# Yield curve terminology and concepts

Notes on the Bank of England UK yield curves

The Monetary and Financial Conditions Division of the Bank of England estimates yield curves for the United Kingdom on a daily basis. They are of two kinds. One set is based on yields on UK government bonds. It includes nominal and real yield curves and the implied inflation term structure for the UK. Another set is based on sterling overnight interest rates (SONIA) and on related overnight index swap rates (OIS). A third set- commercial bank liability curves- which were based on London interbank offered rates (LIBOR) were discontinued at the end of 2021 in line with the cessation and loss of representativeness of the LIBOR benchmarks.

The methodology used to construct the yield curves is described in the Bank of England Quarterly Bulletin article by Anderson and Sleath (1999), and a detailed technical description can be found in their Bank of England Working Paper no.126, 'New estimates of the UK real and nominal yield curves'. The methodology used for the nominal OIS curves is analogous to that of the government bond yield curve; more information on SONIA rates and OIS contracts can be found in the Quarterly Bulletin article by Joyce and Meldrum (2008). The way in which the methodology was adapted for the LIBOR-based commercial bank liability curves is described in the Quarterly Bulletin article by Brooke, Cooper and Scholtes (2000) – see especially the appendix.

The government liability nominal yield curves are derived from UK gilt prices and General Collateral (GC) repo rates. The real yield curves are derived from UK index-linked bond prices (section 1 below describes these instruments). By appealing to the Fisher relationship, the implied inflation term structure is calculated as the difference of instantaneous nominal forward rates and instantaneous real forward real rates (section 2 makes clear exactly what these terms mean). The nominal OIS yield curves are derived from the fixed interest rate component of spot OIS contracts.

The spreadsheets on the Bank’s website provide spot rates and instantaneous forward rates for each type of curve. For horizons out to five years, points on the curves are available at monthly intervals. The spreadsheets also show available points on the government and bank liability curves out to a horizon of 25 years at half-yearly intervals.

# Types of instrument

## Gilt-edged securities (gilts)

A conventional gilt is a guarantee by the Government to pay the holder of the gilt a fixed cash payment (coupon) every six months until the maturity date, at which point the holder receives the final coupon payment and the principal. An index-linked gilt is designed to protect of the value of the investment from erosion by inflation.[1] This is done by adjusting coupon and principal payments to take account of accrued inflation since the gilt's issue.

## General collateral sale and repurchase agreements (GC repo)

Gilt sale and repurchase ("gilt repo") transactions involve the temporary exchange of cash and gilts between two parties; they are a means of short-term borrowing using gilts as collateral. The lender of funds holds gilts as collateral, so is protected in the event of default by the borrower. General collateral (GC) repo rates refer to the rates for repurchase agreements in which any gilt may be used as collateral. Hence, GC repo rates should in principle be close to true risk-free rates. Repo contracts are actively traded for maturities out to one year; the rates prevailing on these contracts are very similar to the yields on comparable maturity conventional gilts.

## Overnight Index Swaps (OIS)

An overnight index swap (OIS) is a contract that involves the exchange at maturity of a payment linked to a predefined interest rate for one linked to the compounded overnight interest rate that has prevailed over the life of the contract. The relevant overnight rate for sterling contracts is the sterling overnight index average (SONIA), which is calculated by the Bank of England.

# Types of yield curve provided

## Nominal zero coupon yields (spot interest rates)

For the data presented on the Bank's website, the nominal government spot interest rate for n years refers to the interest rate applicable today ('spot') on an n year risk-free nominal loan. It is the rate at which an individual nominal cash flow on some future date is discounted to determine its present value. By definition it would be the yield to maturity of a nominal zero coupon bond[2] and can be considered as an average of single period rates to that maturity.[3] Conventional dated stocks with a significant amount in issue and having more than three months to maturity, and GC repo rates (at the short end) are used to estimate these

yields; index-linked stocks, irredeemable stocks, double dated stocks, stocks with embedded options, variable and floating stocks are all excluded from the Bank's nominal yield curve. Spot interest rates from the commercial bank liability curves are equivalent rates implicit in the yields on the LIBOR-related instruments used in the curves' construction. LIBOR rates are for uncollateralised lending within the interbank market. They are not risk free and contain a credit premium to reflect that. SONIA rates should be subject to limited credit risk as the contracts settle overnight. OIS contracts are also structured so that they involve minimal counterparty risk, such that OIS interest rates should contain very little compensation for credit risk.

## Nominal forward rates

Forward rates are the interest rates for future periods that are implicitly incorporated within today's spot interest rates for loans of different maturities. For example, suppose that the interest rate today for borrowing and lending money for six months is 6% per annum and that the rate for borrowing and lending for 12 months is 7%. Taken together, these two interest rates contain an implicit forward rate for borrowing for a six-month period starting in six months' time. To see this, consider a borrower who wants to lock in today's rate for borrowing £100 for that period. He can do so by borrowing £97.09[4] for a year at 7% and investing it at the (annualised) six-month rate of 6%. In six months' time he receives back this sum plus six months' interest at 6% (£2.91) which gives him the £100 of funds in six months' time that he wanted. After a year he has to pay back £97.09 plus a year of interest at 7% (£103.88). In other words, the borrower ensures that his interest cost for the £100 of funds he wants to borrow in six months' time is £3.88. He manages to lock in an annualised interest rate (the forward rate[5]) of 7.77% now for borrowing in the future.

