

Measuring the Policymaker's Credibility:
The Bank of England in 'nice' and 'not-so-nice' times

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Abstract

In the course of the last year or so, the Bank of England has come under pressure to raise interest rates on the grounds that a 'lax' monetary policy in the face of persistent overshoots of the inflation target risks undermining the Bank's hard-won credibility. Using the Bayesian as well as time-varying coefficient Kalman-Filter techniques, and four different measures of inflation expectations, this paper looks at the effect of recent events upon the Bank of England's credibility. Briefly, we find that on most measures of inflation expectations the credibility built up during the relatively benign years from the adoption of an explicit inflation target in 1992 to the onset of the financial crisis in 2007 has deteriorated since.

Although our investigation is focused in this paper on the Bank of England, it is easily transferred to the examination of other central banks and represents an advance on other measures of credibility widely used in the existing literature.

Key words: Monetary policy; credibility; Bayesian; Kalman filter

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*We are grateful to Don Webber and Andrew Mearman for helpful comments on an earlier draft.

1. INTRODUCTION

Within the ‘new consensus macroeconomics’ that emerged during the 2000s, it was widely accepted that the optimal design of monetary policy required a central bank that was independent of government (and other constraints) to focus explicitly upon an inflation target by adjusting the short-term interest rate at which it provided liquidity to financial markets and to carry out its operations with the maximum degree of transparency. Of these features, independence, inflation targeting and transparency were all necessary conditions of optimal policy design because they served to enhance the policymaker’s *credibility* and credibility was essential if expectations were to be managed effectively.

The importance of expectations can be seen in equation (1) which is a simple model of inflation which underlies most monetary policy-making.

$$\pi_{t+1} = \alpha_1 \pi_t^e + \alpha_2 (Y - Y^*)_t \quad \dots(1)$$

In this model, future inflation depends upon agents’ expectations of inflation together with the pressure of aggregate demand (as measured by a so-called ‘output gap’, $Y - Y^*$). Depending on the values of the α ’s, expectations can be made into a critical or subordinate link in the transmission mechanism. But provided merely that $\alpha_1 > 0$, then it follows that insofar as the policymaker can influence expectations, a given inflation target can be achieved with smaller adjustments to the level of aggregate demand. And, since the latter are costly, in terms of lost output, higher unemployment, lower future productivity etc., then successful manipulation of expectations lowers the ‘sacrifice ratio’ in the conduct of monetary policy. The process is nicely described by Dale (2011).

If companies and households expect inflation to return to target quickly they will set their prices and pay demands accordingly. And in so doing, monetary policy has less to do – in terms of varying the level of demand in the economy – to ensure that it does. Inflation credibility is self reinforcing. The credibility gains associated with the move to inflation targeting and an independent policymaking committee in our country led to a reduction in the persistence of inflation. Inflation came back to target more quickly and the cost of it doing so in terms of output volatility was reduced. (Dale, 2011 p.8)

Given the importance of expectations and hence of credibility, it is not surprising that some effort has gone into looking for ways of measuring it. Fundamentally, credibility is measured by the difference between the rate of inflation *expected* by private sector agents and the rate of inflation *targeted* by the policymaker. In many regimes, the latter is unproblematic: there is either an explicit inflation target or an implicit one which can be readily inferred. The problem comes with expectations. Broadly speaking, these can be measured ‘directly’ by looking at survey evidence. This might mean a regular survey of the population at large, or it may take the form (more narrowly) of a survey of professional forecasts. Alternatively, expectations may be inferred ‘indirectly’ by looking at market data which is then argued to be ‘consistent with’ a certain set of expectations.

Why do we raise the issue now? There are at least three reasons. The first dates back to the switch in 2004 from an inflation target expressed as a 2.5 per cent annual increase in the RPIX to the current target expressed as a 2 per cent annual increase in the CPI. In spite of this switch, most indexation in the UK and most contractual negotiations continue to be based upon movements in RPIX (or RPI). As a general rule, RPI inflation has exceeded CPI inflation with the consequence that the latter understates the rate of inflation as many households experience it. If agents behave on the basis that they expect

RPI-inflation while the policy-maker targets CPI-inflation, the CPI measure is not credible.

In addition, recent events suggest two more reasons. As all parents know, the key to credibility is to act always as promised: credibility is something that has to be built.¹ Following the adoption of inflation targeting in 1992, until the onset of the crisis in 2007 the Bank of England was fortunately placed in this respect. This was the period described by some as the ‘great moderation’ and by Mervyn King himself (in 2003) as the ‘non-inflationary consistently expansionary’ or ‘NICE’ decade. Between November 1992 and July 2007 the actual rate of inflation (measured by the rate of increase in the RPIX) remained within one per cent of the inflation target with the exception of a brief period in 1999-2000 when the actual rate was 1.5 per cent *below* target. The consistency of words and deeds in this period is obvious. Since 2007, of course, conditions have not been nice at all. For much of 2008 inflation, measured by the rate of increase in the CPI, exceeded the three per cent threshold at which the Governor of the Bank of England was required to write an explanatory letter to the Chancellor. The same was true for the whole of 2010 when inflation was, if anything, on a rising trend. So far, in 2011, it has exceeded four per cent p.a. This has resulted in increasing demands for a rise in interest rates and, significantly, these demands have focused on the need to protect the Bank of England’s credibility.²

The third of our reasons relates to the zero lower bound problem. At the same time that it lowered the official rate to 0.5 per cent in March 2008, the Bank of England opened its ‘Asset Purchase Facility’ (‘APF’ but better known later as ‘Quantitative Easing’). Initially, the purchases were limited to private sector assets financed by the issue of Treasury Bills but quickly expanded to the purchase of gilts financed by the issue of central bank money. The consequence is that by 2011 Q2, the Bank was holding all but £200bn of UK government bonds purchased under the APF. This makes the Bank one of the Government’s largest creditors and threatens to undermine the independence (actual or perceived) that is a major precondition for credibility.

The threats to independence arise as follows. Firstly there is the widely recognised threat that a central bank willing to purchase government debt removes all market constraints on such debt issues by replacing the debt with broad money while creating additional and matching additional bank reserves – the nearest real world equivalent of ‘printing money’.³ Clearly, a central bank that was willing to do this could quickly find its monetary policy at the mercy of unscrupulous and profligate government. But this is only the simplest part of the picture. One stated purpose of QE has been to reduce medium and long-term interest rates (‘flatten the yield curve’, Bank, 2009, p.10). To the extent that the Debt Management Office’s remit requires it to ‘minimise, over the long-term, the costs of meeting the Government’s financing needs’, then the DMO clearly has an interest in the success of QE and may therefore be tempted to encourage it. Furthermore, the Bank’s ability to make asset purchases requires Treasury approval. The reason for this is that the

¹ The cumulative nature of credibility leads Blinder (1998) to an interesting comment on the significance of central bank independence: ‘[Credibility] is painstakingly built up by a history of matching deeds to words. A central bank that consistently does what it says will acquire credibility...almost regardless of the institutional structure.’ P.65

² See, for example, Julius (2010); Dale (2011); Sentance (2011); Weale (2011)

³ For this reason, article 104 of the Maastricht Treaty (1992) prevents central banks from funding government deficits. However, the wording of the Maastricht clause refers to the ‘*direct*’ (our emphasis) funding of such deficits which central banks have taken to mean the purchase of *newly-issued* government debt. How the distinction between buying debt in the primary and secondary markets makes any difference to the monetary and financial consequences of central bank funding of government deficits is not immediately clear.

Treasury indemnifies the Bank against losses arising from the APF and thus exposes the taxpayer to risk. The consequence is that the use of the QE instrument is effectively at the discretion of government and this undermines the operational independence given to the Bank in 1997.⁴ Without the indemnity, however, the Bank could conceivably be exposed to capital losses that it would then have to offset by varying the size of its balance sheet and the income earned from its assets. In these circumstances, it could no longer claim to be wholly committed to price stability as its policy objective.⁵

In the next section (2) we look briefly at earlier attempts to measure credibility. In section 3 we discuss the data and our approach. Section 4 discusses the results and section 5 summarises and concludes.

2. MEASURING CREDIBILITY IN MONETARY POLICYMAKING

Given the importance of credibility in the design of optimal monetary policy, it is hardly surprising that the credibility literature is extensive. It is more surprising that the attention paid to the question of how we should *measure* credibility is distinctly limited when compared with the effort that has been put into showing how credibility improves policy outcomes, or how it is linked to transparency and/or central bank independence. To mention just three issues. In looking at these broader issues, many papers simply assume that credibility can be measured somehow. As many recent papers have pointed out (Breedon and Hume, 2007; Demir and Yigit, 2008; Tanuwidjaja and Choy, 2006; Gomme 2006; Henckel *et al*, 2010; Lyziak *et al*, 2007; Nahon and Meurer, 2009) credibility requires that agents *expect* targets to be fulfilled.⁶ This being the case, we have only to compare those expectations with targets. But this raises immediately the question of ‘which agents?’ and ‘how do we know their expectations?’ As regards the latter, the literature divides into three approaches.

Firstly, we could quite simply assume that agents’ inflation expectations are broadly correct. Hence we can take inflation in $t+1$, expected at time t , to be equal to actual, or *ex post*, inflation in $t+1$.

Secondly, we may take asset prices and yields (‘market data’) to reveal agents’ expectations. The advantage of this source is that expectations are derived from prices in financial markets where actual investments are made by sophisticated investors and thus are likely to reflect careful considerations. Expectational errors give rise to the possibility of arbitrage profits (at least for professionals) and so we should expect these to be competed away. Financial markets’ expectations are important also insofar as they may play a direct role in the monetary policy transmission mechanism (via the yield curve, for example) and thus determine macroeconomic financing conditions. Furthermore, asset prices are available for long periods.

A third alternative is to use survey evidence. One source of such expectations is contained in *Consensus Forecasts*, provided by a private British survey company, which conducts monthly surveys among financial and economic forecasters on a range of variables,

⁴ The conventional monetary policy instrument – the official interest rate – involves trading in gilt repos. Since such deals are collateralised the Bank is not subject to credit risk.

⁵ See also Stella (2005). For a further discussion of how the central bank’s financial position may inhibit its independence.

⁶ Our definition of credibility as a state wherein expectations coincide with targets has been standard practice in the literature since Svensson (1994). However, it is not the only interpretation. Suppose, for example, that instability in commodity prices makes it impossible for the policymaker to hit the target. Understanding this, agents may still believe that the policymaker is committed to fighting inflation even though they expect targets to be missed. The ‘credibility’ with which the literature is concerned is credibility in the policymaker’s *ability* to deliver low inflation and this, as equation (1) shows depends upon the policymaker’s ability to get expectations into line with targets.

amongst them consumer price inflation. Since inflation forecasts are conducted by professional economists/forecasters, who have the resources for and a professional interest in more sophisticated economic forecasting, this should result in a reliable indicator of inflation expectations. Furthermore, professional forecasts are disseminated to the media and thus professional forecasters may act as opinion leaders, affecting household inflation expectations (see for instance Carroll, 2003 for empirical evidence).

A fourth source of information on inflation expectations is the Bank of England household survey. Empirical studies have shown that inflation expectations from professionals are typically forward-looking. In contrast, consumers' expectations tend to have a larger inertial element (Tronzano, 2005). Recently, Breedon and Hume (2007) show empirically that inflation expectations and perceptions drawn from household surveys in European Union countries shed quite a different light on ECB credibility, compared to those that draw on professional forecasts and market data. Unfortunately, the Bank of England survey yields data only since 1999. Hence, it does not allow us to make any judgement about the move to inflation targeting in 1992. However, it could help to test our hypothesis that the switch from RPIX to CPI in 2004 was seen by households as some sort of sleight of hand or loosening of the inflation target when market practitioners and professional forecasters (in *Consensus Forecasts*) saw it differently.

