use a reaction function to set the monetary policy profile.

Armed with these assumptions for the exogenous variables, and the off-model information discussed above, a projection for inflation can then be derived from **(18)-(19)**.

## 6 Inflation forecasting and probability distributions

So how have the Bank of England's forecasts performed? Charts 2, 3 and 4 - taken from the Bank's February 1996 *Inflation Report* - compare the Bank's central inflation projection with actual RPIX inflation outturns during 1993, 1994 and 1995. During 1993 and most of 1994, the Bank's central forecasts were clearly too pessimistic about the path of future inflation. The forecasts made in November 1994 and February 1995 were, by contrast, too optimistic. Forecasts made from May to November 1995 were broadly on track. Quantifying these forecasting errors to date suggests a mean (absolute) error

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(21) This means there is a slight disjunction between the policy rule in (**1** ) and the precise way in which such a rule is made operational in practice. But both represent attempts to mimic the fully optimal rule by reacting to all current-dated variables in the model.

(22) In running their pre-FOMC forecasts, the Federal Reserve Board likewise usually assume a flat profile for short-term interest rates, for much the same reasons given here (see Reifshneider, Stockton and Wilcox (1996)).

in the region of 1% one year ahead. This is not a small number. It suggests that there are significant uncertainties in the forecasting process. But it also almost certainly overstates the problems that these uncertainties create, for several reasons.

First, a mean error of 1% one year ahead is far from unusual. Granger (1995) reports mean absolute errors of around 1.4% for one-year-ahead inflation forecasts by the NIESR in the United Kingdom over the eleven-year period 1981-92, and of 1.6% in the United States, based on a survey of individual forecasters over the previous 22 years. By comparison, the Bank's performance is not bad. Indeed, there is perhaps evidence of a fall in uncertainty at lower rates of inflation - hence the smaller forecasting errors during 1995. The Bank of Canada have, for example, recently found some evidence for this (see Freedman and Longworth (1995)).

Second, as Chart 5 shows, while the Bank has exhibited a consistent tendency to overpredict inflation, at least in the early years, this tendency was also shared by all other forecasters. This is often the case with macro model-based forecasts which, because they are extrapolations of the past, tend to overpredict a variable when it is falling, and underpredict during an upturn. Indeed, on the evidence of Chart 5, the Bank's forecasts have on occasions clearly 'outperformed the market', lying consistently below the median market forecast and sometimes lying on the right side of the interquartile range. Moreover, in conducting these forecast comparisons the dice is typically loaded against the Bank's projections because of the constant interest rate assumption.[23] Outside forecasters, by contrast, are free to put in a more plausible interest rate profile. If their interest rate projections for the next two years outperform a constant interest rate assumption - if interest rates are anything other than a random walk - so too, on average, will their forecasts (*ceteris paribus*).

Last, and most important, the Bank's approach has been increasingly to move away from thinking about the inflation projection as a single expectation. The one certain thing that can be said about forecasts is that they will be wrong. Often this is the result of shocks to variables or relations which are impossible to predict *ex ante*. Given these uncertainties, the feedback variable for monetary policy is really better thought of as the entire *probability distribution* of future inflation outcomes, including possible risks and asymmetries within this distribution.

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(23) And because some outside forecasters tend to revise their forecasts almost continuously.

**Chart 2**
**inflation projections made in 1993 and subsequent outturns**

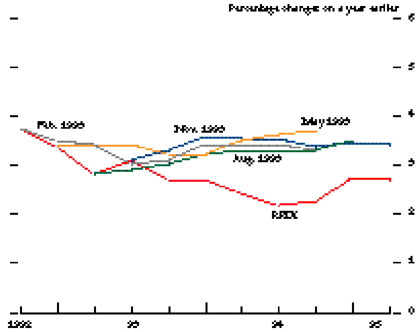



**Chart 4**
**RPIX inflation projections made in 1995 and subsequent outturns**

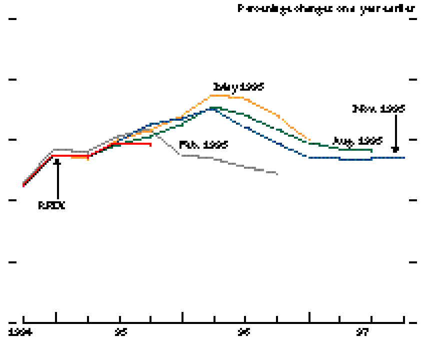



**Chart 3**
**RPIX inflation projections made in 1994 and subsequent outturns**

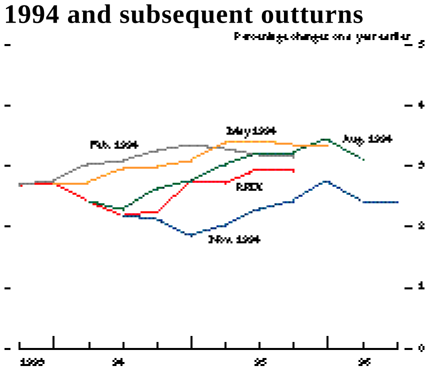
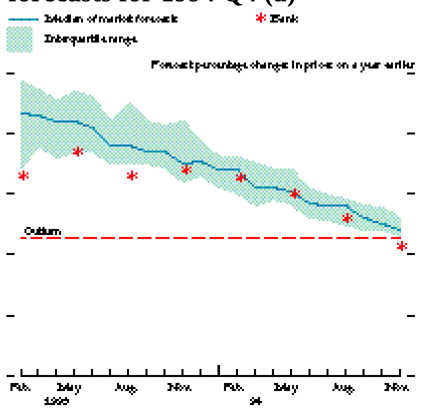
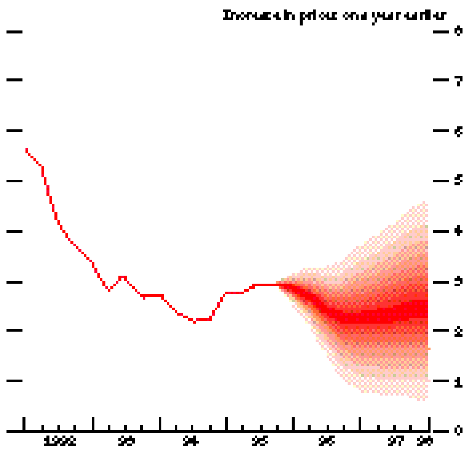



**Chart 5**
**Distribution of RPIX inflatio forecasts for 1994 Q4 (a)**




Saying all of this is, of course, one thing; making it work in practice quite another. In the early days of the *Inflation Report*, risks and potential asymmetries in the forecast distribution were captured qualitatively in the text. Recently, however, the Bank has gone further towards making explicit its quantitative view of the subjective probability distribution for future inflation outcomes. Since the February 1996 *Inflation Report*, the Bank has published a probability distribution for inflation up to two years ahead. An example is shown in Chart 6. To understand this picture, imagine a probability density function from which 10% slices have progressively been cut away from the top downwards. Imagine then the density function reassembled and looked at from above. The deepest-shaded central band is designed to encompass inflation outturns with a 10% probability. It is the top slice. The progressively lighter-shaded areas, on both sides of the distribution, then represent 10% probability contours fanning out around the central projection - the lower slices. The whole of the shaded area aims to capture 90% of the subjective probability distribution of future inflation outturns.

