External MPC Unit

Discussion Paper No.21

The behaviour of the MPC: Gradualism, inaction and individual voting patterns

by Charlotta Groth and Tracy Wheeler

External MPC Unit Discussion Paper No. 21*

The behaviour of the MPC: Gradualism, inaction and individual voting patterns

By Charlotta Groth**
and
Tracy Wheeler***

January 2008

ISSN: 1748 – 6203

The authors wish to thank Kate Barker for valuable comments and suggestions.
This paper has been externally refereed.

(*) Disclaimer: These Discussion Papers report on research carried out by, or under supervision of the External Members of the Monetary Policy Committee and their dedicated economic staff. Papers are made available as soon as practicable in order to share research and stimulate further discussion of key policy issues. However, the views expressed are those of the authors and do not represent the views of the Bank of England or necessarily the views of other External Members of the Monetary Policy Committee.

(**) External MPC Unit, Bank of England.
(***) External MPC Unit, Bank of England.

Contents

Abstract

We evaluate the degree of gradualism and inaction in UK monetary policy over the Monetary Policy Committee (MPC) period (1997-2007) at the quarterly and the monthly frequency. After accounting for misspecification in standard Taylor rules, we find little evidence for gradualism. A measure of optimal policy is calculated. Comparing this with actual policy suggests that there is less inaction in monetary policy decisions than previous work suggested for the period prior to the formation of the MPC. In an analysis of the MPC's monthly voting decisions, we find that the activity rate, defined as the probability that the MPC vote to change interest rates in a given month, has fallen over time. This reflects the increased stability of inflation and output growth, rather than changes in the degree of gradualism and/or inaction. There is some evidence for inaction at the monthly frequency however, demonstrated by the fact that the MPC is more active in the forecast month than in the non-forecast month. The MPC also tends to wait longer before reversing the direction of interest rate changes than continuing them. This difference appears not to be driven by gradualism, and so provides further evidence for inaction at the monthly frequency. A panel data analysis suggests that the MPC as a whole is equally active as its individual members, so inaction appears not to be driven by the use of a committee to set monetary policy. There is no evidence that activity rates fall with the length of time that a member has served on the committee, suggesting that learning about the transmission mechanism has no impact on the tendency for gradualism and inaction.

Summary

This paper investigates the evidence for *gradualism* and *inaction* in UK monetary policy since the establishment of the Monetary Policy Committee (MPC). We define gradualism as the tendency for the central bank to move interest rates in many small steps, rather than fewer larger steps, and inaction as the tendency to delay the decision to change the interest rate, perhaps to wait for more data.

The first part of the paper investigates the evidence for gradualism and inaction in the quarterly data. Although previous work suggests that monetary policy responds gradually to movements in inflation and the output gap, there is strong evidence that these models omit some important variables or are specified incorrectly. We adapt the models and find little evidence for gradualism in UK monetary policy over the MPC period.

To evaluate whether there is any evidence for inaction we estimate a measure of monetary policy when there is no incentive for the MPC to reduce interest rate volatility and compare it with actual monetary policy. Although there is some evidence that monetary policy has been inert over the MPC period, we find markedly less evidence for inaction than previous work suggests. This may reflect the fact that earlier work looked at monetary policy prior to the formation of the MPC, when both inflation and output were considerably more volatile. In line with the results from the previous section this exercise provides little evidence that policy has been more gradual than it should have been at the quarterly frequency given the dynamics of the economy.

The second part of the paper considers whether there is any evidence for inaction in the monthly data as this is the frequency at which monetary policy decisions are made in the UK. We find that the activity rate, defined as the probability that the MPC vote to change the interest rate at a given monetary policy meeting, has fallen over the sample period, though this entirely reflects the increase in the stability of output growth and inflation rather than the Committee becoming more inactive. However, we find some evidence of inaction in the tendency for the MPC to be more active in the quarterly forecast round. This tendency has increased over time, and this increase does not appear to be driven by increased economic stability. We also find evidence for inaction in the tendency of the MPC to wait longer before making an interest rate change which reverses the direction of the previous movement than one which maintains it. This trend is in line with

findings in the quarterly data, and common to other central banks with similar monetary policy frameworks.

In addition, we take advantage of the publication of individual MPC member voting records to analyse whether trends in the activity rate are related to the use of a committee (rather than individual) as a decision making body. There is no evidence that the MPC is less active than its individual members, though we do find differences in the voting patterns of internal and external members. In particular, external members tend to be somewhat more active than the internal members, despite the fact that internal members are more likely to act in response to deviations of the inflation forecast from target.

1 Introduction

It has been long noted that central banks tend to move interest rates gradually, making a series of small changes in one direction, rather than a larger single step change. This tendency is demonstrated in Chart 1, and results in the path of interest rates being smoother, and interest rate changes being smaller and more frequent, than some standard models of monetary policy would predict.

This type of behaviour has been rationalised in a number of different ways. The key argument refers to uncertainty about how much the economy will respond to a given interest rate change, due to parameter uncertainty (Brainard (1967).[1] However, the idea that uncertainty should increase gradualism is not a general principle, but depends on the type of uncertainty facing the policy maker, and the shocks hitting the economy.[2] Another reason for gradualism results from uncertainty about the most recent economic data – the element of noise, relative to news, in early data can motivate a gradual response to changes in the economy (Orphanides (1998) and Aoki (2002)). Woodford (1999) also shows that it may be optimal for central banks to act gradually in order to be able to influence private sector expectations of future short-term rates, and thus long-term interest rates. Blinder (1997), finally, suggested that interest rates may respond only gradually to news because of the inertia generated by a committee-based decision-making process. The idea is that it may take time to build a consensus in a committee for an interest rate move.

Another feature that seems to characterise central banks is that of inaction, or delay, as captured by the fact that for most central banks, the average length of time before a policy reversal exceeds that before a policy continuation. To justify this type of inaction, there must be some cost involved in reversing the decision. One potential cost is that commentators might see reversals as reflecting indecisions or incompetence. Another could be that if interest rates are reversed frequently, the link between short-term and long-term interest rates could be weakened, which would reduce the central bank's ability to control inflation.[3] Little theoretical work has been done

[1] Sack (1998) and Martin and Salmon (1999) provide empirical results which suggest that parameter uncertainty can account for some of the gradualism in actual interest rates in the United States and the United Kingdom.

[2] For example, Soderstrom (2002) finds that uncertainty about the degree of inflation persistence makes the optimal monetary policy less gradual. Leitemo and Soderstrom (2004) show that when there is uncertainty about the size of shocks, a central bank that wants to be robust against particularly bad outcomes will respond more aggressively to shocks hitting inflation.

[3] Woodford (1999) argues that gradualism helps communicate a credible committment to a changed future path of short-term rates, hence increases the pass-through of monetary policy to long-term rates. At the other end of the scale frequent policy reversals suggest that the policy maker has little committment to any future path of short-term rates reducing this pass-through.

on inaction and monetary policy, but a recent paper by Ellison (2006) argues that there is a learning cost involved in interest rate reversals, since frequently reversing the interest rate makes learning about the key features of the monetary policy transmission mechanism more difficult.

Some recent studies, finally, have questioned the evidence in favour of gradualism and/or inaction. Rudebush (2002) and Gerlach-Kristen (2004) argue that some of the evidence for gradualism in Taylor rules for the United States arises spuriously when central banks respond to unobserved variables that exhibit some persistence. Goodhart (2005) estimates Taylor rules using published forecasts for inflation and output growth for the UK, finding little evidence of gradualism or inaction in monetary policy; interest rates are changed whenever the inflation forecast deviates from target with no evidence for deliberate gradualism or inaction in the policy-decision.

This paper evaluates the degree of gradualism and inaction in UK monetary policy, focusing on the period since 1997 when the Bank of England was granted independence and the Monetary Policy Committee (MPC) was formed (the MPC period). We define *gradualism* as the tendency for the central bank to move interest rates in many small steps, rather than in one large change. Gradualism, therefore, results in serial correlation in the interest rate, even after controlling for lags in the transmission mechanism. We define *inaction* as the tendency for central bank to delay the decision to change interest rates, for example to wait for more data.

In the first part of the paper, we use *quarterly* data to estimate Taylor rules. The main conclusion is that, over the MPC period, there is little evidence for gradualism on a quarterly frequency once we account for model misspecification. To evaluate whether there is any evidence for inaction we calculate an estimate of policy when there is no incentive for the MPC to reduce interest rate volatility to use as a reference point. We do this by estimating a structural VAR and solving for the optimal monetary policy under the assumption that interest rates are set to minimise a weighted sum of inflation and output variability only. The main result is that, although there is some evidence that monetary policy has been inert over the MPC period, there is markedly less inaction than previous work suggested.[4] This may reflect the fact that earlier work studied monetary policy prior to the formation of the MPC, when both inflation and output were considerably more volatile. In line with the Taylor rule results, this exercise also suggests that there is little evidence that policy has been more gradual than it should be, given the dynamics of

[4] As reported by Martin and Salmon (1999) and Goodhart (1999).

the economy.

The focus of the second part of the paper is to use published voting records for the period 1997-2007 to analyse the evidence for inaction and gradualism at the monthly frequency. We find that the activity rate, defined as the probability that the committee vote to change interest rates in a given monetary policy meeting, has fallen over time. This fall appears entirely to reflect the increased stability of inflation and output growth since the mid-1990s, rather than changes in the degree of gradualism and/or inaction. There is some evidence for inaction at the monthly frequency however, reflected by the fact that the MPC is more active in the forecast month than in the non-forecast month. The importance of the forecast round has also increased over time, and this increase appears not to be related to increased economic stability. There is no evidence that the MPC waits longer before a rate rise than a rate cut, though there is evidence that it tends to wait longer before reversing the direction of interest rate changes. This difference appears not to be driven by interest rate gradualism, and so provides some further evidence for inaction at the monthly frequency.

We also use the panel data properties of the voting records of the individual members to analyse differences in activity rates across members, and compare individual voting patterns to that of the committee as a whole. There is no evidence that the MPC is less active than its individual members, contrary to the theory suggested by Blinder (1997). External members tend to be more active than internal ones, despite the fact that internal members respond more strongly to deviations of the inflation forecast from target. Internals also tend to be more active before an interest rate rise, compared to a cut. There is no evidence that activity rates are falling with the length of time that a member has served on the committee, suggesting that learning about the transmission mechanism has no impact on the tendency for gradualism and inaction.

The paper is organised in the following way. Section 2 investigates the evidence for gradualism in UK interest rates at the quarterly frequency using Taylor rules, and a simulation of policy when there is no incentive for the MPC to reduce interest rate volatility. Section 3 uses monthly voting data to analyse the evidence for inaction and gradualism at the monthly frequency, both for the MPC as a whole and its individual members. Section 4, finally, concludes.

2 Inaction and gradualism at the quarterly frequency

In this section, we look at the data on a quarterly frequency and ask two questions: Is there evidence for gradualism in monetary policy, and is there evidence for inaction? To evaluate whether monetary policy has been gradual, we start by estimating Taylor rules, accounting for some estimation issues that have been discussed in the recent literature. To evaluate whether there is any evidence for inaction we need some measure of alternative policy, as a reference point. We calculate a measure of monetary policy when there is no incentive to reduce interest rate volatility and compare this with actual monetary policy to see whether there is any evidence that interest rates have not responded to shocks sufficiently quickly.

2.1 Evidence from Taylor rules

2.1.1 Standard Taylor rules

We estimate the following Taylor rule,

$$i_t = i^* + \phi_\pi \pi_t + \phi_y y_t \qquad \textbf{(1)}$$

where i_t is the nominal interest rate, i^* a measure of the equilibrium nominal interest rate, π_t annual inflation, and y_t a measure of the output gap. We use quarterly data on the official policy rate, RPIX and CPI inflation, and a measure of the output gap, for the period 1976Q1-2007Q2.[5] We test whether any of these variables are non-stationary, and reject the hypothesis of a unit root in the output gap and the various measures of inflation over 1976-2006. For the nominal interest rate, the results are sensitive to the length of the sample period, and the specification of the test. Since the power of this test is low when the sample is small we assume that i_t is stationary.[6]

Column 1 in Table 1 (at the end of the paper) shows the results from the baseline regression, estimated using RPIX inflation, over the full sample period. The estimated coefficients are positive and significant.[7] There is, however, strong evidence of serial correlation in the residual, suggesting model misspecification. One potential explanation for this is that changes in the

[5] The output gap is constructed as detrended whole-economy output, where a HP filter is used to detrend the data.