When it comes to choosing between 'market' and 'survey' data it is worth noting that the latter are sometimes rejected as being 'biased', meaning that the expectations revealed in such surveys, turn out to be incorrect. For example, Yuxiang and Chen (2010, p 488) refer to a number of studies that find that expectations of future inflation are based on recent past rates and that they are influenced by gender, age, personal wealth and other factors. On this basis they argue in favour of inferring expectations from market data, which avoids such bias by being more generally, on average, 'correct'. But this is to beg a major question. It may be that market-derived expectations are more nearly correct than expectations revealed by surveys. We may then take this to be evidence that market practitioners, who must 'put their money where their mouths are' have a greater incentive to be well-informed than the general public. (It might be interesting to see whether such a divergence occurs between survey data drawn from a professional community and that drawn from the general public). But when it comes to improving monetary policy outcomes it is not just financial market practitioners that matter but all agents whose behaviour bears upon the process of price-setting. To return to an earlier point, if trade union leaders (and union members) exhibit persistently biased expectations because they base their perception of inflation on the RPI, then policy is not credible (for them) and there will be unsatisfactory outcomes. The fact that there are different ways of measuring inflation expectations and that different methods may focus on different social groups, may be capable of telling us that policy is more credible with some than with others.⁷ That this is entirely possible is revealed by comparing the results in Goldberg and Klein (2005) with those of Amisano and Tronzano (2010) and Breedon and Hume (2007). The first relies on the expectations of professional forecasters; the second uses market yields while the third uses a broad based survey. The first two suggest the ECB enjoys high credibility; the third does not. In brief, just because some expectations are wrong, does not seem a very good reason for excluding them if we wish to measure credibility. On the contrary, it threatens to prejudice the issue.

In this paper, then, we rely upon four sources of expectations and in that sense we follow in a number of footsteps. Firstly, we proxy expected inflation by *actual* inflation. This approach (effectively endowing agents with rational expectations) follows Svensson (1994) and Amisano and Tronzano (2010). We also use a measure of inflation expectations derived

⁷ And may provide pointers to future credibility enhancement; hardly a trivial outcome.

from yield curve data. This again follows Svensson (1994) and Amisano and Tronzano (2010) but also Reid (2009, for South Africa), Gomme (2006) and Laxton (2002). As regards surveys, we use the expectations of market professionals as published in *Consensus Forecasts*, which bears comparison with the Goldberg and Klein (2005) study of the ECB. And finally, albeit for a shorter period, we use the results of the broad-based Bank of England survey of inflation expectations which will enable us to observe any difference in credibility that may exist between professionals and the general public.

Our test of credibility, as we noted above, is the extent to which expectations conform to targets. We turn now to that data used for those targets.

To test for this credibility, we follow the approach of Svensson (1994), Demir and Yigit (2008) and Amisano and Tronzano (2010), amongst others, by comparing the inflation outturn (and agents' expectations of the outturn) against an inflation target, expressed as a *range*. This is not without problems since (a) the UK inflation target has not always been explicitly expressed as a range and (b) the Bayesian method and the Kalman Filter that we use as the basis of tests requires a series of inflation targets *prior to 1992* in order to capture any effect on credibility of the explicit switch to inflation targeting. We deal firstly with issues arising from (a), that is the specification of upper and lower limits during the period of explicit inflation targeting.

In the UK, the explicit targeting of inflation dates from October 1992, following sterling's exit from the European Exchange Rate Mechanism (ERM). Since then, the target has taken three distinct, though closely related, forms. These are shown in Table 1.

<i>Date</i>	<i>Upper limit %</i>	<i>Lower limit %</i>	<i>Index</i>
January 1988 – September 1992 ⁸	3.5	0.5	RPIX
Oct 1992 – April 1997	4	1	RPIX
May 1997 – December 2003	3.5	1.5	RPIX
January 2004 -	3	1	CPI

Notice that we have expressed the target in terms of upper and lower limits, implying a target *range* even though the UK Treasury's presentation of the target has varied over the years. For our purposes, of course, what matters is the yardstick against which agents are interpreting inflation outcomes. It is their perception of what the policymaker is seeking to achieve that matters. When the first inflation was set, the UK Treasury announced an *explicit* target range, of 1 to 4 per cent for the annual increase in the retail price index excluding mortgage interest payments – RPIX, with the aim of bringing the rate down to the mid-point of the range over the next two years. Then, in May 1995, the UK Chancellor announced a point target of 2.5 per cent, with the rationale 'that setting interest rates consistently at the level judged necessary to achieve the inflation target of 2.5 per cent or less should ensure that inflation will remain in a range of 1 per cent–4 per cent.' (Haldane, 1995, p.250). Hence, a range remained clearly defined until 1997.

Since the Bank of England was granted operational independence in May 1997, however, its remit from the Treasury has stressed the target is a *point* target. But at the same time, the remit provided for the Governor of the Bank to write an open letter explaining why the target had been missed and what was being done to retrieve the situation if inflation exceeded 3.5 per cent or fell below 1.5 per cent. For the purposes of this paper we take the view that is this range that plays the key role in agents' assessment of credibility, even though the Treasury is insistent that 'The[se] thresholds do not define a target range' (Bank, 2011).

⁸ Implied target range. See discussion in text below.

Like the Treasury itself, agents accept that inflation targeting is not a precise science and that ‘...there should be no stain on [the Bank’s] reputation if inflation was not exactly at 2.5 per cent’ (Besley and Sheedy, 2011, p.R19). The same reasoning applies after January 2004 when the index underlying the measurement of inflation was switched from RPIX to the Consumer Price Index and the target adjusted to 2 per cent with epistolary thresholds of 1 and 3 per cent.

The switch from RPIX to CPI raises a number of issues for this study. The first of these is the break in system of inflation measurement and target setting, since we wish to see how credibility evolved over a period of time. There is then also the possibility that the switch from RPIX to CPI itself damaged the credibility of inflation targeting. This possibility arises because, although the ‘permanent’ difference between the two indices was thought to be about 0.7 per cent (see Fenwick and Roe, 2004), inflation as measured by RPIX was between 1 and 1.5 per cent higher than inflation measured by the CPI at the time of the switch and has often shown significant deviations since (Besley and Sheedy, 2011 p.R24). There are two implications for credibility here. The first is that agents may think that the inflation target is, in effect, being loosened since they may be aware that the equivalent CPI inflation rate should have been 1.8 per cent rather than 2.0. The second, as we noted in our introduction, is that the RPI or RPIX was retained for most other purposes where a measure of inflation was required (indexation of social security benefits, tax bands etc). Given the relationship between the two indices for much of the period, any broad-based survey of agents’ expectations of inflation from 2004 onwards is subject to the possibility that they regularly exceed the target. Interestingly, inflation expectations derived from alternative sources (the yield curve, say) where the views of professional analysts dominate, may be less subject to this bias. By using several sources of inflation expectations our investigation allows us to test for this possibility.

We turn now to the second issue which is the extension of inflation targets into the period preceding October 1992. The need for this arises because in testing for credibility, part of our investigation follows the approach of Amisano and Tronzano (2010). For this we require an *implied* target range for inflation reaching back to August 1988 in order to supply 50 additional observations. Inevitably, this is a somewhat speculative exercise. We have taken the view that the rationale behind the link with the Deutschmark was intended to achieve the same inflation outcomes as the Bundesbank was aiming for, and largely achieving. As von Hagen (1995) and Bernanke and Mihov (1997) have shown, the Bundesbank’s setting of a money growth target throughout this period was based upon an assumption of a likely rate of 2 per cent, p.a. We have therefore created an *implied* inflation target of 2 per cent with upper and lower limits of 0.5 and 3.5 per cent for the period from 1988 to 1992.⁹

3. MODEL AND METHODOLOGY

3.1 The Model

Our approach to testing for credibility follows closely that used by Amisano and Tronzano (2010). The basic idea of their model is based in turn on (Svensson, 1994), who suggests calculating inflation target consistent (t.c.) real interest rates (based on nominal bond yields

⁹ In setting the upper and lower limits, we have used the 3 per cent ‘spread’ adopted at the time of the adoption of an explicit target. A different approach altogether would have been simply to take the 1992 target and project it back to 1988 on the basis that this what the UK authorities would have done had they not been following the alternative policy of ERM membership.

(i_t) which correspond to the upper (π_{max}) and lower inflation targets (π_{min}) announced by the Central Bank. When the *expected* real interest rate falls inside these boundaries, the central bank is anti-inflationary credible.

Amisano and Tronzano (A&T) operationalise the model for estimation purposes by introducing auxiliary variables z_u and z_l , defined as follows:

$$z_{u,t} = r_t^e - (i_t - \pi_{max})$$

$$z_{l,t} = r_t^e - (i_t - \pi_{min})$$

The Central Bank is anti-inflationary credible when the expected real rate is greater than the lower t.c. real interest rate and the Central Bank is anti-deflationary credible when the expected real rate is less than the higher t.c. real interest rate. More formally:

$$z_u > 0 \text{ (anti-inflationary credibility)}$$

$$z_l < 0 \text{ (anti-deflationary credibility)}$$

A&T model the auxiliary variables as follows:

$$z_{u,t} = \theta_u + \rho z_{u,t-1} + \varepsilon_t \quad (2)$$

$$z_{l,t} = \theta_l + \rho z_{l,t-1} + \varepsilon_t \quad (3)$$

where the time series $\{z_t, z_l\}$ are autoregressive processes of first order, with $\{\theta_u, \theta_l\}$ as the mean, ρ is the autoregressive parameter, absolutely smaller than one and ε_t is a white noise normally distributed error term. When $\theta_u > 0$, there is absence of inflationary bias and $\theta_l < 0$ indicates absence of deflationary bias of monetary policy. These conditions will hold as long as $\rho < 0$.

Any estimation method for equations (2) and (3) is required to test a constraint on the conditional means (θ_u, θ_l) and to determine the probability of a stationary stochastic process of $\{z_t, z_l\}$.

3.2 Methodology

The aim of the empirical analysis is to derive information about the degree of monetary credibility over time. The sample period covers the period before and after the introduction of the inflation target in November 1992, the change of the inflation target from RPIX to CPI in January 2004, and the recent financial crisis and its aftermath. In order to estimate how Central Bank reputation evolves over time, A&T suggest a recursive Bayesian method, which assumes constant parameters for the entire sample used at each time of estimation.¹⁰ In this paper, we apply the Kalman-Filter (KF) method with time-varying model coefficients, which we believe is better equipped to allow for any structural change in equations (2) and (3) in relation to, if any, changes in bank credibility. The KF method has also been used by Demir and Yergit (2008) in a similar context. For comparability purposes, the recursive Bayesian method is also reported here. We use the KF estimations as a robustness check on the results of the Bayesian method.

¹⁰ Suppose there are T observations in the entire sample and the first Bayesian estimation uses the first S ($<T$) data points. As the new data at time $S+1$ is added, estimation is repeated based on the assumption that the model parameters stay constant throughout the updated sample period (which now has $S+1$ observations. Readers are referred to Section 4.2.1 in A&T for further details.

3.2.1 The Bayesian approach

The Bayesian estimation here followed that of A&T. In particular, we assume the stationary first-order autoregressive models in (2) and (3) are driven by Gaussian errors and use Markov chain Monte Carlo simulation to obtain the required posterior distribution for θ_u and θ_l .

3.2.2 The Kalman Filter

The Kalman Filter (KF) technique allows us to estimate equations (2) and (3) with time varying parameters θ_t and ρ_t . The corresponding transition equation of the KF model is:

$$(\beta_{t+1} - \bar{\beta}) = F(\beta_t - \bar{\beta}) + v_{t+1}$$

where F is the parameter matrix, β_t is a vector of the parameters θ_t and ρ_t (suppressing the subscripts u and l for the time being), $\bar{\beta}$ is the average of β_t and v_{t+1} is a white noise, normally distributed error term.

The observation equation is then:

$$z_t = x'_t \beta_t + \varepsilon_t$$

where $x_t = \begin{bmatrix} 1 \\ z_{t-1} \end{bmatrix}$ and ε_t is a white noise normally distributed error.

3.2.3 The Credibility Measure

Having obtained θ_t in the KF case, we calculate the probability of a positive θ_t at each point in time. For anti-inflationary credibility,

$$\Pr(\theta_{u,t} > 0 | z_{u,t}, \dots, z_{u,1})$$

would tell us in terms of likelihood that the bank is anti-inflationary credible. Whereas

$$\Pr(\theta_{l,t} < 0 | z_{l,t}, \dots, z_{l,1})$$

provides the corresponding anti-deflationary credibility measure.