**Chart 6**
**RPIX inflation projection**




Herein lies the correspondence with weather forecasting. The chart allows probabilistic statements to be made about inflation outcomes: 'there is an *x*% probability of inflation lying within a range of *y*% to *z*%' or 'there is an *x*% chance of the inflation target being breached'. The latter statement is a direct analogue of the meteorological statement: 'there is a *y*% chance of rain tomorrow'. Such probabilistic statements have motivated the Bank's policy advice in the recent past.[24] For example, the published minutes of the September and October 1996 monthly meetings between the Chancellor and the Governor both recorded the Bank offering advice with a view to securing a 'better-than-evens' chance of hitting the inflation target two years hence. That is the sort of statement which is possible only with some estimate of the probability distribution of future inflation in mind.

(24) In the period prior to operational independence.

The mechanics of the probability distribution can be briefly sketched.[25] It is built up from the probability distributions of each of the variables - exogenous and endogenous - which feed into the inflation reduced form, **(18)**. The shape of these distributions is characterised by setting values for their (error) variance and skewness - the second and third moments. So for each variable the 'neutral' assumptions are: that the uncertainty surrounding a variable is given by the historical error variance on the model equation; and that the balance of risks around a variable is symmetric. If these neutral assumptions held for each model variable, the result would be a symmetric probability distribution for future inflation, with error bands given by the historical forecast errors.

Often, however, there may be evidence of a deviation from these neutral assumptions for one or more of the variables affecting the inflation projection. For example, a model equation may be running off track, suggesting a possible regime shift in behaviour; or there may be indirect 'off-model' information of inflationary risks in the pipeline, for example from surveys, from financial market expectations or from money outcomes; or there may be one-sided risks to an exogenous variable assumption. Concentrating just on the central inflation outcome would mean discarding this information.

These risks to the model variables are identified up-front, and then discussed and quantified in a series of meetings between the Bank's Monetary Policy Committee (MPC) and various economists at the Bank. So all levels of the Bank provide input into the forecasting process. In most cases, what is agreed at these meetings is a ranking of the risks to each of the model variables, in terms of their severity and the extent of their asymmetry. So, for example, if the risks to a variable were felt to be highly asymmetric it might receive a 90/10 or 10/90 weighting, depending upon in which direction the risks were felt to lie. Likewise, the historical error variance can be re-weighted up or down, depending on whether the uncertainty surrounding a variable, or its structural relationship, was felt to be more or less acute than in the past. The end-product is an agreed-upon skewness and variance adjustment for each variable entering the inflation reduced form. This allows the Bank to characterise the shape of the probability distribution of each (exogenous and endogenous) variable. Using the weights of each of these variables in the model, these risks can then be translated into a probability distribution for inflation itself. The distribution underlying Chart 6 is a modified normal - modified to take account of the variance and skewness of

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(25) Britton and Whitley (1996) provide a detailed and comprehensive analytical discussion of the derivation of the Bank's probability distributions.

its underlying determinants. But other distributional assumptions would probably give similar results.(26)

The probability distribution adds value in three respects. First, it helps to emphasise the inherently probabilistic nature of forecasting and hence policy-making; and, in so doing, it helps de-emphasise single-point expectations of inflation as a measure of monetary stance. Second, it allows priors and non-model information to have a bearing upon the policy-making process. The emphasis here is upon 'telling stories' through the probability distribution - corroborated through various pieces of evidence, on and off-model - rather than on a mechanical extrapolation of moments. And third, it accommodates, and attempts to quantify, possible asymmetries in the balance of inflation risks, the type of which before February 1996 were referred to only qualitatively in the text of the *Inflation Report*.

Chart 6 helps to illustrate these last two points. Although the asymmetries were not large in February 1996, the inflation distribution is skewed downwards slightly over the first year; and is skewed slightly upwards over the second year. These asymmetries in turn correspond to two 'stories' which came to prominence last year: the downside risk to output posed by the possibility of a rundown in stocks; and the upside risk to nominal demand in 1997 posed by strong broad money growth. These asymmetries in the distribution of risks are difficult to capture from conventional model-based projections, whose risks are symmetric. A published probability distribution - albeit a partially subjective probability distribution - helps to make systematic and publicise the Bank's view of these inflation risks and asymmetries at different time horizons.

(26) The published distribution is more sophisticated than is presented here. For example, the endogenous and exogenous variables are partitioned into aggregate demand and aggregate supply blocks, to help in identifying and understanding their downstream effects on inflation. Also, the distribution accommodates covariances among the risks, since many of the risks identified will not in practice be independent.

## 7 Inflation targeting and transparency

While straightforward in principle, the feedback rule under an inflation target is in practice likely to be quite complex. The feedback variable is the full probability distribution of inflation outcomes, into which will feed a myriad of information variables. This complexity confers both costs and benefits. The benefits derive from the use of a wide range of information variables, as under the optimal feedback rule; it is 'engineering-efficient', in a Friedman (1975) sense. The costs are the loss of simplicity and thus transparency about what monetary policy is doing and why. This cost could be important if agents believe that complexity is being used as a smokescreen for underhandedness - as a front for periodic inflation surprises. An inflation bias might then arise (see Cukierman and Meltzer (1986), Briault, Haldane and King (1996) and Nolan and Schaling (1996)).

Recognising this, many inflation-targeting countries have made conscious efforts to improve the transparency of monetary policy; to spell out their reaction functions in clearer and simpler terms than in the past. There have been several ways of achieving this. Perhaps the most important has been the announcement of formal and quantified targets for inflation itself. Following its introduction in October 1992, the UK's inflation target has been formally reaffirmed twice: in the then Chancellor's Mansion House speech in June 1995; and in the current Chancellor's Mansion House speech in June 1997.