[6] The argument is that the nominal interest rate cannot have a unit root when both the real rate (for theoretical reasons) and inflation are stationary.

[7] We also find that the estimated Taylor rule does not fulfil the Taylor principle that states that the coefficient on inflation should be greater than one. This means that over the period as a whole, monetary policy seems to have failed to provide a nominal anchor for the economy, in line with findings in Nelson (2000).

monetary policy regime are not properly captured by this model. We instead focus on the period 1997-2007 (the MPC period), as reported in column 2. The estimated coefficient on inflation is now greater than one, but there is still strong serial correlation in the residual. Another issue is the switch from a RPIX target to a CPI target at the end of 2003. We construct an inflation measure that is defined as the deviation of the target measure of inflation from its target (RPIX until 2003Q4 and CPI thereafter), with regression results reported in column 3. The fit of the model is slightly better, but there is still evidence of misspecification.

Columns 4-5 in Table 1 report the results when the lagged interest rate is included in the regression, for the whole sample, and for the inflation targeting period,

$$i_t = i^* + (1-\rho)\left(\phi_\pi \pi_t + \phi_y y_t\right) + \rho i_{t-1} \tag{2}$$

We find little evidence of serial correlation in the residual when the model is estimated over the whole sample (column 4). The estimated coefficient on the lagged interest rate is 0.93, which implies a mean lag of 13 quarters.[8] This suggests that three years after a shock to inflation or output, only half of the adjustment of the policy rate to its optimal level is completed. There is less evidence of gradualism for the MPC period, with a mean lag of around 7 quarters (column 5). However, there is still strong evidence of misspecification, such that the Taylor rule with a role for interest rate gradualism is rejected by the data for the MPC period.[9]

2.1.2 Allowing for model misspecification

Under an inflation targeting framework, policy-making is forward-looking and aims at stabilising inflation around target at the relevant time horizon. In this case, the Taylor rule specified in (1) or (2) can be thought of as a reduced-form relation, where current inflation and output enter the reaction function of the central bank since they are predetermined variables that, in equilibrium, determine expectations about future inflation and output. As shown by Svensson (2003) however, a current-value Taylor rule is unlikely to be a solution to the central bank's optimisation problem if there are important state variables other than inflation and the output gap. This means that the simple Taylor rule may suffer from omitted variables, in which case the estimated coefficients tend to be biased. In addition, if the omitted variables are serially correlated, this could give

---

[8] The mean lag, defined as the time it takes before half of the adjustment of interest rates to movements in inflation or the output gap has been made, is given by $\rho/(1-\rho)$ quarters. Since the partial adjustment model is only valid when $\rho < 1$, we also test the hypothesis that $\rho = 1$. This hypothesis is rejected.

[9] We test for serial correlation in the residual using the Ljung-Box Q statistics, where we include 8 lags in the test specification. The null hypothesis of no serial correlation is rejected at all lags.

spurious evidence for interest rate gradualism, as pointed out by Rudebusch (2002). Another issue is that the standard Taylor rule is estimated on final output data, whereas policy-makers only have access to real-time data on output. If this is not properly accounted for, this may spuriously give a role for lagged interest rates in the Taylor rule.[10]

One way to deal with measurement issues is to try to account for them in the empirical specification of the Taylor rule.[11] Let $y_{t|t}$ denote the output gap in period t, as perceived by policy-makers in period t, and let y_t denote the final estimate of the output gap. Assume that policy-makers follow a Taylor rule of the following form

$$i_t = i^* + \phi_\pi \pi_t + \phi_y y_{t|t} \quad \textbf{(3)}$$

The estimated Taylor rule can then be expressed as

$$i_t = i^* + \phi_\pi \pi_t + \phi_y y_t + u_t \quad \textbf{(4)}$$

where

$$u_t = \phi_y \left(y_{t|t} - y_t \right) \quad \textbf{(5)}$$

Since the residual u_t is correlated with the explanatory variables, OLS gives biased estimates of the model parameters. To control for this, the model is estimated using an instrumental variable approach, as shown in column 6 in Table 1.[12] We find, however, that the results are similar to those obtained using OLS.

Recent work by Rudebusch (2002) and Gerlach-Kristen (2004) on US data argue that the role for lagged interest rates in the Taylor rule arises partly because policy-makers respond to (for the econometrician) unobserved variables, which exhibit some persistence. An alternative interpretation is that serially correlated data revisions give rise to persistent errors in the estimated Taylor rule.[13] In the model described by **(3)**-**(4)**, this would imply serial correlation in u_t.

[10]See Aoki (2002) for a model with noisy data and interest rate gradualism.

[11]Another way to account for this would be to estimate the Taylor rule using real-time data on the output gap. We do so, and find that the results are similar to those obtained using final data. This may reflect the fact that policy-makers know that some of the data will get revised, and therefore may not take the real-time data at face value. Instead, one would have to recreate a measure of the output gap, as perceived by the policy-makers (see eg Nelson and Nikolov (2001)).

[12]We use lag 1-4 of inflation, the output gap and the interest rate, as instruments. To avoid weak identification, the instruments need to be correlated with the explanatory variables π_t and y_t. We use the partial R^2 statistics by Shea (1997), to assess instrument weakness. The statistics are high for both variables, suggesting that the instruments are sufficiently correlated with both model variables (partial R^2 equals 0.56 for π_t and 0.67 for y_t).

[13]There is strong evidence of serial correlation in the data revisions. As a measure of the size of revisions, we use the difference between the output gap constructed using the final estimate of output, compare to the initial estimate, where the final estimate is constructed using data released in October 2006. The revisions are serially correlated, with a correlation coefficient of 0.9 between $y_t - y_{t|t}$ and $y_{t-1} - y_{t-1|t-1}$.

We account for unobserved factors that exhibit persistence by specifying the following Taylor rule:

$$i_t = i^* + (1-\rho)\left(\phi_\pi \pi_t + \phi_y y_t + \phi_z z_t\right) + \rho i_{t-1} \quad \textbf{(6)}$$

$$z_t = \gamma z_{t-1} + \upsilon_t \quad \textbf{(7)}$$

where z_t is an unobservable factor that policy-makers respond to, and γ captures the degree of persistence in this factor. Variable υ_t is assumed to be white noise. We can rewrite **(6)** as

$$i_t = i^* + (1-\rho)\left(\phi_\pi \pi_t + \phi_y y_t\right) + \rho i_{t-1} + \varepsilon_t \quad \textbf{(8)}$$

$$\varepsilon_t = (1-\rho)\phi_z z_t = \gamma \varepsilon_{t-1} + \upsilon_t \quad \textbf{(9)}$$

If the true model is given by **(6)**-**(7)**, but we estimate the standard Taylor-rule in **(8)**, the residual will be serially correlated.

Combining (8) and (9) gives

$$i_t = (1-\gamma)i^* + (1-\rho)\left[\phi_\pi(\pi_t - \gamma\pi_{t-1}) + \phi_y(y_t - \gamma y_{t-1})\right] + (\rho+\gamma)i_{t-1} - \rho\gamma i_{t-2} + \tilde{\upsilon}_t \quad \textbf{(10)}$$

where the residual $\tilde{\upsilon}_t = (1-\rho)\phi_z \upsilon_t$ is white noise. Equation (10) can be estimated using OLS, as reported in in columns 7-8 in Table 1.[14] By comparing column 7 with column 4, we see that allowing for unobserved variables does not have a big impact on the results over the full sample; The estimated coefficient on the lagged interest is 0.9, which implies a mean lag of 9 quarters, compared to 13 quarters in the baseline estimation. But allowing for unobserved variables during the MPC period greatly reduces the implied degree of interest rate gradualism, by reducing the mean lag from 7 quarters to 1.6 quarters (column 8 compared to column 5 in Table 1). We also find that there is a high degree of serial correlation in the unobservable component over the MPC period. This means that deviations of the actual interest rate from that predicted by the standard Taylor rule are persistent. In a model which does not allow for unobservable components, this would be picked up as evidence for interest rate gradualism. By contrast, in our model it suggests that policy-makers are responding to variables not well captured by a standard Taylor rule.

One issue is that it is difficult to identify and estimate partial adjustment models in the presence of serially correlated shocks. This was pointed out by Blinder (1986) in the context of an inventory model, who stressed that there has to be sufficient variations in the dependent variable to allow identification of the partial adjustment (ρ) and the serial correlation (γ) parameters. To

[14] We also estimate (8) and (9) using a Kalman filter, which gives similar results to those reported in Table 1.

analyse whether γ and ρ are uniquely identified in our model, we estimate a reduced-form version of (10),

$$i_t = \mu_1 + \mu_2 \pi_t + \mu_3 \pi_{t-1} + \mu_4 y_t + \mu_5 y_{t-1} + \mu_6 i_{t-1} + \mu_7 i_{t-2} + \tilde{\upsilon}_t \qquad \textbf{(11)}$$

for which we obtain

$$i_t = \underset{(0.26)}{0.34} + \underset{(0.17)}{0.02}\pi_t - \underset{(0.16)}{0.03}\pi_{t-1} + \underset{(0.18)}{0.45}y_t - \underset{(0.20)}{0.42}y_{t-1} + \underset{(0.14)}{1.52}i_{t-1} - \underset{(0.13)}{0.58}i_{t-2} \qquad R^2 = 0.96 \quad \textbf{(12)}$$

where standard deviations are reported within parenthesis, and where the reduced-form parameters are related to the Taylor-rule parameters according to

$$\begin{aligned} \mu_1 &= i^* (1-\gamma), \quad \mu_2 = (1-\rho)\phi_\pi, \qquad \mu_3 = -(1-\rho)\phi_\pi \gamma, \\ \mu_4 &= (1-\rho)\phi_y, \quad \mu_5 = -(1-\rho)\phi_y \gamma, \quad \mu_6 = \rho + \gamma, \quad \mu_7 = -\rho\gamma. \end{aligned} \qquad \textbf{(13)}$$

We can combine the expressions for μ_6 and μ_7 (the coefficients on lagged interest rates) to get a second-order equation for γ, which means that we cannot rule out the existence of two solutions for γ and ρ – one in which there is little serial correlation in the residual, but strong gradualism, and one in which there is less gradualism, but strong serial correlation. While the response of the interest rate to inflation is insignificant (captured by μ_2 and μ_3), the estimated response to the output gap is significant (μ_4 and μ_5). By combining the expressions for μ_4 and μ_5 using (13), we are able to pin down a unique solution for γ and ρ. Thus, since changes in the output gap are associated with sufficient variation in the interest rate, we are able to obtain fairly precise estimates of γ and ρ.[15] For the MPC period, this solution implies a high degree of serial correlation in the unobservable component, and a lower degree of correlation in the interest rate rule.[16] In particular, the results suggest that the mean lag for the policy rate over the MPC period is less than 2 quarters.

[15] In a similar context, this was also found by English, Nelson and Sack (2003).

[16] We also look at the relation between the unobservable component and some variables that, *a priori*, could be captured by the unobserved variable components. We find that a measure of financial market conditions, as proxied by the equity risk premia for the FTSE 100, and a measure of data revisions together can account for around 70% of the variations in the unobservable component. In particular, when the equity risk premium is high, the interest rate is lower than predicted from a Taylor rule regression. When output data has been revised up compared to the initial release, interest rates are lower than predicted from a Taylor rule regression based on the final data.

