BANK OF ENGLAND

Speech

What is the right amount of guidance? The experience of the Bank of England with forward guidance

Speech given by

David Miles, Monetary Policy Committee, Bank of England

De Nederlandsche Bank annual research conference, Amsterdam

13 November 2014

I would like to thank Rodrigo Guimaraes, Jochen Schanz, Charlotte Adams and Chuan Du for excellent research assistance, and others for helpful comments. The views expressed are my own and do not necessarily reflect those of the Bank of England or other members of the Monetary Policy Committee.

1. Introduction

The Monetary Policy Committee at the Bank of England began to give more explicit guidance on future monetary policy in August 2013. In a recent talk I gave at the London School of Economics I said that thinking about how that guidance had been received in the 18 months or so since we formally embarked on it made me think about the old Yiddish proverb: "Mensch tracht, und Gott lacht" – men plan and God laughs. Woody Allen put the same thought this way: "If you want to make God laugh tell him about your plans". I noted that some people might see these as a fitting epitaph for forward guidance on monetary policy. The Bank of England certainly faced a good deal of criticism for the guidance that it has recently been giving, as has the Federal Reserve in the US. In both cases the nature of the guidance has changed over time. I think that is one reason why some people might think that the Yiddish proverb is apposite because they think that changing guidance proves the folly of announcing plans.

But no central bank believes that giving no guidance on its future strategy is sensible just because it avoids ever having to change that guidance. The question is not whether to give any guidance but rather: what is the most useful way for a central bank to provide information about the way in which it will set monetary policy?

That is the question I want to consider. And I want to do so by reference to the experience of the Bank of England.

2. Recent guidance from the Bank of England

First, the facts.

August 2013 saw the introduction of more explicit guidance from the Monetary Policy Committee at the Bank of England about the future course of policy. As in many other countries, monetary policy in the UK had gone through a long phase of exceptionally low interest rates and unprecedented asset purchases. With the economy starting to pick up speed again, uncertainty about how the MPC would respond to signs of a gradual economic recovery appeared particularly great. The combination of unprecedented shocks and exceptional policy meant that past actions might not be giving much information about how policy might be set. So it seemed to the MPC right to give more guidance than had been given in the past. For me there was one specific risk in mid-2013. This was that at the emerging signs that the growth of GDP might be returning to levels that were closer to the long run trend for the UK, people might assume that with inflation also fairly close to target that monetary policy might quickly be returned to something that looked more normal. "Normal" might well be thought of as a level for Bank Rate of around 5% (which is the average Bank Rate since 1694 and also the average in the 10 year period between the formation of the MPC and the onset of the financial crisis – a period when inflation was close to target and growth close to the long run average for the UK). So the guidance we gave was that policy would **not** be tightened until unemployment had fallen

materially further. I saw the advantage to this was that it made clear that a couple of quarters of growth at or above trend would not be enough in itself to make a tightening in monetary policy appropriate. There would probably still be slack in the economy. So the guidance was this: there will be no tightening in policy until a simple measure of slack (unemployment) had fallen materially, at least so long as inflation pressures were not heading in the wrong direction.

Some points:

1. It was absolutely not an unconditional commitment. What we said was that we would not raise interest rates ***at least until*** unemployment fell to 7%, ***provided*** the inflation outlook remained benign. And neither did we commit to raise interest rates when unemployment fell to 7% (which it subsequently did fairly quickly).
2. The guidance was effectively a rule we said we would follow until unemployment fell to 7% – and it was a conditional rule.
3. It was somewhat complex precisely because it was not a simple commitment to a specific path.

Why did we do it? For me the main reason was to head off risks that after a few decent bits of news on quarterly growth the shorter end of the yield curve steepened in a way that was not justified by the state of the economy

The guidance was **not** given as a means of committing to a policy that we thought optimal but was time inconsistent. I make that point because one argument for guidance that is given at the zero lower bound is that it can make people believe a policy will be followed which involves lower interest rates – and higher inflation – at subsequent points than would be chosen by a central bank that was not constrained by past announcements. In principal that might be helpful as a means to reduce current real interest rates – by raising future inflation expectations.