In the Bayesian case, similar probabilities are calculated using simulation, with the posterior distribution at each time point t estimated on the assumption that the parameter θ is a constant throughout z_1, \dots, z_t .

4. RESULTS

4.1 Alternative proxies for the expected inflation rate

Inflation expectations are not directly observable and need to be estimated. As we explained in section 2, there are three sources that provide (forward-looking) inflation expectations. The first is expectations derived from financial asset prices, a second option is survey data from professional forecasters and thirdly, there is information from survey data from households.

Additionally to forward-looking sources of inflation expectations, we also use a backward-looking approach, where expected inflation is proxied by ex-post inflation. We treat the *ex post* approach as a benchmark to which we compare the results of the forward-looking expected real rates.

The advantage of the first source is that expectations are derived from prices in financial markets where actual investments are made by sophisticated investors and thus are likely to reflect careful considerations. The Bank of England publishes market expectations of inflation by calculating the yield differential between index-linked and conventional bonds which have otherwise comparable characteristics (for more detail, see Breedon, 1995). We use the implied inflation forward curve for bonds with a maturity of 10 years. This series is available monthly since 1985.

The second source of forward looking inflation expectations is from *Consensus Forecasts*. We use the one-year-ahead consensus forecast of the retail price index and the one-year-ahead consumer price index during the RPIX and consumer price index targeting period of the Bank of England, respectively. The data are available for the UK monthly since October 1989.

The third source for forward looking inflation expectations is the Bank of England household survey. We use the data from the Bank of England's *Inflation Attitudes Surveys*, which asks households since November 1999 in quarterly intervals by how much households expect prices to change in the next 12 months. Households answer to any of 9 different categories and the result is summarised in a median of inflation expectations, which is used in this study.

4.2 Assessing the Bank of England's policy credibility

We use two estimation approaches to assess monetary policy credibility: the Bayesian method estimates the parameters recursively, while the KF approach assumes stochastic parameters and is a time varying estimation approach.

The interpretation of the results is based on equations (2) and (3) as presented in the previous section. The overall absence of an inflationary bias in monetary policy is given when $\theta_u > 0$ and absence of an overall anti-deflationary bias is satisfied when $\theta_l < 0$. As before, we follow Amisano and Tronzano (2010) and relate long-run credibility to the stationarity of the $\{z_u, z_l\}$ series. Stationarity is found when ρ is below one.

The results are presented below in two major sections. The first part (4.2.1) shows the graphs of the parameters θ and ρ from both, the Bayesian and the KF estimations. The estimated parameters relate to equation (2) in the previous section and thus inform about Central Bank anti-inflation credibility. The second section (4.2.2) presents the results in the same format as before, but these are tests for anti-deflationary credibility, as outlined in equation (3). In each of these major sections we begin with presenting graphs of the overall and long-run anti-inflation credibility where the real expected interest rate is first determined by *ex post* inflation expectations, followed by inflation expectations from *Consensus Forecasts*, implied market expectations and BoE household survey expectations. At the end of each major section, the main results are summarised.

4.2.1 Anti-inflation credibility

In this section we turn to the results of anti-inflationary credibility estimated with the Bayesian and KF approaches. Long-run credibility is captured by the stationarity of the auxiliary variable z_u and shows in the graphs as ρ being less than 1. The overall absence of an inflationary bias is given when $\theta_u > 0$. All graphs depict a probability curve, which defines the probability of a positive θ_u over the estimation period (and thus overall inflation

target credibility) in all figures denoted with ‘.a’ and ‘.b’, while the probability curve in all figures denoted with ‘.c’ depicts the probability of a mean reverting process for z_t over time and thus long-run credibility.¹¹

Figure 1a relates to the ex-post real interest rate and depicts the plot of the Bayesian results (denoted by mcmc) of the overall anti-inflation credibility. It presents the posterior mean θ that corresponds to the anti-inflation credibility constraint and its 95% confidence interval. The line denoted as ‘prob’ is the probability with which θ is greater than zero.

Figure 1a: Backward-looking expectations: Posterior mean and confidence interval for θ and posterior probability of $\theta > 0$ (*prob*)

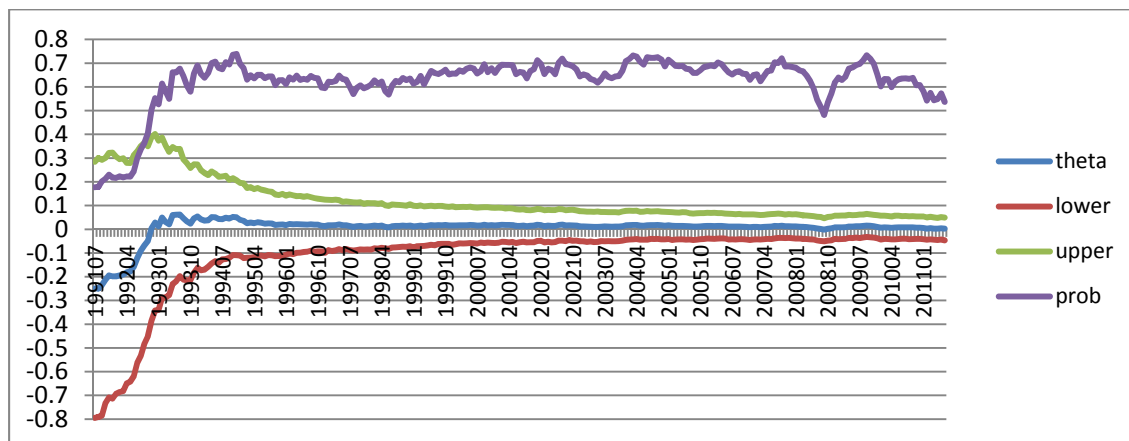
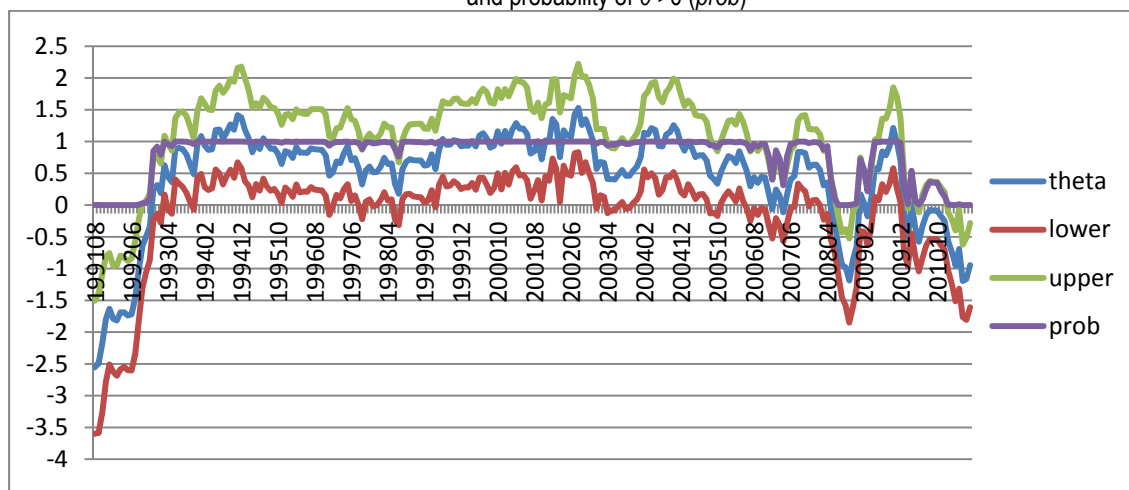


Figure 1b below corresponds to Figure 1a, but uses KF estimation instead.

Figure 1b: Backward-looking expectations: time varying coefficient θ , its 95% confidence interval and probability of $\theta > 0$ (*prob*)



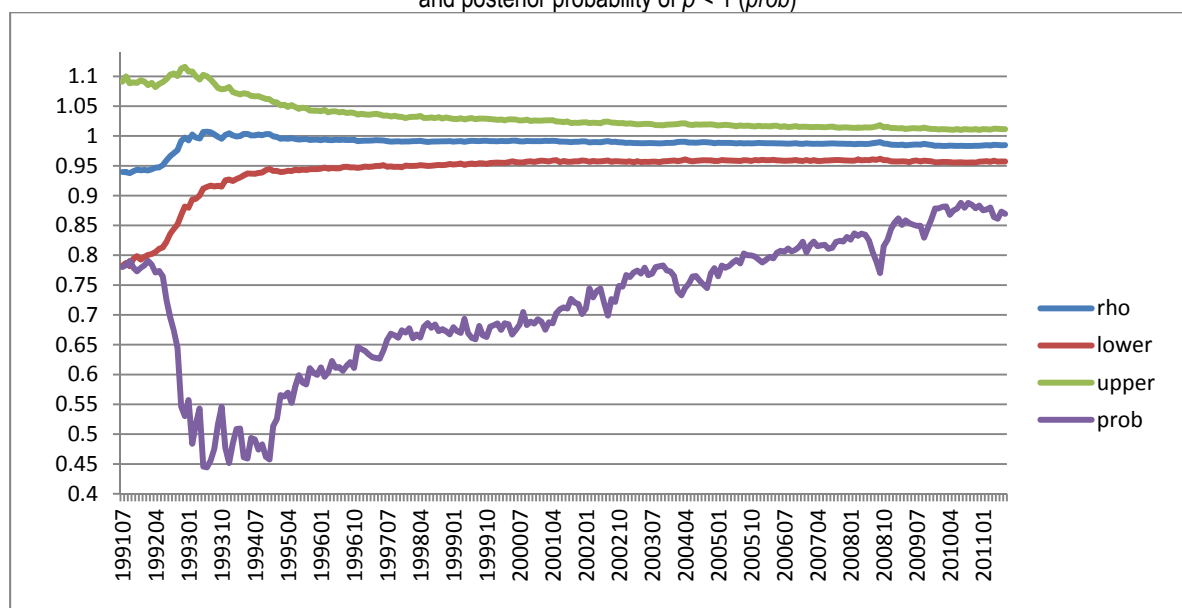
Both graphs have an intuitive interpretation. They reveal little or no credibility before the inflation targeting period beginning in 1992. θ is negative in both graphs until the end of 1992 and its corresponding probability is rather low or close to zero over this period. From then onwards, anti-inflation credibility rises steeply and remains high until the financial crisis. The Bayesian estimation shows a positive θ throughout, except for September 2008.

¹¹ Note that the figures display ‘theta’ only, since it is clear from the context whether they refer to θ_u or θ_l .

After September 2008, θ is positive, but close to zero, accompanied by a falling probability, indicating a rising loss of anti-inflationary credibility. The KF estimations show greater variability in general and in particular during the crisis period. From May until December 2008, θ is significantly negative (the probability of a positive θ is zero), indicating *no* anti-inflationary credibility. There is some fluctuation in θ since then, but the overall tendency is of a fall in anti-inflationary credibility since May 2008. Since 2010, θ is negative and since January 2011, anti-inflation credibility is rejected. This is consistent with the not-so-nice conditions referred to in our introduction: inflation well above target, since 2008, interest rates at their zero lower bound and a policy of quantitative easing. Rightly or wrongly, it seems that this is being taken as a signal that the Bank is much more concerned about recession than about keeping inflation within target. Note, that while the Bayesian estimator maintains BoE credibility over the entire estimation period (albeit at varying levels), the KF rejects overall credibility for the period before inflation targeting and, again, during the height of the financial crisis and, then again, since January 2011.

The results of long-run credibility from the Bayesian estimation broadly confirm the Bayesian overall results (Figure 1c). Throughout the estimation period, ρ is significantly below one. The probability for long-run credibility rises since the end of 1994 quite smoothly. In September 2008, at the same time when θ becomes negative, there is a dip in credibility, but there is a rather instant recovery from then onwards. From 2010 onwards, the upward trend is reversed and long-term credibility seems to remain constant.