2.1.3 Forward-looking policy

As discussed above, one reason for why we found evidence for model misspecification above is that, when actual policy is forward-looking, the current-value Taylor rule is a reduced-form equation that is likely to be misspecified when the policy-maker uses a large number of state variables to form expectations about the future. One way to get around this problem is to estimate a forward-looking policy rule directly,

$$i_t = i^* + (1-\rho)\left(\phi_\pi \mathrm{E}_t \pi_{t+\tau} + \phi_y \mathrm{E}_t y_{t+\tau}\right) + \rho i_{t-1} \qquad \textbf{(14)}$$

where $\mathrm{E}_t \pi_{t+\tau}$ and $\mathrm{E}_t y_{t+\tau}$ denote expectations about inflation and the output gap τ quarters ahead.

The challenge in estimating (14) is that expectations are not readily available. There are two main approaches to get proxies for expectations – to use future values of inflation and the output gap, and to use actual forecast data. Work by Nelson (2000) and Clarida, Gali and Gertler (1998) among others use actual realisations of inflation and the output gap τ quarters ahead to proxy expectations. Under the assumption of rational expectations, actual realisations of the variables can be used to proxy expectations, and an instrumental variable approach can be used to estimate the model. We follow this approach and estimate a forward-looking Taylor rule, with the results shown in Table 2, for values of $\tau = -1$ (lagged specification) to $\tau = 4$, focusing on the period 1994-2006.[17]

The estimated response to inflation is increasing in the horizon while the response to the output gap falls with the horizon, which was also found in Orphanides (2001). However, the estimated parameter values are very uncertain, and not significant at horizons over 3 quarters. The estimated degree of gradualism varies between 0.86 to 0.90, which is similar to the results reported in Table 1.

However, one drawback of this approach is that the forecasts are conditional on the interest rate path. If the central bank is able to control inflation perfectly, the resulting low variability of inflation may lead to insignificant estimates of the policy response to expected (ie future) inflation. Since 1994, UK inflation has indeed been very stable around the inflation target, as documented by eg Benati (2004). Recent work by Orphanides (2001), Boivin (2005) and Goodhart (2005) uses actual forecasts of inflation and output growth instead, these are

[17] We extend the sample to 1994 since the sample period would otherwise be very short.

constructed under the assumption that the nominal interest rate will remain constant within the forecasting horizon.[18]

Goodhart (2005) points out that the inflation and output forecasts published by the UK MPC which are conditional on a constant interest rate assumption also incorporate the *preceding interest rate decision*. If the MPC believes it is entirely successful in bringing inflation back to target at the relevant forecast horizon, the constant-rate inflation forecast at that horizon should always be at target. Once again, there would be very little variability in the inflation forecast over the inflation targeting period, and the estimated coefficient on inflation would be insignificant. Goodhart creates an 'ex ante' forecast, that prevailed before the preceding interest rate decision, by adding on to the ex post forecast the estimated responses of inflation and output to the implemented interest rate change.[19]

Here we update the dataset by Goodhart for the period 1997Q1-2006Q3, applying the same adjustments as he did to create the ex ante data.[20] We estimate the following Taylor rule

$$i_t = c + \alpha_\pi \mathrm{E}_t \pi_{t+\tau} + \alpha_y \mathrm{E}_t y_{t+\tau} + \alpha_i i_{t-1} \quad \textbf{(15)}$$

using ex post and ex ante data, as reported in Table 3, where the rows shows the results for different time horizons ($\tau = 0$ refers to the inflation report quarter, and $\tau = 8$ to the forecast two years ahead). For the ex post data, the estimated coefficient on inflation is insignificant, at most horizons. The output gap coefficient is insignificant at longer horizons. The coefficient on lagged interest rate is close to one, in all cases, and the overall fit of the regression is not good, especially at longer horizons. When the model is estimated using ex ante data, by contrast, the estimated coefficient on the lagged interest rate is equal to one for many of the horizons, suggesting that the equation should be estimated in first difference, rather than levels. At the two-year horizon, however, the equation performs reasonably well. The estimated coefficient on inflation is positive, and borderline significant. The coefficient on the output gap is positive, but not significant. These results suggest a large degree of interest rate smoothing. The null hypothesis that the coefficient on lagged interest rates equals one cannot be rejected, however.

[18] Orphanides (2001) and Boivin (2005) use the Greenbook forecasts for the US, constructed under the assumption that the nominal federal funds rate will remain unchanged over the next sixth to eighth quarter. Goodhart (2005) uses the constant interest-rate forecasts, as published by the Bank of England.

[19] This means that the ex post and the ex ante forecasts are identical when interest rates are left unchanged, but differ when rates have changed. The interest rate adjustments are based on a Bank of England MPC publication (Monetary Policy Committee, 1999), which shows the estimated responses of inflation and output growth to an interest rate change.

[20] The bank publishes projections for inflation and output growth conditional on two different paths for the interest rate: a constant path and a path based on market expectations. Here we focus on the first of these.

Since the results suggest that the ex ante equation should be estimated in first difference, we proceed by estimating the following equation

$$\Delta i_t = \phi_\pi \mathrm{E}_t \pi_{t+\tau} + \phi_y \mathrm{E}_t y_{t+\tau} + \alpha_i i_{t-1} \quad \textbf{(16)}$$

where we have added the lagged interest rate on the right-hand side to allow for interest rate gradualism. The reason for this is that, since the results regarding interest rate smoothing are sensitive to whether the equation is specified in levels or first difference terms, we do not want to impose a unit coefficient on the lagged interest rate. If the data prefers a levels specification to the first difference specification, the estimated coefficient on the lagged interest rate will be significantly different from zero. Table 4 reports the results for the ex ante data, estimated using both OLS and an IV approach, to account for potential measurement issues. As reported in the table, the coefficient on inflation is positive at all horizons, and significant for horizons over a year. The output gap coefficient is positive and significant at all horizons except for the very longest one. Judging from the R^2 and the DW statistics, the model fits the data the best at the longer horizons (7-8 quarters ahead), where it is able to explain over 60% of interest rate changes, with little evidence of serial correlation in the residual. The estimated coefficient α_i tends to be insignificant, suggesting that the first difference specification is indeed suitable. We also find that the results based on the IV approach are similar to those obtained using OLS. Altogether, this suggest that the MPC has responded by changing interest rates whenever the inflation forecast has deviated from target at the relevant forecast horizon, with little evidence of gradualism.

2.2 Evidence from a monetary policy experiment

Whereas the Taylor rule analysis is useful for analysing monetary policy gradualism, it cannot tell whether monetary policy has been inactive, in the sense that monetary policy responds too slowly to shocks hitting the economy. In this section, we instead estimate a measure of monetary policy when there is no incentive to reduce interest rate volatility and compare this to actual monetary policy, to see whether there is any evidence for inaction.

2.2.1 The model

Consider the following specification for Y_t,

$$Y_t = ZY_{t-1} + C\varepsilon_t, \quad \textbf{(17)}$$

where Y_t is a $(n \cdot p) \cdot 1$ vector of endogenous variables, where n denotes the number of variables and p the lag length, Z is a matrix of coefficients and ε_t is a vector of structural disturbances, with variance covariance matrix $E\left[\varepsilon_t \varepsilon_t'\right] = I$. To identify the structural shocks (ie matrix C), we use two different identification procedures. We start by imposing a recursive Cholesky factorisation, and order the variables such that $Y_t = (y_t, \pi_t, i_t)$. Under this ordering, y_t is the most exogenous variable, which cannot respond contemporaneously to any of the other variables. Inflation only responds contemporaneously to real activity, whereas the policy rate i_t can respond to both inflation and real activity. We also make the assumption that the policy rate only responds to the output gap with a lag, reflecting the delay in published statistics.

The drawback with the Cholesky identification is that some of the restrictions are stringent and not based on theoretical considerations. For example, assuming a zero contemporaneous impact of a monetary policy shock on output is inconsistent with a large class of general equilibrium models. In order to check the robustness of the results, we consider an alternative identification procedure based on sign restrictions. As discussed by Peersman (2005), the advantage of this approach is that zero constraints on the contemporaneous impact matrix are not necessary. Instead, restrictions on the contemporaneous and lagged response of the model variables to the structural shocks, which are often made implicitly, are made more explicit. Here we assume that a positive monetary policy shock has a non-negative impact on the interest rate, and a non-positive impact on the output gap. A positive demand shock has a non-negative impact on the interest rate and inflation, while a positive supply shock (in our trivariate model, this implies a positive shock to inflation) has a non-negative effect on inflation and the interest rates and a non-positive effect on the output gap. These identifying assumptions are similar to those laid out in Peersman (2005) and Castelnuovo and Surico (2006).[21] The technical implementation of this strategy is discussed in Peersman (2005) and Uhlig (1999), and will not be covered here. Note, however, that we do not identify a unique structural VAR based on the sign restrictions. Instead, the method provides us with a large number of estimates of the structural VAR (17) such that they all fulfill the identifying conditions. For each structural VAR, we then solve for the optimal policy.

The central bank is assumed to minimise an intertemporal loss function

$$E_t \sum_{\tau=0}^{\infty} \beta^{\tau} L_{t+\tau} \qquad \textbf{(18)}$$

[21] We thank Paolo Surico for making his program that identifies the structural VAR using sign restrictions available to us.

where the period loss function is $L_t = \pi_t^2 + \lambda y_t^2$ and where the constraints of the economy are given by the structural VAR (17). This specification of the loss function means that the central bank does not have any preferences for reducing interest rate volatility, *per se*.

To solve the model, it is convenient to express it in state-space form as $X_{t+1} = AX_t + Bi_t + \eta_{t+1}$, where the state vector $X_t = \left(y_t, .., y_{t-p}, \pi_t, ..., \pi_{t-p}, i_{t-1}, ..., i_{t-p}\right)$, $\eta_t = C\varepsilon_t$, and i_t is the instrument of the central bank. The model can be solved using standard techniques (eg Rudebusch and Svensson (1999)). The solution implies that, in any period t, the policy rule i_t can be expressed as a function of the state of the economy, $i_t = FX_t$, where F will depend on the dynamics of the economy and the parameters in the central bank's loss function.

2.2.2 Estimating the model

We estimate a trivariate VAR containing a measure of the output gap (y_t defined as the deviation of output from trend, where trend is estimated using a HP filter), the deviation of inflation from its target (π_t) and the nominal interest rate (i_t) for the period 1994Q1-2007Q2.[22] All variables are expressed in terms of deviations from the mean before estimating the model. As was discussed in section 2, we reject the hypothesis of a unit root for the output gap and the deviation of inflation from target, but not for the nominal interest rate. Since the power of the test is low when the sample is small, we continue to assume that i_t is stationary.

We solve the model under the assumption that the central bank only cares about inflation and output stabilisation, where the relative weight on the output gap, λ, equals 0.5. The one step-ahead forecast for the estimated policy-rule based on the Choleski decomposition is shown in Chart 2, together with the actual policy rate. Judging from the chart, the predicted interest rate tracks the actual rate reasonably well. Table 5 shows the proportion of quarters in the sample when interest rate movements are classed as continuations, reversals and no change, for actual data (column 1) and the predicted interest rate rule obtained under this identification scheme (column 2), where interest rate movements in any quarter (actual or predicted) between plus and minus 0.125 basis points is classified as a no change decision.[23]

[22] To increase the number of observations, we extend the sample period to 1994 for this exercise. We refer to this period as the inflation targeting period.

[23] Interest rate changes tend to be made in steps of 0.25 basis points whereas the interest rate changes in the model can take any size. To control for this, we classify any interest rate change less than 0.125 as a no change decision.

As reported in columns 1 and 2, the proportion of continuations under actual policy (0.46) is very close to predicted (0.44), but there are fewer reversals than predicted (0.15 vs 0.26) and more no change decisions (0.38 vs 0.30). These results differ from those by Martin and Salmon (1999), shown in columns 4-5 in the table.[24] In their study, they find that over the time period 1981-1996 (the 'pre-MPC period'), the proportion of reversals is small compared to that predicted from the model, whereas the proportions of continuations and no change decisions are much larger.

The table reveals that the proportion of continuations estimated by the model has not changed much between the pre-MPC period and the MPC period. By contrast, the actual proportion of continuations has fallen markedly. Since gradualism would result in a high proportion of continuations, this suggest that monetary policy has become less gradual during the MPC period. In fact, the results give little evidence that policy has been more gradual than it should be, given the dynamics of the economy.

