

#### Box 4

### COMPUTING LONG-TERM INTEREST RATE ASSUMPTIONS FROM THE EURO AREA YIELD CURVE

The Eurosystem staff macroeconomic projections<sup>1</sup> are based on a set of technical assumptions about the future value of several variables, including long-term interest rates in the euro area, defined as ten-year government bond yields. This box describes the computation of the technical long-term interest rate assumptions in the context of the Eurosystem projections.

Since the June 2008 broad macroeconomic projections exercise, the long-term interest rate assumptions have been based on the euro area government bond yield curve statistics, published daily on the ECB's website.<sup>2</sup> Previously, the assumed path of ten-year government bond yields was calculated indirectly on the basis of an estimated term structure of swap interest rates corrected for most recent observations of the spread between euro area ten-year swap and government bond interest rates. Since the release of the euro area government bond yield curve statistics, the quality and availability of data on the nominal euro area government bond yield curve have improved greatly, which in turn has led to an improved consistency of the methodology behind the computation of technical long-term interest rate assumptions.

In the context of the Eurosystem staff macroeconomic projections, it is assumed that ten-year government bond yields evolve in accordance with prevailing market expectations. Market expectations, in turn, are equated with mid-quarter values of forward ten-year par government bond yields for each future calendar quarter of the projection horizon (the maximum forecast horizon is three years), as implied in the term structure of interest rates measured on the general cut-off date for all technical assumptions.<sup>3</sup> The assumptions for the first quarter of the forecast

1 For more details on the Eurosystem staff macroeconomic projections, see Section 6 of this Monthly Bulletin.

2 For more information on the euro area government bond yield curve data, see the article entitled "The new euro area yield curves" in the February 2008 issue of the Monthly Bulletin. Most recent data and background information can be accessed via <http://www.ecb.europa.eu/stats/money/yc/html/index.en.html>.

3 Equating market expectations for long-term interest rates with corresponding forward rates abstracts from the possible impact of maturity-specific term premia.

horizon (current quarter) are set equal to a time-weighted average of euro area average ten-year bond yields realised up to the cut-off date during this quarter and the forward par yield projected for the end of the quarter as implied in the term structure of the euro area yield curve on the cut-off date.

The projected long-term interest rate values for individual euro area countries are obtained by adding or subtracting prevailing differentials relative to the euro area yields. These differentials, which are assumed to be constant throughout the forecast horizon, are obtained as the average differentials for each euro area country observed during the two weeks prior to the cut-off date.

As mentioned above, forward par yields are used for long-term interest rate assumptions. The new euro area yield curve prepared by the ECB allows the calculation of par yields, which are conceptually closely related to yields to maturity. A par yield is defined as the yield to maturity on a hypothetical bond issued or traded at par (i.e. the current value of the bond is equal to the redemption value). For a given term structure of interest rates, the value of a hypothetical bond can always be brought to par by adjusting the coupon accordingly.

The advantage of using par yields is the endogenous determination of coupons. Instead of using an arbitrary coupon of a certain benchmark bond and assuming that this coupon remains constant over the entire projection horizon, forward par yields implicitly assume a path of coupons consistent with the yield curve. Moreover, the computations to derive forward par yields are relatively simple, transparent and easily replicable. Par yields derived from the ECB yield curve with all central government bonds rated from A minus to triple A (as opposed to only triple A-rated bonds) are computed, as they are quantitatively and conceptually closer to the historical series of average ten-year bond yields.<sup>4</sup>

From the new ECB yield curve, a path of forward par yields can be directly computed as:

$$R_t(h) = \frac{D_t(h) - D_t(h+10)}{\sum_{m=1}^{10} D_t(h+m)}$$

where  $h$  is equal to the difference between the middle of the calendar quarter for which the forward par yield needs to be calculated and the cut-off date of the projection, expressed in years.  $D_t$  is the discount factor, which is calculated from the zero coupon yield derived from the estimated yield curve parameters.<sup>5</sup>

4 Historical data on ten-year government bond yields for the euro area as a whole are computed on the basis of harmonised national government bond yields weighted by GDP (up to December 1998) and the nominal outstanding amounts of government bonds in the ten-year maturity band (from January 1999 onwards). The average difference between this series and the ten-year par yield from the all-bonds euro area yield curve amounts to only 4 basis points for the entire sample of available daily data (starting on 1 January 2007) and 3 basis points on 14 November 2008 (the cut-off date for the December 2008 Eurosystem staff macroeconomic projections).

