

ABSTRACT

Monetary authorities often seem reluctant to discuss the conduct of monetary policy. There is a concern that greater openness in monetary policy-making may lead to volatility in financial markets, and specifically in interest rates. However, to date there is very little direct empirical evidence but recent changes in the monetary policy framework of the UK provide an opportunity to gain some insight on this issue. First, we present a model of monetary policy showing that volatility that would otherwise occur to aggregate prices is transmitted to the rate of interest in a tightly specified nominal regime. Under some circumstances information flows may add to volatility; if volatility is harmful then central bankers may be right to be reticent. However, the evidence suggests that even though volatility has indeed risen in the recent past, there is no evidence that this volatility is directly attributable to increased information flows *per se*.

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INFLATION TARGETING, TRANSPARENCY AND INTEREST RATE VOLATILITY: DITCHING ‘MONETARY MYSTIQUE’ IN THE UK¹

Jagjit Chadha²
University of Cambridge

Charles Nolan³
University of Reading

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“Greater openness is not a popular case in central banking circles, where mystery is sometimes argued to be essential to effective monetary policy...[but] a more open central bank, by contrast, naturally conditions expectations by providing the markets with information about its own view of the fundamental forces guiding monetary policy.”

Alan Blinder (1998)

1. INTRODUCTION

Over the last decade and more, an important debate has been conducted concerning the optimal degree of transparency and commitment in monetary policy-making. The discussion surrounding the development of explicit inflation targeting (see e.g., Leiderman and Svensson (1995) or King (1997)) as a policy rule illustrates this well. While there now seems to be widespread agreement on the need for a degree of commitment in the conduct of policy, there is little consensus as to how open the process of policymaking should be. Indeed, there often seems to be little

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² Clare College, Cambridge and Department of Applied Economics. Austin Robinson Building, Sidgwick Avenue, University of Cambridge, Cambridge CB3 9DE, United Kingdom. Tel: +44 1223 335280. E-mail: jagjit.chadha@econ.cam.ac.uk.

³ Department of Economics, Reading University, Whiteknights, Reading, RG6 6AH, United Kingdom. Tel: +44 118 987 5123 x4068. E-mail: C.Nolan@reading.ac.uk.

agreement on what it means to be “transparent”.⁴ In any event, traditionally central bankers have appeared reticent in making clear what they do and why. More recently, things have started to change.

In some, perhaps unlikely, quarters this natural reticence of central bankers has been shed and replaced by something close to a reforming zeal.⁵ Inflation targeting countries, in particular, seem to be in the process of redefining the agenda for transparency and have influenced the IMF's (1999) recently published *Code of Good Practices on Transparency in Monetary and Financial Policies*. In this vein the recent experience of the UK and the eleven founding members of EMU provide possibly polar examples. The former used the opportunity of monetary reform - following ERM exit in 1992 and especially following the adoption of instrument independence of the Bank of England in 1997 - to conduct a monetary experiment in inflation targeting and openness *à la mode*.⁶ The latter has used a similar opportunity involving an experiment in supra-national monetary commitment, leading up to the creation of European Monetary Union on 1 January 1999, to adopt, by comparison, a relatively secretive regime.

As we outline in more detail below, the arguments against “too much” openness seem to be essentially two-fold. The first argument, expounded primarily by monetary policymakers, but which has received relatively little attention in the academic literature, is that a consequence of greater information flows, for example from forecast revisions or from published disagreements amongst policymakers, will be a monetary policy regime characterised by high interest rate variability. The second argument, which has received more attention in the theoretical literature, is that a degree of secrecy will give the authorities an informational advantage and therefore greater likelihood of success in formulating (counter-cyclical)

⁴ The debate between Buiter (1998) and Issing (1999) illustrates this point very well. See the discussion below.

⁵ King (1997), for example, argues that post-ERM arrangements possess “a degree of transparency and accountability unprecedented in UK monetary history”. See also the discussion in Blinder (1998).

⁶ The IMF's Public Information Notice No 99/17 following this year's Article IV consultations frequently praised the UK's monetary “framework (as the) notably clear and symmetric target in the transparent process had...led to timely and judicious changes in policy interest rates...On transparency of the monetary framework, (the) Directors considered the UK to be close to the frontier.”

Policy.⁷ Such views may indeed be discernible in recent pronouncements by senior officials of the European Central Bank to justify what many commentators view as an undesirably secretive approach to policymaking.⁸

In any case, the possible advantages of secrecy in playing the monetary authorities' hand continue to be the focus of ongoing macroeconomic research.⁹ However, relatively little empirical work has focussed on the first argument outlined above and consequently that is the focus of this paper: What are the implications for interest rate volatility of increasing the degree of transparency in the conduct of monetary policy?

1.1 Some Related Literature

Central bankers appear to dislike interest rate volatility. Froyen and Boyd (1995) note arguments by both Alfred Hayes, former president of the Federal Reserve Bank of New York, and Paul Volcker in favour of reducing interest rate variability. There have also been a number of papers documenting and analysing so-called 'interest rate smoothing' (see e.g., Goodfriend, (1991), Goodhart (1996) and Woodford (1999)). Although the primary focus of that literature is the observed tendency for the smoothing of policy rates, part of the motivation for such behaviour has been to provide a stable environment for financial markets. In a well-known analysis of some of these issues, Goodfriend (1986, p78) noted that "the FOMC values secrecy because it is thought to promote interest rate stability".¹⁰ And this supposed role for secrecy in helping monetary authorities to stabilise interest rates goes beyond the US. The President of the European Central Bank, Wim Duisenberg, has recently argued against publishing the minutes of the ECB's governing council

⁷ These views can be discerned in Duisenberg (1998) and Issing (1998a,b). Such views are not only the preserve of European central bankers as Goodfriend (1986) shows. In the EU context an additional argument in favour of secrecy is that it preserves independence of national representatives on the board from domestic pressure, although this must surely boil down to a concern for the credibility of the policy process.

