Annex
to the Resolution No. 26/1,
July 25, 2024 of the Board
of the Central Bank of Uzbekistan

The methodology for estimating and publishing the yield curve of government securities

The following is the methodology for estimating and publishing the yield curve of government securities.

The yield curve is a graphical representation of the interest rates on debt in national currency for a range of maturities.

Also, the estimation and publication of the yield curve of government securities provides insights into the valuation of financial instruments and borrowing costs as well as the assessment of interest rate and credit risks.

I. Basic concepts

1. In this methodology, the following basic concepts are used:

Government securities – government treasury bonds issued on behalf of the Republic of Uzbekistan, as well as notes of the Central Bank of the Republic of Uzbekistan;

Government securities yield curve – a graphical representation of the yield curve calculated in accordance with this methodology;

Securities with benchmark maturities – government securities that are issued at a specified interval and whose parameters are used to form a yield curve;

The money market overnight rate – an indicator of an interest rate, calculated as the weighted average interest rate on transactions such as interbank REPO and deposit operations, performed in national currency on an overnight basis between banks in secured and unsecured interbank money markets, respectively;

The REPO auction *(1-week term)* – central bank operations to provide (absorb) liquidity through the purchase (sale) of securities from (to) banks, with an obligation for their subsequent sale (purchase) after a specified period at a price determined through the auction.

II. Calculating the yield curve

2. Money market overnight rate, deposit and REPO auctions interest rates as well as yields on government securities (the yields on both primary and secondary markets) are used as the main instruments for estimating the yield curve of government securities.

In order to conform yields of these instruments to one another, the interest rates of the instruments are converted into zero coupon continuous compounding and their prices (dirty) are calculated, which are then used to estimate the yield curve of government securities.

3. When calculating the yield curve, government securities are selected according to the following criteria:

a) auction results of securities, which are not older than 120 days are used in estimation;

b) in cases when the most recent auction results of government securities with maturities up to 10 years are more than 120 calendar days, one of the following methods is used:

- the security with the longest benchmark maturity that is not older than 120 days is selected. For example, 10-year bond is excluded from yield curve estimation and 5-year bond is assigned as the longest maturity security, or

- 10-year bond is replaced with a 10-year synthetic bond that is calculated by adding term premium *(estimated from 2-year historical average data)* to the yield of 5-year bond.

Yields on long-term instrument can also be approximated using the long-term forecast of the weighted average interest rate of the interbank money market, calculated on the basis of the Quarterly Projection Model (QPM), the standard error of this forecast, as well as the term premium.

In the construction of the yield curve, which fully reflects the expectations of market participants, it is important that government securities are issued on a regular basis according to a predetermined schedule.

4. The following methodology is used for the estimation of the yield curve of government securities:

a) **instantaneous forward rate** – an unobservable continuous function of instruments' yields in national currency with the following relationship:

$$F(\tau) = \frac{-y'(\tau)}{y(\tau)}$$

where

$\boldsymbol{\tau}$ – maturities of instruments in national currency;

$\boldsymbol{y(\tau)}$ – the yield of zero-coupon instruments in national currency with $\boldsymbol{\tau}$ maturities.

b) **zero-coupon yield** – yield corresponding to zero-coupon instruments in national currency with an expiration date of τ. There is the following relationship between zero-coupon yield $y(\tau)$ and instantaneous forward rate:

$$y(\tau) = \frac{1}{\tau}\int_0^{\tau} F(u)du$$

c) **discount rate** – the cumulative representation of discount factors in each maturity of the yield curve. For each maturity τ, the relationship between $D(\tau)$ and $y(\tau)$ as follows:

$$D(\tau) = \exp\left(-\tau^{*} y(\tau)\right)$$

$D(\tau)$ – the discount rate of instruments in national currency with maturity τ.

d) **Yields of instruments in national currency at par** – represents the yields of instruments in national currency at nominal values. The par yield curve has the following relationship with $D(\tau)$:

$$Par(\tau) = \frac{1 - D(\tau)}{\int_0^{\tau} D(u)du}$$

5. The Nelson-Siegel parametric model is used for constructing the yield curve of government securities:

a) instantaneous forward rate curve is given by the following formula:

$$F_{\tau} = \beta_0 + \beta_1 \exp\left(-\frac{\tau}{\lambda}\right) + \beta_2 \frac{\tau}{\lambda} \exp\left(-\frac{\tau}{\lambda}\right)$$

b) zero coupon yield curve is then estimated by integrating over the instantaneous forward rate curve:

$$F_\tau = \beta_0 + \beta_1 \exp\left(-\frac{\tau}{\lambda}\right) + \beta_2 \frac{\tau}{\lambda} \exp\left(-\frac{\tau}{\lambda}\right)$$

where

$\boldsymbol{\beta_0}$– the long-run levels of interest rates

$\boldsymbol{\beta_1}$– the short-run component (slope parameter)

$\boldsymbol{\beta_2}$– the medium-run component (curvature parameter)

$\boldsymbol{\lambda}$ – decay factor

c) The dynamic zero coupon yield curve (The dynamic Nelson-Siegel model) takes the following form (Diebold and Lee, 2006):

$$y_{t,\tau} = \beta_{0,t} + \beta_{1,t} \frac{1 - e^{-\lambda\tau}}{\lambda\tau} + \beta_{2,t} \left(\frac{1 - e^{-\lambda\tau}}{\lambda\tau} - e^{-\lambda\tau} \right)$$

III. The publication of yield curve

6. The yield curve of government securities is estimated based on the results of the most recent transactions on the money market overnight rate, deposit and REPO auctions interest rates and government securities yields (the yields on both primary and secondary markets) every Tuesday until 18:00.

7. The yield curve of government securities is then published every Wednesday until 10:00 on the official website and social media pages of the Central Bank.

Moreover, parameters for estimating the yield curve of government securities are also posted on the official website of the Central Bank for enhancing the transparency and replicability of the estimation.

8. In cases where the estimation and publication of the yield curve of government securities falls on weekends or holidays, these processes are carried out in the next working day in the sequence provided by paragraphs 6-7 of this methodology.

9. The yield curve of government securities is estimated and published by the Department of Monetary Operations.