Monetary policy and the yield curve

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This article examines and interprets movements in the yield curve at the time of changes in monetary policy. These responses provide a measure of the degree of transparency and credibility of a monetary regime. There is evidence of yield-curve responses having been dampened since the introduction of inflation targeting in the United Kingdom in 1992—consistent with greater transparency and credibility of this monetary regime.

Changes in monetary policy in the United Kingdom are enacted by the Bank of England altering the rate at which it lends to the money markets. Typically, the Bank lends money for a two-week maturity and so directly affects short-term interest rates. Central banks in other developed countries also operate on short-term interest rates. But following changes in monetary policy, long as well as short-term interest rates tend to adjust. There is usually a 'jump' in the entire term structure of interest rates.(1)

Chart 1 plots the yield curve—the spectrum of interest rates running from short to long maturities—on the two days on either side of the upward adjustment in UK official interest rates on 4 June 1998. The short end of the yield curve tilted upwards in response to this change in monetary policy, though the long end remained largely unchanged. Chart 2 plots the yield curve on the two days on either side of the cut in official interest rates on 4 February 1999. On this occasion, the whole yield curve pivoted, with the short end shifting down and the long end up. Though the pattern of yield-curve responses is different, in both cases the change in monetary policy clearly revealed 'news'—at least in the eyes of the market—about the path of short and long-term interest rates, thus causing the yield curve to adjust.(2)

This article documents and interprets movements in the yield curve at the time of changes in monetary policy. What explains these yield-curve shifts? Why might responses be different at long and short maturities? And why might they differ across time and across different monetary regimes? We first set out a conceptual framework that allows us to address these questions. We then discuss some empirical evidence, drawn from the United Kingdom and from other developed countries, which illustrates some of the key implications of this framework. This evidence highlights some of the benefits brought about by improved monetary policy transparency and credibility, since these benefits can be inferred directly from adjustments in the term structure at the time of monetary policy changes.

Chart 1
Yield curve: 25 basis point increase in interest rates on 4 June 1998

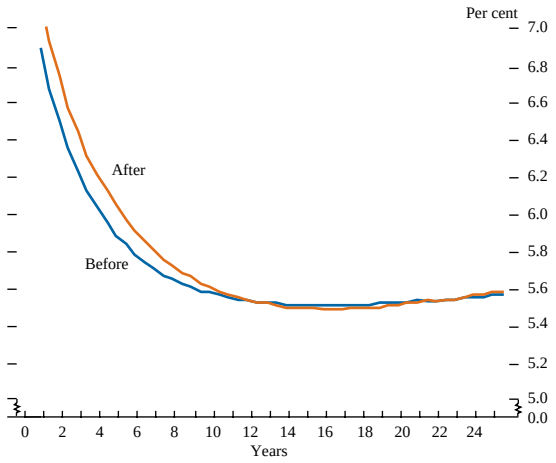
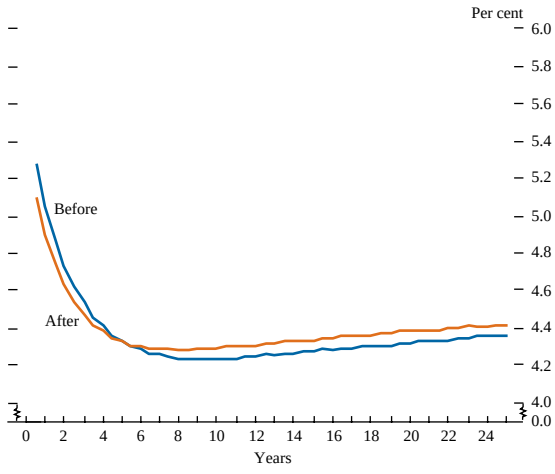


Chart 2
Yield curve: 50 basis point cut in interest rates on 4 February 1999



(1) Empirical evidence on these adjustments in the yield curve at the time of monetary policy changes is provided in Cook and Hahn (1989) for the United States, Dale (1993) for the United Kingdom, Hardy (1996) for Germany, and Buttiglione, Giovane and Gaiotti (1997) for a range of European countries.
(2) Assuming that there was no other macroeconomic news affecting the yield curve significantly over the two days.

A stylised model

It is useful to begin with a simple model of monetary policy. The central bank is assumed to implement monetary policy by setting a short-maturity interest rate—the rate at which the central bank lends to the money markets. For simplicity, assume that the central bank sets one-month maturity interest rates, and re-sets these official rates once every month on a known date.