⁸ For example, Buiter (1998) compares approaches and finds that the Bank of England answers 'yes' and the ECB 'no' to the following: publication of minutes; publication of the inflation forecast; publication of individual voting records; existence of clear operational target. Duisenberg (1999) is equally adamant that the ECB is a very transparent regime. As we noted above, the sufficient revelations of transparency seem to lie in the eye of the beholder.

⁹ See, for example, Cukierman and Meltzer (1986), Faust and Svensson (1999) and Muscatelli (1998).

¹⁰ See Buiter (1998) for a textual analysis of the pro-secrecy views of Executive Board members of the ECB.

(analogous to the FOMC) on the basis that it would lead to undesirable speculation in the financial markets.¹¹ The concern of the policymakers seems then to be that financial markets may pick up false signals about the future course of monetary policy. On the other hand, Buiter (1998) and Blinder (1998) turn this argument on its head, arguing instead that publishing minutes (greater openness, more generally) is a mechanism to guide markets to focus on the fundamental determinants of the course of monetary policy.

To our knowledge, there have been no direct tests for a link between transparency and interest rate volatility, but a few studies have been suggestive in this regard. For example, based on an analysis of FOMC voting minutes, Belden (1989) argues that knowledge of the dissenting votes allows one to attribute to policy makers possibly markedly differing preferences.¹² One implication of this work is that the markets may have difficulty interpreting any particular FOMC decision, in terms of these preferences, resulting in financial market volatility. In a similar vein, Friedman and Schwartz (1963, p133-4) argue that dollar exchange rate variability was the price paid for monetary policy uncertainty, over the continuing operation of the gold standard, towards the end of the nineteenth century.¹³ Finally, Alesina and Summers (1993) present cross-country evidence that higher central bank independence may be associated with lower interest rate variability, suggesting that more credible regimes enjoy less variable interest rates. Of course, the key issue then is what is the relationship between openness and credibility.

It would seem, therefore, that the arguments for and against secrecy could go either way. If markets were uncertain about policy preferences then a priori it seems plausible that increased transparency could reduce financial market volatility, as financial market agents became better informed. On the other hand, if markets trade on every twist and turn in the policy debate, volatility may well rise (Blinder (1998)).¹⁴ In the following section we shall try to sharpen the testable implications of this debate by providing some theoretical backdrop to the link between transparency and volatility of interest rates.

The rest of the paper is set out as follows. Section 2 introduces a simple model of interest rate volatility, building on the analyses of Svensson (1991) and Gerlach (1994), and demonstrates that interest rate volatility may be a natural

¹¹ His Chief Economist, Otmar Issing, may not share his boss's view, see Issing (1999, p.6)

¹² See Bomberger (1996) for an analogous relationship between dispersion in survey correspondents' views on inflation and inflation uncertainty.

¹³ We thank Hugh Rockoff for drawing our attention to this point.

¹⁴ Blinder (1998) documents, but does not appear to share, this concern.

consequence of a tightly focussed (in a sense we explain below) monetary policy. The model also implies some testable implications with respect to the level of transparency and interest rate volatility. In Section 3 we turn to the empirical evidence and estimate the volatility of short-term UK interest rates. Section 4 investigates whether the information flows associated with increased transparency have been associated with higher interest rate volatility, as the model of Section 2 implies under some circumstances. Briefly, we do find that interest rate volatility has risen over this period, however, there is little indication, based on UK evidence, that increased information flows are “disruptive”. Section 5 summarises, concludes and offers some thoughts on further work.

2. A SIMPLE MODEL OF INTEREST RATE VARIABILITY UNDER INFLATION TARGETING

Gerlach (1994) has observed that there is a close formal symmetry between target zone models of the exchange rate and inflation targeting. In this section we build on this observation to examine the model’s implications for the volatility of interest rates in a credible, inflation-targeting regime with narrow bands. As we note in the discussion at the end of this section, this model arguably captures some important aspects of the most recent monetary policy regime in the UK. Much of the derivation is familiar from the literature on exchange rate target zones, stemming from Krugman (1991), and so we go through it rather quickly. More details are contained in Appendix A.

2.1. The Model

Equations (1) and (2) represent respectively the demand for money, and the Fisher equation for the nominal interest rate. All variables are in natural logarithms (except the interest rate):

$$m - p = \mathbf{a}y - \mathbf{b}i + u \quad (1)$$

$$i = r + E(dp)/dt \quad (2)$$

Where m is the nominal stock of money, p is the price level, y is real output, i is the nominal interest rate, u is an i.i.d. mean zero disturbance, with bounded support, r is the real rate of interest and E is the expectations operator. (1) and (2) can be solved for the price-level,

$$p = f + \mathbf{b} E(dp) / dt \quad (3)$$

Where $f \equiv m - \mathbf{a}y + \mathbf{b}r - u$.

Equation (3) shows that the price level ‘today’ is a function of fundamentals (f), and expectations about future changes in the price level. Following Gerlach (1994) we de-trend the price level in the following way:

$$p - c = f - c + \mathbf{b} E(dp - dc) / dt + \mathbf{b} E(dc) / dt$$

Letting $\bar{p} \equiv p - c$, and $\bar{f} \equiv f - c + \mathbf{b}p$, we may write,

$$d\bar{f} = \mathbf{s}dz \quad (4)$$

$$\bar{p} = \bar{f} + \mathbf{b} E(d\bar{p}) / dt \quad (5)$$

That is, the fundamentals (4) follow the continuous time version of a random walk. The closed-form solution for the, the price-level is given by the following expression (see the Appendix A for details).

$$\bar{p}(\bar{f}) = \bar{f} + r^{-1} \left[\frac{e^{r\bar{f}} - e^{-r\bar{f}}}{e^{rs} + e^{-rs}} \right] \quad (6)$$

In what follows we drop the overbars for notational convenience. $-r$ and r represent the roots of the familiar second-order differential equation (equation A Appendix A), and $(-s, s)$ is the interval in which the fundamentals take values. The similarity between this expression and the expression in Krugman (1991) for the target zone exchange rate is clear. Both imply that when their respective fundamentals follow a Brownian motion, in the presence of well-defined and credible

reflecting barriers, the price-level/exchange rate will have the familiar *S*-shaped pattern.¹⁵

As in the case of a target zone exchange rate¹⁶, the asymptotic distribution for the price-level will be bi-modal, since towards the barriers the price-level will become less responsive to the fundamentals as the expectation term in (8) plays an increasing role. In other words, more intuitively, once the price-level wanders near to the barriers, it tends to spend a long time there.