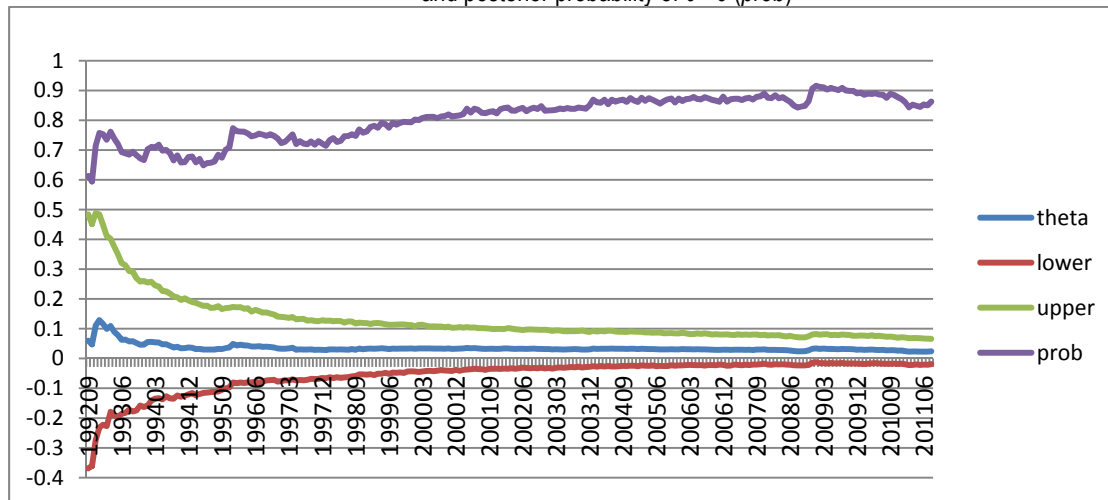
Figure 1c: Backward-looking expectations: Posterior mean and confidence interval for ρ and posterior probability of $\rho < 1$ (*prob*)



The following graphs show the development of anti-inflation credibility calculating the real expected interest rate using inflation expectations as reported by *Consensus Forecasts*. The results of the overall Bayesian and KF estimations are shown in Figures 2a and 2b, respectively. Figure 2a shows that θ is positive and relatively high compared with the results on ex-post expectations and its corresponding probability is also relatively high, varying between 0.6 and 0.9. At the end of 1992, θ rises sharply until March 1993 after which the trend is downward until end 1995 from when it rises steadily. The next sharp fall is again

in September 2008 and in January 2009 credibility rises again to fall then off from February 2009 onwards.

Figure 2a: Consensus forecasts: Posterior mean and confidence interval for θ and posterior probability of $\theta > 0$ (*prob*)



These results are broadly confirmed by the KF estimations. Variations of θ are greater compared to the Bayesian estimation and θ is mostly positive until February 2008. After that, it becomes negative until October 2008. In January 2009, θ rises sharply and then falls off from February onwards when it is either close to zero or negative for the remaining period. Both estimation methods show a sudden short-lived rise in credibility just after November 2008. This may be related to the rising fear of a deflationary threat at that time. After the brief rise in credibility from December 2008 until April 2009, there is a predominantly downward trend in CB credibility.

Long-run credibility (Figure 2c) has been established throughout the sample period, albeit at a comparatively low probability at the very beginning of the sample period. There is no indication that long-run credibility has fallen during the crisis period.

Figure 2b: Consensus forecasts: time varying coefficient θ , its 95% confidence interval and probability of $\theta > 0$ (*prob*)

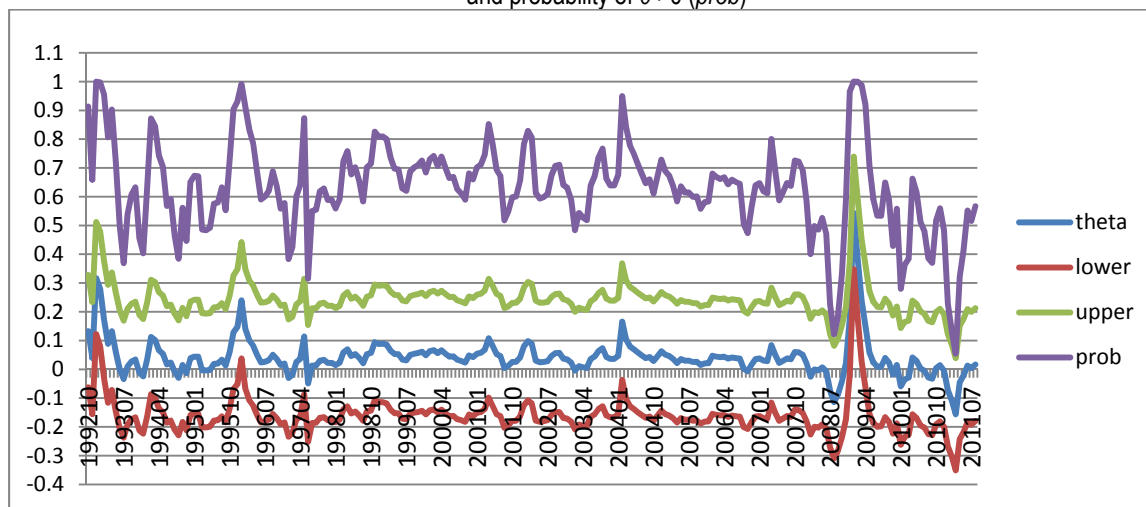
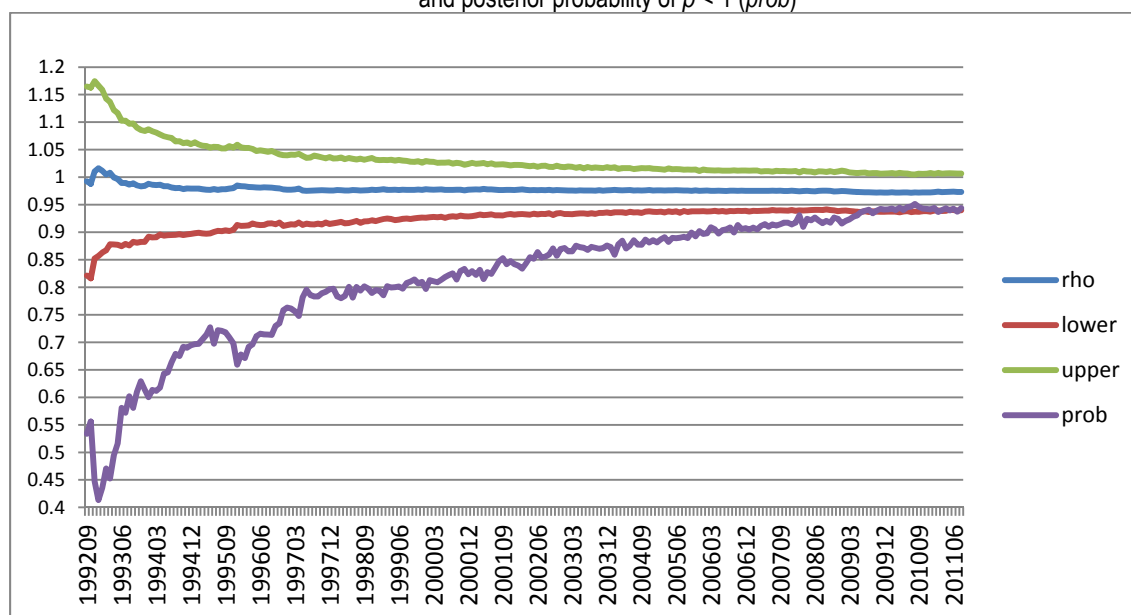


Figure 2c: Consensus Forecast: Posterior mean and confidence interval for ρ and posterior probability of $\rho < 1$ (*prob*)

We now consider the credibility estimates obtained using market-based expectations of inflation. This set of estimates supports the previous findings, but also discloses some new empirical results. We consider first overall inflation credibility based on the Bayesian method as shown in Figure 3a. Even though financial markets find that the Bank of England has anti-inflation credibility throughout the sample, the significance level is low at just above 10 per cent for most of the period until mid-1997. Only in early 1992, just before the introduction of inflation targeting, we observe a rise in θ , indicating that markets seem to have initially anticipated the planned change in the monetary policy regime as a positive step toward curbing inflationary pressure. However, shortly afterwards, close to the official introduction of the inflation targeting regime, θ begins to fall again and remains negative until mid 1997. From then onwards, it begins to hover around zero, until it becomes negative again at the height of the financial crisis in August 2008. Since then θ has been falling.

These results are reinforced in the KF estimations. While the Bayesian results, 3b, still suggest overall anti-inflationary credibility, the results of the KF show periods over which markets are obviously doubting the Bank's anti-inflation policy. In particular, until March 1992, KF estimations suggest no credibility. In line with the Bayesian results, credibility appears to rise in anticipation of the introduction of the inflation target in November 1992, but then, markets do not seem to regard the BoE anti-inflationary credible until summer 1993. Overall, there are various switches between short periods of anti-inflationary credibility followed by short periods of a loss of anti-inflationary credibility. The overall picture is that anti-inflationary credibility was high between the beginning of 1998 and the end of 2005, which agrees mostly with the results of the Bayesian estimations. From 2006 onwards, θ has fallen. Significantly, anti-inflationary credibility has been rejected since May 2007.

Figure 3a: Market expectations: Posterior mean and confidence interval for θ and posterior probability of $\theta > 0$ (*prob*)

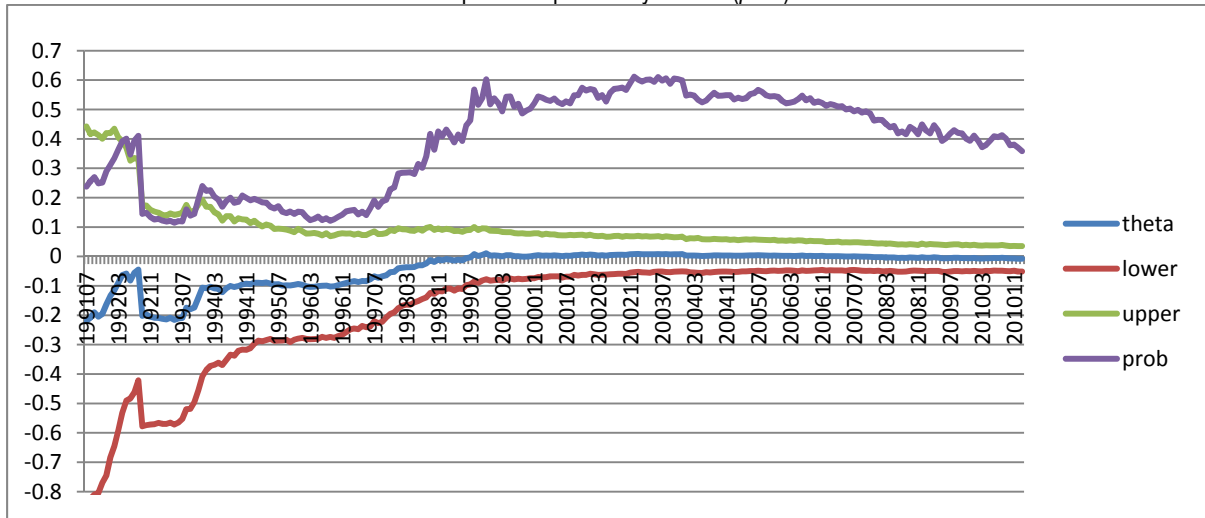
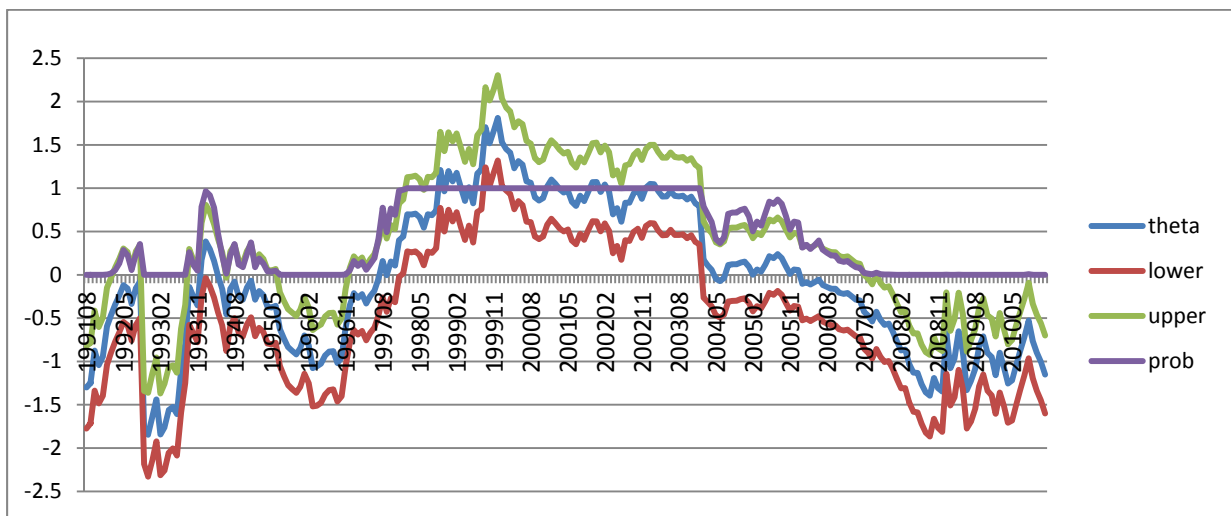
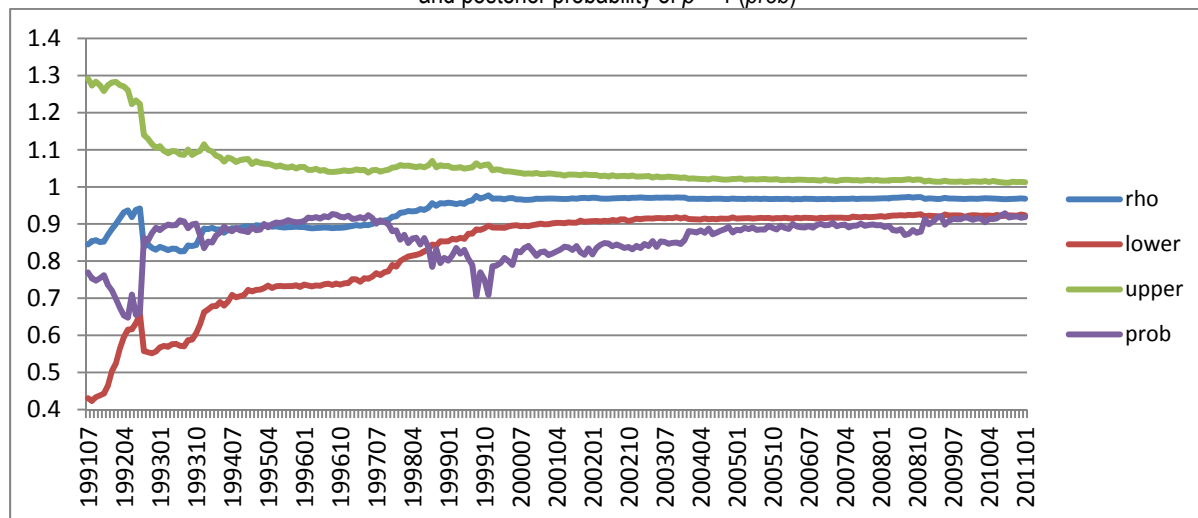