Inflation or monetary policy reports have been another important vehicle for greater transparency among inflation-targeters. These are now published by Canada, New Zealand, Sweden, Spain and the United Kingdom.[27] In addition, in the United Kingdom the minutes of the monthly monetary policy meetings have been published since April 1994, with a lag of around six weeks. Prior to operational independence, these took the form of minutes of the meetings between the Chancellor and the Governor. Since operational independence in May 1997, the Bank has begun publishing the minutes of the meetings of its Monetary Policy Committee (MPC), with the voting patterns of members of the committee identified. This is intended to enhance further the transparency of the policy-making process.

Further examples of greater transparency would include the increased use of press notices to explain monetary policy decisions; regular appearances before Parliamentary committees; and more frequent speeches by members of the monetary policy-making council. For example, press notices have

(27) Norway also publish an inflation report, even though they do not have a formal inflation target. Even countries which have not introduced a formal inflation report have begun to produce more detailed synopses of inflation in their regular bulletin publications - such as in Australia.

accompanied monetary policy changes in the United Kingdom since the introduction of the inflation target. And the Bank of England is required routinely to make reports and give evidence to the House of Commons, through the Treasury Select Committee (TSC). The Bank is also required, under the terms set out in the Chancellor's Mansion House speech in June 1997, to write an open letter to the Chancellor in the event of inflation deviating by more than 1 percentage point either side of the 2.5% point target (see Rodgers (1997)). Those developments add to the transparency and accountability of the United Kingdom's inflation-targeting framework.

A further example of greater transparency is the publication of forecasts for inflation (and for other variables) - as in New Zealand and the United Kingdom. These serve as a summary statistic of the myriad information variables upon which policy is set, thus simplifying monitoring by outside agents (see Svensson (1996) for a discussion of this). In the UK case, information on higher moments of expected future inflation is also revealed, through the published probability distribution for future inflation. New Zealand provides perhaps the best example of transparency taken to its limit. There, not only are inflation forecasts published, but forecasts for other variables too (see Mayes and Chapple (1995)). The result is that market interest and exchange rate movements often pre-empt the actions of the central bank, adjusting to a level where monetary conditions are consistent with inflation objectives. The central bank then need do no more than validate this adjustment in monetary conditions - the monetary policy equivalent of autopilot.

Having outlined some of the steps taken in inflation-target countries to improve transparency, how might we quantify the benefits that arise as a result of them.(28) In the long run, if inflationary surprises are mitigated, then the effect of greater transparency should be evident in observed inflation. But it is early days to make such an assessment about inflation-target countries. As an indirect measure, Dotsey (1987) suggests two testable implications of greater central bank transparency: it should increase the unconditional variance of asset prices - for example, short-term interest rates - because it means that more 'news' is being revealed; but it should reduce the conditional variance of asset prices - for example, through smaller and less frequent interest rate forecasting errors - because agents are working from a superior information set. Capturing these effects in the time series is difficult as it requires us to control for the whole sequence of shocks hitting the economy. But it is possible to get a feel for these effects by looking at some event studies. The United Kingdom is used as a case study.

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(28) Goodfriend (1986) offers an excellent survey of the case for central bank secrecy.

The 'events' which are focused on are the publication of the Bank of England's *Inflation Report* and of the monthly Governor/Chancellor minutes - probably two of the largest transparency innovations since the United Kingdom's new monetary framework was put in place. The asset price monitored is the next-maturing short sterling futures contract. This contract gives the market's point expectation of three-month interest rates in the United Kingdom in March, June, September and December of each year. As 'news' about the authorities' reaction function is released, we would expect these interest rate expectations to adjust.

Chart 7 shows the *intra-day* response of implied sterling futures interest rates on six days - three corresponding to the release of the Bank's *Inflation Report*, and three corresponding to days on which Chancellor/Governor minutes were published. The time of publication is also shown. It is fairly clear that the 'news' from these publications does indeed have an effect upon interest rate expectations, as we might expect.[29] In some cases - for example, the May 1995 *Inflation Report*, and the November 1994 and January 1995 Governor/Chancellor minutes - the effects are sizable. This suggests, tentatively, that greater transparency may have raised *unconditional* asset price variability on the day of news releases. These effects are usually small, however - for example, the February 1996 *Inflation Report*. And it is not altogether clear that *total* unconditional variability has been raised by transparency, aggregating across news and non-news release days.

To capture the *conditional* variance of asset prices, we looked at the forecasting error - or 'surprise' - in short-term interest rate expectations. The events we consider now are official interest rate changes in the period before and after the introduction of the United Kingdom's inflation target regime. So we measure the interest rate 'surprise' for each official interest rate change, indexed $k$, as:

$$\text{'surprise'}_k = \mid i_{k,t} - E_{k,t\text{-}1}(i_{k,t}) \mid \qquad \textbf{(20)}$$

where the expectation of an official rate change is given by the previous day's implied interest rate on the futures contract which is next to expire.[30] We compare average interest rate surprises over two windows: March 1984-

(29) Haldane (1997) looks at the same evidence, for both short and long-term interest rate expectations, averaged over a greater number of events, and finds the same patterns.

(30) Clearly this is only a proxy. For example, the next expiring futures contract can cover interest rate expectations up to three months ahead. But as the mean time to expiry of the next contract is 1 1/2 months, whereas the maximum frequency of routine interest rate changes is one month, this is unlikely to be a big problem for our exercise.

May 1992 (covering 58 official rate changes);  and October 1992- March 1996 (covering eleven rate changes).[31] The latter period covers the inflation target regime.

Over the earlier sample, the average interest rate surprise was 55 basis points; whereas over the latter sample the mean is around 18 basis points.  To control for the different average size of official rate changes over the two samples, we can look at the mean of the ratio of interest rate surprises to official interest rate changes over the two periods.  This gives numbers of over 100% for the first sample, and of 34% for the second.  The implication, then, from both pieces of evidence is that interest rate forecasting errors are around three times as large in the earlier period.[32] This is a striking difference.  At least some of this can probably be put down to heightened transparency about the UK authorities' monetary policy reaction function, including the publication of the Bank's *Inflation Report*;  the scheduling of regular monthly monetary policy meetings;  and the inflation target itself.[33]

How might we weight these competing - conditional versus unconditional - effects?  First, as a *practical* matter, it seems that the unconditional variability effect is in many cases minor in comparison with the conditional variability effect.  Second, as a *theoretical* matter, it is clearly *conditional* moments which affect real decisions - for example, through risk premia. Unconditional variability is merely reflecting the revelation of previously asymmetric information between private sector agents and the monetary authorities.  Heightened unconditional variability

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(31) We omit from both samples the three interest rate changes - on 16, 17, 22 September - around the time of sterling's exit from the ERM.