The central bank sets official interest rates according to a monetary policy rule. This rule or reaction function for the monetary authorities describes how interest rate decisions are linked to the state of the economy—for example, to the inflation rate and the level of output relative to potential. For simplicity, assume that official interest rates depend only on current inflation outcomes.[1] The monetary policy rule is then given by equation **(1)**:

$$i_t = \beta (\pi_t - \pi_t^*) \qquad \textbf{(1)}$$

where i_t is the official interest rate in the current period, time t; π_t is the inflation rate in the current period; π_t^* is the inflation target; and β is a (positive) feedback coefficient determining the strength of the monetary authorities' response to a deviation of inflation from target.

Participants in the money market lend to each other, at both long and short maturities. These money-market interest rates adjust to reflect the actual and expected path of official interest rates, because banks will not make loans to one another at rates that are very different from those at which they can borrow from the central bank. Consider, for example, the behaviour of one-month money-market interest rates. The day before official interest rates are re-set, one-month money-market rates will reflect expectations of the level at which official interest rates will be set for the forthcoming month. To the extent that these guesses about official interest rates are roughly correct, any change in official rates will be anticipated, and reflected in one-month money-market rates ahead of the policy change.

The same type of behaviour affects longer-maturity interest rates, which reflect expectations about the future path of official interest rates over the term of the loan. For example, one-year money-market interest rates will reflect expectations about the path of official interest rates over the next twelve months. Put slightly differently, the j-period forward interest rate—the spot rate expected to prevail j periods in the future—will depend on expectations of what official interest rates will be j periods hence.

This relationship linking forward interest rates to the expected path of future official rates is described by equation **(2)**:

$$i_{t,j} = \mathrm{E}_t (i_{t+j}) \qquad \textbf{(2)}$$

where $i_{t,j}$ is the j-period forward interest rate (the spot rate expected j periods in the future), E_t denotes the expectations of private sector agents based on information up to time period t, and i_{t+j} is the official interest rate prevailing at time $t+j$.

In this pure form, equation **(2)** embodies what is known as the 'expectations theory' of the term structure. According to this theory, forward interest rates are determined by expectations of the future path of short-term spot interest rates, which in turn are set by the central bank. In other words, longer-maturity interest rates embody expectations of future short rates at all dates up to the maturity of the loan.[2]

So the yield curve depends on the markets' guess about the actual and expected path of official rates, as in equation **(2)**. And official rates depend on the monetary policy rule, given by equation **(1)**. Given this, the markets will tend to form their guesses about future official rates based on their knowledge and understanding of the monetary authorities' policy rule. If some of the terms in that rule alter, so too will the markets' expectations about the future path of monetary policy. The yield curve will jump. For example, news about the authorities' inflation target (π_t^*) or the current inflation rate (π_t) would be expected to induce yield-curve responses, because these are factors entering the authorities' policy rule.

Consider as a benchmark a highly stylised model in which the monetary authorities' policy rule is perfectly understood and perfectly credible. The variables entering the rule—inflation (π_t), the feedback coefficient (β) and the inflation target (π_t^*)—are all common knowledge, and the rule itself is fully credible. In effect, the transparency and credibility of the monetary rule are perfect.

In this highly simplified setting, unexpected inflation outcomes—inflation 'news'—will still affect actual and expected monetary policy choices. Through the policy rule, these will in turn result in adjustments in the yield curve. But changes in official interest rates will now be perfectly anticipated: all of the arguments in the policy rule will be transparent and understood ahead of any policy change. So in a world of fully transparent, perfectly credible monetary policy, there will be no news in monetary policy itself. Monetary policy actions will not be a source of yield-curve instability in their own right. Only news about the macroeconomy will matter.

A less stylised model

Charts 1 and 2 suggest that, in practice, the yield curve does shift following official interest rate changes. Typically, there is news in monetary policy announcements. How can these yield-curve shifts be explained? Relaxing some of the restrictions on the simple model outlined above provides one explanation. Indeed, the components of the policy rule can

(1) In practice, under the United Kingdom's inflation-targeting regime, official interest rates are related to *expected* inflation outcomes (see Batini and Haldane (1999)).
(2) More complicated versions of the expectations theory would embody premia of various kinds, which are not considered here (see Anderson *et al* (1996)).

be disentangled by gauging the different response of the yield curve at long and short maturities.

