CONVERTING COMMONLY USED INTEREST RATE QUOTATIONS TO EFFECTIVE ANNUAL RETURNS*

I. Treasury bills, commercial paper, finance paper, bankers' acceptances, and agency discount notes

A. quoted (discount) rate: $d = \left(\frac{100 - P}{100}\right) \frac{360}{M}$

B. effective rate:[1/] $R_d = \left(1 + \frac{dxM}{360 - dxM}\right)^{\frac{365}{M}} - 1$

C. coupon equivalent rate:[1/] (Treasury bills ≤ 6 months) $c = \left(\frac{dxM}{360 - dxM}\right) \frac{365}{M}$

effective rate: $R_c = \left(1 + \frac{M}{365} c\right)^{\frac{365}{M}} - 1$

coupon equivalent rate:[2/] (Treasury bills > 6 months) $c = \dfrac{-\frac{1}{2}\left(1 + \frac{m}{n}\right) + \left[\frac{1}{4}\left(1 + \frac{m}{n}\right)^2 + \frac{m}{n}\left(\frac{dxM}{360 - dxM}\right)\right]^{\frac{1}{2}}}{\frac{m}{2n}}$

effective rate: $R_c = \left[\left(1 + \frac{m}{n}\frac{c}{2}\right)\left(1 + \frac{c}{2}\right)\right]^{\frac{365}{M}} - 1$

II. Federal funds, RP's, bank loans, CD's (not exceeding one year), and municipal notes

quoted rate: $e = \left(\frac{F + I - P}{P}\right) \frac{360}{N}$

effective rate: $R_e = \left(1 + \frac{N}{360} e\right)^{\frac{365}{M}} - 1$

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* Notation follows formulas.

1/ Note: $\frac{100 - P}{P} = \frac{dxM}{360 - dxM}$.

2/ With more than six months to maturity, the annualized coupon equivalent rate, c, is solved from the following equation:

$\left[1 + \left(\frac{m}{n}\right)\left(\frac{c}{2}\right)\right]\left(1 + \frac{c}{2}\right) = \frac{100}{p}$. Replacing $\frac{100}{p}$ with $1 + \frac{dxM}{360 - dxM}$, c can be solved in terms of d. The quadratic formula that solves for c, in terms of d, is that given here.

III. Federal Reserve Discount Rate

quoted rate: $D = \frac{I}{P}\frac{365}{M}$

effective rate: $R_D = (1 + \frac{M}{365} D)^{\frac{365}{M}} - 1$

IV. Treasury notes and bonds, corporate, municipal, and agency bonds

A. Not more than six months to maturity[1/]

quoted rate: $a = (\frac{\frac{C}{2} + 100 - P - A}{P + A}) \frac{Q}{N}$

effective rate: $R_a = (1 + \frac{N}{Q} a)^{\frac{365}{M}} - 1$

B. More than six months to maturity

quoted rate (b): $(P + A)(1 + \frac{m}{n}\frac{b}{2}) = \frac{C}{2}\frac{m}{n} + \frac{C}{2} \sum_{j=1}^{J} \frac{1}{(1 + \frac{b}{2})^j} + \frac{100}{(1 + \frac{b}{2})^J}$

effective rate:[2/] $R_b = [(1 + \frac{m}{n}\frac{b}{2})(1 + \frac{b}{2})^J]^{\frac{365}{M}} - 1$

C. More than six months and an integer number of semi-annual coupon periods (or years) to maturity

quoted rate (b): $P = \frac{C}{2} \sum_{j=1}^{J} \frac{1}{(1 + \frac{b}{2})^j} + \frac{100}{(1 + \frac{b}{2})^J}$

effective rate: $R_b = (1 + \frac{b}{2})^2 - 1$

1/ Also includes 9-month bonds issued by the Farm Credit Banks.

2/ This is derived by taking the implied total return to maturity of a one dollar investment, $(1 + \frac{m}{n}\frac{b}{2})(1 + \frac{b}{2})^J$, and solving for R_b, setting it equal to $(1 + R_b)^{365/M}$.

V. Mortgage Loans (with monthly interest and amortization schedule)

quoted rate (c): $$L = k\sum_{t=1}^{Z} \frac{1}{(1 + \frac{c}{12})^t}$$

$$\text{with } k = \frac{c}{12}\left(L - \sum_{i=0}^{t-1} L_i\right) + L_t;\ L_0 = 0;\ L = \sum_{t=1}^{Z} L_t$$

effective rate: $$R_c = (1 + \frac{c}{12})^{12} - 1$$

Notation

A - Accrued interest.

C - Annual coupon (C/2 paid semi-annually).

F - Face value or principle.

I - Interest paid at maturity.

J - Number of full coupon periods remaining until maturity.

M - Actual number of days to maturity.

N - Actual number of days to maturity for all issues except corporate and agency bonds and municipal notes and bonds.

- Number of full months until maturity x 30 plus odd days in any partial months for corporate and agency bonds and municipal notes and bonds (approximate).

Q - 365 days for Treasury notes and bonds.

- 360 days for other issues.

m - Number of days left in current coupon period for Treasury notes and bonds.

- M - 182.5 for coupon equivalent formulas for bills greater than six months to maturity.

- Number of months left in current coupon period x 30 plus odd days in any remaining months of current coupon period for other issues (approximate).

n - 182.5 days in current coupon period for Treasury bills, notes and bonds.

- 180 days for other coupon issues.

P - Market price of security or initial amount of loan.