Figure 3b: Market expectations: time varying coefficient θ , its 95% confidence interval and probability of $\theta > 0$ (*prob*)



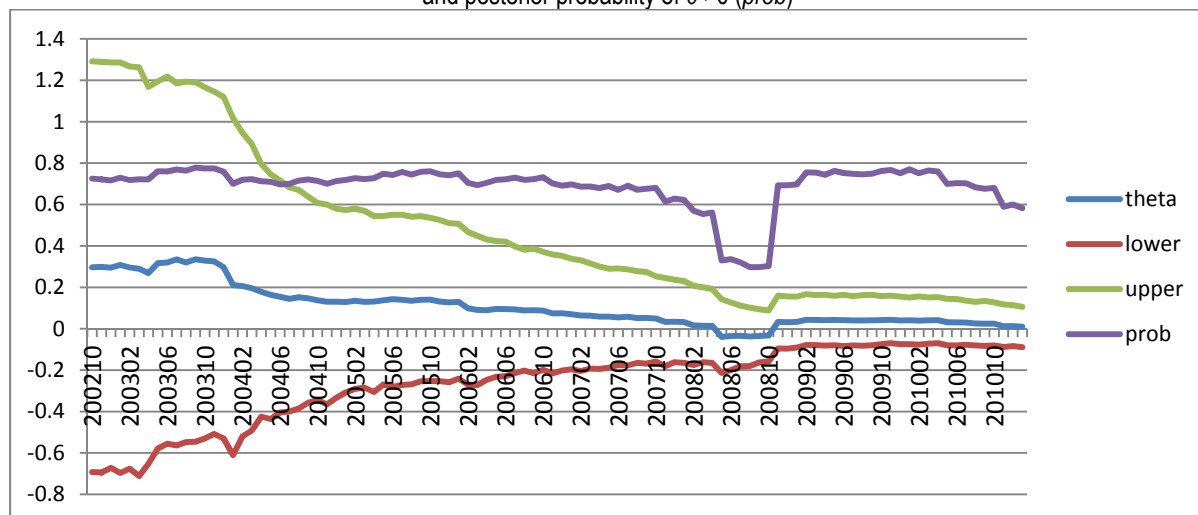
Consider now long-run inflation credibility (Figure 3c). The probability (*prob*) and ρ show that z is a mean reverting process during the entire period, supporting the Bayesian estimation of overall credibility throughout the sample period.

Figure 3c: Market expectations: Posterior mean and confidence interval for ρ and posterior probability of $\rho < 1$ ($prob$)



We turn now to anti-inflationary credibility based on inflation expectations of households as revealed by survey data since the end of 2002. Both, the Bayesian and KF estimations show that anti-inflationary credibility has been high for most of the period. Turning to Figure 4a first, overall anti-inflationary credibility is high until the end of 2007, when it begins to fall moderately. In May 2008, θ falls sharply and remains negative until October 2008. Subsequently, θ rises, but since the beginning of 2010, credibility has been falling.

Figure 4a: Household Survey: Posterior mean and confidence interval for θ and posterior probability of $\theta > 0$ ($prob$)



The overall anti-inflationary credibility results from the KF show a generally lower θ with a corresponding lower probability (Figure 4b). The financial crisis is reflected similarly in the estimations as in the Bayesian results: θ is negative between March and November 2008. Thereafter, θ rises initially, to begin a downward trend from 2009 onwards.

Lastly we turn to the long-run inflation target credibility from the perspective of the households. ρ is mostly below 1, only between May and October 2008, ρ is about 1, but not

significantly so in a statistical sense. We may conclude that there has been overall and long-run inflation target credibility from the household perspective.

Figure 4b: Household survey: time varying coefficient θ , its 95% confidence interval and probability of $\theta > 0$ (*prob*)

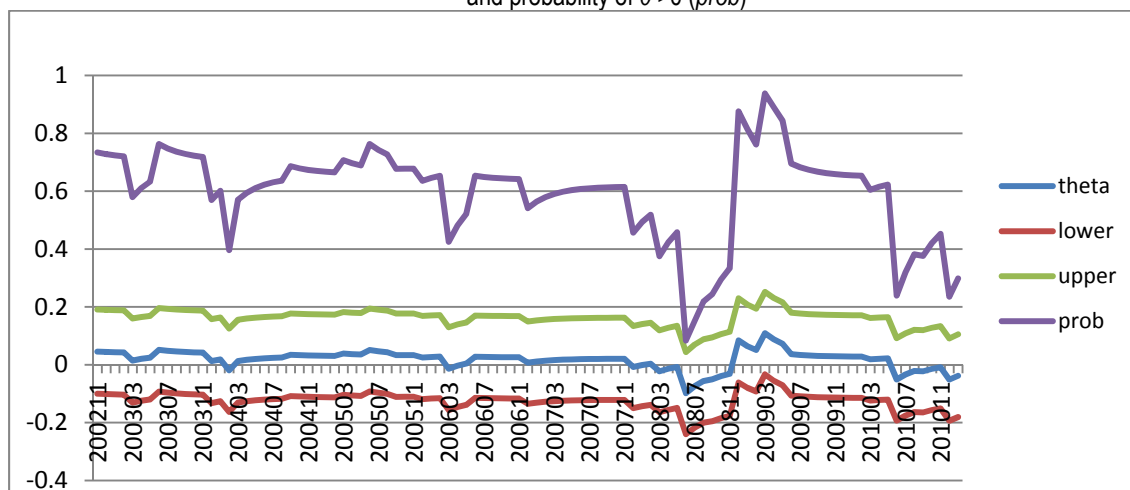
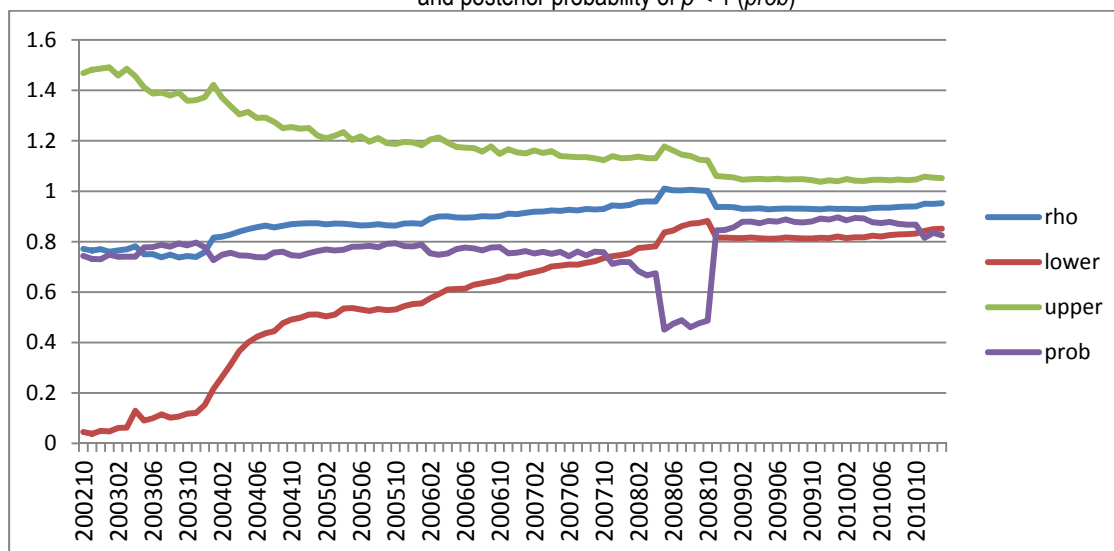


Figure 4c: Household survey: Posterior mean and confidence interval for ρ and posterior probability of $\rho < 1$ (*prob*)



What we find, therefore, is that anti-inflation credibility using household survey data is rather similar to that of professional forecasters and when we use *ex post* expectations (i.e. *actual* inflation). This is similar to the results in Breedon and Hume (2007) who also use household survey data on inflation expectations in the UK and find that they are in line with actual inflation. In the light of recent events in the UK this is an interesting result since it rejects the impression created in the media that the general public has become very sceptical about the Bank of England's commitment to low inflation in the light of the change in inflation target in 2004 and the high levels of RPI inflation since 2008. Of course, part of the explanation may lie in low response rates (for which surveys are notorious). This could mean that the expectations reported in the survey come from a subset of 'households' with a particular interest in inflation (so they form their views by reference to professional opinion).

However we look at these results, it is the measure of anti-inflation credibility based upon inflation expectations derived from market (yield curve) data that stands out from the others. The *majority* view, with only detailed variations, regarding the Bank of England's anti-inflation credibility, is that:

- The adoption of an explicit inflation target had a positive effect
- The switch from an RPIX to CPI target in 2004 had no detectable negative effect
- Credibility has declined since 2008, since the onset of the crisis and the introduction of QE

The most surprising of these is the second, which was our subsidiary hypothesis, namely that households might have interpreted the switch as some sort of trickery or perhaps a loosening of the inflation target. We thought this was worth pursuing because of the subsequent divergence between CPI and RPI inflation and the publicity given to arguments, from wage negotiators in particular, that CPI inflation systematically understated the impact on their members. We find no evidence of this, even where expectations information is drawn from a general household survey.