There are two components of the monetary policy rule about which the private sector may have different information from the monetary authorities:

(a) *Private information on macroeconomic outcomes*—for example, in equation **(1)**, inflation outcomes. This is information to which the monetary authorities may have privileged or more timely access. Or the monetary authorities may interpret the implications of this data for the macroeconomic outlook differently—for example, because of their understanding of the monetary policy transmission mechanism. In either case, the monetary authorities may have different information from the private sector about the near-term macroeconomic outlook.

This source of monetary policy news might be termed 'private information about macroeconomic variables'. It is information that the monetary authorities would reveal in the course of following their monetary policy rule. Interest rate changes reveal information about the monetary authorities' interpretation of recent data and their view of the near-term macroeconomic outlook.

(b) *Private information on policy targets*—for example, in equation **(1)**, the inflation target. This may arise because the markets do not completely believe that the monetary authorities will adhere to their announced targets—there is a problem of imperfect credibility. Alternatively, the targets themselves may be imprecisely specified. In both cases, monetary policy embodies news, because the public are learning about the true targets of the monetary authorities through their monetary policy actions.

This second source of monetary policy news might be termed 'private information about macroeconomic preferences'. Again, it is information that the authorities would reveal in the course of following their monetary policy rule. But the greater the credibility of the monetary authorities in the first place and the more transparent their policy targets, the less monetary policy news will come from this source. For example, the better the inflation track-record of the monetary authorities, the greater their credibility is likely to be—and so the less monetary policy news will come from private information on policy targets.

Both of these types of private information, about macroeconomic variables and about macroeconomic preferences, would be expected to influence the yield curve. But their effects are likely to show up at different points along the term structure. For example, private information about macroeconomic variables is likely to be shorter-term, probably no more than a few months ahead.

Private information about the monetary transmission mechanism is likely to be longer-lasting, but would still be a source of news only up to a maximum of two or three years ahead. So if there is monetary policy news about macroeconomic variables, this is most likely to show up in movements in shorter-maturity interest rates following a change in official rates.

Conversely, private information about policy targets or objectives is likely to be longer-term. If monetary policy is credible, long-run expectations are anchored. But if it is non-credible, then long-run expectations will tend to shift around. So if there is monetary policy news about macroeconomic preferences, this is most likely to show up in movements in longer-maturity interest rates, following a change in official interest rates.(1)

This framework provides a simple decomposition of monetary policy news when a policy change is implemented.(2) The key implications of this framework can be summarised as follows:

(a) In a world of perfect monetary policy transparency and full credibility, there would be little or no adjustment in the yield curve following a change in official interest rates.

(b) Adjustments in the yield curve can be traced to two sources of private information on the part of the monetary authorities: information about macroeconomic variables (imperfect transparency), and information about macroeconomic preferences (imperfect credibility).

(c) News about macroeconomic variables is most likely to show up in movements at the short end of the yield curve following a monetary policy change; news about macroeconomic preferences is most likely to show up in longer-maturity interest rate movements.

(d) The effects of greater monetary policy *transparency* (for example, about the inflation outlook) are likely to show up in smaller movements in short-maturity interest rates. Transparency dampens yield-curve volatility at the short end.

(e) The effects of greater monetary policy *credibility* (for example, belief in the inflation target) are likely to show up in smaller movements in longer-maturity interest rates. Credibility dampens yield-curve volatility at the long end.

The last two of these implications make clear some of the benefits of greater monetary policy transparency and credibility. Both will reduce the yield-curve shifts arising from monetary policy actions.(3) The next two sections aim to illustrate empirically some of these implications, and their relation to the transparency and credibility of a monetary

(1) This distinction between short-run information on macroeconomic variables and long-run information on macroeconomic preferences is likely to be imperfect in practice. For example, information on some macroeconomic variables, such as the long-term real interest rate, may have an influence along the entire term structure. Conversely, information on the authorities' macroeconomic preferences, for example their preferred degree of output stabilisation, may have an influence at the short end of the yield curve.
(2) Haldane and Read (1999) provide a mathematical framework that captures these effects and attempts to calibrate them.
(3) There are other potential benefits of greater monetary policy transparency and credibility. For example, transparency plays an important role in ensuring that an appropriate degree of accountability is exercised over the monetary authorities, and credibility serves to reduce the output costs of bringing inflation back to target following a shock. See King (1995) on both of these points.

regime, by looking at policy experience in a number of developed countries.

