Market-based estimates of expected future UK output growth

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This article derives some simple market-based projections of future output growth from a Taylor monetary policy rule, yield curves and inflation surveys. The results can be used as a timely cross-check on output growth expectations from other sources. We find that over the recent past the projections have been plausible in magnitude against both recorded outturns and survey expectations.

Introduction

Financial market data reflect, among other things, market participants' views about the future of the economy. That information is of interest to monetary policy-makers who, because of lags in the policy transmission mechanism, need to set policy with regard to future inflation and output. This article focuses on information from the yield curve which, subject to some caveats described below, can be thought of as containing information about financial market expectations of the future profile for the official interest rate and so the future state of real activity and inflation. Our aim is to provide a quantitative measure of these implicit expectations of future output growth using yield curve estimates and a simple monetary policy rule.(1)

Simple monetary policy rules

Over the past decade there has been considerable interest in the use of simple monetary policy rules to analyse central banks' behaviour. Monetary policy rules provide a framework for relating variations in the policy-makers' instrument to deviations of policy objectives from trend or target. These simple rules can be used to provide a useful summary of the economy in terms of a familiar variable, for example, the level of the policy rate. Stuart (1996) discusses simple policy rules, and Hauser and Brigden (2002) describe them in the context of the Bank's assessment of monetary conditions.

The policy rule is sometimes specified in terms of a monetary aggregate, for example the McCallum (1988) rule, but the rule that we focus on in this article is an interest rate rule suggested by Taylor (1993). His article says that the level of the official policy rate in the United States could be characterised as reflecting the rate of inflation relative to target and the level of output relative to potential (the output gap). As a simplification of the monetary policy process, the Taylor rule has become popular for monetary policy analysis among academics, policy-makers and commentators. However, it is important to stress, as Taylor did, that monetary policy-makers do not follow rules that can be summarised in an equation (simple or otherwise). King (1999) describes Taylor rules as '…not a mechanical rule to guide policy, but a vehicle to clarify issues'.

The standard way of using the Taylor rule is to derive a value for the policy rate in any given period from contemporaneous values of the output gap and the deviation of inflation from target.(2) But it could be re-arranged to derive, for example, the implied output gap, given policy rates and inflation. This rearrangement is interesting because there are independent measures of what market participants think future policy rates and inflation outturns will be. If policy rates were expected to rise, and market participants believe that the policy response is characterised by a Taylor rule, then this must either be in response to higher inflation or rising output. In this framework, if the market did not expect inflation to rise, then higher expected policy rates must be a response to rising output expectations. So if market participants think that a Taylor rule is a reasonable characterisation of policy, it would be possible to obtain a plausible and timely market-based measure of implicitly expected future GDP growth.

(1) We focus on the information in fixed-income markets, but information from other asset prices is also important for monetary policy. See Clews (2002).
(2) In practice, output and inflation data may not be contemporaneous because of publication lags.

Reversing the Taylor rule

The Taylor rule can be written as follows:

$$i_t = i_t^* + a(y_t - y_t^*) + b(\pi_t - \pi_t^*)$$

In this equation i_t is the official policy rate in period t, y_t is the logarithm of the level of output and π_t is the annual rate of inflation. The 'starred' variables are intended to summarise some notion of the economy's equilibrium. The inflation target is denoted by π_t^*. The other starred variables are conceptually attractive but less easy to quantify. The variable y_t^* is the logarithm of the potential level of GDP. This is the level of output at which firms in the economy are working at their normal-capacity output, and are under no pressure to change output or product prices faster than the expected rate of inflation.(1) The variable i_t^* summarises the idea of a neutral level of the nominal interest rate at which policy is neither tight nor loose. In the Taylor rule, it is by definition the interest rate at which inflation is at target and output is at potential.

The nominal interest rate is approximately equal to the real interest rate plus the expected rate of inflation.(2) This is known as the Fisher relationship and describes how nominal debt contracts build in compensation for inflation. Using this relationship, the nominal interest rate will be at a neutral level if inflation expectations are at target, and real interest rates are at some steady-state level, a condition that would be satisfied on a balanced growth path with unchanging consumer preferences.

