Research Note

Real-world Modelling: Forward Curves, Projected Rates, and Term Premia

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Forward curves implied by nominal bond yields have moved substantially over the past year. Such changes in the forward curve reflect fluctuations in market expectations of future interest rates & term premia[1]. The challenge for a real-world calibration is to decompose the initial forward curve into each of these components. In the past, we have used the extended 2 Factor Black-Karasinski model (E2FBK) with a constant market price of risk for long-horizon real-world projections. This has the result that the term premium in the initial forward curve is approximately constant from one projection date to the next: any changes to the level and shape of the yield curve are attributed entirely to changing expectations of future interest rates. There are few economic explanations for such large revisions to longer term interest expectations over a short period of time.

In an arbitrage free interest rate model, any variation in the shape and level of the forward curve across terms can be attributed to either expectations about future interest rates or risk premia

With the release of ESG 6.2.3, we have enhanced our preferred real world interest rate model such that the market price of risk varies over time (The Time Varying Term Premium extension–TVTP), and from end-September 2009 we have provided calibrations of this model. The model is calibrated to a plausible target path for average short rates, consistent with the following observations: 1) People do not make frequent changes to long term expectations. 2) Interest rates are mean reverting. 3) Short term nominal forward rates hold good informational content about future expectations while long term forward rates do not. 4) The mean reversion level of interest rates needs an appropriate economic justification.

The main implication of this calibration is that any differences in level and shape of longer term nominal forward rates are primarily attributed to term premia, whilst long term expectations remain largely unchanged.

When calibrating the TVTP model to such a target path we may also want to impose a constraint on the smoothness of risk premia that are expected to be earned on longer dated government bonds. Exhibit 1 illustrates the main difference between the two model projections (Constant Term Premium and Time-Varying Term Premium) for USD at end December 2008.

Using the former model you will see that the structure presented in the initial forward curve is passed-on to the expected level of interest, even at long horizons. In contrast, with the TVTP model, the nominal short rate has reverted to its long-term level around 15-20 years out in the future – the impact of the initial forward curve is 'forgotten'. From a model application point of view, this enhancement provides a way for users to improve stability of projected interest rate levels and – because of our models' economic structure – also projected nominal returns on risky assets. In many situations (eg, run-off capital calculations) this will lead to improved stability of end results, which in-turn often leads to greater acceptance and understanding: many stakeholders will find it hard to justify why expected rates 20 years hence look quite different from one projection to the next.

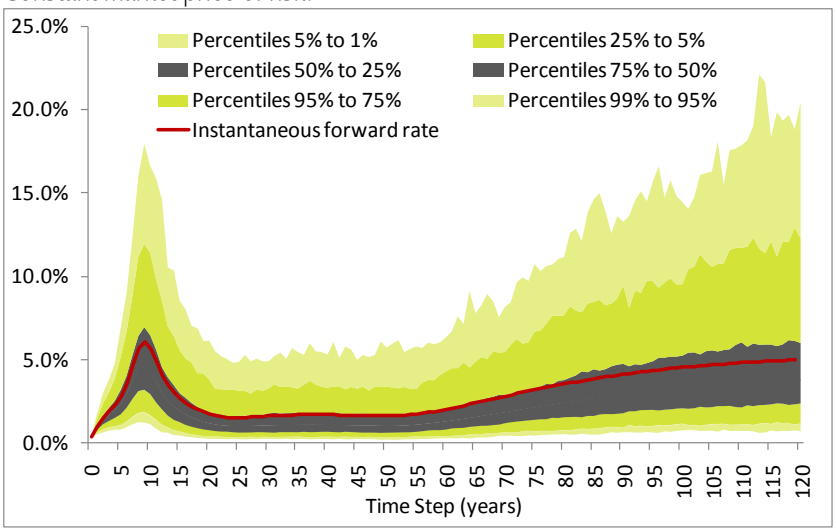
[1] *The technical 'convexity effect' will also have a small part to play.*

Exhibit 1

USD: Real – world short rate projection against initial instantaneous forward curve, End December 2008

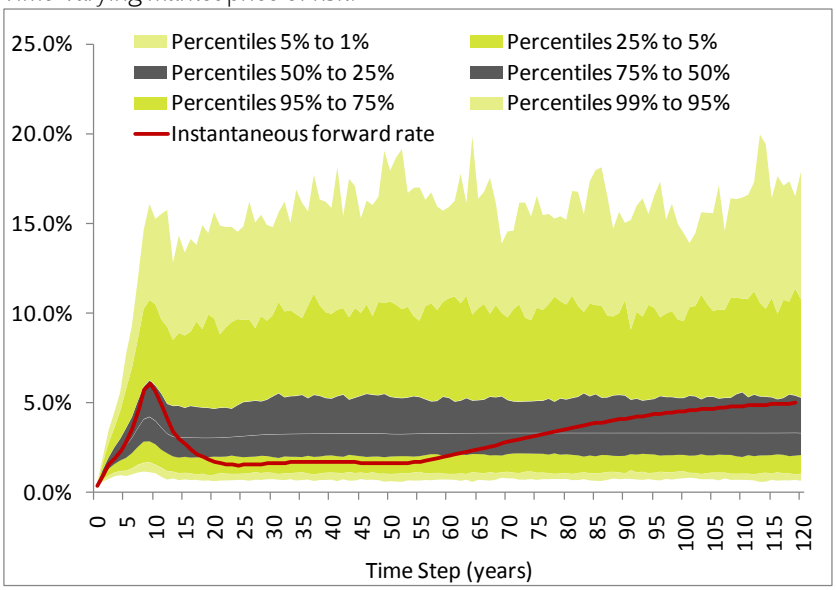
If you calibrate the no-arbitrage model with a constant market price of risk, there can be a significant variation in the level and shape of future interest rate expectations. This is one view of the real world.

Constant market price of risk:



If you use an interest rate model with a time-varying term premium, you can easily calibrate the model to a mean path of future interest rates that can be justified by economists. This is another, and our preferred, view of the real world

Time-varying market price of risk:



If you believe that a constant market price of risk log normal interest rate model is a better description of the real-world, then you need to subscribe to a view that the percentiles of future interest rates can depend materially on how far you are in the future and these percentiles can change quite materially from one calibration date to another. This is not due to the assumption of a constant market price of risk but, in part, is simply a consequence of a lognormal interest rate model. With a lognormal assumption, the volatility of interest rates is a function of the level of the short interest rate; volatility is low when interest rates are low and high when interest rates are high.

It is important to carefully consider your model choice for real-world interest rate modelling and to understand the implications of the model + calibration. We believe that the projection of the short rate based on the TVTP model calibration makes most economic sense.

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