There is indeed a perfectly coherent view that when facing the ZLB the optimal monetary policy may be to commit to generate sufficient future inflation to reduce expected real rates. This could be seen "as committing to being irresponsible" since once the ZLB is no longer binding a purely forward looking central bank would not find it optimal to implement. In this world, forward guidance can be effective in as much as it facilitates commitment, resolving the time inconsistency of the high inflation future path required to deal with the ZLB. [1]

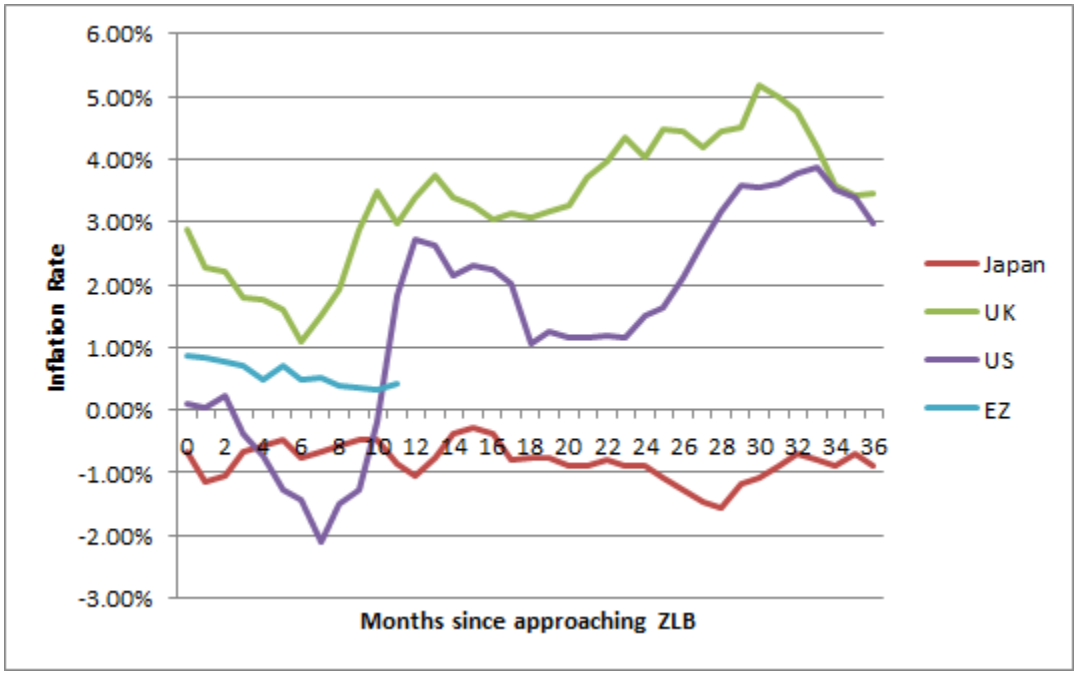
But this is not what we at the Bank of England were doing at all. There were two reasons for that. First, far from facing a position of an inflation under-shoot and imminent deflation, the UK had experienced a consistent overshoot of the inflation target. Committing to a time inconsistent policy through announcements

[1] See in particular Gauti Eggertsson and Michael Woodford (2003) and Paul Krugman (1998).

of future policy may be sensible if the ZLB is accompanied by deflation. This was the case in Japan, the case often mentioned by the main proponents of the commitment view (Woodford, Krugman and Svensson). But as the chart below shows, the UK has actually experienced relatively high inflation throughout most of the ZLB period (and higher than in the US or Euro zone). In Figure 1, I plot the path of CPI inflation in selected regions up to three years (36 months) after the point when their official policy rate approached the zero-lower-bound.

In fact, in the UK our concern has been not to let inflation and inflation expectations become de-anchored from the 2% target. The last thing we wanted to do was to make people believe we were committed to an inflation overshoot in the future!.

Figure 1. **Path of CPI inflation in selected zero-lower-bound experiences**



Notes: For Japan the series for inflation starts from October 1999, when their policy rate hit 0% for the first time (Statistics Bureau Japan; Bank of Japan). For the UK, the series starts from March 2009, when the Bank Rate was first reduced to 0.5% (ONS, Bank of England). The US and Eurozone series start in December 2008 and November 2013 respectively, when their policy rate first hit 0.25% (US Bureau of Labor Statistics; Federal Reserve; Eurostat; ECB).