Compared with this majority view, we can summarise the results obtained from expectations based on yield curve data as suggesting that 'the markets' are generally more 'sceptical' about the Bank's anti-inflation credibility. In contrast to the other three sources of expectations, where we mostly found an extended period of rising anti-inflationary credibility, here, we only identified a short period of rising credibility from about 1997 until the end of 2003. Since then, credibility has fallen steadily. The overall result of the Bayesian estimation is that the markets regarded the BoE as anti-inflationary credible, but generally at a lower level than was found under *ex post*, *Consensus Forecasts* and household survey inflation expectations. Remember that these rather pessimistic expectations are drawn from a yield curve. In so far as those expectations of inflation are higher than expectations derived from alternative sources, this must mean that the yield curve (abstracting from questions of risk and liquidity premia) is steeper than it would be if based on our other sources of expectations.

4.2.2 Anti-deflation credibility

In this section we turn to the results of anti-deflationary credibility estimated with the Bayesian and KF approaches. The question here is whether agents are confident in the policymakers' ability to prevent inflation falling too close to negative territory. As before, long-run credibility is captured by the stationarity of the auxiliary variable and shows in the graphs as ρ being less than 1. The overall absence of a deflationary bias is given when $\theta_l < 0$. As before, all graphs depict a probability curve, which defines the probability of a negative θ_l over the estimation period (and thus overall deflation target credibility) in all Figures denoted with ' .a ' and ' .b ', while the probability curve in all Figures denoted with ' .c ' depicts the probability of a mean reverting process for z_t over time and thus long-run credibility.¹²

As in the previous section, we discuss the results in sequence of the inflation expectations proxies. We begin with *ex post* inflation expectations. Figure 5a plots θ , its confidence interval and the posterior probability of θ being lower than 0. Until October 1992, θ was negative and started to rise once inflation targeting was introduced. It hovered around zero most of the time until September 2009, when it rose for a very short period. It has been

¹² Note that the figures display 'theta' only, since it is clear that we refer to θ_l in this section.

negative with rising probability since. Overall, anti-deflationary credibility has been maintained. These results are broadly confirmed by the KF estimation (Figure 5b). Here also, θ stays close to zero and becomes positive for most of 2009. However, again, anti-deflationary credibility is not rejected at any time.

Figure 5a: Backward-looking expectations: Posterior mean and confidence interval for θ and posterior probability of $\theta < 0$ ($prob$)

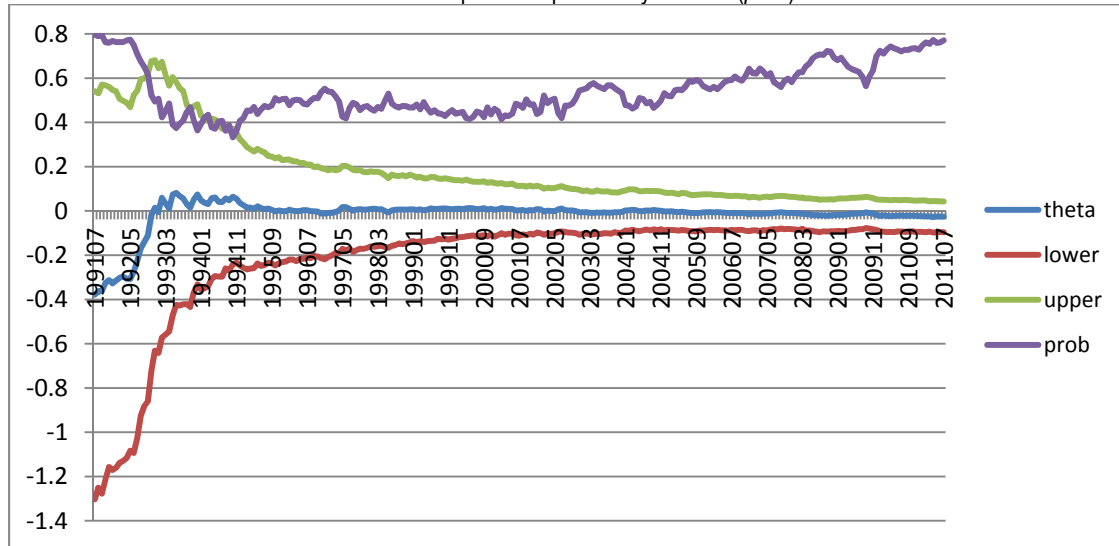


Figure 5b: Backward-looking expectations: time varying coefficient θ , its 95% confidence interval and probability of $\theta < 0$ ($prob$). p was estimated recursively.

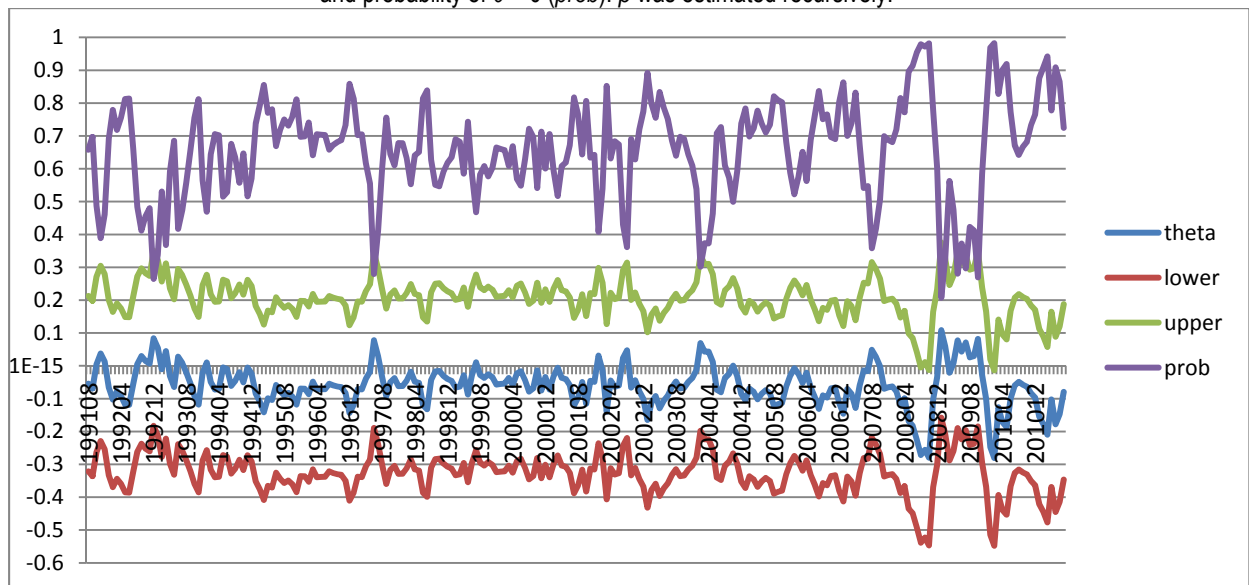
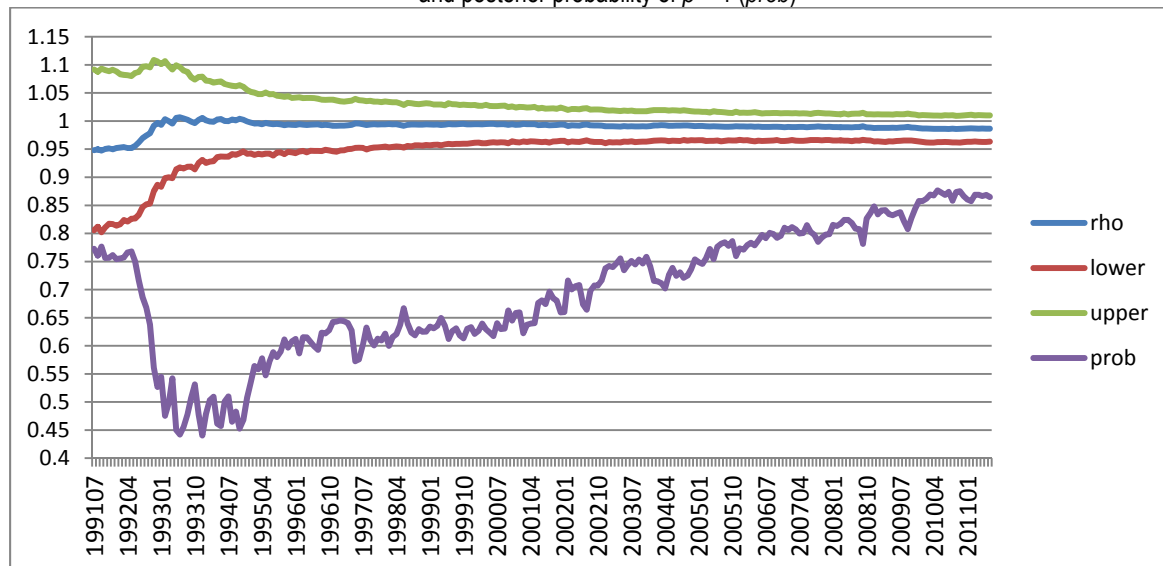


Figure 5c: Backward-looking expectations: Posterior mean and confidence interval for ρ and posterior probability of $\rho < 1$ ($prob$)



Turning to long-run credibility, ρ is close to or equal to one, but there is no evidence of significant non-stationarity. Over the estimation period, the probability of ρ being below one rises, confirming the results of overall anti-deflationary credibility.

We turn now to the findings of anti-deflationary credibility based on the expectations of professional forecasters. θ is negative over the entire estimation period, except during the early 1990s (Figure 6a). The probability of a negative θ is on average 0.6. It rises over time. In line with previous results on anti-deflationary credibility when ex-post inflation expectations were used to calculate z , here, θ also falls during 2009. The KF estimations (Figure 6b) confirm the findings, only in a more obvious way. A brief glance at Figure 6c confirms that z is stationary and that long-run anti-deflationary credibility has prevailed over the entire estimation period.

Figure 6a: Consensus forecasts: Posterior mean and confidence interval for θ and posterior probability of $\theta < 0$ ($prob$)

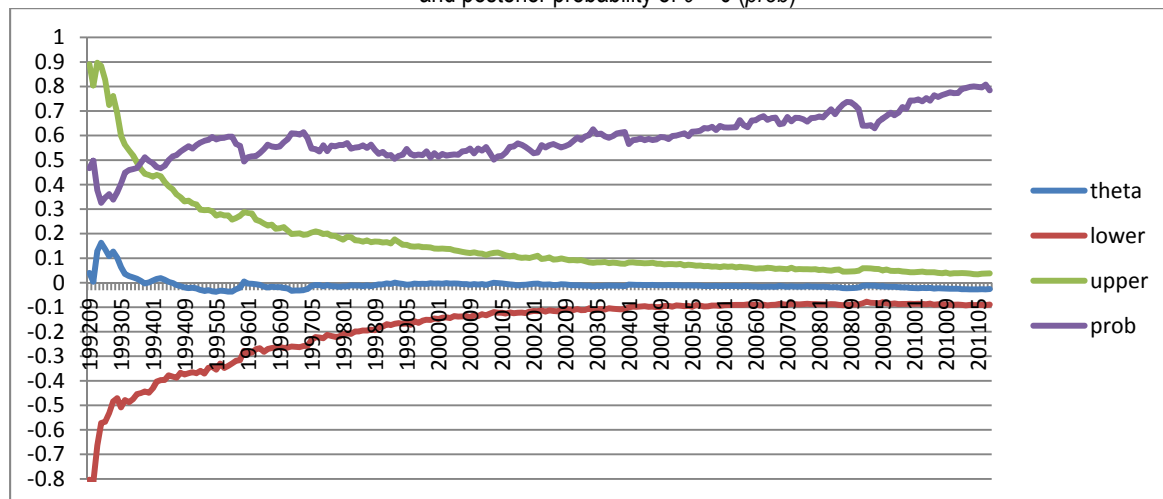


Figure 6b: Consensus forecasts: time varying coefficient θ , its 95% confidence interval and probability of $\theta < 0$ ($prob$)