Both the conditional and unconditional distribution of interest rates can now be easily derived in the current set up (see Appendix A). The nominal interest rate can then be written as (using (2) and (3) and (B) in the Appendix A):

$$i = r + \frac{1}{b} \left(A e^{-r_1 \bar{f}} + B e^{r_2 \bar{f}} \right) \quad (7)$$

For the case of zero drift and symmetric band the nominal interest rate is given by (8)¹⁷:

$$i = r - \frac{e^{r \bar{f}} - e^{-r \bar{f}}}{b l [e^{rs} + e^{-rs}]} \quad (8)$$

This model has precise implications for the conditional or instantaneous distribution of interest rates, which we denote $s^i(f)$. The product of the partial derivative of the interest rate with respect to the fundamentals, and the standard deviation of the fundamentals gives this¹⁸, that is:

$$s^i(f) = -i_f s_f$$

Using (7) above, and our expression for the price-level, we can re-write this as

¹⁵ In fact the precise result depends on a number of other assumptions, such as the nature of policy interventions, but most of them can be disposed of without affecting the flavour of the basic result.

¹⁶ See Froot and Obstfeld (1991) for a discussion of this point. See also Svensson (*op. cit.*).

¹⁷ The close similarity between these expressions and those corresponding to the basic target zone model remains. For example, compare our expression (6) with expression (32) in Svensson (1991).

$$\mathbf{s}^i(f) = \mathbf{b}^{-1}(\mathbf{s}_f - \mathbf{s}^p(f))^{19}, \quad (9)$$

In other words, the instantaneous standard deviation of interest rates is a function of the difference between the standard deviation of the fundamentals and the variability of the price-level; there is a trade-off between price-level variability and interest rate variability. And importantly, for the case where the fundamentals band is “narrow”, the interest rate’s instantaneous standard deviation is “large”. That is, when the band is narrow the price-level will be relatively unresponsive to changes in the fundamentals (intuitively, it is close to the bands and so expectational forces are increasing in importance), and as we noted above there is a negative association between price-level and interest rate variability. In fact, it is apparent from (9) that as the standard deviation of the price-level approaches zero, the instantaneous standard deviation of the interest rate increases and reaches a finite limit.²⁰ On the other hand, interest rate variability is low for a large band mirroring the fact that the responsiveness of the price level to the fundamentals is relatively large, except towards the edge of the band when, for the reasons just mentioned, variability rises sharply.

This model may capture some aspects of recent UK experience. When the Bank of England was made independent in 1997 long term interest rates, specifically inflation expectations, fell suggesting that credibility had risen. Indeed since then inflation expectations, extracted from the nominal and real yield curves, have remained close to the target inflation rate of 2½%. Similarly, the symmetry of the target zone bears close resemblance to the UK regime. The mapping is not one-one, however. There is no presumption that the ±1% band is a reflecting barrier, in the strict sense (Harrison, 1985). Nevertheless, since May 1997 actual inflation (and *a fortiori*, inflation expectations) have respected this band.

The model also suggests potential links between information flows (from the monetary policy authorities to the financial markets) and interest rate volatility. If information flows are indeed informative about the evolution of fundamentals then the model implies that these should have explanatory power with respect to interest rate volatility. However, this need not be the only role such information flows play,

¹⁸ That is, if p follows a general diffusion process

$dp = [g'(f)\mathbf{m} + 1/2 g''(f)\mathbf{s}_f^2]dt + g'(f)\mathbf{s}_f dw$, we note that the instantaneous standard deviation is the final term in this expression.

¹⁹ We have normalised the real interest rate to zero in deriving (9).

²⁰ For the target zone exchange rate model Svensson (1991) derives an analogous result.

as they may also provide information on the nature of the reflecting barriers (more generally, policy preferences). In the case of a narrow band regime, which we are arguing is reminiscent of recent monetary reforms in the UK, a relatively high degree of interest rate volatility would be observed regardless of the level of openness. If volatility in nominal interest rates is costly, and we do not in this paper need to take a view on this issue, then it is important for policymakers to distinguish between these two channels. One implies that a degree of secrecy may indeed be beneficial, while the other implies that having ‘indistinct’, or perhaps wide, reflecting barriers may be more appropriate. In our empirical section, therefore, we shall investigate closely how information flows and interest rate volatility are related. Before doing this, however, we establish the key characteristics in the behaviour of interest rate volatility across the recent past.

3. THE BEHAVIOUR OF THREE-MONTH STERLING LIBOR

In order to understand the impact of the choice of the nominal regime on the behaviour of short-term rates, in particular the instantaneous standard deviation, we outline the behaviour of three-month Sterling LIBOR since 1987.

3.1 The Regimes

We identify and examine five nominal regimes:

1. DM-shadow: 23/3/87 – 29/2/88;
2. Pre-ERM: 3/5/88 – 5/10/90;
3. ERM: 19/11/90 – 27/8/92;
4. Inflation Target I: 9/10/92 – 12/3/97;
5. Inflation Target II – 23/5/97 – 31/5/99.