5 A zero coupon yield for a given maturity  $m$  is calculated as follows:

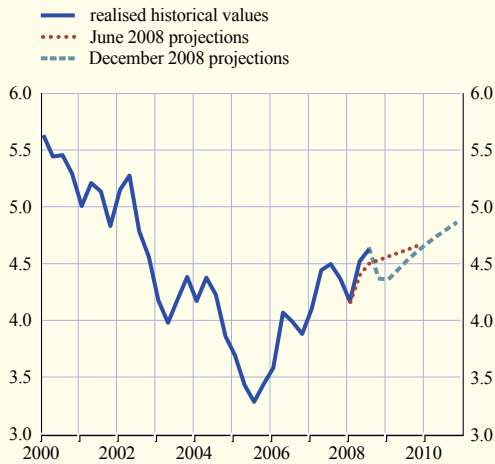
$$y(m) = \beta_0 + \beta_1 \left( \frac{1 - \exp\left(-\frac{m}{\tau_1}\right)}{\frac{m}{\tau_1}} \right) + \beta_2 \left( \frac{1 - \exp\left(-\frac{m}{\tau_1}\right) - \exp\left(-\frac{m}{\tau_2}\right)}{\frac{m}{\tau_1}} \right) + \beta_3 \left( \frac{1 - \exp\left(-\frac{m}{\tau_2}\right) - \exp\left(-\frac{m}{\tau_2}\right)}{\frac{m}{\tau_2}} \right)$$

where  $\beta_0, \beta_1, \beta_2, \beta_3, \tau_1, \tau_2$  are the estimated parameters of the euro area yield curve. The discount rate is given by:

$$D_t(m) = \exp\left(\frac{-y(m)}{100} m\right).$$

### Long-term interest rate assumptions in the Eurosystem staff macroeconomic projections

(percentages per annum; quarterly data)



Sources: EuroMTS, Reuters, ECB.

Note: The realised historical values up to the cut-off date represent the weighted average of harmonised yields to maturity of national government bonds in the euro area with maturities of about ten years. The weights are the nominal outstanding amounts of government bonds in the respective maturity band.

The chart shows the long-term interest rate assumptions underlying the Eurosystem staff macroeconomic projections of December 2008, which are described in Section 6 of this issue of the Monthly Bulletin.

According to data as at 14 November 2008 (the cut-off date for the December 2008 Eurosystem staff macroeconomic projections), long-term interest rates are assumed to increase slightly, from 4.2% on the cut-off date to an average of 4.5% in 2009 and 4.7% in 2010. Compared with the June 2008 Eurosystem staff macroeconomic projections, the assumptions for long-term interest rates in 2009 have been revised downwards by about 15 basis points, on average. These relatively minor revisions occurred despite strong downward revisions to market participants' short to medium-term growth and inflation expectations between June and December 2008. These, in turn, seem to some extent to reflect increases in the credit risk component embedded in long-term

government bond yields in euro area countries in the context of the potential fiscal risks arising from government interventions to address the intensified financial crisis.<sup>6</sup>

To conclude, the use of forward par yields derived from the ECB yield curve provides a consistent and transparent way of computing long-term interest rate assumptions for the Eurosystem staff macroeconomic projections.

<sup>6</sup> See the box entitled "Recent widening in euro area sovereign bond yield spreads" in the November 2008 issue of the Monthly Bulletin.