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: \[ d = \frac{100 - P}{100} \left( \frac{360}{365} \right) \frac{360}{M} \]

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

C. coupon equivalent rate: \[ c = \left( \frac{dx M}{360 - dx M} \right) \frac{365}{M} \]
(Treasury bills < 6 months)

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

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

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

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

* Notation follows formulas.

1/ Note: \[ \frac{100 - P}{P} = \frac{d x M}{360 - d x M} \]

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

\[ \left[ 1 + \left( \frac{C}{n} \right) \left( \frac{C}{2} \right) \right] \left( 1 + \frac{C}{2} \right) = \frac{100}{P} \]. Replacing \( \frac{100}{P} \) with \( 1 + \frac{d x M}{360 - d x M} \), \( c \) 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

quoted rate: \( a = \frac{n}{P + A} \frac{Q}{N} \)

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

B. More than six months to maturity

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

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

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

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

effective rate: \( R_b = \left( 1 + \frac{b_j}{2} \right)^2 - 1 \)

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\( 1/ \) 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, \((1 + \frac{m b}{n 2})(1 + \frac{b_j}{2})^J\), setting it equal to \((1 + R_b)^{365/M}\), and solving for \( R_b \).
V. Mortgage Loans (with monthly interest and amortization schedule)

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

with \( k = \frac{c}{12} \sum_{t=0}^{t-1} (L_t - \sum_{t=1}^{Z} L_t) + L_t \); \( L_0 = 0; L = \sum_{t=1}^{Z} L_t \)

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

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,