(32) The 100% forecasting error in the earlier period seems large and so is its variance.  It is affected by several large surprises during periods when interest rates were being changed very frequently - for example, at the beginning of 1985.  But stripping these out - which it is by no means clear is optimal - would still give the same qualitative differences.  The large variance also means that we are unable to reject the hypothesis that the mean surprises are not statistically significantly different.

(33) Haldane and Read (1997) find a significant stabilising effect of the inflation-targeting regime on the whole of the interest rate term structure in the United Kingdom.

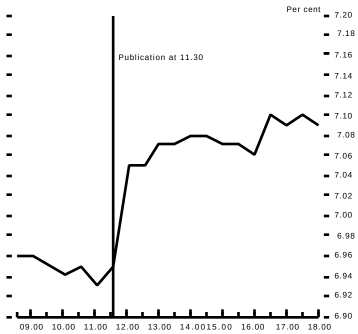
Chart 7

Implied intra-day sterling interest rates

Inflation Report: selected publication dates

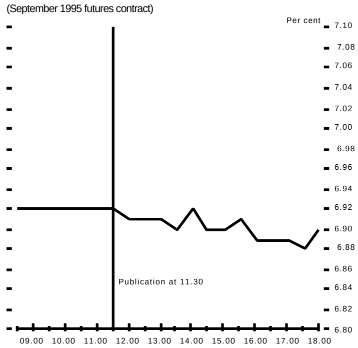
11 May 1995

(June 1995 futures contract)



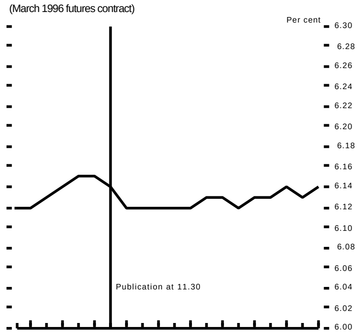

2 August 1995

(September 1995 futures contract)




14 February 1996

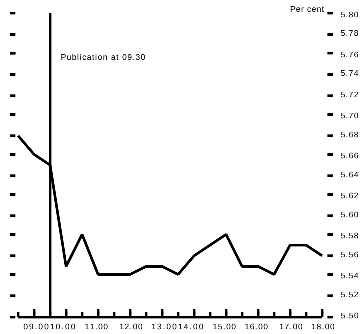
(March 1996 futures contract)




Governor / Chancellor minutes: selected publication dates

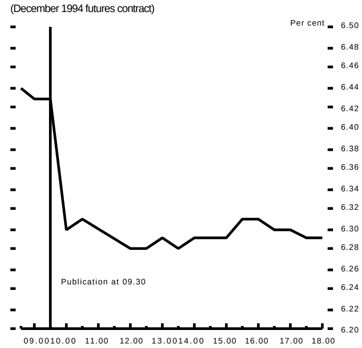
15 June 1994

(September 1994 futures contract)



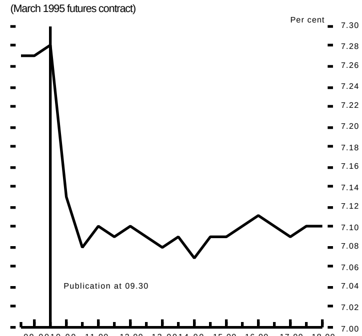

16 November 1994

(December 1994 futures contract)




11 January 1995

(March 1995 futures contract)



ought then to reduce conditional volatility over the long run, with beneficial effects for information assimilation by agents and hence risk premia. By this measure, greater transparency has clearly had a net beneficial impact in the United Kingdom, and probably elsewhere too.

## 8 Does inflation targeting destabilise output?

One of the original arguments for monetary targets, dating back at least to Friedman (1959), was that they embodied an automatic cyclical stabiliser. So, for example, a *supply* shock which shifted prices and quantities in opposite directions would prompt an *accommodating* response from interest rates, which would remain (broadly) unchanged for fixed money supply. This is the correct response in the face of a shift in the equilibrium price level. Conversely, a *demand* shock would induce an interest rate response - for example, raising interest rates following a positive money demand shock for fixed money supply - thereby heading off any effect on prices. So money targeting has a built-in cyclical stabiliser - in the absence of velocity shocks - ensuring the right policy response following both demand and supply shocks. The same automatic stabilisers in fact also operate with nominal GDP targets (Bean (1983), Hall and Mankiw (1994)).[34]

Inflation targets appear, on the face of it, to fare badly on these criteria. They induce the correct policy response to demand shocks - a *non-accommodating* one. But, narrowly interpreted and applied, they also imply non-accommodation of supply shocks - a suboptimal response. In effect, inflation-targeting in principle risks responding to one-time shifts in the price level, in addition to trend inflationary disturbances.

In practice, this drawback has been overcome in two ways. First, through the use of exemptions or caveats for certain supply shocks: whether explicitly - as, for example, under New Zealand's Policy Targets Agreement where a wide range of supply shocks are specified up front and then exempted if they are 'significant'; or implicitly - as in most other inflation-target countries.[35] For example, in the United Kingdom the clearest example of supply shock accommodation followed the rises in indirect taxes in 1993 and 1994. These temporarily boosted measured inflation. At this time the UK authorities based monetary policy around an underlying inflation measure, which excluded

(34) More so, in fact, since money GDP targets are not susceptible to destabilising velocity shocks.
(35) For example, the United Kingdom and Spain explicitly exclude only mortgage interest payments from their headline measures; Canada exclude indirect taxes and food and energy prices for operational purposes; Australia exclude mortgage interest payments, government-controlled prices and energy prices; Finland exclude housing capital costs, indirect taxes and government subsidies; while Sweden has no formal exemptions.

first-round indirect tax effects. In this way, the first-round effects of the supply shock were effectively accommodated. A similar policy response was recently evident in other inflation-targeting countries subject to indirect tax rises, such as Spain and Sweden. With supply shocks accommodated in this way, we would expect inflation targets to behave much like money GDP or monetary targets as a cyclical stabiliser.