A second reason why we should not have given guidance to commit to a lower path of rates than we might subsequently prefer is that I do not believe that unconventional monetary policy is powerless at the ZLB. There are means beyond changing the policy rate of making policy more expansionary. So, even if inflation had not been as high as it was, and if deflation concerns had been higher, I believe we had effective tools to further loosen the stance of policy. Even though the effects of assets purchases (quantitative easing, or QE) are quite uncertain, and there is substantial debate about the mechanisms through which it can operate, I believe we had evidence to be more optimistic about monetary policy at the ZLB than the Woodford view. I

also believe the international experience with unconventional monetary policy tools has vindicated that less gloomy view of monetary policy at the ZLB. (See Bernanke (2002), Bernanke & Reinhart (2004) and Bernanke, Reinhart & Sack (2004). For a recent overview of the evidence for the UK see Joyce, Miles, Scott and Vayanos (2012), and other papers in that special edition of The Economic Journal). There are certainly theoretical models – usually where assumptions are made that are comparable to those needed for Ricardian Equivalence – where QE will not work. But to paraphrase Bernanke, QE may be a policy that works in practice but not in (some idealised) theory.

So what was the effect of the guidance and what lessons might we take from it?

First, despite great efforts some people interpreted our guidance as a promise to set rates at specific levels (that is unchanged) for a specific period. Here are some UK press headlines about our guidance.

- "The Bank of England's commitment to low rates will be welcome news for borrowers and is likely to make fixed-rate loans even more attractive, experts said today.", **Daily Telegraph**, 7th August 2013.
- "What is forward guidance? It is making a promise about the future, particularly about future interest rates." **BBC**, 12 Feb 2014.
- "The new Governor of the Bank of England Mark Carney has promised to hold down interest rates for a "considerable amount of time" in a bid to "secure the recovery". **ITV News**, 7 August 2013.
- "Forward guidance was, in effect, a promise to keep rates low for a long time." **The Economist**, 15 February 2014.
- "The world's major central banks are returning to a more opaque and artful approach to policymaking, ending a crisis-era experiment with explicit promises that they found risked their credibility and did not substitute for action." **Reuters**, 7 July 2014
- "Mark Carney pledged that Bank of England officials won't rush to raise interest rates as he highlighted overseas risks to Britain's recovery and the weakness of wages". **Bloomberg**, 13 August 2014.

Second, some people figured out it was not a commitment and then complained that we were being evasive, less than frank, unhelpfully obscure, keeping all our options open, and so on. If you thought we should have been making a commitment for the sort of reasons that Woodford and Krugman thought might be relevant - to commit to a level of rates lower than we might subsequently judge right - I can see that as a valid criticism. But actually the criticism was much less sophisticated than that; it boiled down to "why don't you tell us what you are going to do?"

And it is true that the MPC could commit to a certain path for future interest rates, and stick to it whatever economic circumstances materialise. Indeed the more uncertain the economic environment, the more valuable might people find it to have certainty about where interest rates are heading. Yet the greater the

uncertainty the greater are the chances that the economic environment will turn out to be very different from what the MPC expected at the time they committed to an interest rate path. And this means that sticking to that path can be very costly. In many models sticking to a particular path for interest rates over a specific horizon can mean that at the end of that horizon interest rate may need to move dramatically to prevent serious instability in the economy. If the certainty about the path of rates for some near horizon comes at the cost of far higher uncertainty a bit down the road that hardly looks ideal.

How great is the cost of pre-announcing a path for rates over the next few years? Is that cost greater than the benefits of certainty to households and companies? I have used a simple model of the economy – incorporating several significant sources of uncertainty – to assess that. I want to show some simulations using that model.

The model is reduced to the bare minimum[2]. It has three parts, summarised in three equations, which describe the evolution of output, inflation and supply capacity. Demand and output are assumed to grow faster if interest rates, adjusted for inflation (i.e. real interest rates), are below average. This is a standard demand relation – sometimes called the IS equation. Inflation is assumed to rise when firms produce above their long-run level of supply – in other words there is a link between slack (or spare capacity) and inflation. Finally I assume that supply capacity (more specifically, productivity growth) may respond positively to output growth; this is a simple way of taking account of possible hysteresis effects. I will assume that unless the central bank has committed to a specific path for interest rates it will vary them as it learns about how inflation and output evolve. I assume that the way in which the interest rate responds to inflation and production will be chosen by the central bank optimally in order to achieve its goals (goals which are described below and set out explicitly in my London School of Economics talk).

