New estimates of the UK term structure of interest rates

By John Sleath
Tel: 020 7601 3658
Email: john.sleath@bankofengland.co.uk

The Bank has recently (November 1999) switched to a new approach for estimating the term structure of interest rates from the prices of gilts. The new method is known as the Variable Roughness Penalty (VRP) model, and replaces the previously used Svensson and ITS (based on Svensson) models. This article briefly describes the new model and outlines the reason for its adoption in preference to the earlier models. More detailed information can be found in “New estimates of the UK real and nominal yield curves”, Bank of England Quarterly Bulletin, November 1999, and also in a forthcoming working paper, entitled “New estimates of the UK real and nominal yield curves” by Nicola Anderson and John Sleath.

1 The VRP model

The VRP model is a spline-based approach, that is the forward interest rate curve is fitted by a cubic spline. Splines are mathematical curves which are composed of many segments (each of which in this instance is a cubic polynomial), with constraints imposed to ensure that the overall curve is continuous and smooth. This contrasts with the parametric approach of the earlier Svensson model which specifies a single functional form to describe the entire curve. The ability of the individual segments of the spline curve to move to some degree independently of one another (subject to the continuity and smoothness constraints) gives rise to the superior performance of the VRP method.

The key requirements and properties of the VRP model are summarised in Table 1.

2 Comparison with former models

• Full details of the tests used to compare the VRP and Svensson (and other models) are provided in the references listed above. In summary:
  • The VRP estimates do not show the spurious volatility evident in the Svensson data.
  • The Svensson functional form forces the forward rate curve to asymptote at long maturities, and as a result it is unable to capture the (generally) downward slope evident from market data, and expected by theory. No such constraint is imposed on the VRP fitted curve, and it is able to capture the shape of the interest rate more reliably.
  • We are now able to incorporate additional data (GC repo rates) to substantially improve estimates of the short end of the curve. This was not possible with the Svensson method without distorting the fitted long end.
  • Because gilt prices are quoted as multiples of £0.01, the observed price may differ slightly from the ‘fundamental’ price, i.e. that which would be observed if prices were quoted continuously. Changes to bond prices of this order have, therefore no economic significance, and we require the derived interest rate curves to be largely unaffected by such movements. This criterion is satisfied by the VRP method, but not by the Svensson model.
The VRP model, furthermore, fits the data better, as measured by the out-of-sample goodness-of-fit. This is calculated on any given day by taking each gilt in turn, omitting it from the estimation process, determining the pricing error of the fit for that gilt and then averaging over all gilts used in the complete estimation. A good out-of-sample goodness-of-fit implies that the method is able to fit the data well, without introducing spurious structure.

3 Estimation of the real and inflation term structures

The estimation of the real term structure from the prices of index-linked gilts (IGs) is considerably more complex than deriving the nominal yield from conventional bond prices. This is mainly because IG coupon payments are indexed to the level of RPI prevailing eight months prior to when the cash flows occur; for the last eight months of its life, an IG therefore offers no inflation protection at all, and it trades as a purely nominal bond. As a result, IG prices in general reflect a mixture of both the real and nominal term structures.

Evans (1998)\(^1\) introduced a new framework for dealing with this problem. He derives a relationship between the nominal and real yields and the term structure of (incompletely) indexed bonds,\(^2\) allowing an interest rate curve to be fitted directly to IG prices. We have extended his work to account explicitly for the variation of the effective indexation lag for each IG’s constituent cash flows, and also to deal with the delay in publication of the retail price index.

The new model for the real term structure offers similar advantages to those discussed above in relation to the nominal rate estimates. In particular, the new method is better able to capture the shape of the long end of the real


\(^2\) The index-linked term structure is a mathematical construct that simply allows us to price IGs using the standard discounted present value formula. It is not in itself an interesting term structure, since it is a mixture of the real and nominal curves.
curve, which was previously forced to quickly asymptote because of the functional form used.

Nevertheless, a number of caveats must be placed on the interpretation of the new estimates of the real term structure. First, the sparsity of IG issues means that we are unable to estimate the very short end of the curve. Second, the relatively large spacing between IG redemption dates means the local slope of the yield curve is not as well determined as that of the nominal curve, and hence care must be taken when examining real forward-rate curves. These are fundamental restrictions arising from the structure of the index-linked market, and therefore affect all estimates of the real term structure, irrespective of the method used.

4 Conclusion

As part of the Bank’s continual process of review and improvement, we have switched to a new method for estimating the term structure of interest rates from the prices of coupon bonds. It uses a cubic smoothing spline to fit to the forward rate curve, and is better able to capture the shape of the term structure as observed by other methods (for example from Strips prices), as well as being more stable. All future editions of Monetary and Financial Statistics will present yield curve estimates derived using the new approach.