Second, the forward-looking nature of the reaction function under inflation targeting helps prevent a policy response in the face of supply shocks. Price-level shocks should, in most circumstances, have only a temporary effect on measured inflation which washes out two or more years ahead - the horizon of the (forecast) feedback variable.(36) So following the forward-looking feedback rule, **(1)**, ought to result in supply-shock accommodation and hence no unnecessary destabilisation of output.

Indeed, one can go further and argue that forward-looking inflation targeting generates explicit output stabilisation. This is true in two regards. First, the output gap is a key component of the inflation forecasting model, **(18)-(19)**. So substituting for the expectation in **(1)** using **(18)-(19)** would give a feedback rule conditioned on the currently observed output gap, as well as other predetermined variables. Such a reaction function in fact looks quite a lot like a Taylor rule, though it need not have equal or even similar weights on the inflation and output gap terms (see Svensson (1996)). Because of this, an inflation-targeting reaction function can be seen to imply explicit countercyclical stabilisation. Clark, Laxton and Rose (1995) illustrate this in a simulation setting.(37)

Second, the extent to which policy is forward-looking can be thought to dictate the relative weight placed on output versus inflation stabilisation.(38) So the longer the lead, $j$, in the policy rule **(1),** the greater the implicit weight being assigned to output versus inflation stability. For example, at one extreme monetary policy could aim to correct any deviation of expected inflation from target as quickly as was technically feasible. But that would risk a serious destabilisation of output. Lengthening the targeting horizon - smoothing out the transition path for inflation back to target - makes for a smoother output trajectory too. By judicious choice of $j$, the authorities can secure the desired degree of output smoothing.

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(36) Some supply shocks may be persistent. This persistence would then need to be taken into account by the authorities when choosing the horizon for expected inflation from which to feed back.

(37) Indeed, as Clark, Laxton and Rose (1995) illustrate, with a convex Phillips curve, minimising the variance of output increases the average *level* of output too.

(38) Svensson (1996) provides a formalisation of this point.

Under the current UK policy framework, the Bank is required to declare, in an open letter to the Chancellor, the horizon over which it expects inflation to return to target, should it deviate by more than 1 percentage point either side. The choice of an appropriate horizon will depend, among other things, on the size of the initial inflation deviation from target and the source of the shock causing it (demand versus supply). Such an institutional arrangement automatically builds into the framework some degree of output stabilisation, allowing flexibility in the transition path of inflation back to target following shocks.

## 9 Assessing the effects of inflation targeting

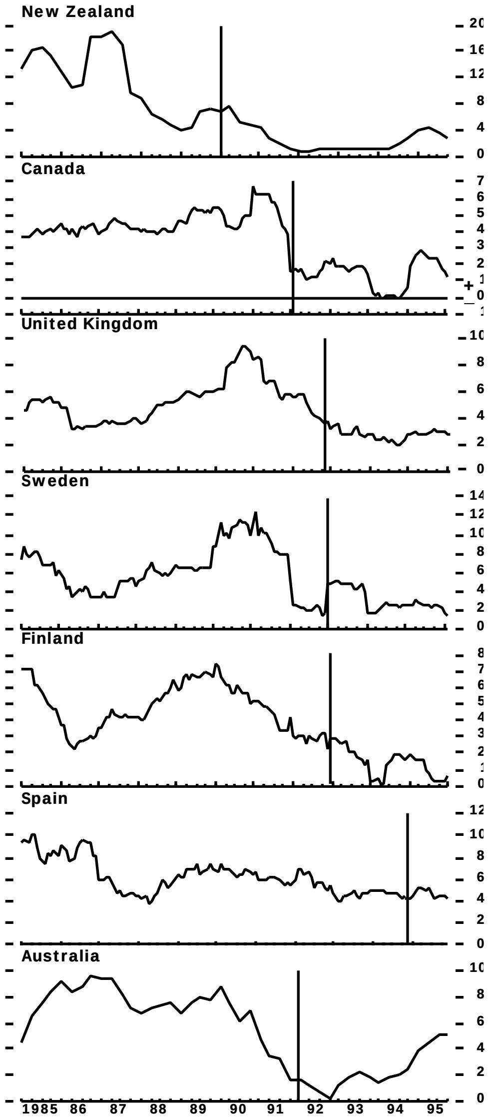
No country has much more than half a decade's experience with inflation targeting. With monetary transmission lags of two or three years, this blights a *quantitative* evaluation of any 'regime shift' induced by the introduction of inflation targets. But the *qualitative* evidence, at least, is broadly encouraging.

Chart 8 plots inflation in New Zealand, Canada, Australia, the United Kingdom, Sweden, Finland and Spain. Also shown is the date their inflation target was first introduced.[39] Chart 9, meanwhile, plots (unweighted) average inflation in these countries against (unweighted) average inflation in a control group of low-inflation countries: France, Germany, the United States, Japan and Switzerland. Inflation is rising at the end of the period among the inflation targeters. But this largely reflects the more advanced stage of these economies in the cycle. The really striking feature is the level at which average inflation seems to be settling in these economies - which is nearer to 1% than 5%.

Of course, the 1990s have been a period of global disinflation. So the charts risk confusing coincidence with causality. After all, inflation was on a downward path in many inflation target countries *prior* to the introduction of their targets. Further, the charts also tell us little about the output costs which disinflationary transition has imposed. Or, put differently, they do not tell us whether inflation targets have secured any 'credibility bonus' by lowering inflationary expectations and, with them, the output costs of disinflation (see, for example, Blanchard (1984)).

(39) For Australia, this is taken (somewhat arbitrarily) to be January 1992.

**Chart 8**
**Inflation**[(a)(b)]

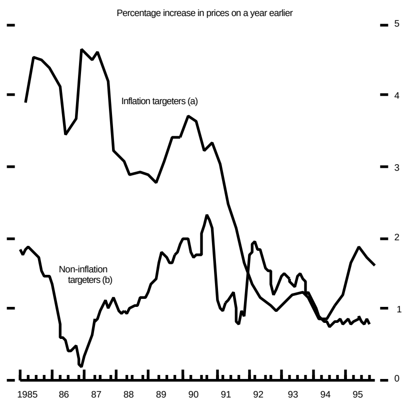



(a) Consumer prices, except for the United Kingdom where RP
(b) Percentage increase in prices on a year earlier. Monthly d
Australia and New Zealand where data are quarterly.
(c) It is difficult to date precisely the introduction of an infl
Australia as it has been gradually increased in importance
of years. For the purpose of this exercise, however, we im
inflation-target boundary at January 1992.