This simple model allows me to incorporate a number of uncertainties that I think are particularly relevant for the UK right now. The first is uncertainty about the degree of spare capacity in the economy. The second is about the impact of monetary policy: since interest rates have been at such exceptionally low levels for so long there is unusual uncertainty about how the return towards more usual levels will affect the economy. The third source of uncertainty is how fast the economy grows in the absence of monetary stimulus (i.e. at a neutral setting for policy). And the fourth source of uncertainty is about the extent to which productivity growth responds positively to output growth. I believe that uncertainty about these four factors – slack, the transmission mechanism of monetary policy, current momentum in the economy, and the endogeneity of productive potential – is substantial and economically significant.

I calibrate the model in a fairly crude way to reflect what I think is a plausible view of how these economic relationships operate, and of how large the associated uncertainties are.

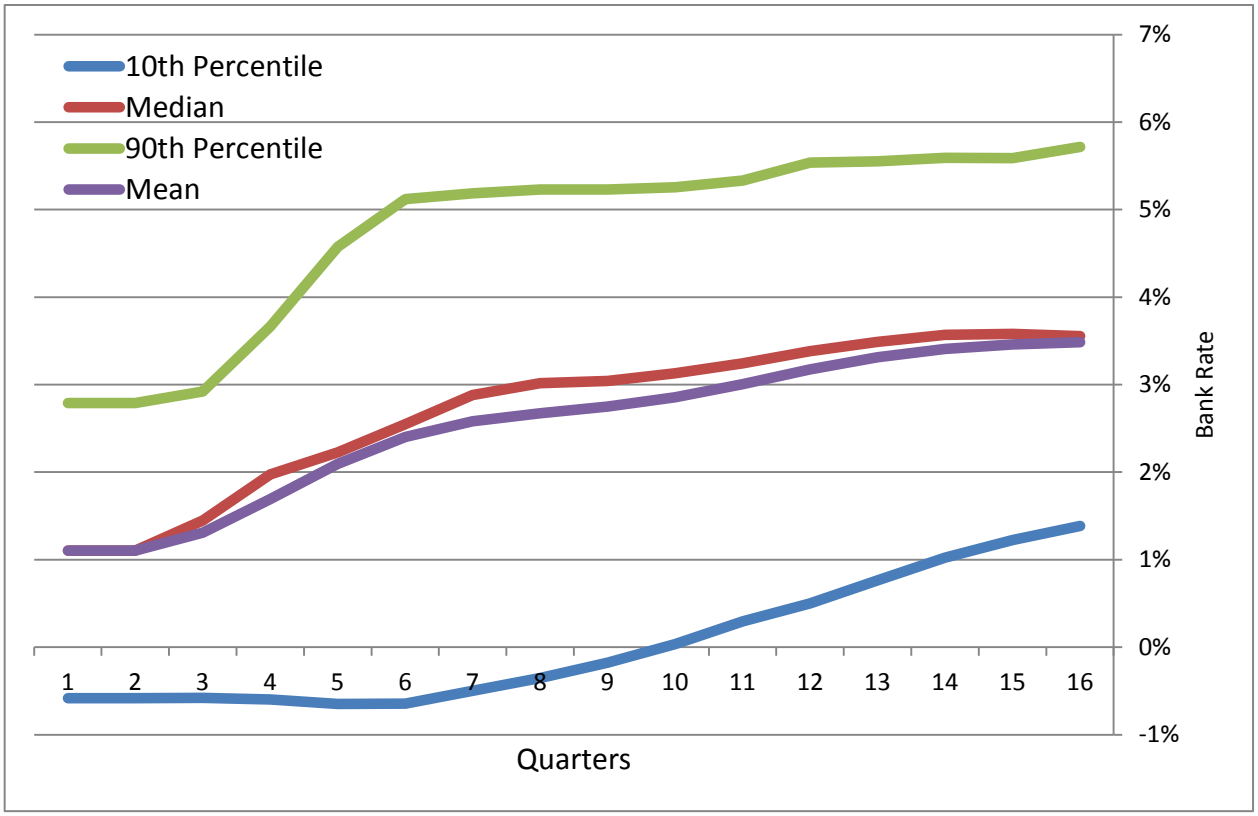
[2] More details of the model are presented in a talk I gave at the London School of Economics in September 2014, available at http://www.bankofengland.co.uk/publications/Pages/speeches/2014/758.aspx.