Turning to reversals, the results suggest that both the predicted and the actual proportion of reversals has fallen between the two time periods. And, as reported in columns 6 and 8 in the table, there is less evidence of deviation between predicted and actual policy during the MPC period, since the proportion of reversals is closer to its predicted level during that period. At the same time, both the actual and predicted proportion of no change decisions has increased, but policy is now closer to that prescribed by the model than it was during the pre-MPC period. Altogether, this suggests that, although there is still some evidence of policy being inactive, there is markedly less inaction than in the past.

We note that the difference in results is unlikely to reflect differences in the methods used to estimate and solve for the predicted policy rule – our method is very similar to that used by Martin and Salmon (1999), as reported in Goodhart (1999).[25] Their identification scheme (Choleski), and choices of model parameters are similar to those used here. The difference in results may therefore reflect the fact that earlier work studied monetary policy prior to the formation of the MPC, when both inflation and output were considerably more volatile.

[24] As reported by Goodhart (1999).

[25] The main difference is that they include the period 1990-92 in their sample, when the UK had an official exchange rate target. For this reason, they include the exchange rate in the policy-maker's objective function, and also in the VAR. We choose not to include the exchange rate in the analysis since we only estimate the model over the period 1994-2007, when the UK did not have an exchange rate target.

Column 3 reports the results when the model is identified using sign restrictions, based on the mean of the results across all solutions, where each solution is such that the identification of the structural VAR satisfy the sign restrictions discussed above.[26] The results differ somewhat from those in column 1; there are fewer continuations and more no change decisions. By contrast, the proportion of reversals is similar to that reported in column 1. Overall, however, these results support the above conclusion that there is markedly less inaction during the MPC period, compared to the period prior to the formation of the MPC.

3 Determinants of monthly activity rates

So far, the focus has been on gradualism and inactivity at the quarterly frequency. Since actual monetary policy decisions are taken at the monthly frequency, we now analyse the monthly activity rate, defined as the probability that the committee vote to change interest rates in a given monetary policy meeting, and relate it to factors that may affect the degree of inaction and/or gradualism. We begin by examining the monthly activity rate of the MPC as a whole, and where relevant compare this to the activity rates of other countries with similar monetary policy frameworks. The UK data also allow us to study how the activity rate varies across individual committee members, and whether any differences appear to be systematically related to members' individual characteristics. All data in this section cover the period since the establishment of the MPC (June 1997) until April 2007.

3.1 How active is the MPC and what determines its activity rate?

We analyse the monthly activity rate of the MPC, where the activity rate (a_t) is defined as the probability that the committee vote to change interest rates in a given monetary policy meeting. Interest rate changes tend to be made in steps of 0.25 basis points. Under the assumption that the committee follows a Taylor rule, with no gradualism and no inaction, we would have

$$a_t = P\left(|\Delta i_t| \geq 0.25\right) = P\left(\left|\alpha_\pi \Delta\pi_t + \alpha_y \Delta y_t\right| \geq 0.25\right) \qquad \textbf{(19)}$$

where $P(\cdot)$ denotes the probability of a given event. By contrast, if there is inaction and/or gradualism, the activity rate would not be well described by (19); With gradualism, one would need to include the lagged interest rate change in the expression above. If monetary policy was inert, factors that affects the degree of inaction would need to be included in the model, or the threshold variable would need to be greater than 0.25.

[26] The median solution gives a very similar picture.

The economic data released at the monthly frequency tends to be volatile and is likely to get revised. For this reason, it is difficult to estimate (19) directly. Instead, this section looks at changes in the activity rate over time, and relates them to factors that affect the degree of gradualism and/or inaction. We begin by using simple statistical analysis to establish some stylised facts about the activity rate, and conclude by estimating an empirical model that controls for changes in the state of the economy.

3.1.1 Has the activity rate changed over time?

Table 6 shows the probability of the committee being active by year since its establishment, whilst Chart 3 shows the same data but on a rolling 12 month basis. *Although the activity rate is volatile, it appears to be on a downward trend*.

Under the assumption that the activity rate is well described by (19), the fall in the activity rate over time would be related to improved economic stability and the consequent need for smaller and fewer interest rate changes.[27] There could be other reasons for the downward trend in activity, however. Previous work suggests that parameter uncertainty can account for part of the gradualism observed in interest rate movements. If parameter uncertainty falls as the MPC becomes more experienced, we would expect monetary policy to become less gradualist over time, which is likely to reduce the activity rate.[28] Activism may also fall over time if inflation expectations become more entrenched as the MPC builds a 'track record' for achieving the inflation target.[29] Empirical work by Blinder and Morgan (2000) also suggests that experience may lead to a greater appreciation of the value of waiting for new information. Under the assumption that the MPC has become more experienced over time, this would lead to a downward trend in activity rates.

[27] As noted by King (2007) 'There is some indication that the number of [Bank Rate] changes was lower in the second than in the first five-year [MPC] period. But that reflected the size and nature of the shocks over the respective periods'.

[28] Under gradualism, a given policy change is implemented over a series of months rather than in one go, thus increasing the degree of activism.

[29] This idea is put forward in the minutes of the MPC meeting in March 1999. The minutes note that 'it was possible that there were signs, for example in the confidence surveys, of a more rapid response to changes in interest rates than there had been in the past. One possible explanation was that the new monetary policy regime provided greater confidence in the commitment to the inflation target which was consistent with the fall in inflation expectations [...].'

3.1.2 Is the MPC more active in a forecast round?

Table 7 shows that *the MPC has a strong tendency to be more active during the forecast round, and this trend has become more pronounced in the latter half of the sample period*.

Lomax (2005) notes that the committee may wait until the forecast round to act because although macroeconomic data accrues fairly evenly through the quarter, during the forecast round the members take a full and comprehensive review of how this data reflects the outlook.[30] Related to this Barker (2007) notes that the reconsideration of the performance of the Bank's model during the forecast round allows the Committee to learn about how the behaviour of the economy may have changed. In addition, the committee may wait for the forecast round to change interest rates if they judge it to be easier to communicate and explain the policy change in the context of the *Inflation Report*.

The tendency for the MPC to be more active during the forecast round could be related to the Bank's use of the forecast as a main tool for communication. Cross-country comparison shows that of seven other comparable central banks three also tend to be more active during their respective equivalents to the forecast round and two of these also use the forecast as the main tool for communication (Table 8).[31] Although this may suggest a link from the institutional role of the forecast to the activity rate during the forecast round, the table also shows that some of the central banks that use the forecast as their main tool for communication do not show a tendency to act more often in the forecast round.

3.1.3 Does the MPC show a bias towards one direction of change?

Comparing the average period of inactivity prior to a rate cut and a rate rise shows that *although the MPC has waited on average 0.8 months longer prior to lowering rates, this bias is not statistically significant* (Table 9). The results also suggest that there is no pattern across central banks of industrialised countries towards more delay prior to moving interest rates in one direction.

[30] Indeed, the committee members may postpone activity until a forecast round if they are uncertain about the full impact of the new data on the economy, and the MPC minutes highlight a few incidence where this appears to have been the case. For example, the minutes for the July 2006 meeting read 'But there was considerable uncertainty about the National Accounts estimates for 2005, which had yet to be balanced. It was difficult to reach a firm conclusion about the implications of the revisions for the overall balance of demand and supply until the data had been fully analysed in the context of the *Inflation Report* round.'

[31] The seven other comparable central banks are those of Australia, Canada, the ECB, New Zealand, Norway, Sweden, and the US.

In contrast, the literature presents arguments as to why inaction may be asymmetric, in the sense that central banks tend to wait longer to raise than to cut interest rates, or vice versa. Our results, however, suggest that inaction is not asymmetric, and either any biases are not relevant for the respective central bank, or biases in opposite directions tend to offset each other.

3.1.4 Is the MPC averse to reversing the direction of interest rate changes?

We use three methods to investigate the frequency of interest rate reversals. First we consider the probabilities that given a central bank is active it moves interest rates in the same and opposite direction to the previous rate change (defined a 'continuation' and 'reversal' respectively). Second, we consider the average number of inactive meetings before a central bank continues and reverses the path of interest rates, and third we compare the probability that action is immediately followed by a continuation to the probability that it is immediately followed by a reversal. For the MPC the probability of an action being a reversal is much lower than the probability of an action being a continuation (0.18 and 0.82 respectively). Similarly, the MPC has on average waited 6.8 months before making a reversal compared to only 1.6 months before making a continuation. Consistent with these findings, there is a probability of 0.3 that an active decision will be followed in the next meeting by a continuation, but in no instances in the sample was action immediately followed by a reversal. Hence, by all measures *the MPC is much more inclined to make policy continuations than policy reversals.* Cross-country comparison suggests that this trend is common to all central banks with similar monetary policy frameworks (Table 10).

That the frequency of interest rate reversals is lower than that of continuations is often taken as evidence for inaction. However, we show above that, based on quarterly data, the MPC's tendency to make more continuations than reversals is consistent with the path of monetary policy suggested by the model with no interest rate smoothing, though it tends to make slightly fewer reversals than this model suggests. Although it is not possible to make a direct link to the monthly frequency, the results based on the monthly data suggest some evidence for inaction at that frequency.

Arguments for why central banks may choose to be inactive include the fact that frequent interest rate reversals may weaken the pass-through from changes in the Bank Rate to changes in market interest rates at the long end of the yield curve, potentially reducing the impact of future Bank

Rate changes on the economy.[32] Increased uncertainty over future short-term rates may also lead to greater volatility in financial markets. Goodhart (1999) draws attention to the negative media response and consequent loss in credibility central banks have received following interest rate reversals.[33] He also suggests that the greater uncertainty over the outlook faced at turning points in the economic cycle maybe why central banks wait longer to reverse the direction of rates, whilst Ellison (2006) suggests that frequent reversals may make learning about the monetary policy transmission mechanism more difficult.

3.1.5 Estimation results

So far, we have established some stylized facts about the monthly activity rate, and discussed reasons for why movements in the activity rate may capture changes in gradualism and/or inaction. This section complements that analysis, by estimating a simple empirical model for the activity rate, where we also control for changes in the state of the economy. To evaluate whether there is gradualism and/or inaction at the monthly frequency, we would like to estimate (19) directly. However, monthly data is noisy and likely to get revised, and MPC members are likely to use a range of indicators to inform themselves about the state of the economy in their monthly MPC meeting. For this reason, we instead estimate the following model

$$y_t = \alpha + \beta X_t + \varepsilon_t \tag{20}$$

where the dependent variable y_t is a dummy variable ($action$) that takes the value one if the committee voted to change interest rates and zero otherwise, and X_t is a vector of explanatory variables that contains two types of variables: Those that proxy for the state of the economy, and those that are likely to be related to movements in the activity rate over time. The choice of the latter is based on the discussion above and includes a linear time trend ($time$), a dummy variable for whether the vote is in a forecast round or not ($forecast$) and a measure of the uncertainty around the forecast ($uncert$) to proxy for changes in economic stability.[34] We also include a dummy variable that indicates whether the next active decision is to raise or cut interest rates (up takes the value of one if the next active decision is to raise rates, and zero otherwise), and one

[32] See discussion of Woodford (1999) in Section 1.

[33] For example: 'Critics ... described the Bank's apparent shift in policy as 'almost laughable" (*The Times*, 11 June 1998), and 'where the committee lost its credibility last week is in its inconsistency ... It suggests a fickle committee influenced by the latest anecdotal or statistical evidence' (in 'The fickleness of hawks today and doves tomorrow', the *Sunday Business*, 7 June 1998).