Table B reports some simple pooled summary statistics of (the mean and standard deviation of) inflation and output among the set of inflation targeters (IT) and non-inflation targeters (NIT) used in Chart 9. For both sets of countries the sample is split: for ITs into the period before and after the introduction of their targets; for NITs into the 1980s and the 1990s. Table B repeats the message from Charts 8 and 9, with (mean/variance) inflation performance now little different between the ITs and the NITs. At the same time, neither the mean nor variance of output appears to have been greatly affected by the introduction of inflation targets in these countries - whether looked at over time or in the cross-section.

Chart 9

Average inflation: ITs versus NITs




(a) United Kingdom, Canada, Sweden, Finland, Spain, Australia and New Zealand.
(b) United States, France, Germany, Japan and Switzerland.

Chart 10

UK forward inflation rates

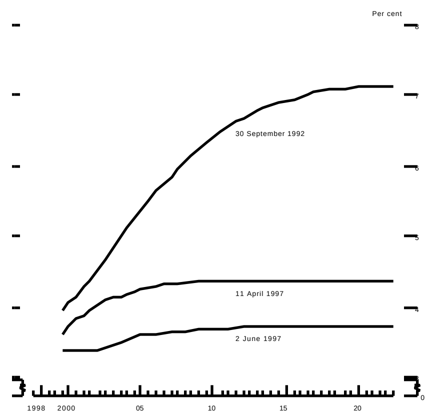


**Table B**
**Summary statistics**

| | Prior period(a) | | | | Post period(b) | | | |
|---|---|---|---|---|---|---|---|---|
| | Inflation | | Output | | Inflation | | Output | |
| | μ | σ | μ | σ | μ | σ | μ | σ |
| Inflation-targeting countries | 8.1 | 1.9 | 2.1 | 0.6 | 2.7 | 1.0 | 2.3 | 1.0 |
| Non inflation-targeting countries | 4.3 | 2.1 | 2.5 | 0.7 | 2.8 | 0.8 | 2.1 | 1.4 |

(a) For the ITs, this covers the period from 1980 Q1 to the introduction of the target; for the NITs it covers the 1980s.

(b) For the ITs this covers the period from the introduction of the target to 1995 Q4; for the NITs it covers 1990 Q1-1995 Q4.

We can firm up these conclusions by conducting some simple tests of the differences in summary statistics. These are shown in Table C. Two features are striking. First, there is a significant difference in mean inflation performance among the ITs before and after their targets were introduced. Further, the significant differences in mean inflation between the ITs and NITs in the prior period disappear in the latter period. Taken together, this constitutes reasonably strong evidence of a regime shift in the inflation performance of the ITs, using either a time-series or cross-sectional counterfactual. Second, there is no evidence of the mean or variability of output having been adversely affected by the disinflationary course that ITs have followed: for both sets of countries there is evidence of output variability having increased more recently; but this change is not statistically significant and there is no evidence of the ITs having fared worse on this front.[40] Although it would be premature to argue that inflation targeting has yielded a credibility bonus - lowering the output costs of disinflation by reducing inflation expectations - nor has it obviously levied a credibility tax.

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(40) Almeida and Goodhart (1996) do some very similar calculations based upon a different set of counterfactual countries - those with previously high inflation but which have not used inflation targets as a disinflationary device. They find that these countries have performed at least as well as the inflation targeters, providing *prima facie* evidence against inflation targets having had much of an independent impact; or at least not one which is statistically discernable as yet. On the basis of this and a comprehensive set of other diagnostic tests of various other macro variables, Almeida and Goodhart (*ibid*) conclude that the case for inflation targets is 'unproven', though it is stronger for countries (like New Zealand and Canada) with a longer track-record. Apart from putting a bit of a gloss on some of the achievements of inflation targeters - for example, as regards transparency, where Almeida and Goodhart (*ibid*) observe that the evidence is stronger - this paper would not demur from those conclusions. Muscatelli and Tirelli (1996) estimate reaction functions for some OECD countries and find little evidence of a regime shift in the United Kingdom following the adoption of an inflation target.

**Table C**
**Tests of summary statistics**

| | Inflation | | Output | |
|---|---|---|---|---|
| | μ | σ | μ | σ |
| ITs: prior and post periods | 7.8 | 3.4 | 0.6 | 3.0 |
| NITs: prior and post periods | -1.6 | 7.2[(a)] | -0.5 | 3.4 |
| ITs v NITs in the prior period | 3.3[(a)] | 1.3 | -1.0 | 1.8 |
| ITs v NITs in the post period | -0.2 | 1.7 | 0.3 | 2.0 |

(a) Denotes significance at 5%. The μ-test is a difference in mean test which is *t*-distributed with *n*-1 degrees of freedom, where *n* is the number of countries. The σ-test is calculated as the ratio of variances which is F-distributed with (*n*,*m*) degrees of freedom, where n is the number of countries in the variance of the numerator, and *m* the number of countries in the variance of the denominator.

Instead of looking at the reduced-form evidence, we might try inferring *directly* any regime shift in inflation expectations. The presence of an index-linked bond market in the United Kingdom offers a measure of inflation expectations (see Deacon and Derry (1994)). Chart 10 presents some evidence on these; it plots the whole inflation term structure on three dates: immediately following the United Kingdom's ERM exit; prior to the announcement of operational independence for the Bank; and more recently. It suggests a pronounced downward shift in inflation expectations between September 1992 and April 1997; and a further downward shift following the announcement of the Bank's operational independence.

Two possible explanations of these falls in implied inflation expectations are that they are cyclically related or reflect a fall in the inflation risk premium.[41] The first seems implausible. Chart 1 plots a ten-year *forward* inflation rate - a point expectation ten years hence - which should in principle be independent of the cycle. This still shows the same fall-off in inflation expectations. And as Chart 10 shows, the decline in inflation expectations has been as evident at the long end of the inflation term structure as the short end.

The bottom panel of Chart 1 provides a proxy for risk premia - the implied volatility embedded in options contracts on long-dated UK government bonds. This measure is little changed comparing the beginning and end of the

(41) A recent paper by Freeman and Willis (1995) considers these (and other) propositions in Canada, Sweden, New Zealand and the United Kingdom using bond yield data. They construct measures of real interest rates - something which we have side-stepped here by using the UK indexed bond market. They find some evidence of a rise in inflation expectations as these countries have emerged from recession; and some tentative signs of a fall in the risk premium.

periods, suggesting that the risk premium itself is potentially little changed. That leaves us tentatively concluding that the movements in Charts 1 and 10 most likely reflect lower inflation expectations which have been regime-induced. The charts also suggest that the *level* of measured inflation expectations may still be too high to be consistent with the United Kingdom's inflation target. Freeman and Willis (1995) find the same to be true in Canada, New Zealand and Sweden. This tells us that the process of credibility accretion has been gradual and is on-going. But because inflation targeting is still in its infancy, this is not that surprising.