Our identification of the last three nominal regimes is relatively uncontroversial. The ERM period involved membership of a target zone system of ‘fixed’ exchange rates. Inflation Target I constituted the period of inflation targeting without operational independence for the Bank of England, and Inflation Target II represents the period following the adoption of operational independence for the

Bank of England. Regimes 1 and 2 require some justification.²¹ The difference between the first two regimes is possibly subtle, but one that we suspect may be significant. The DM-shadow period was a somewhat muddled period in UK monetary policy. The UK government was ostensibly targeting money supply growth. However, it increasingly became clear that, in practice, policymakers were focussing heavily on the exchange (See Lawson (1992)). The pre-ERM period saw the authorities explicitly commit to joining the ERM “when the time was right”.²²

Table 1 – Interest Rate Moments Across Recent UK Regimes

	DM- Shadow	Pre-ERM	ERM	IT-I	IT-II
Maximum ^a	0.426	0.515	0.283	0.294	0.204
Minimum	-0.542	-0.328	-0.339	-0.403	-0.175
Mean	-0.001	0.009	-0.006	-0.002	0.002
Standard Deviation	0.099	0.083	0.069	0.055	0.040
Skewness ^b	0.021	1.868	-0.154	-0.747	0.485
Kurtosis ^c	6.266	8.998	2.683	7.698	4.820

Notes: All numbers are calculated from log differences in the three-month LIBOR interest rate. a) the first three rows are given in percentage points i.e. so the maximum change in the DM-shadow period was 43 bp; b) the skewness is calculated such that a positive (negative) number indicates right (left) skewness and c) a positive (negative) number for kurtosis indicates fatter (thinner) than normal tails (i.e. we have subtracted 3 from the measured kurtosis). Appendix B plots the innovations in the series and its distribution.

Table 1 shows that the character of the interest rate distributions would seem to be strongly influenced by regime choice (and justifies our distinguishing between regimes 1 and 2). There is little evidence of unconditional normality in the interest rate process across these five regimes. Significant skewness is only absent in the period of DM-shadowing and the ERM. In all cases we find significant kurtosis in the interest rate innovations and this suggests that the variance of the interest rate innovations may display serial dependence. The crude unconditional measures of

²¹ In identifying the first three regimes we follow Pesaran and Robinson (1993). We also follow their advice in selecting truncated sub-samples from the operational period of each regime. We measure innovations as the log difference of the end of day closing price average of bid-ask spreads. The data is available on request from the authors.

²² Regimes 1 and 2 both involved indeterminate exchange rates, however. This is because the regimes involved commitments to commit. With no final date of pegging given, any initial exchange rate level can be consistent with any final peg because the authorities must ratify any expectations of future money supply.

variance suggest some reduction in the volatility of interest rate innovations through time. But we will return to the question of interest rate volatility once we have accounted for its time variance.

3.2 Measuring Interest Rate Volatility

Time-varying volatility affects the higher moments of the unconditional distribution of interest rate innovations. Table 1 reports that significantly greater kurtosis is found for the interest rate innovations than a normally distributed random variable and is consistent with the possibility of time-varying volatility. We model the log change, or returns, in three-month Sterling LIBOR following Harvey *et al* (1994). We employ the Kalman filter to estimate the parameters driving stochastic volatility and hence estimate the level of volatility, h_t , at each time t .

$$r_t = \mathbf{s}_t \mathbf{e}_t = \mathbf{s} \mathbf{e}_t \exp(h_t/2), \quad \mathbf{e}_t \sim IID(0,1), \quad t = 1, \dots, T \quad (10)$$

Where,

$$h_{t+1} = \mathbf{f} h_t + \mathbf{h}_t, \quad \mathbf{h}_t \sim NID(0, \mathbf{s}_h^2) \quad (11)$$

The returns process has serial dependence in its variance. We use a quasi-maximum likelihood method (QML) to estimate the state space form of (11) and the squared and logged process for (10) using the Kalman filter giving us recursive estimates of the variance component, h_t .²³ Given the non-normality of the returns process the QML estimator offers an obvious attraction.

Table 2 presents the estimation results and suggests that the time-varying volatility models pass the relevant statistical tests. The volatility process is found to have significant persistence in each regime. The conditional estimate of the error driving the volatility process shows clearly that this has been highest in the second inflation-targeting regime, at 2.011. In terms of a simple intuition relating interest rate and policy uncertainty to macroeconomic instability these findings offers something of a puzzle. In fact, interest rate volatility would seem to have been lowest in the two pre-ERM regimes - which coincided with the late 1980s boom in the UK

²³ These recursive estimates encompass a wide class of GARCH modelling procedures, see Harvey *et al* (1994).

economy.²⁴ It would appear that neither the period of exchange rate targeting in the ERM, which has also been associated with macroeconomic instability, nor the first period of inflation targeting, which was not, offers an obvious pattern to the estimated levels of interest rate volatility.

Table 2: Estimation Results for Interest Rate Volatility

	Dm- Shadow	Pre- ERM	ERM	IT I	IT II
AR(1) Disturbance Term Error	0.513	0.179	0.774	0.557	2.011
AR(1) f	0.818	0.989	0.550	0.794	0.486
Standard Error	2.044	1.738	2.153	2.441	2.316
Log-Likelihood	-177.159	-350.86	-357.663	-717.458	-442.827
Normality	8.720	15.99	36.65	84.15	32.78
Heteroscedasticity	1.405	0.415	1.266	0.793	1.209
Serial Correlation (1)	-0.022	0.090	-0.012	0.018	0.0053
(20)	-0.083	-0.012	-0.014	0.025	-0.045
DW	2.035	1.805	2.006	1.961	1.968
R²	0.035	0.205	0.011	0.021	0.051

Note: The standard deviations of the heteroscedastic error process for each regime is given in the first row. The next row gives the estimated persistence parameter of the volatility process. The remaining statistics refer to the final regression. The standard error is the square root of the prediction error variance, normality is tested by the Bowman-Shenton statistic distributed as χ^2 under the null, heteroscedasticity is an F-test, residual autocorrelation is given at τ lags and DW is the Durbin-Watson statistic. The model is estimated recursively.