A case study: the United Kingdom's inflation-targeting regime

Since October 1992, the United Kingdom has been operating monetary policy with reference to an inflation target. In this period, there have been a number of far-reaching institutional reforms in the United Kingdom that have increased the transparency and credibility of the new regime. These measures have included: the formal scheduling and publicising of the monthly monetary policy decision-making process (the dates of meetings, the timing of policy announcements etc); the publication of the Bank's quarterly *Inflation Report*; the publication of press releases at the time of each monetary policy meeting; and the publication of the minutes of the monthly monetary policy meetings. Before May 1997, the monthly monetary policy meetings took place between the Chancellor of the Exchequer and the Governor of the Bank. Since May 1997 and the announcement of the Bank's operational independence, these have been replaced by monthly meetings of the nine members of the Bank's Monetary Policy Committee (MPC). The minutes of the MPC meetings are published two weeks afterwards, together with a record of the votes.

Using the framework discussed above, it should be possible to assess the effects of some of these institutional changes by examining shifts in the yield curve at the time of monetary policy changes. In particular, we consider the influence on yield-curve responses of the introduction of the United Kingdom's inflation-targeting regime for the period January 1984 to May 1997 (ie before the announcement of the Bank's operational independence and the establishment of the MPC).(1)

Table A summarises the empirical results.(2) The columns show the estimated response of different-maturity (forward) interest rates(3) to a 1 percentage point change in official UK interest rates.(4) These interest rates run from short (one-month) to long (20-year) maturities. For example, the first column gives the average percentage point response in each maturity interest rate over the full sample period (January 1984 to May 1997). The second column gives the change in these average responses since the introduction of the inflation-targeting regime in the United Kingdom in October 1992. So the average response of the yield curve during the inflation-targeting period, which is shown in the final column, is the sum of the responses in the first two columns.

There are several key findings. First, a number of the average yield-curve responses (column 1) are statistically and behaviourally significant over the entire period. Yield-curve 'jumps' following changes in official interest rates were significantly different from zero between 1984–97. Using our earlier framework, that would be interpreted as evidence of imperfect transparency and/or credibility on the part of the UK monetary authorities. On average, monetary policy was itself a significant source of yield-curve news between 1984–97.

Second, yield-curve responses tended to be larger and more significant among short-maturity interest rates over the period. For example, on average around one third of any change in official rates had not been fully anticipated by short-maturity market interest rates. This too is evidence that the monetary authorities' policy rule was less than perfectly transparent between 1984–97, particularly regarding the macroeconomic outlook and its effect on near-term interest rate setting.

Third, the responses from longer-maturity interest rates are often negative. For example, the response from forward rates beyond five years is negative. In effect, the yield curve pivots: higher official rates raise short-maturity interest rates, but lower them at longer maturities. This is as we might expect if unexpectedly tighter monetary policy is successfully lowering inflation expectations and nominal interest rates at more distant horizons.

Fourth, the second column of Table A gives the change in these yield-curve responses since the introduction of the United Kingdom's inflation-targeting regime. These changes have generally tended to be significant (at least up to two years), statistically and economically. They are also typically of the opposite sign to the average yield-curve responses over the entire period. This indicates that the inflation-targeting regime has tended to reduce the size of yield-curve responses to changes in monetary policy. Indeed, the size of these changes is little different from the size of the average response over the entire period. So adding together the first two columns, the final column suggests that monetary policy news over the inflation-targeting period has tended to be insignificantly different from zero. Yield-curve shifts following official interest rate changes have been dampened considerably since October 1992.

Table A
Yield-curve responses (January 1984–May 1997)

Forward interest rate maturity:	Average interest rate response 1984–97	Change in response since October 1992	Average interest rate response 1992–97
1 month	0.32 (a)	-0.38 (a)	-0.06
3 months	0.25 (a)	-0.34 (a)	-0.09
6 months	0.27 (a)	-0.21 (a)	0.06
2 years	0.25 (a)	-0.24 (a)	0.01
5 years	0.09	-0.11	-0.02
10 years	-0.06	0.03	-0.03
15 years	-0.10	-0.04	-0.14
20 years	-0.13	0.04	-0.09

(a) Significant at the 95% confidence level.

(1) This is the period for which the original exercise was run in Haldane and Read (1999). The same paper conducts a similar exercise for the United States, before and after February 1994. This was the date after which all FOMC monetary policy decisions were immediately disclosed to the market. In addition, all but two monetary policy decisions since then have occurred following a scheduled meeting of the FOMC, rather than at irregular intervals between meetings. Haldane and Read (1999) find that these institutional changes have significantly dampened yield-curve volatility in the United States.
(2) The econometric methodology is described in Haldane and Read (1999).
(3) Measured here from the term structure of interest rates from UK government bonds, using the methodology described in Deacon and Derry (1994).
(4) Measured here by banks' base rate.