## 10 Conclusions

This paper has described some of the issues raised by inflation targeting as currently operated in the United Kingdom and elsewhere. Just as central banking has been described as an art, inflation targeting is inevitably a mix of rules and discretion. But provided discretion is exercised subject to the right set of incentives, and with a sufficient degree of transparency, this need not be a cause for inflationary concern. After all, all science is rooted in some set of assumptions or priors. A Bayesian approach underlies monetary policy-making in all central banks, not just the inflation-targeters.

But even priors need scientific verification and testing. This is no trivial task. As Keynes observed:

> '...[A]n internal standard, so regulated as to maintain stability in an index number of prices, is a difficult scientific innovation, never yet put into practice' (Keynes, 1923)

Inflation-targeting countries have put into practice just such a scheme. Some have perhaps made scientific innovations along the way - the Bank of England's published probability distribution perhaps being one of them. In the long run, such technological innovations in the setting of monetary policy should pay dividends.

## References

**Almeida, A and Goodhart, C A E (1996)**, 'Does the Adoption of Inflation Targets Affect Central Bank Behaviour?', *mimeo*, London School of Economics.

**Ammer, J and Freeman, R T (1995)**, 'Inflation Targets in the 1990s: The Experiences of New Zealand, Canada, and the United Kingdom', *Journal of Economics and Business*, 47.

**Andersson, K and Berg, C (1995)**, 'The Inflation Target in Sweden', in A G Haldane (ed), *Targeting Inflation*, Bank of England, London.

**Astley, M S and Garrett, A (1996),** 'Interpreting Sterling Exchange Rate Movements', *Bank of England Quarterly Bulletin*, November, pages 394-404.

**Bank of Canada (1994)**, *Economic Choice and Policy Behaviour Under Price Stability*, Bank of Canada.

**Bean, C R (1983)**, 'Targeting Nominal Income: An Appraisal', *Economic Journal*, 93, pages 806-19.

**Bernanke, B S and Mihov, I (1996)**, 'What Does the Bundesbank Target?', *NBER Working Paper No 5,764.*

**Blanchard, O J (1984)**, 'The Lucas Critique and the Volcker Deflation', *American Economic Review*, 74, pages 211-15.

**Bowen, A (1995)**, 'Inflation Targetry in the United Kingdom', in A G Haldane (ed.), *Targeting Inflation*, Bank of England, London.

**Brainard, W (1967)**, 'Uncertainty and the Effectiveness of Policy', *American Economic Review*, 57, pages 411-25.

**Briault, C B, Haldane, A G and King, M A (1996)**, 'Independence and Accountability', forthcoming in Kuroda, I (ed), *Toward More Effective Monetary Policy*, proceedings of the Bank of Japan's Seventh Annual Conference, October, 1995.

**Britton, E and Whitley, J D (1996)**, 'Asymmetry, Risks and the Probability Distribution of Inflation', *mimeo*, Bank of England.

**Brunila, A and Lahdenpera, H (1995)**, 'Inflation Targets: Principal Issues and Practical Implementation', in A G Haldane (ed), *Targeting Inflation*, Bank of England, London.

**Bryant, R C, Hooper, P and Mann, C (1993)**, *Evaluating Policy Regimes*, The Brookings Institution.

**Cechetti, S (1995)**, 'Inflation Indicators and Inflation Policy', *NBER Working Paper No 5,161*.

**Clarida, R and Gertler, M (1995)**, 'How the Bundesbank Conducts Monetary Policy', *mimeo*, New York University.

**Clark, P, Laxton D and Rose, D (1995)**, 'Capacity Constraints, Inflation and the Transmission Mechanism: Forward-Looking Versus Myopic Policy Rules', *IMF Working Paper No 75*.

**Cukierman, A (1995)**, 'Towards a Systematic Comparison Between Inflation Targets and Monetary Targets', in Leiderman, L and L E O Svensson (eds.), *Inflation Targets*, CEPR.

**Cukierman, A and Meltzer, A (1986)**, 'A Theory of Ambiguity, Credibility and Inflation Under Discretion and Asymmetric Information', *Econometrica*, 54, pages 1,099-1,128.

**Deacon, M and Derry, A (1994)**, 'Estimating Market Interest Rate and Inflation Expectations from the Prices of UK Government Bonds', *Bank of England Quarterly Bulletin*, August, pages 232-40.

**Dhar, S, Fisher, P G, Holland, A and Pain, D L (1995)**, 'Interest Rate Effects in the Bank of England's Medium-Term Forecasting Model', in *Financial Structure and the Monetary Policy Transmission Mechanism*, Bank for International Settlements.

**Dotsey, M (1987)**, 'Monetary Policy, Secrecy and Federal Funds Rate Behaviour', *Journal of Monetary Economics*, 20, pages 463-474.

**Duguay, P (1994),** 'Some Thoughts on Price-Stability Versus Zero Inflation', *mimeo*, Bank of Canada.

**Duguay, P and Poloz, S (1994)**, 'The Role of the Staff Economic Projections in Canadian Monetary Policy Formulation', *Canadian Public Policy*, Vol XX, No 2, pages 189-99.

**Flemming, J (1976)**, *Inflation*, Oxford University Press.

**Fischer, A (1995)**, 'New Zealand's Experience with Inflation Targets', in Leiderman, L and L E O Svensson (eds.), *Inflation Targets*, CEPR.

**Fisher, I (1911)**, *The Purchasing Power of Money*, MacMillan.

**Freedman, C (1994)**, 'The Use of Indicators and of the Monetary Conditions Index in Canada', *Frameworks for Monetary Stability: Policy Issues and Country Experiences*, Balino, T J and Cottarelli, C (eds), Washington: International Monetary Fund.

**Freeman, R T and Willis, J L (1995)**, 'Targeting Inflation in the 1990s: Recent Challenges', *Board of Governors of the Federal Reserve System, International Finance Discussion Paper No 525*.