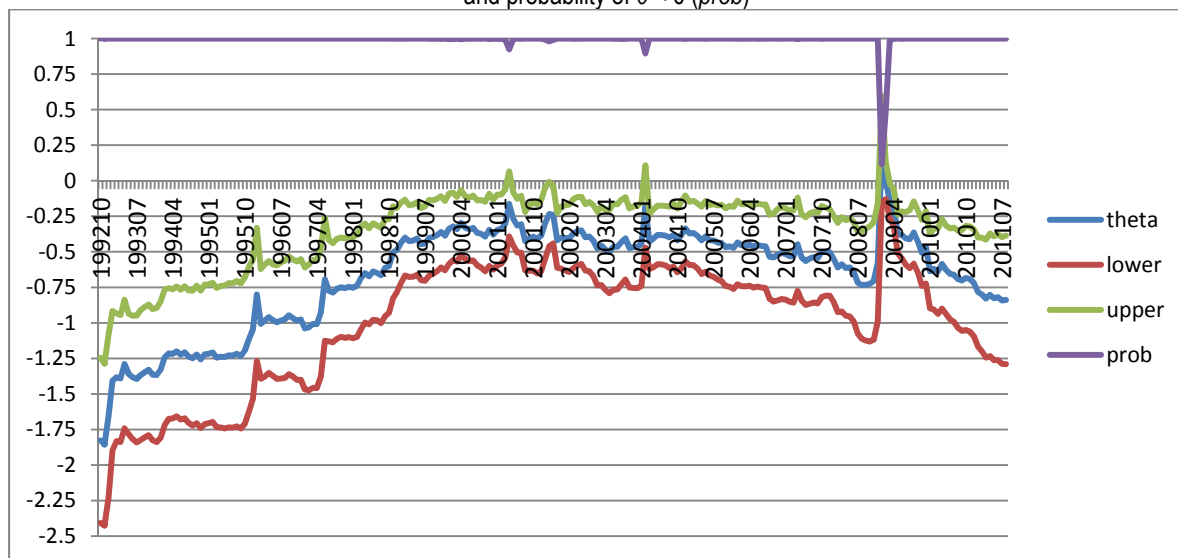
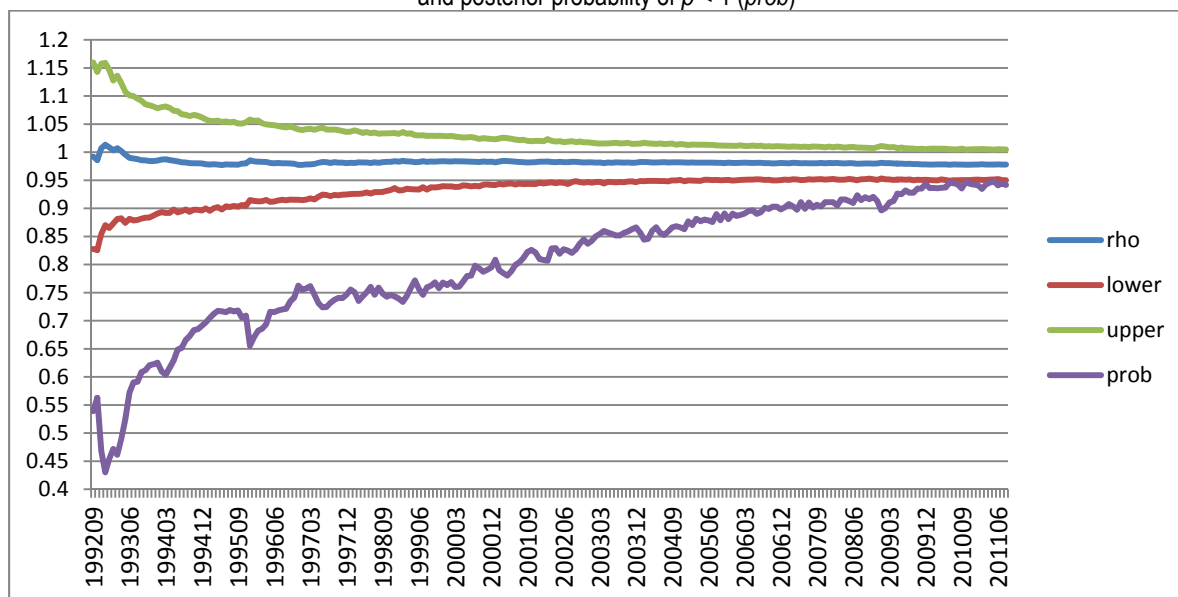


Figure 6c: Consensus forecasts: Posterior mean and confidence interval for ρ and posterior probability of $\rho < 1$ ($prob$)



When we test for anti-deflationary credibility using market inflation expectations, the results are more distinctive and richer. As with all previous results, anti-deflationary credibility cannot be rejected throughout. Mirroring the subdued anti-inflationary credibility, as shown previously in Figures 3a – 3c, market data reveal high anti-deflationary credibility at the beginning of the period until the beginning of 1998, where θ is still negative, but relatively closer to zero (Figure 7a). The probability of a negative θ rises, but falls from about mid 1999 until mid 2000. This coincides with the period during which actual inflation was

below the target. Figure 7b shows market's concern over potential deflationary pressure more clearly – θ is obviously higher from mid 1999 until mid 2000. From then onwards, there is again clear evidence of anti-deflationary credibility. In Figure 7a, we also observe a rising probability since end 2000. The previous graphs, based on *ex post* and consensus forecast inflation expectations, indicate a fall in anti-deflationary credibility some time during the crisis period, suggesting an increased anxiety that inflation might turn negative. This anxiety is not evident in the results based on market inflation expectations. At no time, it seems, did the yield curve suggest a high probability that inflation might fall below the lower target level. This is interesting in the light of our earlier findings about market views on anti-inflationary credibility. We said then that markets appeared 'more sceptical' of the Bank's anti-inflation credentials. Here we see markets expressing a distinct view once again, this time that the Bank has plenty of anti-inflation credibility.

Long-run anti-deflationary credibility (Figure 7c) was particularly high until the beginning of 1997, when it fell, covering again the very low inflation period. Since then anti-deflationary credibility has risen steadily.

Figure 7a: Market expectations: Posterior mean and confidence interval for θ and posterior probability of $\theta < 0$ (*prob*)

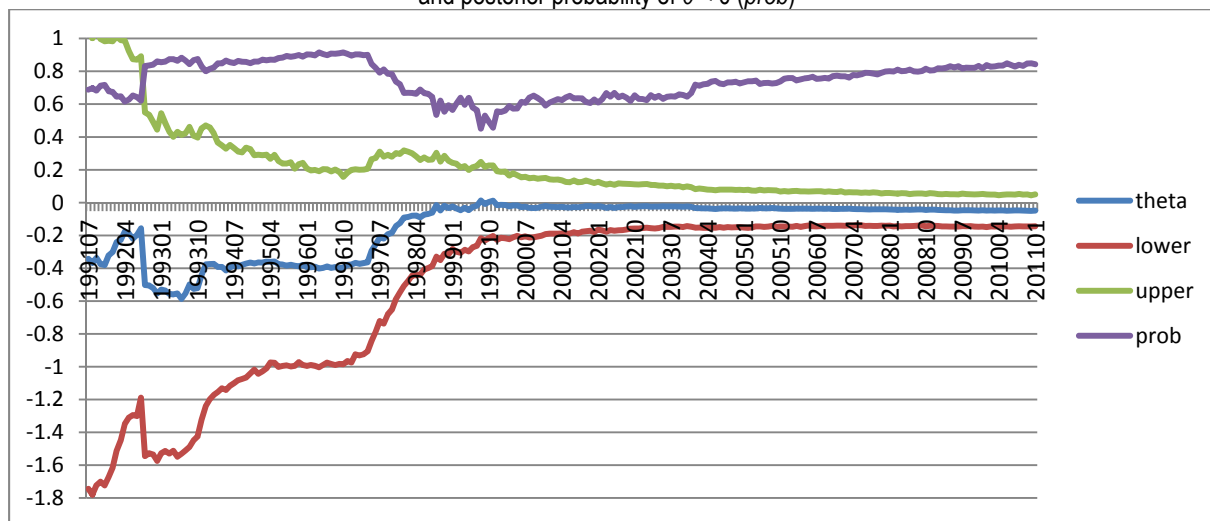


Figure 7b: Market expectations: time varying coefficient θ , its 95% confidence interval and probability of $\theta < 0$ (*prob*)

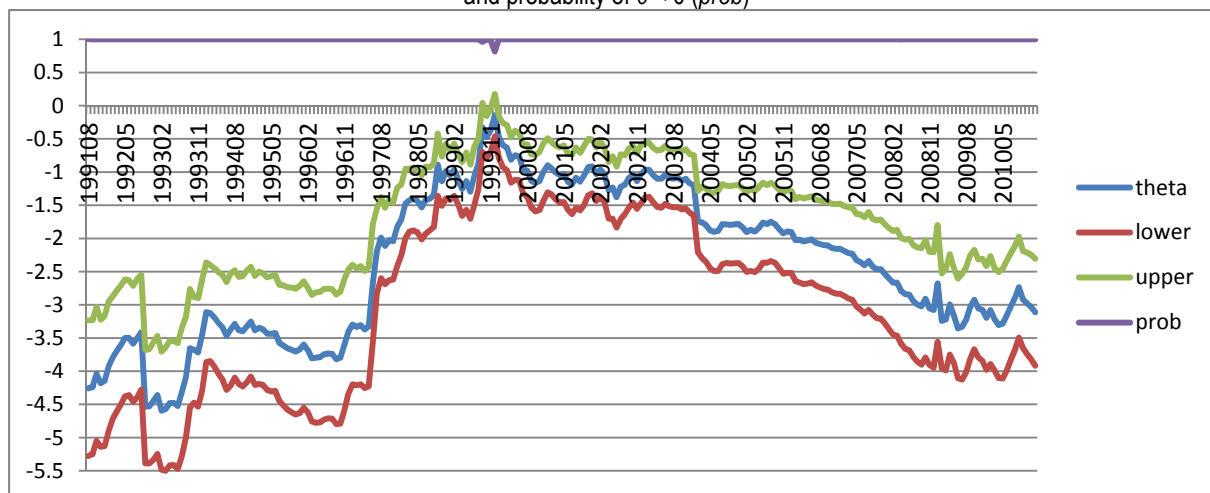
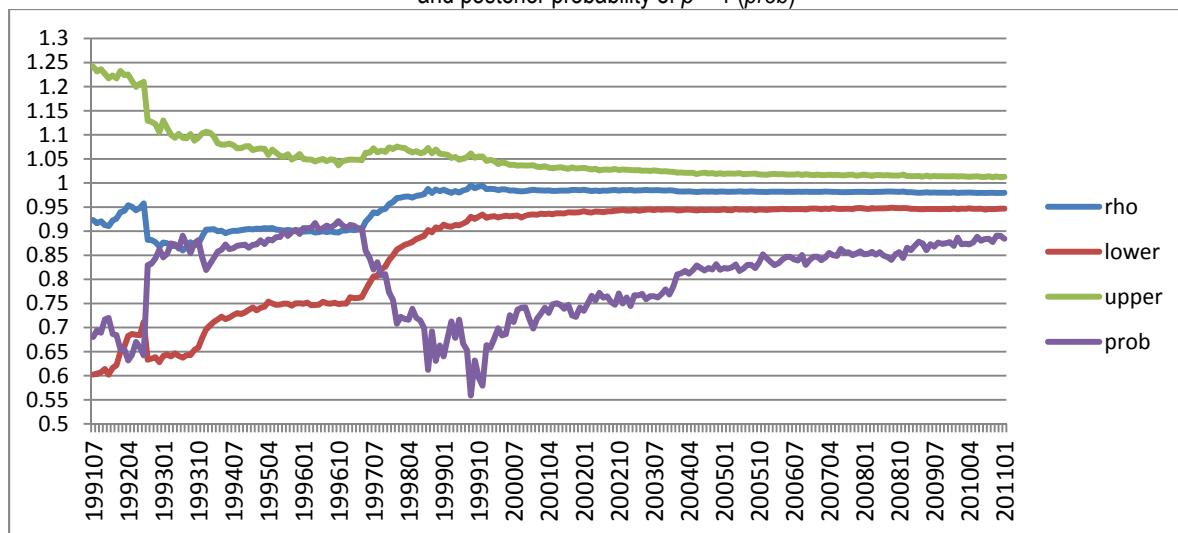


Figure 7c: Market expectations: Posterior mean and confidence interval for ρ and posterior probability of $\rho < 1$ (*prob*)



We finally turn to the anti-deflation credibility results employing survey data. All estimations point to anti-deflationary credibility throughout the estimation period. θ is negative (Figure 8a and 8b) and ρ is significantly below 1 (Figure 8c). However, the Bayesian estimation shows a loss in overall and long-run credibility in the midst of the crisis between May and October 2008. This fall in credibility is not confirmed by the KF results, which show a continuous fall in θ and thus a continuous rise in anti-deflation credibility. The Bayesian results also show a rise in anti-deflation credibility since November 2008.