However, we do find that the highest level of interest rate volatility has been associated with the period of inflation targeting following the adoption of central bank independence and a significant increase in the level of transparency. This is what the model in Section 2 would have predicted for this period although we need to investigate how much of this volatility can be attributed to the information flows *per se*, e.g., the revelation of disagreements over monetary policy, the release of the

²⁴ Pesaran and Robinson (1993) discuss reasons why the lack of credibility in an exchange rate regime may lead to low interest rate volatility. We corroborate these earlier results in finding low (instantaneous) volatility in these earlier regimes.

Inflation Report, and so on. Recall our earlier discussion. We argued that if we find a significant effect of ‘information flows’ onto volatility, then this would be evidence that these provide information on the evolution of fundamentals. If no such influence is found, then we would be more likely to conclude that information flows are revealing information about target bands. If nominal interest rate variability is costly, then it is important for the design of the nominal framework to distinguish between these two cases. We now turn to the key information flows in the IT2 regime.

4. ASSESSING THE INFLUENCE OF TRANSPARENCY ON INTEREST RATE VOLATILITY

4.1 Ditching ‘Monetary Mystique’

Over the last decade or so, as detailed above, the UK has adopted a number of distinct nominal regimes. This sequence has culminated, over the most recent past (from May 1997), in an inflation targeting regime conducted by an instrument independent central bank (in the sense of Fischer 1994, p292), and a policy process which is amongst the most transparent anywhere (see Footnote 3). Monetary policy during this period has been transparent in the following sense: (i) The final objective of monetary policy has been made explicit and passed to an independent central bank; (ii) The date of the MPC meetings are known around a year in advance; (iii) the decision is announced at a set time, often with an explanation for the decision; (iv) minutes detailing voting patterns are published; and (v) regular quarterly forecasts of the intermediate variable under a variety of assumptions are published. In particular, it makes known the voting record of the nine members of the Monetary Policy Committee (MPC), along with a detailed summary/commentary of the MPC’s deliberations.²⁵ As we suggested earlier (Footnote 2), it is difficult to exaggerate the size of this shift in UK monetary arrangements; it is the magnitude of this shift that us with an opportunity to examine the relationship between policy disagreements, openness, information flows and interest rate volatility.

4.2 A Brief History of Agreement and Disagreement within the MPC

²⁵ This summary is not a transcript so that particular arguments advanced by members are non-attributable.

How divided has the Bank of England's Monetary Policy Committee been since its first meeting on 6-7 June 1997? The Table in Appendix C outlines the course of disagreements, on the basis of the published minutes, at the MPC since formulation.²⁶ We find that in 11 of the 23 meetings in our sample there has been sufficient dissent to generate votes being cast against the final decision.²⁷ This unweighted average of dissenting meetings is perhaps a little misleading, as there have been only 23 dissenting votes cast compared with 159 majority votes. It could be argued that much of the observed division could be put down to two factors. First, the nine months from January 1998 to September 1998 were responsible for 8 of the 10 dissenting meetings. Second, either or both of two particular MPC members have always been part of the dissenting minority. Notwithstanding these factors, division seems to be an accepted part of the MPC's public face.

4.3 Minutes and Volatility

Figure 1 plots the measure of time varying interest rate volatility from the inception of central bank independence to end-1998. The day to day process exhibits considerable spikes in volatility. We also plot on this chart the dates of the MPC meetings and the date on which minutes were published.²⁸ At first glance the data appear to indicate some correspondence between monetary “news” and measured volatility. For instance, between October and December 1997 the release of the previous month’s minutes of the MPC meeting seems to result in a considerable spike in volatility even though there was no split votes at these meetings. We turn now to a closer examination of this relationship. We ran a set of basic regressions of the following form:

$$h_t = \beta h_{t-1} + D_{i,t} + \epsilon_t, \quad (12)$$

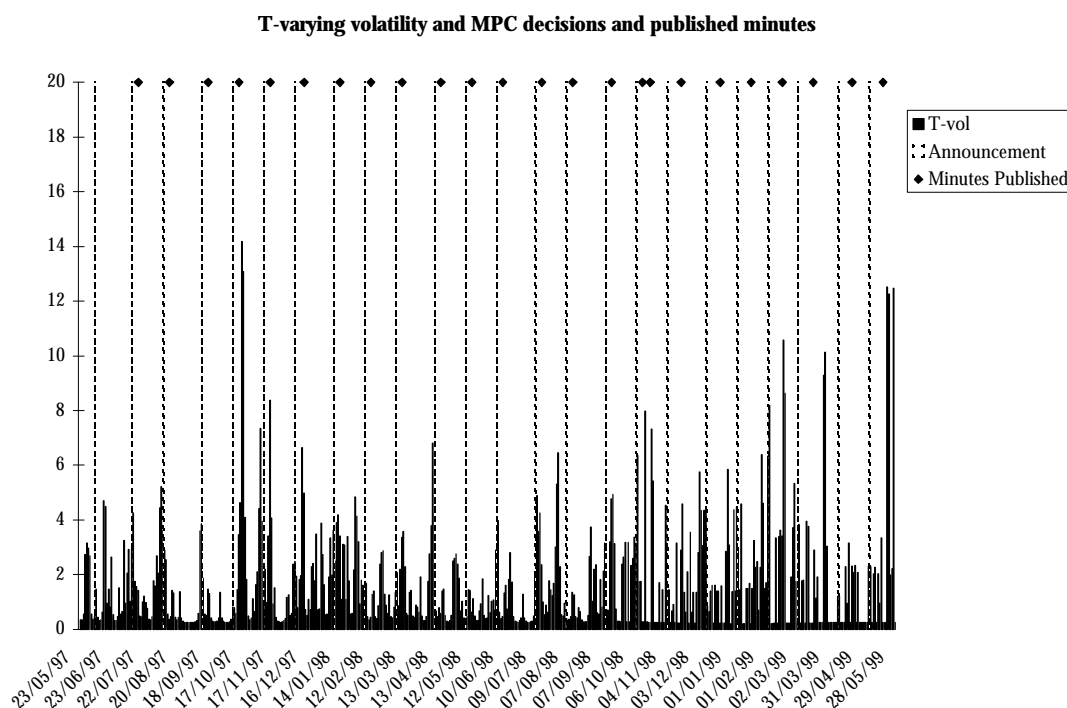
²⁶ Source: Bank of England (1997-9), *Monetary Policy Committee Minutes*, various.