**Friedman, M (1959)**, *A Program for Monetary Stability*, Fordham University Press, New York.

**Friedman, B M (1975)**, 'Targets, Instruments and Indicators of Monetary Policy', *Journal of Monetary Economics*, 1, pages 443-73.

**Goodfriend, M (1986)**, 'Monetary Mystique: Secrecy and Central Banking', *Journal of Monetary Economics*, 17, pages 63-97.

**Goodhart, C A E and Vinals, J (1994)**, 'Strategy and Tactics of Monetary Policy: Examples from Europe and the Antipodes', *Banco de Espana Documento de Trabajo No 9, 425*.

**Granger, C W J (1995)**, 'Can We Improve the Perceived Quality of Economic Forecasts?', *mimeo*, University of California at San Diego.

**Haldane, A G (1995a)**, 'Inflation Targets', *Bank of England Quarterly Bulletin*, August, pages 250-59.

**Haldane, A G (1995b)**, *Targeting Inflation: A Conference of Central Banks on the Use of Inflation Targets*, Bank of England, London.

**Haldane, A G (1995c)**, 'Rules, Discretion and the UK's New Monetary Framework', *Bank of England Working Paper, No 40.*

**Haldane, A G (1997),** ‘Designing Inflation Targets’, in P Lowe (ed), *Monetary Policy and Inflation-Targeting*, Reserve Bank of Australia.

**Haldane, A G and Salmon, C K (1995)**, ‘Three Issues on Inflation Targets’, in A G Haldane (ed), *Targeting Inflation*, Bank of England, London.

**Haldane, A G and Read, V (1997),** ‘Central Bank Secrecy and the Yield Curve’, *mimeo*, Bank of England.

**Hall R E and Mankiw, N G (1994)**, ‘Nominal Income Targeting’, in *Monetary Policy*, N G Mankiw (ed), University of Chicago (for NBER).

**Jonung, L (1979)**, ‘Knut Wicksell’s Norm of Price Stabilisation and Swedish Monetary Policy in the 1930s’, *Journal of Monetary Economics*, 5, pages 459-96.

**Keynes, J M (1923)**, *A Tract on Monetary Reform*, MacMillan.

**King, M A (1994)**, ‘Monetary Policy in the UK’, *Fiscal Studies*, 15, pages 109-29.

**King, M A (1996)**, ‘Direct Inflation Targets’, paper presented at the symposium on ‘Gelpolitische in Europe’ held in Frankfurt, April 1996.

**Leiderman, L and Svensson, L E O (1995)**, *Inflation Targets*, CEPR.

**Longworth, D and Freedman, C (1995)**, ‘The Role of the Staff Economic Projection in Conducting Canadian Monetary Policy’, in A G Haldane (ed), *Targeting Inflation*, Bank of England, London.

**Lougani, P and Swagel, P (1995)**, ‘Supply-Side Sources of Inflation: evidence from OECD countries’, *Board of Governors of the Federal Reserve System, International Finance Discussion Paper No 515*.

**Marshall, A (1887)**, ‘Remedies for Fluctuation in General Prices’, *The Contemporary Review*.

**Mayes, D and Chapple, B (1995)**, ‘Defining an Inflation Target’, in A G Haldane (ed), *Targeting Inflation*, Bank of England, London.

**McCallum, B T (1983)**, ‘On Uniqueness in Rational Expectations Models: An Attempt at Perspective’, *Journal of Monetary Economics*, 11, pages 139-168.

**McCallum, B T (1995a)**, 'Inflation Targeting in Canada, New Zealand, Sweden, the United Kingdom, and in General', forthcoming in Kuroda, I (ed), *Toward More Effective Monetary Policy*, proceedings of the Bank of Japan's Seventh Annual Conference, October.

**McCallum, B T (1995b)**, 'New Zealand's Monetary Policy Arrangements: Some Critical Issues', *Reserve Bank of New Zealand Discussion Paper No G95/4*.

**Muscatelli, V A and Tirelli, M (1996)**, 'Institutional Change, Inflation Targets and the Stability of Interest Rate Reaction Functions in OECD Economies', *mimeo*, University of Glasgow.

**Neumann, M J M (1995)**, 'Monetary Targeting in Germany', forthcoming in Kuroda, I (ed), *Toward More Effective Monetary Policy*, proceedings of the Bank of Japan's Seventh Annual Conference, October, 1995.

**Nolan, C and Schaling, E (1996)**, 'Monetary Policy Uncertainty and Central Bank Accountability', *Bank of England Working Paper No 54.*

**Reifschneider, D L, Stockton, D J and Wilcox, D W (1996)**, 'Econometric Models and the Monetary Policy Process', *mimeo*, Board of Governors of the Federal Reserve System.

**Rodgers, P (1997),** 'Changes at the Bank of England', *Bank of England Quarterly Bulletin*, August, pages 241-47.

**Schachter, A and Stokman, A C J (1995)**, 'Interest Rate Policy of the Deutsche Bundesbank: An Econometric Analysis for 1975 to 1992', *De Economist*, 143, No 4, pages 475-94.

**Sargent, T J and Wallace, N (1975)**, 'Rational Expectations, the Optimal Monetary Instrument and the Optimal Money Supply Rule', *Journal of Political Economy*, 83, pages 241-54.

**Svensson, L E O (1995a)**, 'The Swedish Experience of an Inflation Target', in Leiderman, L and L E O Svensson (eds), *Inflation Targets*, CEPR.

**Svensson, L E O (1995b)**, 'Optimal Inflation Targets', 'Conservative Central Banks and Linear Inflation Contracts', *mimeo*, Institute for International Economics, University of Stockholm.

**Svensson, L E O (1996)**, 'Inflation Forecast Targeting: Implementing and Monitoring Inflation Targets', *mimeo*, Institute for International Economic Studies, Stockholm University.

**Thomas, R S (1996),** 'Understanding Broad Money', *Bank of England Quarterly Bulletin*, May, pages 163-79.

**Whitley, J D (1997),** 'Economic Models and Policy-making', *Bank of England Quarterly Bulletin*, May, pages 163-73.

**Wicksell, K (1898)**, *Interest and Prices*, MacMillan.

**Woodford, M (1994)**, 'Non Standard Indicators for Monetary Policy: Can Their Usefulness Be Judged From Forecasting Regressions?', in N G Mankiw (ed.), *Monetary Policy*, University of Chicago Press, Chicago.

**Yates, A (1995)**, 'On the Design of Inflation Targets', in A G Haldane (ed), *Targeting Inflation*, Bank of England, London.