TREASURY BILLS AND THEIR VALUATION

doc. Ing. Božena Hrvoľová, CSc.
Faculty of Business Management, University of Economics in Bratislava

Treasury bills are discounted short-term debt securities with maturities of up to one year. As a rule, bills are issued by governments and central banks. For a government, the issue of Treasury bills is a way to cover short-term state budget deficits; for the central bank it is a way to control banking sector liquidity. Moreover, bills represent an important instrument of governmental fiscal policy and the central bank's monetary policy. That is why the size of bill issues also depends on where an economy stands in the economic cycle. For instance, at a time of recession, a government will try, in accord with the central bank's monetary policy, to stimulate economic growth by Treasury bill issues designed to finance various development programs.

Bills are one of the most important money market securities. Typical features are virtually no default risk and high liquidity. The bill market is one of the largest and most developed. Short maturities imply low interest rate losses due to interest rate volatility. Another virtue of these short-term instruments is that they enable both the holder and the debtor to respond promptly to changes in the pace of inflation and interest rates.

On the other hand, however, despite the above merits, bills offer a relatively low return. Treasury bill rates are used as a benchmark for other money market rates.

From the point of view of a financial manager as investor, this type of instrument also has the advantage of allowing him, for example, to reduce his portfolio risk, to use bills in repo transactions or as collateral for other forms of loans, such as the Lombard loan.

In the United States, Treasury bills were first issued by the Treasury Department in 1929 to bridge frequent short-term cash lows in the state budget.

There are several types of Treasury bills available in this advanced economy:

• regular Treasury bill series issued weekly (three-month and six-month Treasury bills) or monthly (one-year Treasury bills) at competitive auctions. The Treasury has been raising most of its funds by six-month bills issues;

• irregular Treasury bills issues are mounted only if the Treasury faces any special cash needs. This category includes coupon bills and cash management bills. Coupon Treasury bills sell as a bundle of Treasury bills requiring the investor to pay for the entire series including different bill maturities. Investors who succeed in purchasing such Treasury bills must accept them at the offered price during several consecutive weeks. Cash management bills are reopenings of Treasury bill issues sold in previous weeks. A Treasury bill issue is reopened if the Treasury unexpec-

tedly finds itself in need of extra cash. Treasury bills are generally sold at auctions. That way, the prices and yields are set by the market, rather than the Treasury Department.

In the United States, the Treasury Department considers both competitive and non-competitive bids for Treasury bills. Competitive tenders are usually submitted by large investors – such as commercial banks or stock dealers, who buy Treasury bills worth several million dollars at a time. Non-competitive bids are placed by small investors (less than US$ 1 million), who accept average prices. Most of the time, the Treasury will satisfy all non-competitive bids.

The Czech Republic floated its first Treasury bill issue in 1992. Besides the government and the central bank, bills in the Czech Republic are also issued by the National Property Fund and Komerční banka.

In Slovakia, bills have been issued since the country became independent in 1993. They are issued in book-entry form in denominations of Sk 1 million. As far as the issuer is concerned, there are two types of bills on the Slovak money market – Treasury bills and NBS bills.

Treasury bills are issued by the Slovak Ministry of Finance to bridge short-term state budget deficits, with the NBS acting as the sales agent. The primary sale is usually arranged in the form of an auction – American or Dutch style.

NBS bills are issued by the central bank as one of the tools for managing banking sector liquidity.

In Slovakia, however, access to this type of security is limited to a small number of market players. By the NBS operating rules, bill market participants are broken down into three groups:

• direct participants holding a bill trading license, such as commercial banks, insurance companies and stock brokers,

• indirect participants allowed to trade in bills only through direct participants, such as domestic and foreign corporations registered by the NBS,

• special-status entities – the NBS and the Slovak Ministry of Finance. The NBS and the Ministry of Finance owe their special status to the role they play in bill issuing and trading. The NBS operates in the bills market in its own name, as well as on behalf of the Ministry of Finance as a fiscal state budget agent. The Ministry of Finance may conduct trades in the bill market through the NBS.

Bills are sold at a discount off their nominal value. The nominal value is payable to the final holder upon redemption on maturity. The yield in this type of security is equal

to the difference between the purchase price and the nominal value.

A financial manager, as an investor, will not only need to consider the benefits of the actual form of the primary sale of bills (American or Dutch auction), but also to look at price, return and taxation.

Bill valuation methods

The method applied to determine the value of bills depends on whether the bill price is based on the rate of discount (d) or the rate of return (r). The discount rate is always lower than the return, as it is based on a higher value – the nominal value, rather than the sale price used to derive the rate of return.