²⁷ These 9 months encompassed a turning point in the official interest rate. Of course, a turning point in the instrument variable need not (and perhaps should not) imply a turning point in the target variable.

²⁸ From the first meeting of the MPC on 5-6 June 1997, from which minutes were published on 16 July, until the meeting on 9-10 September 1998 minutes were published some days after the following meeting. This awkward practice was stopped after the October 1998 meeting from which time minutes have been published on the second Wednesday following the announcement of the MPC's decision.

Initially we added three dummies to this basic AR process to capture: (i) the effects of announcements on the interest rate decision of the MPC; (ii) the publications of the minutes of the MPC meetings (including the record of voting patterns); (iii) and the publication of the (Quarterly) Inflation Report.²⁹ In fact, there appears to be little regular association between these information flows and LIBOR volatility. Table 3 shows that the inputting of these dummies appears to add little to the fitted volatility process. When entered individually, the top panel shows that none of the dummies add significant information to the volatility process.³⁰ The dummies fail to be accepted into the fitted volatility process on the basis of the standard variable deletion tests. The first column in the lower panel shows the results of a joint variable deletion test for all three dummies and the second column for the dates of Inflation Reports alone.

FIGURE 1



²⁹ The Inflation Report, *inter alia*, presents the Bank of England's inflation forecast and an assessment of the likely risks to that forecast. We also split the sample of meetings' minutes according to whether the votes cast at the meeting indicated dissent - this changes little.

³⁰ We also try the possible combinations of dummies and find no significant information - results available on request.

It is possible that the day of the monetary policy decision or release of the minutes provided few surprises for the markets, or perhaps the market reacted slowly to the new information. To examine whether or not such effects were present, we added additional dummies one day either side of the announcements. However, the effects of announcements and minutes remain insignificant in accounting for volatility.

Table 3. The Impact of Transparency on Interest Rate Volatility I

	Announcements	Minutes	Inflation Report
Coefficient	0.281	0.392	0.628
T-ratio (p-value)	0.809 (0.385)	1.163 (0.246)	1.103 (.271)
Joint Variable Deletion Test	LM Statistic	2.143 (0.342)	1.238 (0.266)
	LR Statistic	2.15 (0.341)	1.204 (0.265)
	F Statistic	1.053 (0.350)	1.217 (0.271)

Notes: The regression fitted the volatility process with an AR process with lags selected by information criteria to 5. The dummies were not found to be significantly different from zero. The Lagrange Multiplier and Likelihood Ratio Statistic are distributed as χ^2 and the F statistic as F(2,433).

On this evidence, there would seem to be little to support the view that increased information flows have directly increased the volatility of short-term interest rates, and hence are informative about “fundamentals”. We also investigated whether or not volatility rose for a longer period ahead of the various information flows. To test for this we introduced another dummy which took the value of one in the five working days leading up to an announcement. We tried all feasible permutations of these dummies (i.e., one-day and the five-day prior dummies. We present our results in tables 4A-4H, below.

The only significant variables appear to be ‘announcements’ (just significant at the 10% level), and its subset, ‘interest rate changes’ (significant at the 5% level), both identified using our one-day dummy. Neither variable was identified as significant on the basis of the longer dummy. Interestingly, this is in contrast to our earlier results (Table 3). The relative levels of significance of “announcements”, and “interest rate changes” indicate that it is the interest rate changes that are of overriding importance. Neither the release of the minutes nor the Inflation Report appear to be significant, which may be rather surprising, but is consistent with the results in Table 3. It appears that knowing that policymakers disagree over the appropriate level of interest rates does not ‘unsettle the markets’. And since interest rate changes are, in a sense,

unavoidable any increase in volatility that accompanies them is similarly unavoidable; such effects may be present no matter what the information flows.

Table 4 The Impact of Transparency on Interest Rate Volatility II**PANEL A.**

One-day dummy	Announcements	Minutes
Coefficient	0.59	0.03
T-ratio (p-value)	1.61 (0.11)	0.01 (0.937)

PANEL B.

Five-day dummy	Announcements	Minutes
Coefficient	-0.01	0.03
T-ratio (p-value)	-0.1 (0.94)	0.15 (0.88)

PANEL C.

One-day dummy	Announcements	Inflation Report
Coefficient	0.60	0.45
T-ratio (p-value)	1.63 (0.10)	0.71 (0.48)

PANEL D.

Five-day dummy	Announcements	Inflation Report
Coefficient	-0.02	-0.17
T-ratio (p-value)	-0.1 (0.91)	-0.67 (0.50)

PANEL E.

One-day dummy	Change in Rates	Minutes
Coefficient	1.1	0.03
T-ratio (p-value)	1.97 (0.05)	0.07 (0.94)

PANEL F.

Five-day dummy	Change in Rates	Minutes
Coefficient	0.27	0.05
T-ratio (p-value)	1.23(0.22)	0.29 (0.77)

PANEL G.

One-day dummy	Change in Rates	Inflation Report
Coefficient	1.1	0.44
T-ratio (p-value)	1.98 (0.05)	0.70 (0.48)

PANEL H.