The Taylor rule can be reversed to give the output gap in terms of interest rates and inflation all couched in terms of expectations of their future values:(3)

$$E_t\left(y_{t+1} - y_{t+1}^*\right) = \frac{1}{a}E_t\left(i_{t+1} - i_{t+1}^*\right) - \frac{b}{a}E_t\left(\pi_{t+1} - \pi_{t+1}^*\right)$$

This expression could be used to obtain a quantitative measure of the implied output gap, given a value for the neutral nominal rate of interest, but the size and sign of the output gap would depend crucially on the value chosen for i^* (as well as the coefficients a and b).

Instead, the approach adopted here is less ambitious. To derive a measure of expected output growth, we assume that the trend rate of growth of potential output and the inflation target are constant. If the regime is credible, steady-state inflation expectations should also be constant at target.(4) These assumptions lead to the following expression for the growth rate, where we have written $g_{t+1} = y_{t+1} - y_t$ for actual growth and g^* for trend growth:

$$E_t\left(g_{t+1}\right) = g^* + \left\{\frac{1}{a}E_t\left(i_{t+1} - i_t\right) - \frac{b}{a}E_t\left(\pi_{t+1} - \pi_t\right)\right\}$$

This expression says that expected future growth can be decomposed into the expected growth of potential output and expected cyclical deviation of growth from trend. If interest rates are expected to rise rapidly, and inflation is not, then, in this framework, there must be an expectation of strong output growth. If, for the same expected profile of interest rates, inflation is also expected to pick up, then this characterisation of policy reaction means that output is expected to grow less rapidly.

Although this approach avoids having to calibrate the neutral nominal interest rate, it is still necessary to take a view about the trend growth rate of potential output, how to measure expected future policy rates, inflation expectations, as well as the constants a and b. This is the subject of the next section.

Calibration

This section describes how we proxy expectations of future policy rates and the inflation term structure. No one method is ideal, so we calculate several variants using different data sources. This allows us to generate a range for growth expectations defined by the minimum and maximum values given by our variants.

Expected future interest rates

One ingredient is a market-based measure of the expected future official policy rate (or rather its expected rate of change). In the absence of uncertainty, the expectations theory of the term structure says that

(1) For more on these issues, see Monetary Policy Committee (1999).
(2) If inflation is uncertain, nominal interest rates will also incorporate an inflation risk premium.
(3) $E_t(.)$ is the expectations operator on information known in period t.
(4) On a balanced growth path the steady-state real rate of interest should also be constant if the per capita net growth rate is constant. Then from the Fisher equation, the neutral nominal interest rate should also be constant. By looking at the rate of change of the output gap (the growth rate of actual output above that of potential output), the neutral nominal rate of interest and the inflation target drop out of the calculation. Then the deviation of expected growth from trend is determined by expectations of the rate of change of the policy rate and of inflation.

forward interest rates equal expected future interest rates.(1) Therefore it would be desirable to obtain forward rates that correspond to future two-week Bank repo rates. But in practice there are no instruments that allow us to calculate these forward rates precisely and we have to calculate forward rates based on other available instruments. The Bank currently calculates and publishes two types of nominal UK yield curve (and corresponding forward curve). The first, the government liability curve, is based on general collateral repo agreements and yields on conventional gilts. The second, the commercial banks' liability curve (CBL) is based on interbank loans, short sterling futures contracts, forward rate agreements and swap contracts settling on six-month Libor.(2) Both curves have advantages and disadvantages: for example, the CBL curve is derived from more liquid markets, but embodies some credit risk not present in the official interest rate.

In practice, derived forward interest rates will not necessarily equal expected future interest rates. Uncertainty, investor risk aversion, credit risk and liquidity will all introduce a premium, which implies that forward rates will not be an unbiased expectation of future interest rates. Brooke, Cooper and Scholtes (2000) describe the Bank's approach to inferring interest rate expectations from the various instruments described above. In this article we acknowledge, but do not adjust for, the presence of these premia. Since we are primarily interested in the slope of the forward curve, this assumption will only be a significant problem if the premia vary rapidly with maturity.

Inflation expectations

We use two sources to obtain a measure of the slope of the inflation term structure. One is the UK index-linked gilt market (details of this can be found in Scholtes (2002)).(3) The other source is the Consensus Economics survey. Neither measure is ideal, as surveys are not as timely as market data, and inflation expectations from the index-linked market are not available at very short maturities. Implied inflation rates derived from index-linked gilts relate to RPI, as did the Consensus survey before April 1997. All these factors mean that we have to be careful about how much weight to place on the individual Taylor rule projections. Our preferred approach is to look at all possible measures and use these to generate a range of forecasts.