I specify the aim of the central bank as being to try to keep inflation close to a target and output close to its estimate of the supply capacity of the economy. More specifically, I assume that the central bank sets policy to minimise the expected value of the weighted sum of squared deviations from the inflation target and from supply capacity over a horizon stretching many years into the future. We can then compute an optimal policy rule showing how the interest rate should respond to the (uncertain) evolution of actual inflation and output so as to best achieve the aims of policy. What we are doing here is finding that interest rate rule which best achieves the aims of policy and where the rule is chosen at the outset when there is uncertainty about the economic environment. Using this rule we can then show how policy would evolve for any specific realisation of the uncertain parameters which affect the path that inflation and output actually take. This yields a range of paths for output, inflation and interest rates; each path is the outcome for a specific constellation of the uncertain factors incorporated in the model.

Figure 2 shows the resulting probability distributions for the path of Bank Rate[3]. Along the central path (that is the median where 50% of the outcomes are with lower interest rates and 50% have higher rates) the level of Bank Rate rises gradually. But it remains materially below its pre-crisis average of around 5% even after four years. Figure 2 also shows that things may turn out quite differently from the central path. This simple model suggests that there is a 10% chance that the appropriate level of Bank Rate increases to above 5% within 18 months (the line labelled "90th percentile"). It also shows that there is a 10% chance that the appropriate level of Bank Rate is around zero for two years to come and is only just over 1% even four years ahead (the line labelled "10th percentile").

[3] I generate an appropriate path of Bank Rate for each realisation of the set of uncertain parameters. There are 1000 such realisations, or scenarios, in all. Each path is that from following an optimal interest rate rule that is derived ex-ante of the realisations (and thus takes into account the model uncertainties). In the context of this model, this path of Bank Rate could be interpreted as a composite of Bank Rate and asset purchases.

Figure 2: Optimal Bank Rate, simulation



How does a policy of fixing the interest rate for a 3 or 4 year horizon look in the light of this model? Not very attractive I should say. Suppose that interest rates are set at the outset so that they follow the central (median) path. *On average* this is an appropriate policy – but in the light of how things actually evolve it could be very different from the interest rate that would be appropriate based on what actually happens to inflation and output. How wrong could it be? Well 4 years ahead the interest rate to which the central bank commits at the outset if it fixes policy at what is (ex ante) the average outcome could, with about 10% probability, **be at least** 2.5 percentage points too low and with 10% probability it could be **at least** 2 percentage points too high. Having interest rates that far from the right level, and for an extended period, seems to me a very high price to pay for the certainty of following a given path for interest rates. It would probably generate outcomes that were wildly unstable.

Self-evidently uncertainty around the future economic environment is very significant. This is why most MPCs meet regularly to assess the latest developments and, if necessary, to adjust the stance of monetary policy. The commitment to a particular interest rate path is, it seems to me, unlikely to be the answer to the question of what sort of guidance to give on policy.

Yet people who ask what interest rates will be in a few years' time are likely to be disappointed if all they are told is that it might be not much different from today, but it could be around 5%, or somewhere between the two, or maybe even outside that range.

So what is the right sort of information – the right sort of guidance – to give?

3. What does economics tell us?

Economic theory is not terribly helpful on this question. Partly that is because many models assume agents (households, companies and the central bank) share the same information and have the same model of the economy in mind. In stylised models of the economy where the central bank and the general public have exactly the same information about the structure of the economy – and make the same assessment of the nature of uncertainty – then everyone can work out what the central bank will do in various circumstances so long as the central bank explains what exactly the aim of policy is, including about how trade-offs between goals are evaluated. The central bank could specify some reaction function – that is a description (or rule) for how it would set interest rates depending on how the economy evolves. But in a model which assumes perfectly rational, computationally proficient and equally informed people, they could work out for themselves the rule the central bank would follow to best achieve its objectives. If one weakened that assumption on common knowledge then providing a monetary policy reaction function can be a useful form of guidance. But in practice the conclusion that the central bank needs to either simply be explicit about its aims or provide a policy reaction function is not very helpful because it ignores several very significant real world complications:

1. Central banks will have different information about the economy than other agents – not so much in terms of having more raw data (though that will certainly be a factor) but more in terms of the scope to analyse it in an institution that has a small army of people trained to interpret data

2. Central banks will use various models of the economy – all of them imperfect and none used as sole guide to policy. The use of such models in setting policy is part science and quantifiable (in the sense that an explicit policy rule could in principle be codified and shared) and part judgement – which is much more difficult to codify in a useful way. Coming up with a reaction function that is a good approximation to the actual decision making procedure and can also be understood is in practice very difficult. (This is made more complicated if people on the policy Committee don't all agree and if those people change over time).