Five-day dummy	Change in Rates	Inflation Report
Coefficient	0.26	-0.16
T-ratio (p-value)	1.18(0.24)	-0.62 (0.54)

Notes: The regression fitted the volatility process with an AR process with lags selected by information criteria to 5.

As we noted at the beginning of the paper, it is possible that our information flow measures (particularly minutes and announcements) are misleading; perhaps the markets view them as “sanitised” and bereft of much new information, or perhaps policymakers just do not have much of an information advantage over market

participants.³¹ However, if policymakers do have an advantage it probably pertains to “tactics”. For instance, policymakers may decide to push policy rates incrementally to their target level. It is unlikely that such information would be recorded explicitly in official minutes, and so market players would have to deduce the policymakers plans by observing their actions. That being the case, new information concerning fundamentals may well be transmitted through interest rate changes (particularly if interest rates are changing direction). In any case the more interesting question is whether or not the more open regime of recent years has been associated with more or less volatility.

Table 5a. The Impact of Interest Rate Changes on Volatility (One-day dummy)

	DM- Shadow	Pre-ERM	ERM	IT1	IT2
Coefficient	0.31	0.02	0.25	0.28	1.1
T-ratio	4.28	1.32	2.31	1.16	1.97
(p-value)	(.00)	(0.19)	(0.02)	(0.25)	(0.05)

Table 5b. The Impact of Interest Rate Changes on Volatility (five-day dummy)

	DM- Shadow	Pre-ERM	ERM	IT1	IT2
Coefficient	0.08	0.02	0.05	0.21	0.27
T-ratio	2.48	2.94	1.12	2.21	1.21
(p-value)	(.014)	(0.003)	(0.26)	(0.027)	(0.23)

Notes: The regression fitted the volatility process with an AR process with 3 lags. Dummy variables were added taking a value of 1 on the 5 days ahead of an interest rate change and zero otherwise. The coefficient reported in the table, is the coefficient on this dummy.

We now take a closer look at how volatility has responded in the period running up to and the day of policy rate changes across regimes. The results are given in table 5a and 5b. The one-day dummy identifies a significant effect except in the ERM and the IT1 regimes, with the effect being particularly strong in the IT2 period. In contrast, the five-day dummy is highly significant except in the IT2 regime and (again) in the ERM period, where its *p*-value is over 20%. We note in passing

³¹ There is clearly something in this; central banks are famously subtle, or perhaps obscure, in the language they use. Nevertheless, it would be highly misleading to dismiss all information flows as uninformative. For example, publishing voting records is surely information of sorts.

that in the earlier regimes causality may be an issue, since it is plausible that the volatility in part *caused* the interest rate change. We did not investigate this further.

Overall, these results indicate that the IT2 regime has been associated with a notable increase in volatility on the day of decisions but interestingly a reduction in interest rate volatility ahead of policy decisions.

4.4 Discussion of the Results

On one level, it seems that information flows in the form of minutes of policy meetings, published inflation forecasts, and announcements of no change in the policy rate, show little sign of affecting, jointly or individually, the volatility of short-term nominal interest rates. The concern of central bankers that increased transparency would have such an affect, based on this evidence, appears ill founded. In fact, if anything, our results (specifically, Table 5B) indicate that the more open regime in the UK has been associated with less volatile interest rates (ahead of a change in interest rates), in marked contrast to IT1, even though both regimes share a number of operating characteristics.³²

How do these results help us to account for the increase in volatility of interest rates? We tend to view the results as confirming the view sometimes expressed that in practice central banks have little informational advantage over financial markets. By the time monetary policymakers publish their regular reports, minutes, and so on the markets have themselves processed this information. As a consequence, and in the context of a credible nominal target, there are few surprises in the published material. To put the same point slightly differently, we think our results are simply picking up the fact that markets are continually adapting to new information. And as the model of Section 2 suggested, in a tightly specified nominal regime this is perfectly consistent with a relatively high degree of interest rate volatility, as shocks to the fundamentals that would otherwise show up in prices are transmitted to movements in interest rates.³³

We note that our results have to remain somewhat tentative not least because the IT2 regime is still in operation in the UK. But, with this caveat in mind, what might these results imply for the design of a nominal framework for monetary policy,

³² For instance in IT1 the advice given by the governor of the Bank of England to the Chancellor on the appropriate level of interest rates was published, as were forecasts of inflation. Nevertheless, most commentators agree that IT2 is much more open than its predecessor, and of course the Bank of England is now independent of government in the setting of interest rates.

³³ This point shows in the high elasticity of volatility with respect to interest rate innovations.

perhaps one that aimed to some extent to stabilise interest rates? We think our results have two implications. First, detailed information releases in and of themselves may do little to increase the volatility of interest rates; if anything, they may even serve to reduce it. Second, some fuzziness, or widening of the ‘reflecting barriers’ may serve to reduce volatility. However, since in practice no regime as far as we are aware operates with the strict reflecting barriers (often used for reasons of tractability) in stochastic control theory, it may be that policymakers have *de facto* taken this point on board.

5. CONCLUDING REMARKS

This paper has sought to make three separate points. First, the inception of transparent monetary policy-making in the UK, since May 1997, has coincided with a rise in the level of day-to-day interest rate volatility, as some policymakers might have feared. Second, this volatility may be an unavoidable side effect of a credible nominal regime. We showed that in such a case interest rate volatility acts to absorb volatility that otherwise be transmitted to changes in the aggregate price level. Third, information flows associated with IT2 had little or no effect on interest rate volatility; secrecy does not appear to help stabilise interest rates.

We think future work might usefully focus on two things. First, it would be interesting to observe in practice, across different countries, the relationship between the degree of transparency and the volatility of interest rates, although measurement issues are likely to loom large in such a study. Second, as we noted above, there is little agreement about what actually constitutes “information”. The remark by Issing (1999) which we quoted on page 6 makes this clear. It would therefore be interesting to know what central banks actually believe they are doing when they formulate and disseminate their public statements.