Figure 8a: Household survey: Posterior mean and confidence interval for θ and posterior probability of $\theta < 0$ (*prob*)

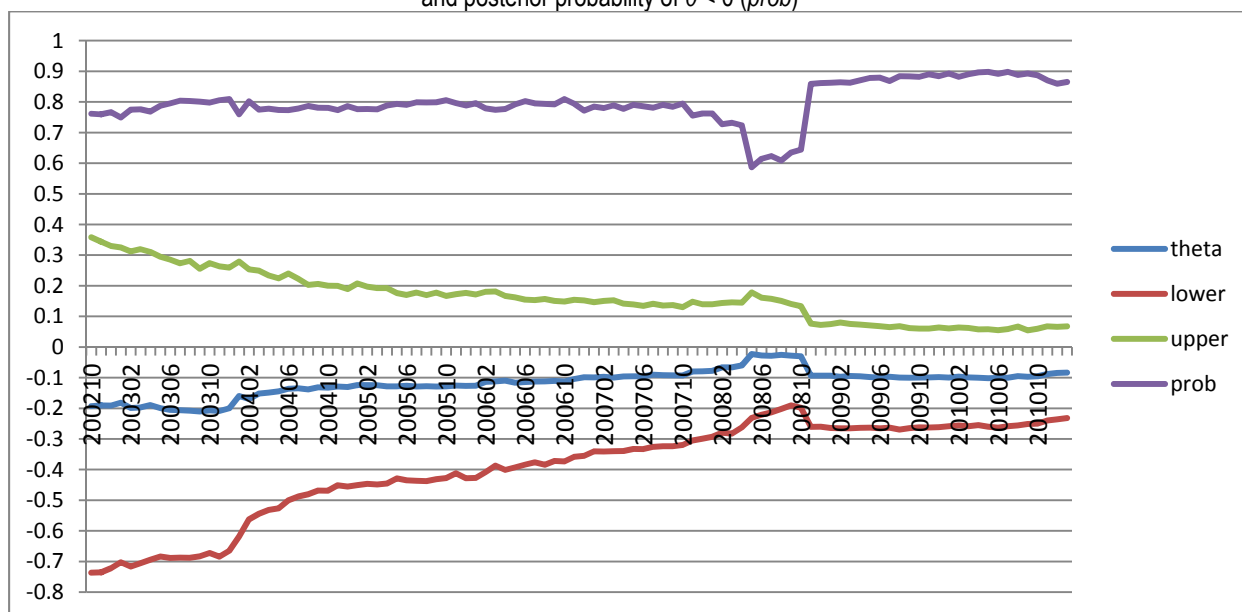


Figure 8b: Household survey: time varying coefficient θ , its 95% confidence interval and probability of $\theta < 0$ ($prob$)

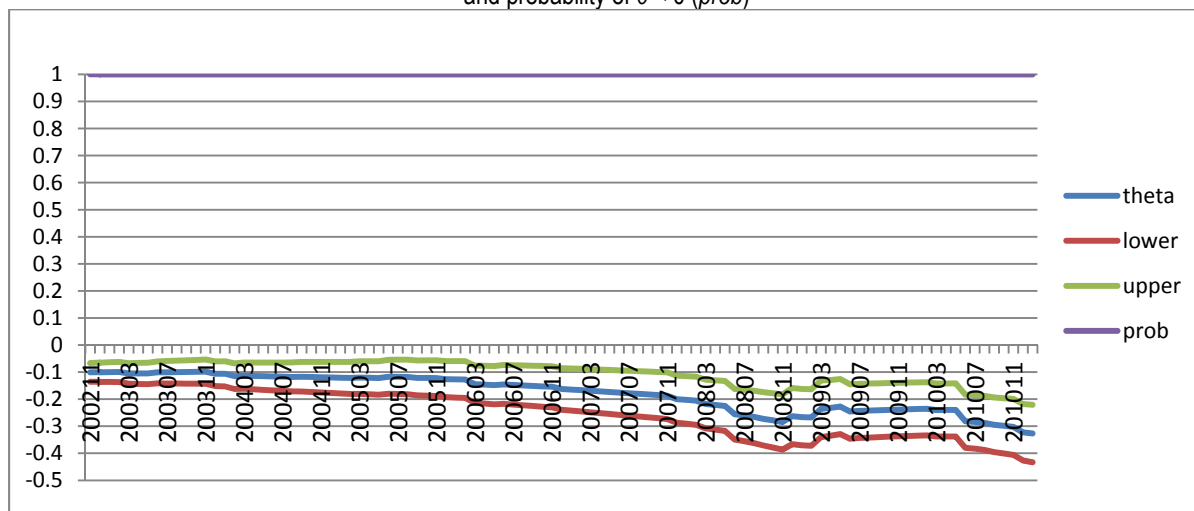
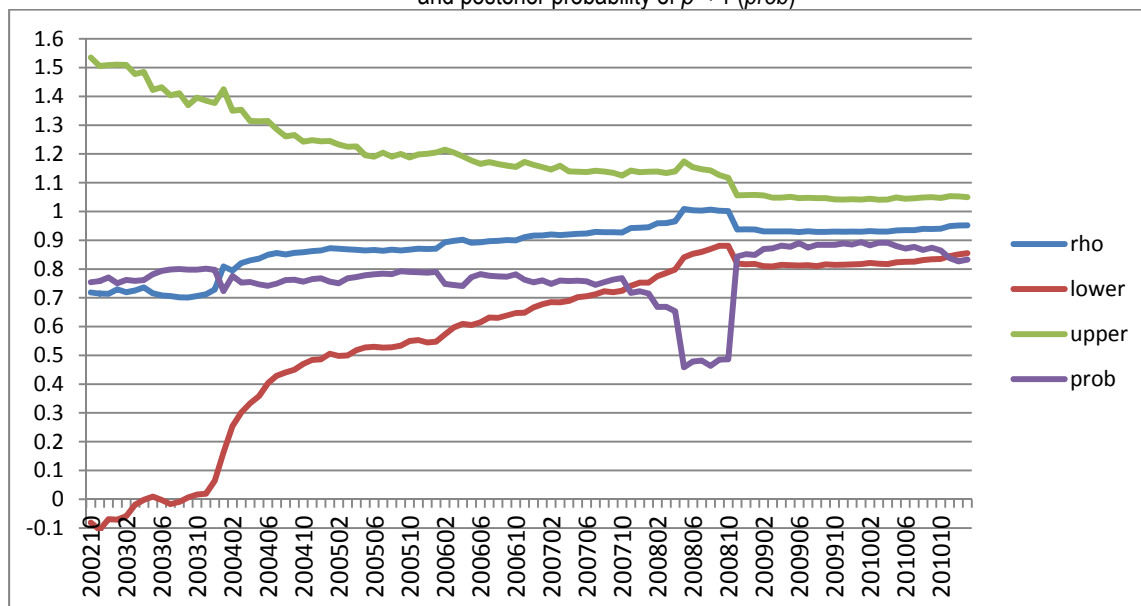


Figure 8c: Household survey: Posterior mean and confidence interval for ρ and posterior probability of $\rho < 1$ ($prob$)



Overall, we see once again a broad consensus where anti-deflationary credibility is concerned. Of course, the background is rather different when we compare inflation and deflation expectations. Over the estimation period, inflation was below target only over a brief period between 1999 and 2000. There was another brief period of deflationary fears during the crisis in 2008, but by and large the opportunities to ‘worry’ about deflation were far fewer than those which gave rise to inflation anxieties. However, the crisis period is particularly important in this respect since, as we said in the Introduction, the Bank of England felt obliged to loosen monetary policy quite dramatically. Generally, our results suggest that anti-deflationary credibility is never rejected.

However, there is once again a distinctive outcome when we look at credibility measured by expectations from market sources. When we look at the graphs based on *ex post*, *Consensus Forecast* and household survey inflation expectations, these indicate at least a fall or reduction in anti-deflationary credibility some time during the crisis period, when the possibility of a Japan-style deflation looked possible. Apparently, this was never a worry for bond markets. At no time, it seems, did the yield curve suggest a high probability that inflation might fall below the lower target level. This is interesting in the light of our earlier findings about market views on anti-inflationary credibility. We said then that markets appeared ‘more sceptical’ of the Bank’s anti-inflation credentials. Here we see markets expressing a distinct view once again, this time that the Bank has plenty of anti-inflation credibility. Taken together, the two outcomes suggest that markets view the Bank as having either an ‘inflation bias’ in its preferences or, at least, as finding it technically more difficult to restrain inflation than to avoid deflation.

It may be objected that the difference in results concerning market expectations compared to those from all other proxies may be related to the calculation of implied inflation expectations. Breedon (1995) shows that from 1989 until 1993, market inflation expectations in the UK were consistently higher than the actual inflation rate. He argues that this may be because it actually reflected market expectations, but that it is also possible that the difference in returns between conventional and index linked bonds overestimates inflation expectations. It has long been known that extracting forecasts of future short-term interest rates from the yield curve is difficult because of time varying risk premia (see, for example, Breedon, 1995; Joyce and Meldrum, 2008) and the extraction of inflation forecasts requires further assumptions in connection with the Fisher identity. The idea that inflation forecasts based on market yields might differ from other sources of inflation expectations, therefore, is unsurprising, especially during a period of dramatically fluctuating risks of various kinds, after 2008. However, the fact remains that market-based expectations produce rather different results throughout our period and, as we said earlier, it is the yield curve that influences macroeconomic behaviour, and maybe also the setting of the policy instrument. If this is giving signals that conflict with those from other sources, this is important and needs to be recognised.

5. CONCLUSION

In the course of this paper we have used two estimation methods (Bayesian and Kalman-Filter) and four different measures of inflation expectations, to examine the relationship between these expectations and the Bank of England’s inflation targets. Given the two estimation methods and the four sources of inflation expectations we have eight tests of expectations against targets from which we can draw conclusions about both the Bank’s anti-inflation and anti-deflation credibility.

The most striking conclusion is probably the degree of unanimity shown across all the tests. Generally speaking, the Bank’s anti-inflation credibility is increased by the announcement of inflation targeting in 1992; is unaffected by the switch from RPIX to CPI targeting in 2004 but falls after the onset of the financial crisis in 2007. However, when we focus on inflation expectations derived from the yield curve we find that bond markets are not so convinced of the Bank’s anti-inflation credentials, though expectations derived from the yield curve must be treated with caution.

When it comes to anti-deflation credibility, the picture is rather more complicated. When we use expectations based upon actual inflation outturns and on the views of professional forecasters, the switch to inflation targeting increases credibility, the change from RPIX to CPI makes no difference (again) and the onset of the crisis *increases* the Bank’s anti-deflation credibility, suggesting that its aggressive loosening of monetary policy

(and no doubt the fact of above-target inflation) persuaded agents that deflation was unlikely. Using expectations derived from the yield curve, we find that the Bank's anti-deflation credibility for the whole period is higher than when using other measures of inflation. This links with the yield curve results for anti-inflation credibility since it suggests that markets see the Bank as more certain to avoid deflation than inflation. In this sense, markets appear to detect an inflation bias in Bank policy. When it comes to household views about anti-deflation credibility, the 2004 change has no effect and since November 2008, the Bank's anti-deflation credibility has risen.

The principle motivation for this paper was a concern that recent events may have undermined the Bank's credibility, especially with respect to its anti-inflation commitment. Somewhat disturbingly, that does seem to be the case. But looking at the UK economy in the autumn of 2011, it is difficult to imagine anyone seriously calling for a *rise* in interest rates, even amongst those who earlier in the year had thought this was necessary.

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