Constants and coefficients

The model requires a quantitative estimate of the trend rate of growth. We replace trend growth with the average growth of real GDP since 1955, so g^* equals 2.5%.

Taylor (1999) notes that simulation studies suggest weights of $a = 1.0$ and $b = 1.5$. For the United Kingdom, Nelson (2000) estimates a weight of $a = 0.5$ on output and $b = 1.3$ on inflation for the period 1992–97. We take Taylor's weights as the central case, plus or minus the gap between his weights and Nelson's estimates to give an illustrative range.

Results

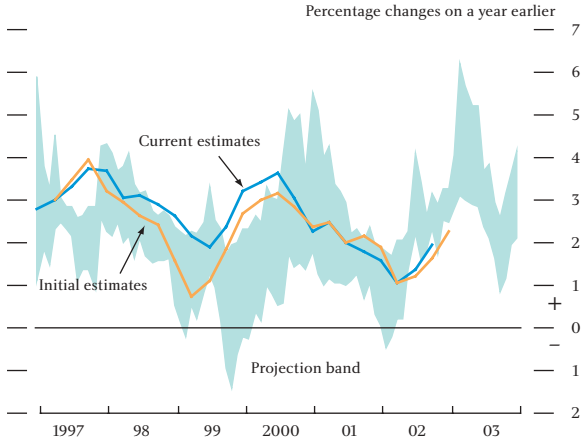
Time series of growth forecasts

We construct monthly time series of implied growth forecasts, using interest rate expectations either from the CBL curve or the government liability curve.(4) Inflation expectations are derived either from the index-linked gilt market, or from the Consensus Economics survey of inflation expectations.(5) The range between the minimum and maximum of forecasts, based on the two measures of interest rate expectations, two measures of inflation expectations and three choices of Taylor rule coefficients, is our forecast band for output growth.

We can compare this forecast band with the growth outturn recorded in the subsequent year over the period since the Bank was granted operational independence. This is shown in Chart 1.(6) Overall, the profile of the band is not dissimilar to outturns. Compared with final outturns of GDP growth in the latest available vintage of data, the Taylor rule measure has, on average over the sample, been pessimistic. However, GDP data are revised over time. And the magnitude of this downward bias becomes considerably smaller when we compare the reverse Taylor rule forecasts with the preliminary ONS

(1) Forward rates are the interest rates for future periods that are implicitly incorporated within today's spot interest rates for loans of different maturities.
(2) These data are available at www.bankofengland.co.uk/statistics/yieldcurve.
(3) Data on implied inflation rates are also available at www.bankofengland.co.uk/statistics/yieldcurve.
(4) Prior to March 1997, the estimated government liability curve does not extend to the shortest maturities. See the appendix.
(5) The method for obtaining these is described in the appendix.
(6) The comparable growth forecast is quarter on four quarters earlier. Note that the labels on the chart refer to the reverse Taylor rule forecasts from the previous year.

Chart 1
One year ahead growth expectations versus outturns



estimates of GDP growth, which would reflect more closely what was known by markets at the time.(1)(2)

Comparison with Consensus forecasts over 2002–03

As another metric of forecast plausibility we can also compare the Taylor rule growth projections with the monthly Consensus Economics surveys for output growth expectations over the current and next calendar years.

Charts 2 and 3 compare the reverse Taylor rule forecast band for average GDP growth in 2002 and 2003 with past Consensus forecasts for these years. We can see that our market-based forecasts were slightly less optimistic about UK prospects in 2002 than Consensus for the first half of 2001. Our implied forecast became more optimistic around the turn of 2002, but subsequently moderated, in particular falling around the time of the large falls in world equity markets around July. By the end of 2002, our forecast band pointed to a slightly higher outturn than was expected by Consensus in the final months of 2002. Our market-based projections have also been fairly close to, though more variable than, the Consensus forecasts for 2003, with the width of the forecast band primarily explained by the divergence between our two measures of the inflation term structure.

Term structure of growth expectations

As a case study, we can specifically look at the evolution of views about the UK economy since mid-2001.