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APPENDIX A

Using Ito's lemma, we can express the price level (5) in the following way:

$$\bar{p}(\bar{f}) = \bar{f} + \frac{1}{2} \sigma_{\bar{f}}^2 \bar{p}''(\bar{f}) \quad (\text{A})$$

The fundamentals process is assumed to take values in the open interval $(-s, s)$. We may write the general solution to (A) in the following familiar way:

$$\bar{p}(\bar{f}) = \bar{f} + A e^{-r_1 \bar{f}} + B e^{r_2 \bar{f}} \quad (\text{B})$$

and where

$$r_1 = \sqrt{\frac{2}{bs}}, \quad r_2 = -\sqrt{\frac{2}{bs}}.$$

A and B are definitized in the usual way by value-matching conditions, $\bar{p}'(-s) = 0 = \bar{p}'(s)$.

Svensson (1991) has analysed the distribution of interest rates within the context of target zone models, and we follow fairly closely his general approach. We use the fact that for $Y = f(X)$, if we know the distribution of X , then, under certain conditions,

we can write the density function for Y as $f_Y(y) = \left| \frac{d}{dx} f^{-1}(y) \right| f_X(f^{-1}(y))$

$$f^p(p) = \frac{f^f(p^{-1}(f))}{|p'(f)|}$$

where we have used that $\frac{dy}{dx} = \frac{1}{dx/dy}$.

The numerator is derived in Harrison (1985) and represents the unconditional distribution of a regulated Brownian motion with zero drift.

$$\mathbf{f}^p(p) = \frac{1/(\bar{f} - f)}{\left| 1 - \left[\frac{e^{r\bar{f}} + e^{-r\bar{f}}}{e^{rs} + e^{-rs}} \right] \right|}$$

The unconditional distribution of interest rates is then given by

$$\mathbf{f}^i(i) = \frac{\mathbf{f}^i(i^{-1}(f))}{|i'(f)|}, \text{ or } \mathbf{f}^i(i) = \frac{1/(\bar{f} - f)}{\left| -r \left[\frac{e^{r\bar{f}} + e^{-r\bar{f}}}{e^{rs} + e^{-rs}} \right] \right|}$$

APPENDIX B: MONETARY POLICY COMMITTEE: VOTES AND DECISIONS										
<i>Date</i>	<i>Eddie George</i>	<i>David Clementi</i>	<i>Mervyn King</i>	<i>Ian Plenderleith</i>	<i>Charles Goodhart</i>	<i>DeAnne Julius</i>	<i>Sir Alan Budd</i>	<i>Willem Buiter</i>	<i>John Vickers</i>	<i>Decision</i>
6/97	Hike	Hike	Hike	Hike	Hike	Hike	N/A	Hike	N/A	7-0 HIKE 25BP
7/97	Hike	Hike	Hike	Hike	Hike	Hike	N/A	Hike	N/A	7-0 HIKE 25BP
8/97	Hike	Hike	Hike	Hike	Hike	Hike	N/A	Hike	N/A	7-0 HIKE 25BP
9/97	Hold	Hold	Hold	Hold	Hold	Hold	N/A	Hold	N/A	7-0 HOLD
10/97	Hold	Hold	Hold	Hold	Hold	Hold	N/A	Hold	N/A	7-0 HOLD
11/97	Hike	Hike	Hike	Hike	Hike	Hike	N/A	Hike	N/A	7-0 HIKE 25BP
12/97	Hold	Hold	Hold	Hold	Hold	Hold	Hold	Hold	N/A	8-0 HOLD
1/98	Hold	Hold	Hold	Hold	Hike	Hold	Hike	Hike	N/A	5-3 HOLD
2/98	Hold	Hold	Hike	Hold	Hike	Hold	Hike	Hike	N/A	4-4* HOLD 7.25%
3/98	Hold	Hold	Hike	Hold	Hike	Hold	Hike	Hike	N/A	4-4* HOLD 7.25%
4/98	Hold	Hold	Hike	Hold	Hold	Hold	Hike	Hike	N/A	5-3 HOLD 7.25%
5/98	Hold	Hold	Hold	Hold	Hold	Cut	Hold	Hike	N/A	6-2 HOLD 7.25%
6/98	Hike	Hike	Hike	Hike	Hike	Cut	Hike	Hike	Hike	8-1 HIKE 25BP 7.50%
7/98	Hold	Hold	Hold	Hold	Hold	Hold	Hold	Hold	Hold	9-0 HOLD 7.50%
8/98	Hold	Hold	Hold	Hold	Hold	Cut	Hold	Hike	Hold	7-2 HOLD 7.50%
9/98	Hold	Hold	Hold	Hold	Hold	Cut	Hold	Hike	Hold	7-2 HOLD 7.50%
10/98	Cut	Cut	Cut	Cut	Cut	Cut	Cut	Cut	Cut	9-0 CUT 25BP 7.25%
11/98	Cut	Cut	Cut	Cut	Cut	Cut	Cut	Cut75bp	Cut	9-0 CUT 50BP 6.75%
12/98	Cut	Cut	Cut	Cut	Cut	Cut	Cut	Cut75bp	Cut	9-0 CUT 50BP 6.25%
1/99	Cut	Cut	Cut	Hold	Cut	Cut50bp	Cut	Cut	Cut	8-1 CUT 25BP 6.00%
2/99	Cut	Cut	Cut	Cut	Cut	Cut	Cut	Cut75bp	Cut	9-0 CUT 50BP 5.50%
3/99	Hold	Hold	Hold	Hold	Hold	Hold	Hold	Cut40bp	Hold	8-1 HOLD 5.50%
4/99								11/22		CUT 25BP 5.25%
Against Majority	0/22	0/22	3/22	1/22	3/22	5/22	4/15	8/22	0/10	10/22

Notes: Governor exercises casting vote; and **bold typeface indicates vote against majority decision**