The discount rate and the rate of return can be computed using equations [1] and [2]:

$$d = \frac{D}{NV} \cdot \frac{360}{n_{sm}} \quad [1] \qquad r \frac{D}{P} \cdot \frac{360}{n_{sm}} \quad [2]$$

where:
D = discount,
NV = nominal value,
P = purchase price,
n_{sm} = number of days from sale to maturity,
$360/n_{sm}$ = a factor used to annualise the discount rate and the rate of return.

The discount rate serves as the basis for bill-quotation in the United States and Great Britain, for instance. However, the U.S. and Great Britain apply different standards to calculate the bill discount. While the U.S. uses the ACT/360 standard, Great Britain uses the ACT/365 standard, or 366 in a leap year.

In Slovakia and the Czech Republic, bill price is based on the rate of return, which in turn is determined using the ACT/360 standard.

Where bill quotes refer to the discount rate, the discount and the purchase price (primary market issue price or secondary market sale price) will be calculated as follows:

Discount = NV . d . (n_{sm}/360)   [3]
Price (P) = NV − discount = NV . (1 − d . n_{sm}/360) [4]

Example: Calculate the discount and the issue price of Treasury bills if the nominal value is US$ 1 million, the discount rate is 9%, and maturity is 28 days.
Discount = 1,000,000 . 0.09 . 28/360 = US$ 6,999.90
P = 1,000,000 − 6,999.90 = US$ 993,000.10
P = 1,000,000 . (1 − 0.09 . 28/360) = US$ 993,000.10

In addition to the absolute amount of return in the form of a discount, an investor will naturally want to know the rate of return on his investment, i.e. the ratio of the discount to the purchasing price, i.e. the product of equation [2] which may be modified as follows:

$$r = \frac{D}{P} \cdot \frac{360}{n_{sm}} = \frac{d}{1 - d . (n_{sm}/360)} \qquad [5]$$

Example: Calculate the rate of return on bills, assuming the data used in the previous example.

$$r = \frac{6\,999.90}{993\,000.10} \cdot \frac{360}{28} =$$

$$= \frac{0.09}{1 - 0.09(28/360)} = 0.090622, \text{ i.e. } 9.06 \%$$

As the examples indicate, the rate of return (r) on bills is higher than the discount rate (d), i.e. r > d. This is quite obvious, since (as we have noted above), the discount is based on the price, rather than the nominal value.

Equation [5] may be used to derive the discount assuming a known rate of return:

$$r = \frac{d}{1 - d . (n_{sm}/360)} \rightarrow \frac{r}{1 + r . (n_{sm}/360)} \qquad [6]$$

Example: Assuming that Treasury bills have been issued at a rate of return of 8.5% for 60 days, the appropriate discount rate will be derived as follows:

$$d = \frac{0.085}{1 + 0.085 . (60/360)} = 0.0838126, \text{ i.e. } 8.38 \%.$$

In professional literature (1), we may find an equation which allows us to translate the discount rate of Treasury bills into a return on investment (an equivalent of the coupon yield) used to compare the yields on various debt securities.

The investment return (IR) can be determined according to the following formula:

$$IR = \frac{365 . d}{360 - (d . n_{sm})} \qquad [7]$$

Example: Calculate the investment return on bills issued at a 9% discount for 28 days.

$$IR = \frac{365 . 0.09}{360 - (0.09 . 28)} = 0.09189325, \text{ i.e. } 9.19 \%$$

In previous equations, we assumed that an investor purchased bills quoted on the basis of the discount rate in a primary or secondary market and would hold them to maturity.

However, if an investor buys bills after the primary market issue date and sells them before maturity, he will want to know the rate of return for the holding period – holding return (r_h). This figure may be obtained by the following equation:

$$rh = \left[\frac{(1 - ds . n_{sm}/360)}{(1 - dp . n_{pm}/360)} - 1 \right] \cdot \frac{360}{n_{pm} - n_{sm}}, \qquad [8]$$

where:
dp =   bill discount rate on purchase date,
ds =   bill discount rate on sell date,
n_{pm} = number of days from purchase to maturity,
n_{sm} = number of days from sale to maturity.