[34] The uncertainty measure captures the width of the fan charts published in the inflation reports. As a starting point, the width is based on the actual dispersion of outturns around the forecast over the preceding 10 years. The MPC then judges whether uncertainty looking forward is likely to be greater or less than that over the past, and modifies the fan chart accordingly. The variability of inflation and output growth has fallen substantially since the mid-1990. As a result, the degree of uncertainty has tended to fall over time.

that indicates whether the next active decision continues the decision made the last time interest rates were changed, or whether it reverses it (rev takes the value of one if the next decision is to reverse the last decision, and zero otherwise). To control for the state of the economy, we include a measure of inflation expectations ($inflexp$), as proxied by the four year ahead inflation expectations estimated using index-linked bonds.[35] In addition, we include the absolute deviation from target of the mean and the mode inflation forecast at the one year horizon ($mean$, $mode$).[36] We also include a range of monthly indicators, including the unemployment rate, industrial production, the CIPS manufacturing new orders survey, the CBI producer price survey and the absolute deviation of inflation from target. In line with equation (19), we enter these variables in terms of the absolute value of their first differences. Since the dependent variable is a dummy variable, the model is estimated using a probit model, with the estimated parameters presented in Table 11.

Regression (1) confirms the result that the activity rate has fallen over time, and that it is higher in a forecast month than in a non-forecast month. Regression (2) includes the uncertainty measure, to control for changes in economic stability. An increase in uncertainty has a large and positive impact on the activity rate. Controlling for this variable also means that the time trend becomes insignificant. This suggests that the fall in the activity rate is driven by economic factors, rather than by changes in gradualism and/or inaction.

Regression (3) includes a larger set of variables in the regression to control for changes in the state of the economy and additional factors that are likely to affect the activity rate. Uncertainty remains significant, and the activity rate is significantly lower when the next move of the committee is to reverse the previous decision. By contrast, whether the next decision is to raise or cut interest rates does not affect the activity rate. The regression confirms the result that the importance of the forecast round has increased over time, as captured by the positive coefficient on the $time \cdot forecast$ interaction term. We also let the forecast term interact with uncertainty, but found that it was not significant. This suggests that the upward trend in activity levels during forecast rounds is not related to the increase in economic stability, but that it has been driven by other factors. In addition, an increase in the absolution deviation of (the mean) of forecasted inflation from its target increases the probability of changing rates. We found that the absolute

[35]We focus on four-year ahead inflation expectations since this is the shortest maturity at which data for index-linked bonds are available for the whole sample period.

[36]We also include the mean and the mode output growth forecasts, but find that these do not enter significantly into the regression equation.

value of the change in the unemployment rate or in the two surveys (CIPS and CBI) had no explanatory power for the activity rate, so these variables were not included in the regression equation. By contrast, the measure of industrial production ($indprod$), and the deviation of current inflation from target were marginally significant ($infldev$).

Regression (4) excludes variables that are not significant. The equation explains around one third of the variation in the activity rate. Finally, regression (5) includes the first lag of $action$ to see if there is evidence of interest rate gradualism at the monthly frequency, but the estimated coefficient is insignificant.[37]

To sum up, the results suggest that the fall in activity is mainly driven by economic stability. There is some evidence for inaction at the monthly frequency, reflected by the fact that the MPC is more active in the forecast month than in the non-forecast month. The importance of the forecast round has also increased over time, and this increase appears to be unrelated to increased economic stability. We find that the activity rate is lower before an interest rate reversal than before a continuation, and the results suggest that this difference has not been driven by a tendency for interest rate gradualism. There is no evidence that the MPC waits longer for a raise than a cut.

3.2 How does the behaviour of the MPC compare to that of its individual members?

We next compare individual activity rates to those of the committee to see whether the use of a committee, rather than an individual, for monetary policy decision making can explain some of the inaction at the monthly frequency. To do so, we start by establishing some facts about how the activity rate of the MPC differs to that of its individual members, and how the degree of activism differs between the individual members. We then estimate the model using panel data analysis. This allows us to identify factors that influence the activity rate across members, at a given point in time.

3.2.1 Is the MPC less active than its individual members?

We compare the probabilities of the MPC and its individual members being active, where the probabilities for individual members are conditional on them having voted with the majority of

[37] We also include the second and third lags of $action$, but none of these variables enter significantly.

the Committee at the previous meeting. This conditionality is necessary to enable a fair comparison to be made.[38] Charts 4 and 5 show the probability that the committee and its members voted for a change including and excluding the condition that they voted with the majority last period, and Table 12 summarises the data. The conditional data suggest that *on average there is no statistical difference between the activity rates of the committee and its individual members*.[39] The charts highlight that the difference in activity rates between individual members is large, with the conditional probabilities varying from 0.11 to 0.86. However, removing the top and bottom quartiles leaves a fairly small range of 0.23 to 0.36, and the median and mean are fairly close together suggesting little skew in the data. Differences across individual activity rates may be due to different perceptions of the impact of an interest rate change on inflation and output, or differences in the horizon over which members prefer to bring inflation back to target. Some members may also feel greater uncertainty regarding the economic outlook, or respond differently to this uncertainty.[40]

That the committee is as active as its individual members suggests that *the use of a committee for monetary policy decision making has not increased the degree of inaction and/or gradualism in UK monetary policy*. Indeed, if we examine the four periods over the life of the committee when it has been inactive for eleven months or more, only in the first of these was the proportion of dissenting members (members voting against the majority) above average, in the other three the proportion of dissenting votes was the same or below the sample average. This suggests that the inactivity was due to economic factors rather than committee inaction.

That the use of a committee decision making procedure does not appear to increase inaction relative to an individual decision making procedure may be because as noted by Sibert (2006), the structure of the MPC – with majority voting and no attempt at consensus, published minutes that allow external scrutiny and the presence of external members – helps to reduce the extent to which the committee's decision will differ from the mean of individuals' decisions. It is also consistent with the outcome of a policy experiment by Blinder and Morgan (2000) which finds that committees do not make decisions more slowly than individuals, but in contrast to findings

[38] It is necessary to account for this in order to compare the activity rates of individuals with the committee and the activity rates of individuals across the sample. Individuals that did not vote with the majority in the previous meeting may vote for a change even if the most recent vintage of data contains no news because they believe that interest rates were not set at the right level at the previous meeting. Not accounting for this will bias the activity rates of individual members who consistently voted against the decision of the committee upwards.

[39] As under majority voting the committee's interest rate decision is the *median* vote of its individual members it is possible that the committee's activity rate may differ to the sample the *mean* of its individual member's activity rates.

[40] See Bhattacharjee and Holly (2006).

from a similar experiment by Lombadelli et al. (2002).[41]

3.2.2 Do individual members show a greater tendency to be more active in a forecast round?

Table 7 shows *that individual members also show a tendency to be more active in the forecast round*, although for them the tendency is less pronounced than for the committee as a whole and has not become more evident in the latter part of the sample period.[42] The data also show that this tendency is more pronounced for internal members than external members.

3.2.3 Does individual member activity decline in their second 'term'?

Comparing the probabilities of members being active in their first three years on the MPC to thereafter (defined as 'first term' and 'second term') shows that *the activity rate of members in their first term is 0.1pp higher than in the second term*, and this difference is statistically significant at the 1% level.[43]

As discussed above, if the committee faces less uncertainty as time progresses it should become less gradualist and therefore also less active. This principle could apply to individual members as well as the Committee. In a monetary policy experiment Blinder and Morgan (2000) find that both committees and individuals 'learn to wait' for more data before making a decision as the experiment progressed, which is consistent with the results reported above. However, the decline in individual member activity could also be driven by changes in the overall activity rates over time, something we try to control for below using panel data analysis.

3.2.4 Are internal members more active than external members?

The activity rates of external members tend to be higher than those of internal members. If only members that voted with the majority in the previous round are considered the difference is

[41] On the theoretical side, Gerlach-Kristen (2006) argue the opposite, that as individuals are less certain about potential output, they attach more weight to past observations, and are thus less active than the committee. Although we find no evidence to support this, our data does not offer a strictly fair comparison as members have the opportunity to discuss the data with the committee, thus increasing their information set prior to voting.

[42] That the tendency to be more active in a forecast round is higher for the committee than its individual members implies that the whilst the forecast increases the probability of the median voter being active, it may not increase the probability of all members on the committee being active.

[43] The sample was divided into members' votes during their first three years on the committee and thereafter rather than official terms to avoid problems associated with members having terms of different lengths and some internal members terms having started before the establishment of the committee.

0.02pp, and statistically significant at the 10% level. However, if we do not account for whether members were in the majority in the previous round the difference is much larger at 0.08pp and this is significant at the 1% level. Accounting for the conditionality makes a large difference because external members have a lower probability of being in the majority than internal members (0.82 compared to 0.92 for internal members).[44]

There is little theoretical work on whether externals or internals are likely be more active. In an empirical study, Battacharjee and Holly (2006) find that the external members are more responsive than the internal members to a deviation of forecast inflation from target, which in some cases would cause them to be more active. Gerlach-Kristen (2007) also finds that the dissenting votes of external members contain information about the future direction of monetary policy, whilst the dissenting votes of internal members do not, which is consistent with externals being more active than internals.

3.2.5 Are individual members more or less averse to interest rate reversals?

In addition to the arguments for why the committee may be more averse to interest rate reversals than continuations, individual members may also be averse to voting to move rates in the opposite direction to their own previous vote due to concerns over their individual reputation.

Table 13 shows the probability that individual members and the committee vote to continue/reverse the previous active decision of the committee (given that they act) and the probability they vote to continue/reverse their own previous active decision (given that they act). We would expect individuals to be more likely to vote to reverse the committee's previous decision than the committee as a whole, as they may not have supported this decision. The data shows that this tends to be the case, however if an outlier is excluded from the sample *the probability of the MPC and its individual members voting to reverse the direction of monetary policy is the same*.[45] For the same reason we would expect that *individual members are more likely to vote to reverse the MPC's previous decision than their own*, and the results show that

[44] Gerlach-Kristen (2007) proposes that internals have a higher probability of voting with the majority because a) as they are in contact with each other more than external members an organisational consensus may form and b) disagreeing with other internal colleagues may be potentially damaging to their future career path. Given the internal members form a majority any 'internal consensus' would leave them on the winning side of an interest rate decision. In contrast, outsiders may find that the media attention gained from dissenting helps to raise their public profile and may promote their post-MPC career.

[45] For the outlier (Walton) the probability of voting to reverse the direction of interest rates (given that he acted) is one, compared to 0.33 for the member with the next highest probability. The high probability of Walton voting for a reversal is partly due to his short time on the committee.

this is the case.

3.2.6 Panel data analysis

Next, we estimate a simple empirical model using panel data analysis. Whereas the focus of the time series analysis was whether there was any evidence for inaction or gradualism for the MPC as a whole, here we take the degree of inaction/gradualism for the MPC as given, and focus on differences in the activity rate across members. We estimate the following equation

$$y_{it} = \alpha_i + \beta_1 X_{it} + \varepsilon_{it} \quad \textbf{(21)}$$

where subindex i denotes member i and where α_i is included to control for fixed effects. The dependent variable y_{it} ($action$) is a dummy variable that takes the value of one when a member votes for a rate change, and zero otherwise. The explanatory variables included in the vector X_{it} are based on the above discussion, and contain two types of variables; Those that are common across members of the committee, and those that differ across members. The former include a linear time trend ($time$), a measure of the uncertainty around the forecast ($uncert$), a measure of inflation expectations ($mean$, $mode$) and dummy variables that take the value of one if the vote is in a forecast round ($forecast$), if the committee's next active decision is to raise interest rates (up), and if the committee's next active decision reverses the last decision (rev). As individual-specific variables, we include dummy variables that take the value of one if the member is internal ($internal$), if the member has served more than three years ($term$), if the member voted with the majority of the committee in the previous meeting ($pastmaj$). We also use dummy variables to distinguish between members' backgrounds ($academic$, $business$, $finance$ and $public$**)**, and let some of the variables interact. The model is estimated using panel data analysis, as shown in Table 14.

Regression (1) confirms that individual members are more likely to be active in a forecast round, when uncertainty is high, and when the member is an external (as reflected by the negative coefficient on internal). There is no evidence that individual activity rates have fallen over time when we control for the level of uncertainty, suggesting that the fall in individual's activity rates can be explained by economic factors, rather than changes in the degree of gradualism and /or inaction. Another result is that, once we control for whether a member is internal or external, the length of time served on the committee has no significant impact on the activity rate, reflecting the fact that internals tend to serve longer on the committee than the externals, and also tend to be less active. This result suggests that members do not 'learn' to wait for new information (as suggested by Blinder and Morgan (2000)).