Chart 2
Projection band for 2002 versus Consensus growth forecasts

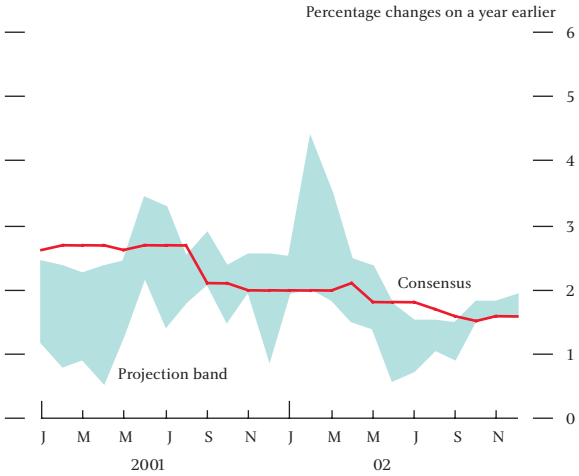
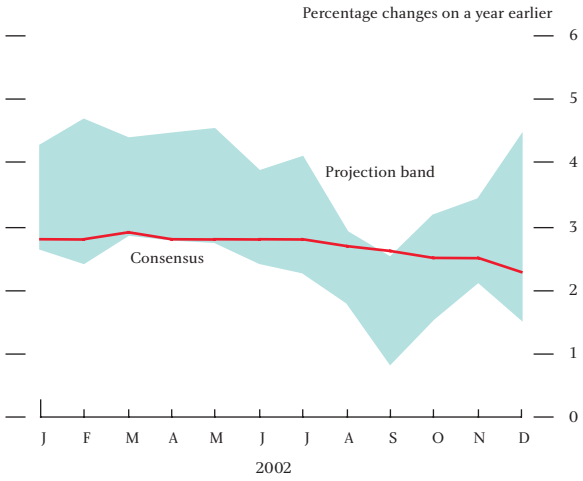


Chart 3
Projection band for 2003 versus Consensus growth forecasts



The February 2002 *Inflation Report* noted that 'Expectations of future short-term sterling interest rates rose from mid-November onwards…in line with the steepening…of the yield curve in the United States and the euro area. This suggests that investors have become more optimistic about a global economic recovery.' Chart 4 shows UK government forward curves at four *Inflation Report* publication dates in the past two years.

Chart 5 tracks the evolution of growth forecasts for the next four quarters in months corresponding to those in Chart 4, using inflation expectations from index-linked gilts and interest rate expectations from the government liability curve (the measure based on surveys of inflation expectations shows a similar picture). As the UK yield

(1) We could eliminate the bias altogether by adjusting our assumption for trend growth. Relative to initial GDP estimates, we would need to increase our assumption for g^* by slightly more than 0.1 percentage points.
(2) Vintages of GDP(E) data are available from the real-time database at www.bankofengland.co.uk/statistics/gdpdatabase/ For details about its construction, see Castle and Ellis (2002).

Chart 4
GC repo/gilt two-week forward curve

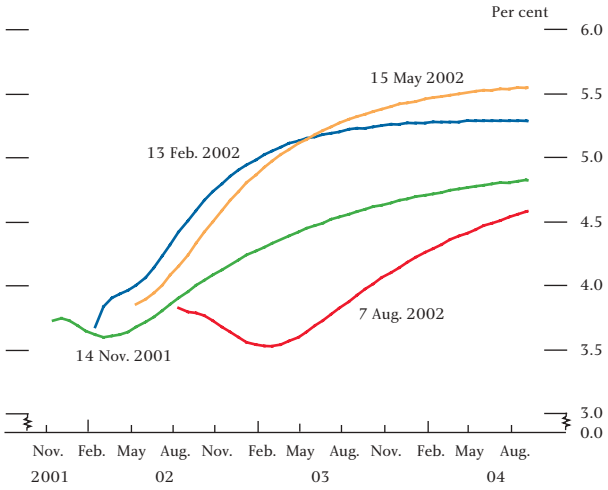
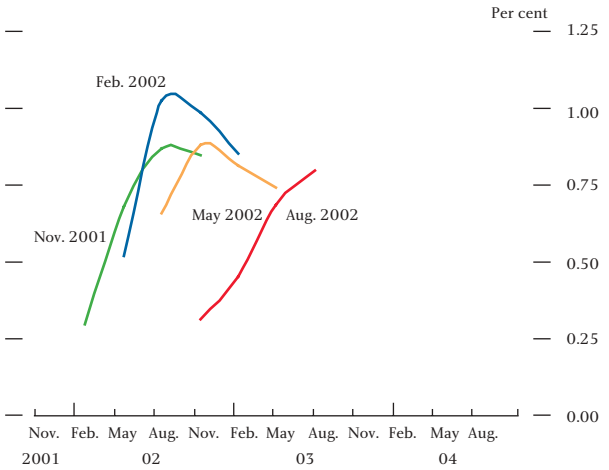