Example: Determine the rate of return for an 81-day holding period if an investor purchased the bills 10 days after issue and sells them at 74 days to maturity. The discount rate is a constant 10%.

$$r_h = \left[\frac{(1 - 0.10 \cdot 74/360)}{(1 - 0.10 \cdot 81/360)} \right] - 1 \cdot \frac{360}{81 - 74} =$$

$$= 0.0918, \text{ i.e. } 9.18\%$$

If the quoted bill price is based on the rate of return (r), the purchase price (both in the primary and secondary markets) may be determined according to the accepted for zero-coupon debt securities:

$$P = \frac{NV}{(1 + r \cdot n_{sm}/360)} \qquad [9]$$

As we mentioned above, in Slovakia the quoted bill price is based on the rate of return. In our bill-market, the purchase price is calculated as:

$$\text{Purchase price} = \frac{NV \cdot 360}{(DTM \cdot US) + 360} \qquad [10]$$

where:
DTM = days to maturity
NV =   nominal value
US =   rate of return required by the buyer.

If we translate equation [10] into the symbols used in this paper, we can see that, if both the numerator and denominator are divided by 360, the result is equation [9]:

$$P = \frac{NV \cdot 360 \qquad / 360}{(n_{sm} \cdot r) + 360 \quad / 360} \quad \Rightarrow \quad \frac{NV}{(1 + r \cdot n_{sm}/360)}$$

Example: Let us assume that bills worth Sk 1 million in nominal value are issued for 273 days at a rate of return of 7.78%. What we want to know is a) the purchasing price, b) the discount, c) the corresponding discount rate, and d) the investment discount.

a) $P = \dfrac{1\,000\,000}{1 + 0.0778 \cdot (273/360)} = 944\,289\ Sk$ *or* $\dfrac{1\,000\,000 \cdot 360}{(273 \cdot 0.0778) + 360} = Sk\ 944\,289$

b) Discount = NV – P = 1 000 000 – 944 289 = 55 711 or
   Discount = P · r · (n_{sm}/360) = 944 289 · 0.0778 · (273/360) = 55 711

c) $d = \dfrac{D}{NV} \cdot \dfrac{360}{n_{sm}} = \dfrac{55\,711}{1\,000\,000} \cdot \dfrac{360}{273} = 0.0735$, *i.e. 7.35% or*

   $d = \dfrac{r}{1 + r \cdot n_{sm}/360} = \dfrac{0.0778}{1 + 0.0778 \cdot 273/360} = 0.0735$, *i.e. 7.35% .*

d) $IR = \dfrac{365 \cdot d}{360 - (d \cdot n_{sm})} = \dfrac{365 \cdot 0.0735}{360 - (0.0735 \cdot 273)} = 0.0789$, *i.e.. 7.89%*

The total return for an investor is also affected by taxation. In many countries, Treasury bills are tax-free. This also used to be the case in Slovakia. At present, however, income on Treasury bills is subject to a 15% tax. Income on Treasury bills is defined as the difference between their nominal value (Sk 1 million) and the issue price. There is one particular thing about taxing Treasury bill yields in Slovakia, namely that the date of taxation is the date of issue, which means that the initial Treasury bill holder, i.e. the one who buys them on issue date, is deemed to be the taxpayer.

Example: Let us say we want to know the yield of the initial holder of Treasury bills, assuming the values defined in the previous example and a 15% tax on Treasury bills yield.

Discount = NV – P = 1 000 000 – 944 289 = 55 711 i.e. the tax base
15% tax = 55 711 · 0.15 = 8 356.65
Net yield = 55 711 – 8 356.65 = Sk 47 354.35

Rate of net return to the investor $= \dfrac{47\,354.35}{944\,289 + 8\,356.65} \cdot \dfrac{360}{273} =$

$$= 0.0655, \text{ i.e. } 6.5\%.$$

This particular feature of the tax system in Slovakia, of course, makes secondary market trading more complicated, as it requires the calculation of a pro-rata portion of the tax for different bill holding periods.

References:
1. Rose, P. S.: Money and Capital Markets, Prague, Victoria Publishing 1994, p. 477.
2. Blake, D.: Financial Markets Analysis, Prague, Grada Publishing, 1995.
3. Brealey, R.A. – Myers, S. C.: Corporate Finance Theory and Practice, Prague, Victoria Publishing 1994.
4. Chovancová, B.: Treasury Bills as a Short-Term State Budget Financing Instrument, published in the Czech Economy at the Turn of the Millennium, Compiled Papers of the International Scientists Conference, Volume I, Brno 2001.
5. Mishkin, T.: Money, Banking and Financial Market Economy, Finance and Credit 2/1992.
6. Petrjánošová, B.: Business and Banks, Bratislava, FITR 1994.
7. Polidar, V.: Managing Banks and Banking Transactions, Prague, Economia 1991.
8. Income Tax Act No. 285/1992 Zb. as amended.