3. Even if models could all be codified and some policy rules specified, then if they were to be even an approximate guide to actual decisions they would probably be complicated. They might be of the form: "if X, Y and Z happen, and none of A, B or C happen, then policy will be set according to the following (non-linear,

dynamic, regularly re-estimated) equation…." The number of people who could understand what that means and find it useful may be very small; the scope to misinterpret it is large[4].

So what are some other options for giving useful guidance?

One is to provide an expected path for the policy rate. But without giving some idea about how likely it is that policy will be close to this path this may not be particularly useful. While making clear there is uncertainty around those paths is simple, quantifying that uncertainty is tricky. One might just draw on the volatility of past interest rates (around some previously expected path) as a guide to uncertainty in the future. Or a stochastic simulation using a monetary policy rule could be used to derive fan charts for the policy rate. That is what figure 2 is. But to construct figure 2 you need the following elements:

1. An assessment of all the random factors (or shocks) that can impinge on the economy and their probabilities
2. A model of how those shocks then impact on the outcome you care about – inflation, growth, output etc.
3. A model for how monetary policy affects those outcomes and can be used to offset the impact of shocks
4. An assessment of what the optimal policy response to such shocks is (which means using 1-3 above to derive a policy rule that maximises some specified target function).
5. If policy is made by a committee you need to reach an agreement on 1-4; if it is a committee with members responsible for their own votes you somehow need to reconcile a unique path of rates (for given realisation of shocks) with individual accountability in an environment where people will take

[4] You may think this is an exaggerated statement about what a policy rule might look like. But consider the rule that the MPC adopted in August 2013. This is how it was described:

The Committee intends at a minimum to maintain the current highly stimulative stance of monetary policy until economic slack has been substantially reduced, provided this does not entail material risks to either price stability or to financial stability.
In particular, the MPC intends not to raise Bank Rate from its current level of 0.5% at least until the Labour Force Survey headline measure of the unemployment rate has fallen to a threshold of 7%, subject to the conditions below.
The MPC stands ready to undertake further asset purchases while the unemployment rate remains above 7% if it judges that additional monetary stimulus is warranted. But until the unemployment threshold is reached, and subject to the conditions below, the MPC intends not to reduce the stock of asset purchases financed by the issuance of central bank reserves and, consistent with that, intends to reinvest the cash flows associated with all maturing gilts held in the Asset Purchase Facility.
The guidance linking Bank Rate and asset sales to the unemployment threshold would cease to hold if any of the following three 'knockouts' were breached:

- in the MPC's view, it is more likely than not, that CPI inflation 18 to 24 months ahead will be 0.5 percentage points or more above the 2% target;
- medium-term inflation expectations no longer remain sufficiently well anchored;
- the Financial Policy Committee (FPC) judges that the stance of monetary policy poses a significant threat to financial stability that cannot be contained by the substantial range of mitigating policy actions available to the FPC, the Financial Conduct Authority and the Prudential Regulation Authority in a way consistent with their objectives.

The Committee will continue to set the level of Bank Rate and the size of the asset purchase programme each month, taking these criteria into account. The action taken by the MPC if any of these knockouts were breached would depend upon its assessment at the time as to the appropriate setting of monetary policy in order to fulfil its remit to deliver price stability. There is therefore no presumption that breaching any of these knockouts would lead to an immediate increase in Bank Rate or sale of assets.

This policy rule runs to 360 words.

different views on the structure of the economy, its current state and the chances of various shocks hitting in the future.

This is a complex task.

The MPC could nonetheless decide to use a mechanical procedure that is some sort of rough approximation to its decision making so as to produce a fan chart for interest rates. That might involve using a model with a policy rule for setting interest rates for any given state of the economy embedded in it. This would be a (pretty crude) approximation to the decision making process of any one member of a Committee. Whether the resulting probability distribution of interest rates was a useful guide to the true chances of interest rates taking on different values is hard to judge. Whether any resulting fan chart of interest rates would be an improvement over a rougher sort of guidance – for example a statement that interest rates are expected to only increase gently from the current level over the next few years – is also unclear.