Regression (2) excludes the variable $term$ but controls for whether members voted with the majority in the past meeting ($pastmaj$). The estimated coefficient is negative, which shows that members are less likely to be active if they agreed with the committee's decision in the previous meeting. We also find that, although the estimated coefficient on $internal$ is still significant, the difference in activity rates across internal and external members falls once we control for $pastmaj$. This reflects the fact that external members have a lower probability of having voted with the majority in the previous period, and therefore are more likely to be active than internals.

Regression (3) shows that individual members are less likely to be active when the next decision of the committee is to reverse the last decision, compared to a continuation. By contrast, the activity rate is not significantly affected by whether the next active decision is to raise or cut interest rates.

Regression (4) excludes the variable $internal$ and instead includes the background of the individual members. The results suggest that members with experience of academia are more active than those with other backgrounds. In fact, when we include both $internal$ and $academia$, variable $internal$ no longer enters significantly (regression (5)). To some extent, this captures the fact that externals are more likely to have an academic background compared to internals.[46] However, since $academia$ remains significant, this suggests that the difference in activity rates across internals and externals may be related to their different backgrounds.[47]

To better understand the difference between internals and externals, we also interact the internal dummy variable with some of the explanatory variables that mattered for the activity rate: $forecast$, $uncert$ and $mean$, as shown in regression (6). Internals tend to be more active when uncertainty is high (capturing a stronger tendency to act in the beginning of the sample period), when forecast inflation deviates from target,[48] and when the next decision is to raise interest rates.[49]

[46]64% of externals have experience in academia, and 27% of internals.

[47]Previous related work finds that members with experience of academia do not show a tendency to vote for higher or lower interest rates than other members (Gerlach-Kristen (2007)) and that career backgrounds have no significant effect on members tendency to cast dissenting votes (Spencer (2006)).

[48]By contrast, Harris and Spencer (2007) and Brooks, Harris and Spencer (2007) find that that external members are more responsive to deviations of the inflation forecast from target than internal members.

[49]This is consistent with Spencer and Harris (2007) and Gerlach-Kristen (2007) who find that internal members show a preference for

To sum up, these results suggest that, similar to the committee, individual members are more active in a forecast round and when uncertainty is high. Also, they are less likely to be active before an interest rate reversal, compared to a continuation. We find some difference in activity rates across members. In particular, internals tend to be less active than externals, despite being more responsive to deviations of the inflation forecast from target. Internals also tend to be more active before an interest rate rise, compared to a cut. Some of the difference between internals and externals appears to be related to their background - externals are more likely to have an academic background, and members with an academic background tend to be more active.

4 Conclusions

Standard estimates of the Taylor rule suggest that monetary policy responds gradually to movements in inflation and the output gap. There is strong evidence that the model is misspecified, however. We account for this by addressing various measurement issues, and also allow for the fact that policy-makers may respond to variables not included in the Taylor rule. When doing so, there is little evidence for interest rate gradualism. To evaluate whether there is evidence for inaction we estimate a measure of monetary policy when there is no incentive for the MPC to reduce interest rate volatility and compare it with actual policy. The main result is that, although there is some evidence that monetary policy has been inert over the MPC period, there is markedly less inaction than previous work suggested. This may reflect the fact that earlier work looked at monetary policy prior to the formation of the MPC, when both inflation and output were considerably more volatile. In line with the Taylor rule results, this exercise also suggests that there is little evidence that policy has been more gradual than it should be at the quarterly frequency, given the dynamics of the economy.

However, there is some evidence for inaction at the monthly frequency, indicated by the tendency of the committee to be more active in the forecast round. The importance of the forecast round has increased over time, and this increase appears not to be related to increased economic stability. There is no evidence that the MPC waits longer before a rate rise than a rate cut, but they tend to wait longer before reversing the direction of interest rate changes. This difference appears not to be driven by interest rate gradualism, and so provides some evidence for inaction at the monthly frequency, in line with the results at the quarterly frequency. Any inaction in

higher interest rates.

monetary policy does not appear to be related to the use of a committee, as the individual MPC members are not more active than the MPC as a whole. We also find that external members tend to be more active than the internal members, despite the fact that internals tend to respond more strongly to deviations of the inflation forecast from target.

Appendix A: Tables and charts

TABLE 1: ESTIMATION RESULTS: STANDARD TAYLOR RULES

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
ϕ_π	0.53**	1.24**	1.50**	0.60**	2.24	3.11	0.59**	0.10
	(0.05)	(0.53)	(0.48)	(0.27)	(1.53)	(2.39)	(0.24)	(0.42)
ϕ_y	0.40**	1.35**	1.57**	4.61*	3.29**	3.40**	3.12*	1.30*
	(0.20)	(0.38)	(0.38)	(2.35)	(1.49)	1.53	(1.69)	(0.79)
ρ				0.93**	0.87**	0.86**	0.90**	0.64**
				(0.03)	(0.05)	(0.09)	(0.04)	(0.19)
c	5.76**	2.09	5.23**	0.33	0.56*	0.67**	0.50*	1.74*
	(0.39)	(1.29)	(0.13)	(0.22)	(0.29)	(0.43)	(0.30)	(0.97)
γ							0.19*	0.83**
							(0.10)	(0.17)
R^2	0.47	0.27	0.34	0.94	0.92	0.92	0.94	0.96
DW	0.15	0.19	0.33	1.69	0.79	0.89	1.98	1.85
Obs	123	39	39	122	39	39	121	39
$Sample$	76Q1-07Q2	97Q1-07Q2	97Q1-07Q2	76Q1-07Q2	97Q1-07Q2	97Q1-07Q2	76Q1-07Q2	97Q1-07Q2

Notes: (1)-(5), (7)-(8) estimated using OLS, (6) estimated using IV (instruments: lag 1-4 of the interest rate, inflation and the output gap). Standard errors in parenthesis, based on the Newey-West heteroskedasticity and serial correlation robust estimator.

TABLE 2: ESTIMATION RESULTS: BACKWARD- AND FORWARD-LOOKING TAYLOR RULES (1994Q1-2007Q2)

i	-1	0	1	2	3	4
ϕ_π	1.54	2.92*	3.62*	5.13*	7.12	9.81
	(1.19)	(1.47)	(2.09)	(3.04)	(5.37)	(10.20)
ϕ_y	2.61*	3.63**	4.14**	3.77*	3.01	1.41
	(1.38)	(1.29)	(1.71)	(1.95)	(2.59)	(3.97)
ρ	0.90**	0.84**	0.86**	0.88**	0.89**	0.91**
	(0.09)	(0.08)	(0.07)	(0.07)	(0.08)	(0.08)
c	0.52	0.82**	0.70*	0.60	0.55	0.46
	(0.45)	(0.39)	(0.38)	0.39	0.41	0.44
R^2	0.91	0.92	0.92	0.91	0.89	0.87
DW	0.77	0.88	1.05	0.86	1.03	0.82
Obs	50	51	50	49	48	47

Notes: Estimated using IV. Instruments: Lag 1-4 of inflation, the output gap, and the interest rate. Standard errors in parenthesis based on the Newey-West heteroskedasticity and serial correlation robust estimator.

TABLE 3: TAYLOR RULES BASED ON EX POST AND EX ANTE DATA - LEVELS SPECIFICATION

	Ex Post data						Ex Ante data					
τ	α_π	α_y	α_i	c	R^2	DW	α_π	α_y	α_i	c	R^2	DW
8	-0.29	-0.20	0.92**	1.57	0.90	1.19	5.56	1.75	0.89*	-1.35	0.91	1.11
7	-0.28	-0.18	0.91**	1.52	0.90	1.20	25.69	1.67	0.95**	0.09	0.96	1.61
6	1.52**	0.09	0.97**	0.15	0.96	1.61	52.11	3.37	0.97	0.15	0.96	1.61
5	-0.14	0.08	0.95	0.29	0.90	1.30	1130.953	858.84	1.00**	-0.06	0.93	1.35
4	-0.00	0.35	1.07**	-1.24	0.91	1.51	928.68	934.94	1.00**	-0.06	0.93	1.49
3	0.06	0.51**	1.14**	-2.19**	0.93	1.95	262.61	1126.24	1.00**	-0.11	0.94	1.87
2	0.06	0.44**	1.06**	1.61**	0.94	2.14	81.99	1079.44	1.00**	-0.10	0.95	1.98
1	0.02	0.35**	0.98**	-0.82*	0.94	1.97	-1.01	22.90	0.98**	-0.01	0.95	1.97
0	0.06	0.30**	0.89**	-0.38	0.93	1.83	0.55	2.95**	0.90**	0.41**	0.93	1.83

Notes: Estimated using OLS. **(*) denotes significant at the 5 (10)% level. The first column (τ) denotes quarter-ahead forecasts. Sample period: 1997Q1-2007Q3.

TABLE 4: TAYLOR RULES BASED ON EX ANTE DATA, FIRST DIFFERENCE SPECIFICATION

	Lagged interest rate, OLS estimation					Lagged interest rate, IV estimation				
τ	α_π	α_y	α_i	R^2	DW	α_π	α_y	α_i	R^2	DW
8	1.81**	0.00	-0.01	0.67	2.26	1.81**	0.15	0.03	0.96	2.03
7	1.53**	0.14**	-0.01	0.64	1.63	1.63**	0.36*	-0.01	0.63	1.39
6	0.79**	0.27**	-0.00	0.33	1.38	1.08**	0.46**	-0.01	0.36	1.39
5	0.48**	0.32**	-0.00	0.32	1.32	0.65**	0.41**	-0.01	0.44	1.47
4	0.35*	0.30**	-0.00	0.33	1.33	0.49**	0.35**	-0.01	0.44	1.48
3	0.11	0.30**	-0.02	0.39	1.42	0.24	0.30**	0.01	0.42	1.54
2	0.04	0.34**	-0.01*	0.49	1.76	0.18	0.33**	-0.01	0.48	1.72
1	-0.02	0.35**	-0.01*	0.52	1.97	0.16	0.37**	-0.01	0.48	1.87
0	0.02	0.28**	-0.02*	0.33	1.83	0.06	0.33	-0.01*	0.32	1.86

Notes: Estimated using OLS. **(*) denotes significant at the 5 (10)% level. The first column (τ) denotes quarter-ahead forecasts. Sample period: 1997Q1-2007Q3.

TABLE 5: ACTUAL AND 'PREDICTED' INTEREST RATE CHANGES

	Proportion of total interest rate decisions					Ratio of actual to predicted		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Actual	Predicted (Cholesky)	Predicted (SR)	Actual 1981-1998	Predicted 1981-1998	(Cholesky)	(SR)	1981-1998
Continuations	0.46	0.44	0.35	0.55	0.41	1.04	1.31	1.34
Reversals	0.15	0.26	0.24	0.24	0.58	0.58	0.60	0.41
No change	0.38	0.30	0.41	0.21	0.02	1.27	0.95	10.5

Notes: Column (2) and (6) use Cholesky decomposition to identify the structural VAR. Column (3) and (7) use sign restrictions. Data in column (4), (5) and (8) are based on Goodhart (1999). A value of $\lambda = 0.5$ has been used to calculate predicted policy.

TABLE 6: PROBABILITY OF COMMITTEE ACTIVITY BY YEAR

	P(Act)
June 1997- April 2007	0.28
1997[1]	0.50
1998	0.33
1999	0.50
2000	0.17
2001	0.54
2002	0.00
2003	0.25
2004	0.33
2005	0.08
2006	0.17
2007[2]	0.25

[1] 1997 data are from June to December only

[2] 2007 data are from January to April only.

TABLE 7: PROBABILITY OF ACTIVITY BY FORECAST ROUND

		P(act)	P(act | forecast)	P(act | no forecast)	P-value[1]
Committee	July 1997-April 2007	0.28	0.46	0.19	0.002
	July1997-2001	0.40	0.56	0.32	0.101
	2002-April 2007	0.17	0.38	0.07	0.002
Individual members[2]	July 1997-April 2007	0.30	0.36	0.19	0.000
	July 1997-2001	0.41	0.47	0.30	0.000
	2002-April 2007	0.17	0.29	0.10	0.000
External members [2]	July 1997-April 2007	0.31	0.34	0.20	0.001
Internal members[2]	July 1997-April 2007	0.29	0.40	0.19	0.000

[1] P-value of a test for no statistical difference between P(act | forecast) and P(act | no forecast).