This greater stability in the yield curve under the inflation-targeting regime shows up much more clearly at the short end of the yield curve. This suggests that the United Kingdom's new monetary regime has provided much greater transparency about influences on near-term interest rate decisions. This is consistent with the institutional changes that were put in place following the introduction of inflation targeting in the United Kingdom—for example, the publication of the Bank's inflation forecasts in its quarterly *Inflation Report* and the scheduling of regular monthly monetary policy meetings. The evidence here suggests that the United Kingdom's post-1992 monetary framework has secured a far more transparent monetary policy rule than under earlier regimes.

Cross-country yield-curve responses

Table A compares yield-curve responses in the United Kingdom across time. Table B does the same across four developed countries: the United Kingdom, the United States, Germany and Italy.(1) These countries' monetary regimes have quite different degrees of transparency and credibility. For example, the inflation track-record of the United States and Germany during the 1970s and 1980s was much better than that of the United Kingdom and Italy. These differences in the transparency and credibility of these countries' monetary regimes should be discernible in different yield-curve responses following monetary policy changes.

Table B suggests that, on average, yield-curve responses have been larger and more significant in the United Kingdom and Italy than in the United States and Germany. For example, the response of short-maturity interest rates to a 1 percentage point rise in official rates was 35–45 basis points in Italy and around 15–30 basis points in the United Kingdom, but only around 5–15 basis points in the United States and Germany. This suggests that the monetary policy regimes in the United States and Germany were, on average, better defined and understood over the period 1990–97 than those in the United Kingdom and Italy. This is not surprising, since monetary regimes in the United States and in Germany did not undergo any major transitions in this period, whereas those in the United Kingdom and Italy changed on several occasions.

Table B
Cross-country yield-curve responses

Forward interest rate maturity:	United Kingdom	United States	Germany	Italy
1 month	0.17 (a)	0.16 (a)	0.12 (a)	0.45 (a)
3 months	0.28 (a)	0.07	0.08 (a)	0.35
6 months	0.22 (a)	0.14 (a)	0.09	0.33
2 years	0.15 (a)	0.03	0.08	0.23
5 years	0.03	0.005	0.09	0.38
10 years	0.16 (a)	0.08	0.17	-0.05
15 years	-0.23 (a)	0.13 (a)	0.11	0.32
20 years	-0.33 (a)	0.16	-0.02	-0.19

(a) Significant at the 95% confidence level.

The same pattern is generally evident at the longer end of the term structure, though the differences in yield-curve responses between the countries are less statistically significant. Responses at the long end of the yield curve are small and often insignificant in Germany and the United States. This reflects the credibility of these countries' monetary regimes. Inflationary expectations—and hence long rates—are anchored following monetary policy adjustments (provided that monetary policy is not responding to, or inducing, changes in the long-term real interest rate). Monetary policy credibility is manifest in a more stable yield curve.

In the past, there has been less evidence of this in the United Kingdom and Italy. Yield-curve responses at longer maturities have tended to be larger and negative. This is how we would expect monetary policy to operate during the process of building up credibility. For example, monetary policy tightenings in these two countries have tended to depress inflation expectations and hence long rates. The lesser credibility of the monetary regimes in Italy and the United Kingdom is consistent with these countries' historically higher inflation rates and with their monetary regimes being newer.

Summary

A perfectly transparent, fully credible monetary policy will insulate the yield curve from jumps at the time of monetary policy changes. Indeed, stability of the yield curve around the time of monetary policy changes provides one measure of the degree of transparency and credibility of a monetary regime.

Most monetary regimes are less than perfectly transparent and credible. Typically, the yield curve does jump at the time of official rate changes. But evidence in the United Kingdom suggests that these yield-curve shifts have been dampened considerably since the introduction of inflation targeting and the transparency reforms that have accompanied it. Greater transparency has manifested itself in greater stability in the yield curve, especially at the short end. As the credibility of the inflation-targeting regime grows, longer-maturity yields might also be expected to be more stable following policy changes.

(1) For each of these countries we use slightly different sample periods, depending on data availability: for the United Kingdom, January 1990–March 1997; for the United States, January 1990–March 1997; for Germany, May 1990–March 1997; and for Italy, March 1992–March 1997.

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