There is no getting around the fact that constructing fan charts of interest rates that represent the MPC's view of the probability of different paths present many problems. It involves, for example, the quantification of the chances of various events happening which may go beyond what can meaningfully be done. The apparent precision of probability statements in a world of uncertainty (not just risk) can be misleading[5].

More useful can be the assessment of different scenarios and the use of model to (in a rather mechanical way) find a path for interest rates which in that particular scenario delivers a path for output and inflation with particular features. This gives an indication of the sort of policy response that might be appropriate in a specific eventuality. One possibility is something along the lines of the Riksbank's 'four-panel graphs' as illustrated in their February 2012 minutes (Sveriges Riksbank 2012), or the 'three policy paths' used by Yellen (Yellen 2012). (See also Svensson (2013)).

Some central banks do provide forecast of the future policy rate. For example, the members of the Federal Open Market Committee (FOMC) each provide their central projection of the appropriate Federal Funds rate target at the end of each of the next several years, as well as in the longer run. (These views are represented as individual points on a 'dot chart'). FOMC members also provide forecasts for key economic variables – such as output growth, unemployment and inflation – based on their own individual assessment of appropriate monetary policy.

It might seem clear that to condition forecasts on policymakers' views on what would be their own future monetary policy response is a better alternative than the Bank of England approach, which has been to use

[5] The distinction between uncertainty and risk is one that Knight and Keynes both made. In a famous passage Keynes described what he meant by "uncertain knowledge":
"By 'uncertain' knowledge, let me explain, I do not mean merely to distinguish what is known for certain from what is only probable. The game of roulette is not subject, in this sense, to uncertainty...The sense in which I am using the term is that in which the prospect of a European war is uncertain, or the price of copper and the rate of interest twenty years hence...About these matters there is no scientific basis on which to form any calculable probability whatever. We simply do not know." Keynes (1937).

a path for interest rates implied by market prices of money market instruments; and that if risks around that preferred central path can be quantified it provides more useful information than the FOMC dot chart which is just a set of measures of the expected rate. In rather different ways The Reserve Bank of New Zealand, the Norges Bank, and the Riksbank attempt to do just this***. If*** the path of interest rates used is a reasonable approximation to the true expectation based on how the Committee will actually make decisions in the future, then this would seem a better option than using a market implied path for interest rates and would avoid some well-known problems of consistency and interpretation. But there is a big **if** in that statement.

4. Where now for guidance about the future path of policy in the UK?

To my mind our original guidance from August 2013 served its purpose. Even though unemployment fell fast towards 7% (and reached that level by early 2014) there was not a sharp rise in the expected path of the policy rate. Although people said that the MPC was then "forced" to abandon its guidance, it seems to me more accurate to say that as unemployment fell under 7% the nature of guidance changed for the obvious reason that guidance which told people our strategy while unemployment was above 7% needed to be updated. Now the MPC is giving some qualitative judgements on most likely outcomes – saying that interest rate rises are expected to be gradual and probably to a level lower than had been seen as normal pre-crisis. It is a message that seems pretty well understood. At the time of our last policy meeting at the start of November the market implied path for Bank Rate implied that rates did not rise until the second half of 2015. More significant is the fact that the market expectation for where Bank Rate would be at the end of 2017 was only around 1.7%. That seems to be a path that could described as gradual and to a level of the policy rate well below what used to be thought of as normal.

Is this guidance too imprecise? Is it more vague than is optimal?

The MPC could try to give more information on how it will set policy; it could give some approximation to its future reaction function. But I have argued that an easy to understand reaction function will likely be too crude to accurately reflect how decisions will actually be made – so runs the risk of being more misleading than informative. It is not self-evident that some approximation to a collective reaction function (even ignoring such issues as different members having different reaction functions) is really helpful to ordinary people in understanding what the prospects are for interest rates. It is very likely that any reaction function the central bank gives will at best be a rough approximation; and the more precise you make it the more people may see it as a rule which will absolutely be followed. This is one aspect of a broader problem with guidance which is the danger that people confuse guidance with commitment, or confuse an expectation with a promise.

5. Conclusions

In an ideal world (and in idealised models) the Central Bank can just explain its objectives; maybe it would also need to describe its reaction function. No more is needed.