[2] Weighted average conditional on member having voted with the majority in the period before.

TABLE 8: A COMPARISON OF ACTIVITY ACROSS CENTRAL BANKS

	UK	Australia	Canada	Euro -area	New Zealand	Norway	Sweden	US	Mean
P(Act per meeting)	0.28	0.19	0.50	0.22	0.45	0.38	0.35	0.46	0.32
Meetings per year	12	11	8	12	8	9	8	8	9.9
Average activity per year	3.4	2.1	4.1	2.6	3.6	3.3	3.0	3.8	2.9
Decision making process[1]	maj	maj	cons	cons	gov	cons	maj	maj	
Accountability[2]	ind	coll	coll	coll	gov	coll	ind	ind	
Members on committee	9	9	6	18	1	7	6	12	8.3
P(Act per meeting|forecast)	0.46	0.28	0.65	0.36	0.44	0.42	0.41	0.39	0.43
P(Act per meeting|no forecast)	0.19	0.14	0.39	0.18	0.44	0.35	0.31	0.44	0.31
P-value[3]	0.00	0.05	0.07	0.07	0.97	0.61	0.39	0.58	
Forecasts per year	4	4	4	4	4	3	4	2	3.3
Forecast owner	Comm	Comm	Staff	Staff	Gov	Comm	Staff	Comm	
Main policy tool for communication	Y	Y	Y	N	Y	Y	Y	N	
Sample period[4]	06/97-04/07	06/97-04/07	12/00-04/07	01/99-04/07	04/99-04/07	01/01-04/07	01/99-04/07	06/97-04/07	

Sources: National central bank websites.
[1]Maj refers to majority voting, cons consensus decision making, and gov indicates that the Governor has the final decision.
[2]If accountability is collective (coll) individual members decisions are not made public and all members defend the majority view. If accountability is individual (ind) members votes are made available to the public. If the Governor makes the decision alone (gov) then he is accountable.
[3]P-value of a test for nostatistical difference between P(act per meeting|forecast) and P(act per meeting|no forecast).
[4]Sample period is from June 1997 unless the respective central bank changed its policy making procedure after June 1997, in which case only data since the structural break are analysed.

TABLE 9: AVERAGE MONTHS INACTIVITY PRIOR TO A RATE RISE/CUT

		UK	Australia	Canada	Euro-area	New Zealand	Norway	Sweden	US	Mean
Average months pre-	raise	2.1	3.8	1.3	3.3	1.1	2.4	2.2	0.6	3
	lower	2.9	3.3	0.6	3.6	1.3	0.4	1.9	1.7	2.3
	P-value[1]	0.56	0.83	0.21	0.9	0.8	0.06	0.8	0.2	

Sources: National central bank websites
[1]P-value of test for no statistical difference between the average wait pre-lower and average wait pre-raise.
Sample: June 1997-April 2007 unless the respective central bank changed its policy making procedure after June 1997, in which case only data since the structural break are analysed.

TABLE 10: MEASURES OF THE WILLINGNESS OF CENTRAL BANKS TO MAKE INTEREST RATE REVERSALS/CONTINUATIONS

	UK	Australia	Canada	Euro-area	New Zealand	Norway	Sweden	US	Mean
P(Continuation | Act)	0.82	0.86	0.83	0.86	0.86	0.90	0.77	0.89	0.84
P(Reversal | Act)	0.18	0.14	0.17	0.14	0.14	0.10	0.23	0.11	0.17
Average months pre-continuation	1.6	3.7	0.6	1.8	0.8	0.5	1.7	0.4	1.6
-reversal	6.8	5.7	2.0	16.7	3.5	6.0	3.4	5.3	5.7
P(Continuation | Act_{t-1})	0.30	0.46	0.67	0.17	0.59	0.52	0.36	0.64	0.4
P(Reversal | Act_{t-1})	0	0	0	0	0	0	0	0	0

Sources: National central bank websites
Sample: June 1997-April 2007 unless the respective central bank changed its policy making procedure after June 1997, in which case only data since the structural break are analysed.

TABLE 11: TIME SERIES ESTIMATION

Dependent variable: Committee Action	1	2	3	4	5
$time$	-0.01**	0.00	0.00		
$forecast$	0.82**	0.85**	0.48		
$uncert$		4.86**	6.35*	6.46**	6.84**
$time \cdot forecast$			0.02*	0.02**	0.02**
up			-0.19		
rev			-1.35**	-1.21**	-1.31**
$mode$			-2.25		
$mean$			2.88**	1.24*	1.32*
$inflexp$			0.42		
infldev			-1.89*	-1.81*	-1.96*
indprod			-0.29	-0.28*	-0.30*
$action(-1)$					-0.32
$constant$	-0.42	-3.45**	-4.97**	-3.94**	-3.98**
R^2	0.09	0.13	0.30	0.27	0.27

Notes: Estimated using binary probit model. **(*) denotes significant at the 5 (10)% level. Sample: July 1997-March 2007

TABLE 12: COMPARISON OF COMMITTEE AND INDIVIDUAL MEMBERS ACTIVITY LEVELS

	Committee	Individual members					
		Weighted Mean[1]	P-value[2]	Mean	Median	Max	Min
P(Act|majority$_{t-1}$)	0.28	0.30	0.67	0.33	0.31	0.86	0.11
P(Act)	0.28	0.34	0.19	0.36	0.33	0.71	0.09

Sample: July 1997-April 2007

[1]The weight given to each individual member in the aggregation of their probabilities is proportional to the number of meetings at which they voted

[2]P-value of test for no statistical difference between the activity rate of the committee and the weighted average of its individual members.

TABLE 13: PROBABILITY OF VOTING FOR A REVERSAL OF A) THE COMMITTEE'S AND B) MEMBER'S PREVIOUS ACTIVE DECISION

	Committee's previous decision		Own previous decision	
	P(Reverse|Act)	P(Continuation|Act)	P(Reverse|Act)	P(Continuation|Act)
Bean	0.22	0.78	0.21	0.79
Clementi	0.14	0.86	0.14	0.86
George	0.13	0.87	0.13	0.87
Gieve	0.33	0.67	0.33	0.67
King	0.20	0.80	0.19	0.81
Large	0.15	0.85	0.08	0.92
Lomax	0.33	0.67	0	1
Plenderleith	0.14	0.86	0.14	0.86
Tucker	0.27	0.73	0.09	0.91
Vickers	0.12	0.88	0.13	0.87
Allsopp	0.11	0.89	0	1
Barker	0.28	0.72	0.16	0.84
Bell	0.10	0.90	0.22	0.78
Besley	0	1	0	1
Blanchflower	1	0	NA	NA
Budd	0.14	0.86	0.17	0.83
Buiter	0.06	0.94	0.11	0.89
Goodhart	0.13	0.87	0.13	0.87
Julius	0.14	0.86	0.21	0.79
Lambert	0.29	0.71	0.33	0.67
Nickell	0.16	0.84	0.10	0.90
Sentance	0	1	0	1
Wadhwani	0.21	0.79	0.11	0.8
Walton	1	0	0.33	0.67
Weighted average	0.20	0.80	0.15	0.85
Weighted average (ex-Walton)	0.18	0.82	0.14	0.86
Committee	0.18	0.82	0.18	0.82

TABLE 14: PANEL DATA ESTIMATION

Dependent variable: Individual Action						
	1	2	3	4	5	6
$forecast$	0.59**	0.59**	0.65**	0.59**	0.59**	0.62**
$uncert$	3.45**	3.60**	2.96**	3.62**	3.50**	1.45
$internal$	-0.19**	-0.14**	-0.11		-0.13	-2.15**
$pastmaj$		-0.93**	-1.09**	-0.93**	-0.92**	-1.12**
$term$	-0.12					
$time$	0.00					
up			0.83			-0.13
rev			-0.60**			-0.76**
aca				0.26**	0.14*	
bus				0.13		
fin				0.17		
$mean$						0.36
$int \cdot forecast$						0.11
$int \cdot uncert$						2.64**
$int \cdot mean$						0.98**
$int \cdot aca$						0.17
$int \cdot up$						0.36*
$int \cdot rev$						0.30
R^2	0.07	0.11	0.16			

Notes: Estimated using binary probit model. **(*) denotes significant at the 5 (10)% level. Sample: July 1997-March 2007

Chart 1: Interest rates of selected industrialised countries

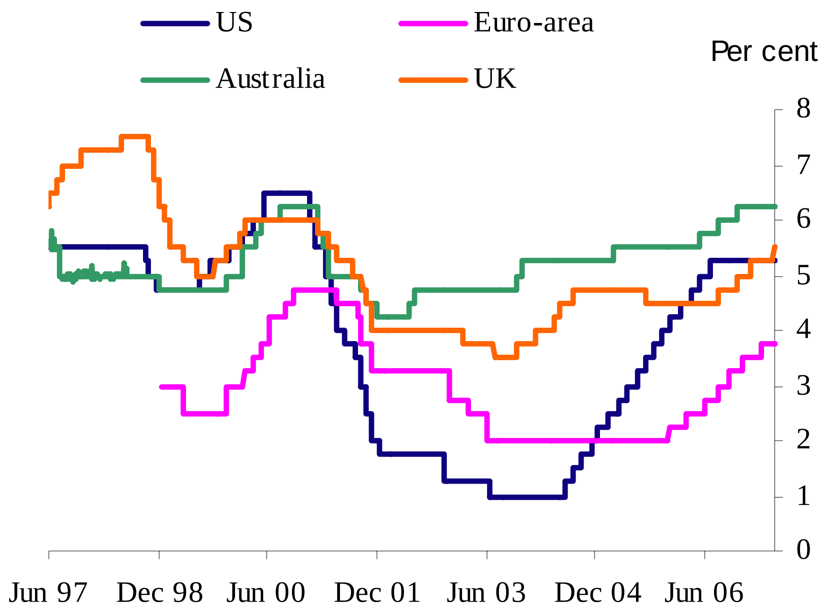


Chart 2: Actual and 'estimated' Bank rate

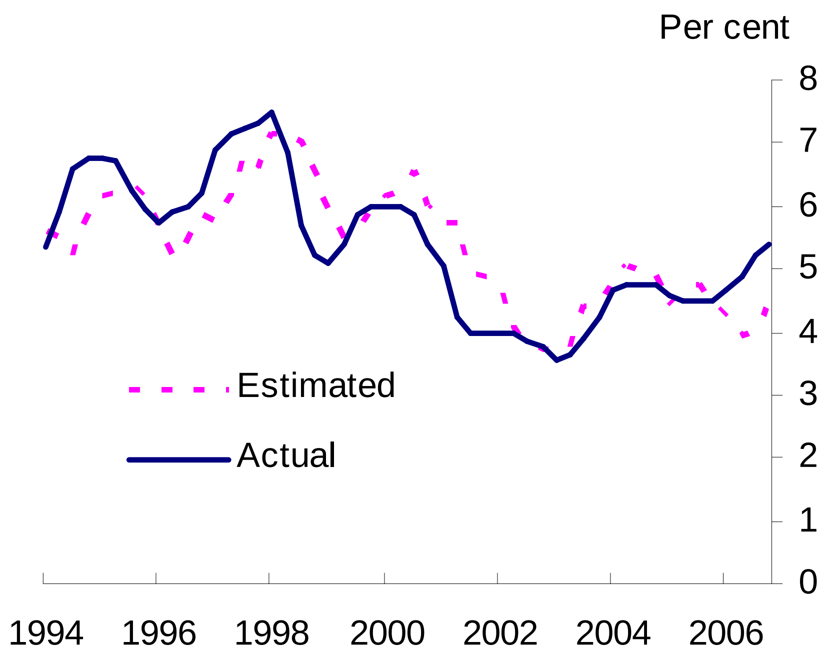


Chart 3: Twelve month rolling probabilities that the Committee and its individual members act.