In this example, we considered six-month forward rates. We can consider forward rates that rule for different periods, for example 1-year, or 3-month or two-week forward rates. In the limit, as the period of the loan considered tends to zero, we arrive at the instantaneous forward rate. Instantaneous forward rates are a stylised concept that corresponds to the notion of continuous compounding, and are commonly used measures in financial markets. Instantaneous forward rates are the building block of our estimated yield curves, from which other representations can be uniquely derived.[6]

## Real spot and forward rates

The return on a nominal bond can be decomposed into two components: a real rate of return and a compensation for the erosion of purchasing power arising from inflation. For conventional government nominal zero coupon bonds, such as those in the example above, the nominal return is certain (provided it is held to maturity) but the real return is not (because

inflation is uncertain). An index-linked zero coupon bond would have its value linked to movements in a suitable price index to prevent inflation eroding its purchasing power (so its 'real value' is protected). For such a zero coupon bond the real return would be certain if the bond were held to maturity. A real debt market provides information on the ex ante real interest rates faced by borrowers and lenders who want to avoid the effects of inflation. In practice, there are factors that mean index-linked gilts do not offer complete inflation protection, and the UK index-linked gilt market is not as liquid as that for conventional UK gilts. Nevertheless, this market allows us to calculate real spot and forward rates analogous to the nominal spot and forward rates described above.

### Implied inflation rates

We have seen that the index-linked gilt market allows us to obtain real interest rates and the conventional gilt market allows us to obtain nominal interest rates. These nominal rates embody the real interest rate plus a compensation for the erosion of the purchasing power of this investment by inflation. The Bank uses this decomposition (commonly known as the Fisher relationship) and the real and nominal yield curves to calculate the implied inflation rate factored in to nominal interest rates. This is often interpreted as a measure of inflation expectations, although some care is required in doing so.[7] As with nominal and real interest rates, we can think of 'spot' implied inflation rates (subject to the caveats in footnote 8) as the average rate of inflation expected to rule over a given period. Similarly forward implied inflation rates can be interpreted as the rate of inflation expected to rule over a given period which begins at some future date. In the limit, we can calculate instantaneous forward implied inflation rates just as with real and nominal rates.

## Data coverage

The nominal government yield curves are available on a daily basis from 2 January 1979, and the real yield curves and implied inflation term structure are available from 2 January 1985. The absence of data for a given day at a given maturity is due to one of the following reasons:

- There are no yield curve data for non-trading days, such as UK Bank Holidays.
- There are no data for maturities outside the range of covered by existing gilts. For example, for dates in the past where there was no bond longer than 20 years we do not provide a 20-year spot or forward rate.[8]
- In addition, we only provide data at maturities where we think the curve can be fitted so that it is stable and meaningful. Instability arises when small movements in bond prices lead to unrealistically large moves in the estimated yield curves, essentially because there

is not enough information from observed prices at a given maturity to allow us to fit that segment of the curve. This is usually a problem at short maturities where we require more information because we expect the short end of the yield curve to exhibit the greatest amount of structure. This is because expectations about the future path of interest rates are likely to be better informed at shorter maturities, and are more likely to respond to short term news.[9]

- In March 1997 the Bank started conducting daily money market operations in gilt repo. Since this date we have used GC repo data to estimate the short end of the nominal yield curve, and so the short end of the nominal curve is provided down to very short maturities after this date. No corresponding instrument is available to help model the short end of the real yield curve. Since implied inflation rates are calculated as the difference of the nominal and real curves, an absence of either real or nominal interest rate data at a given maturity implies an absence of corresponding implied inflation rate data at that maturity.

The commercial bank liability curve starts in November 1990 and is estimated to a maturity of 10 years. From July 1997 it is estimated to a maturity of 15 years and from January 1999 until the end of 2021 it is estimated to a maturity of at least 25 years. These maturities are determined by the data available at the time the curves were estimated.

# Acknowledgements & disclaimer

We are grateful to Bloomberg, the Gilt Edged Market Makers' Association, Reuters, Tradeweb and the UK Debt Management Office for providing access to underlying data used to estimate the yield curves.

Every effort has been made to ensure this information is correct, but we cannot in any way guarantee its accuracy and you use it at your own risk.

Comments and questions can be directed to ✉ **yieldcurve@bankofengland.co.uk**.

## Footnotes

1. In practice, various factors (such as lags in the publication of the price index) mean the inflation protection is not perfect.
2. That is, a bond that pays no coupons and only has a final principal repayment.
3. By contrast the yield to maturity on a coupon bond is the single rate of interest which, when used to discount all future coupon payments and the redemption payment, gives the current price of the bond. Because the same rate is used to discount payments at different points in the future, the yield to maturity is a less useful analytical tool than the spot interest rate.

4. This is the present value of £100 in six months' time \[100 \left ( \frac{1 }{1 + \frac{0.06}{2}} \right )\] The figures in this example are quoted to 2 decimal places, but full accuracy was retained in the calculation.
5. The implicit forward rate is given \[2\left ( \left ( \frac{1 + ^r0.12 }{1 + \frac{{r}0.6}{2}} \right ) - 1 \right )\] where $r_{0,12}$ is the one-year interest rate and $r_{0,6}$ is the six month interest rate.
6. With continuous compounding, an amount $A$ invested for $n$ years at rate $r$ grows at $Ae^{Rn}$ .
7. Illiquidity in the conventional and index-linked gilt markets could distort this measure, and in practice there will be an 'inflation risk premium' incorporated in the implied inflation rate.
8. It may also be the case that missing historical data means that we are unable to provide a portion of the curve.
9. For more details, see Anderson and Sleath (2001), **Bank of England Working Paper no. 126**.