But unless outsiders have as good information on the economic outlook – and can plug that into the reaction function – then they may be left floundering in attempting to assess the prospects for interest rates. And any reasonable approximation to a reaction function might be very complex. (Indeed it is very likely that it is; otherwise MPC meetings would be mechanical affairs lasting 5 minutes).

In light of this I believe that the central bank directly giving some assessment of the likelihood of interest rates following different paths is likely to be helpful, particularly in situations in which past action and communication is not enough to describe new trade-offs in an unusual environment.

But constructing an explicit probability distribution for the central bank's own policy rate that is based on the realities of how policy is made and gets across a message that can be widely understood is a major challenge.

Attempting to provide a specific central path with fans around it is a complex task, and may go beyond what is feasible and useful. Spurious accuracy is unhelpful. So while I am open minded about whether the MPC should provide fan charts for interest rates, I am not convinced that is clearly a step forward.[6]

Currently, it might be just as useful – and probably less misleading and possibly even more accurate – to give forms of guidance which are more qualitative, such as: "interest rate rises will probably be gradual and likely to be to a level below the old normal".

That says something substantive; **and** most people can understand it.

[6] As Gilboa has stressed a probabilistic approach is quite useful in illustrating a broad sense of subjective uncertainty, but can be counter-productive if it forces the practitioner to impose an arbitrary degree of precision to that uncertainty. In a case where we want to communicate that interest rates are likely to rise gradually whilst also emphasising there is a significant degree of uncertainty around this expected path, a model based fan chart forces us to address the question: 'Exactly how uncertain are you? By 1% or 2%?' It can be difficult to provide an answer without imposing some spurious level of precision. The reality is that not all types of uncertainty can be meaningfully quantified. As Gilboa says: "The Bayesian approach is quite successful at representing knowledge, but rather poor when it comes to representing ignorance. When I try to say, within the Bayesian language, 'I do not know', the model asks me, 'How much do you not know? Do you not know to degree 0.6 or to degree 0.7?' " Gilboa (2014).

References

Bernanke, B. 2002. " Deflation: making sure it doesn't happen here", Remarks by Governor Ben S. Bernanke before the National Economists Club, Washington, D.C. November 21, 2002

Bernanke, B., and V. Reinhart. 2004. "Conducting Monetary Policy at Very Low Short-Term Interest Rates." American Economic Review 94, no. 2: 85–90.

Bernanke, B. and B. Sack. 2004. "Monetary Policy Alternatives at the Zero Bound: An Empirical Assessment." BPEA, no. 2: 1–100.

Eggertsson, G. and M. Woodford, 2003. "The Zero Bound on Interest Rates and Optimal Monetary Policy" Brookings Papers on Economic Activity, 1:2003, 139-211.

Gilboa, I. (2014) "Rationality and the Bayesian Paradigm: An Integrative Note".[7]

Gerdrup, K. R., and Nicolaisen. J. (2011) "On the Purpose of Models—The Norges Bank Experience." *Norges Bank Staff Memo No. 6/2011*.

Keynes, J.M. (1937), " The Ex Ante Theory of the Rate of Interest", *Collected Works of John Maynard Keynes , vol. XIV, pp. 215-223, Macmillan, Cambridge University Press,* 1971-1983.

Krugman, Paul. (1998). "It's Baaack! Japan's Slump and the Return of the Liquidity Trap" Brookings Papers on Economic Activity, 2:1998, 137–87.

Joyce, M, Miles, D, Scott, A. and D. Vayanos, (2012) ""Quantitative Easing and Unconventional Monetary Policy", **The Economic Journal**, November 2012, vol. 122, pp 271-289.

Svensson, L. (2013). "Some Lessons from Six Years of Practical Inflation Targeting", *CEPR Discussion Paper DP9756*

Sveriges Riksbank. (2007). "Calculation Method for Uncertainty Bands." *Monetary Policy Report* 2007:1.

Sveriges Riksbank (2012a), "Minutes of the monetary policy meeting, no. 1", February 15, 2012, www.riksbank.se.

Woodford, M. (2013) "Forward Guidance by Inflation-Targeting Central Banks", *CEPR Discussion Paper 9722*, November 2013.

Yellen, J. (2012), "Perspectives on Monetary Policy", Remarks at the Boston Economic Club Dinner, Federal Reserve Bank of Boston, Boston, Massachusetts. www.federalreserve.gov.

[7] Available at: http://www.bankofengland.co.uk/research/Documents/pdf/gilboa_0414.pdf