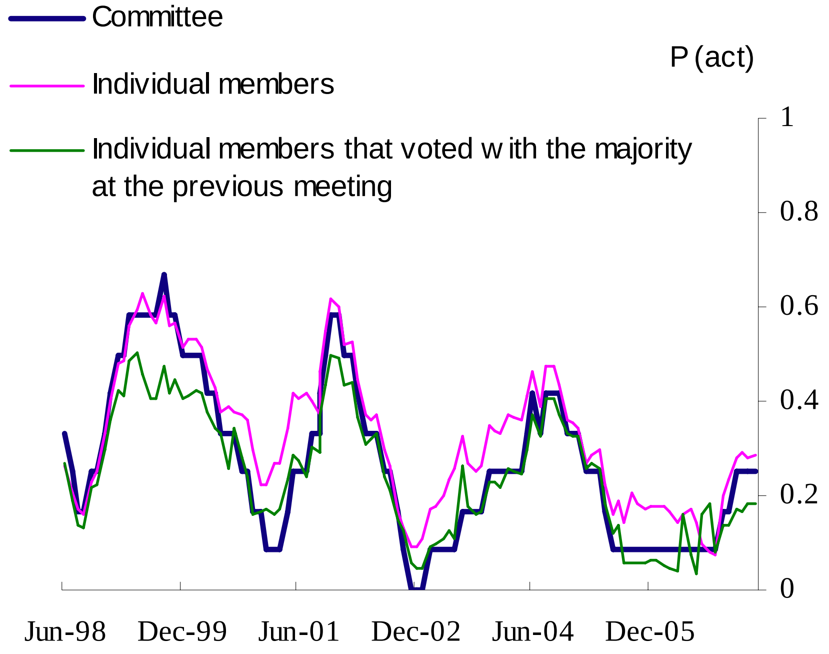


Chart 4: Probability individual members act given they voted with the majority at the previous meeting (June 1997-April 2007)

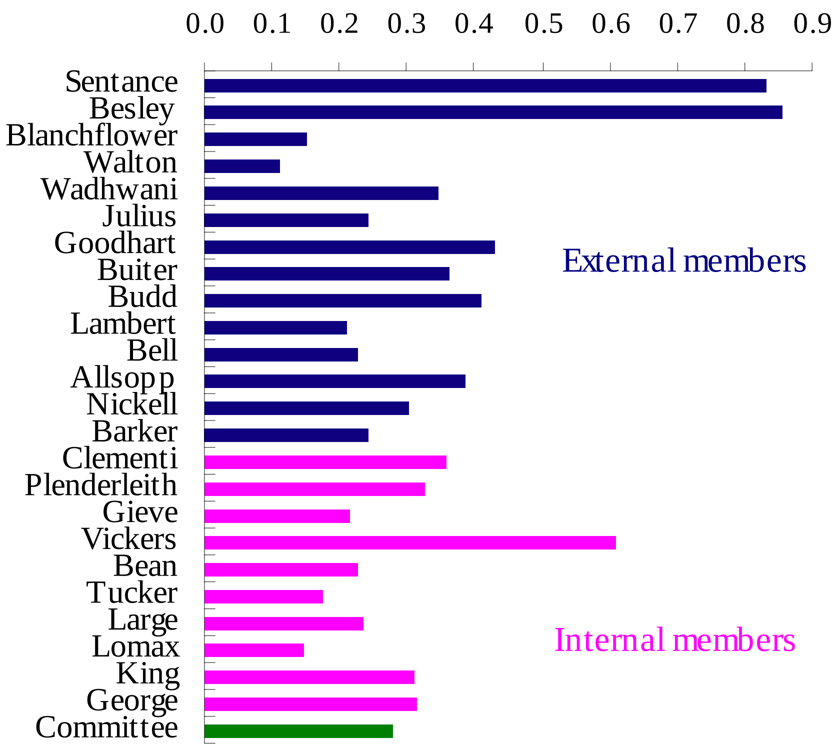
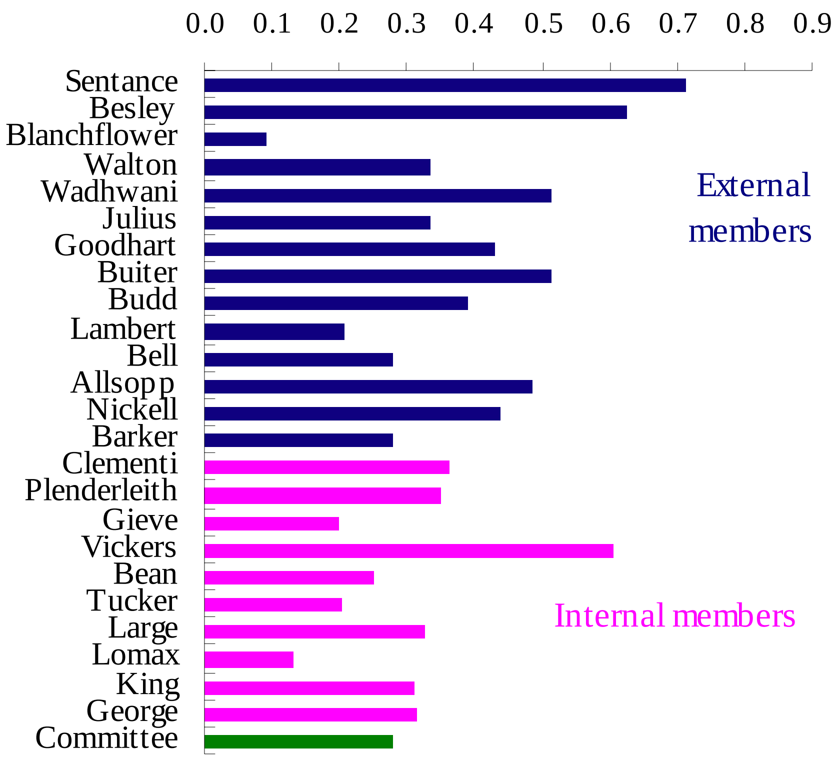


Chart 5: Probability individual members act (June 1997-April 2007)



References

Aoki, K (2002), 'On the optimal monetary policy response to noisy indicators', *Journal of Monetary Economics* 50 (2003) 501-523.

Barker, K (2007), 'Interest rate changes – too many or too few?', Speech to the *CBI North-East Dinner at Newton-Aycliffe,* 20 March 2007.

Benati, L (2004), 'Evolving post-World War II UK economic performance', *Bank of England Working Paper No. 232*.

Bhattacharjee, A and Holly, S (2006), 'Taking personalities out of monetary policy decision making? Interaction, heterogeneity and committee decisions in the Bank of England's MPC', *Centre for Dynamic Macroeconomic Analysis Working Paper Series CDMA06/12*.

Blinder, A (1997), 'Distinguished lecture on economics in government: What central bankers could learn from academics – and vice versa', *The Journal of Economic Perspectives*, Vol. 11, No 2. (Spring 1997) pp 3-19.

Blinder, A (1986), 'More on the speed of adjustment in inventory models', *Journal of Money, Credit and Banking*, Vol 18, pp 355-65.

Blinder, A and Morgan, J (2000), 'Are two heads better than one? An experimental analysis of group versus individual decision making', *NBER Working Paper 7909.*

Boivin, J (2005), 'Has US Monetary Policy Changed? Evidence from Drifting Coefficients and Real-Time Data', *NBER Working Paper 11314*.

Brainard, W (1967), 'Uncertainty and the effectiveness of policy', *American Economic Review Papers and Proceedings* 57(2): 411-425.

Brooks, R Harris, M and Spencer, C (2007), 'An Inflated Ordered Probit Model of Monetary

Policy: Evidence from MPC Voting Data', mimeo, *Monash University and University of Surrey*.

Castelnuovo, E and Surico, P (2006), 'The price puzzle: fact or artefact', *Bank of England Working Paper no 288.*

Clarida, R, Gali, J and Gertler, M (1998), 'Monetary policy rules and macroeconomic stability: Evidence and some theory', *NBER Working Paper 6442.*

Ellison, M (2006), 'The learning cost of interest rate reversals', *Journal of Monetary Economics* 53 (2006) 1895-1907.

English, W, Nelson, W and Sack, B (2003), 'Interpreting the significance of the lagged interest rate in estimated monetary policy rules', *Contributions to Macroeconomics*, Vol. 3.

Gerlach-Kristen, P. (2004), 'Interest-rate smoothing: monetary policy inertia or unobserved variables', *Contributions to Macroeconomics*, Volume 4, issue 1.

Gerlach-Kristen, P. (2006), 'Monetary policy committees and interest rate setting', *European Economic Review*, Vol 50, pp 487-507.

Gerlach-Kristen, P. (2007), 'Outsiders at the Bank of England's MPC', mimeo.

Goodhart, C (1999), 'Central bankers and uncertainty', *Bank of England Quarterly Bulletin*, February 1999.

Goodhart, C (2005), 'The Monetary Policy Committee's reaction function: An exercise in estimation', *Topics in Macroeconomics*, Volume 5, Issue 1, Article 18.

Harris, M, and Spencer, C (2007), 'Policy choices and reaction functions of Bank of England MPC members', Presented to the *European Economic Association conference* in Budapest, August 2007.

King, M (2007), 'The MPC ten years on', Lecture delivered to the *Society of Business Economists*, May 2007.

Leitemo and Soderstrom (2004), 'Robust monetary policy in the New-Keynesian framework', *Bank of Finland Discussion Paper no 31*.

Lomax, R (2005), 'Inflation targeting in practice: Models, forecasts and hunches' Speech to the *59th International Atlantic Conference in London*, 12 March 2005

Lombardelli, C, Proudman, J and Talbot, J (2002), 'Committee versus individuals: an experimental analysis of monetary policy decision-making', *Bank of England Working Paper no 165.*

Martin, B and Salmon, C (1999), 'Should uncertain monetary policy-makers do less?', *Bank of England Working Paper no 99.*

Monetary Policy Committee (1999), 'The transmission mechanism of monetary policy', available at http://externalboeweb/publications/other/monetary.htm

Nelson, E (2000), 'UK monetary policy 1972-97: a guide using Taylor rules**',** *Bank of England Working Paper no 120.*

Nelson, E and Nikolov, K (2001), 'UK inflation in the 1970s and 1980s: the role of the output gap and mismeasurement', *Bank of England Working Paper no 148.*

Orphanides (1998), 'Monetary policy evaluation with noisy information', *Finance and Economics Discussion Series 1998-50,* Board of Governor of the Federal Reserve System.

Orphanides, A (2001), 'Monetary Policy Rules Based on Real-Time Data', *The American Economic Review*, Vol 91, pp 964-85.

Peersman, G (2005), 'What caused the early millennium slowdown? Evidence based on vector autoregressions', *Bank of England Working Paper no 272.*

Rudebusch, G (2002), 'Term structure evidence on interest rate smoothing and monetary policy inertia', *Journal of Monetary Economics* 49 (2002) 1161-1187.

Rudebusch, G and Svensson, L (1999)**,** 'Policy Rules for Inflation Targeting', in John B. Taylor (ed.), *Monetary Policy Rules*, University of Chicago Press.

Sack, B (1998), 'Does the Fed act gradually? A VAR analysis', *Board of Governors of the Federal Reserve System*, April.

Sibert, A (2006), 'Central banking by committee' *CEPR Discussion Paper no 5626*.

Soderstrom, U (2002),'Monetary policy with uncertain parameters', *Scandinavian Journal of Economics*, Vol 104, pp 125-45.

Spencer, C (2006), 'The dissent voting behaviour of Bank of England MPC members', *University of Surrey Discussion Papers in Economics DP 03/06.*

Svensson (2003), 'What is wrong with Taylor rules? Using judgment in monetary policy through targeting rules' Version 3.1, *Journal of Economic Literature,* 41, pp 426-477.

Uhlig, H (1999), 'What are the effects of monetary policy: results from an agnostic identification approach', *Journal of Monetary Economics,* Vol 52, pp 381-419.

Woodford, M (1999). 'Optimal monetary policy inertia', *NBER Working Paper no 7261*.