Chart 5
Term structure of quarter-on-quarter GDP growth rates



curve steepened between November 2001 and February 2002, with the profile of inflation expectations broadly unchanged, the implied term structure of growth rates became initially steeper. From February to May 2002, a steepening of the inflation term structure caused the implied growth forecasts to moderate. Finally, a flattening of the yield curve caused the growth profile to weaken further in August 2002.

Conclusion

This article has derived some simple market-based projections of future GDP growth based on a Taylor rule, yield curves and inflation surveys. The results can be used as a timely cross-check on output growth expectations from other sources. We find that over the recent past the forecasts have been plausible in magnitude against both recorded outturns and survey expectations.

Appendix

Data

This section describes the specific assumptions made to construct the reverse Taylor rule forecasts outlined in this article.

Interest rate expectations

We use monthly averages of instantaneous forward rates derived from the UK government liability curve or commercial banks' liability (CBL) curve at one to eight-quarter horizons. The Bank's method for estimating UK yield curves is described in Anderson and Sleath (2001). We acknowledge, but do not adjust for premia. We use interest rate expectations from the CBL curve for output growth forecasts going back to January 1993. From March 1997, we also produce forecasts using the government liability curve.

Inflation expectations

We use two methods to obtain a measure of the slope of the inflation term structure. First, using monthly averages of data from the UK index-linked market, we interpolate between the latest observed outturn for RPIX inflation and the shortest available inflation forward. Alternatively, we use information from Consensus Economics surveys for inflation expectations. We have two surveys available. The monthly Consensus survey gives us year-averages for expected inflation in the current and next calendar years. We obtain the slope of the inflation term structure by linear interpolation from the last observed RPIX outturn through these two survey observations. Alternatively, we obtain the slope of the inflation term structure from the quarterly Consensus survey, which gives us a more detailed quarter-by-quarter profile for expected inflation. However, this survey is less timely.

References

Anderson, N and Sleath, J (2001), 'New estimates of UK yield curves', *Bank of England Working Paper no. 126*.

Brooke, M, Cooper, N and Scholtes, C (2000), 'Inferring market interest rate expectations from money market rates', *Bank of England Quarterly Bulletin*, November, pages 392–402.

Castle, J and Ellis, C (2002), 'Building a real-time database for GDP(E)', *Bank of England Quarterly Bulletin*, Spring, pages 42–49.

Clews, R, (2002), 'Asset prices and inflation', *Bank of England Quarterly Bulletin*, Summer 2002, pages 178–85.

Hauser, A and Brigden, A (2002), 'Money and credit in an inflation targeting regime', *Bank of England Quarterly Bulletin*, Autumn, pages 299–307.

King, M (1999), 'Challenges for monetary policy: new and old', paper for the Symposium on *New Challenges for Monetary Policy*, sponsored by the Federal Reserve Bank of Kansas City at Jackson Hole, Wyoming.

McCallum, B (1988), 'Robustness properties of a rule for monetary policy', *Carnegie Rochester Conference Series on Public Policy*, Vol. 29, pages 173–204.

Monetary Policy Committee (1999), *The transmission mechanism of monetary policy*, Bank of England, available at www.bankofengland.co.uk/montrans.pdf

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

Scholtes, C (2002), 'On market-based measures of inflation expectations', *Bank of England Quarterly Bulletin*, Spring, pages 67–77.

Stuart, A (1996), 'Simple monetary policy rules', *Bank of England Quarterly Bulletin*, August, pages 281–87.

Taylor, J (1993), 'Discretion versus policy rules in practice', *Carnegie Rochester Conference Series on Public Policy*, Vol. 39, pages 195–214.

Taylor, J (ed) (1999), *Monetary policy rules*, The University of Chicago Press, Chicago and London.