Zero Coupon Bonds

Bonds are fixed-income securities that allow governments, companies and other types of issuers to borrow money from investors.

Bonds Markets

A debt market is where investors and traders buy and sell debt securities (bonds) that are issued by corporations or governments.

Example: New York Stock Exchange https://www.nyse.com/products/bonds (https://www.nyse.com/products/bonds)

Bond's features include:

the issuer, maturity, par value, coupon rate, frequency and the currency denomination.

- The issuer of the bond (the borrower)
- Fixed maturity date (years)
- Par value or face value or principal of a bond is the amount that the issuer agrees to repay the bondholders on the maturity date (usually 100 or 1000)
- required rate of return

YTM: Yield Measures - there are many ways to measure the rate of return on a bond investment.

- Coupon rate (%) of a bond is the interest rate the bond issuer agrees to pay each year until maturity (the coupon = annual amount of interest payments made)

All bonds make periodic coupon payments, except zero-coupon bonds.

Plain vanilla bonds are conventional bonds that pay a fixed rate of interest.

Zero-coupons bond pay the bondholders no interest payments. The interest earned on a zero-coupon bond is implied and equal to the difference between the par value and the purchase price.

Zero-coupon bonds trade on the major exchanges:

- They often trade at deep discount that render a profits at maturity when the bonds are redeemed for their full face value.
- Zero-coupon bonds (e.g. T bills) provide investors with a steady source of regular income
- Since the value of zero coupon bonds is entirely based on the current price compared to face value, their prices rise/fall faster when interest rates fall/rise. That makes zero-coupon bonds particularly useful to hedging stock portfolios.

Notation:

M = Maturity value or face value of the bond

r = required rate of interest

n = number of years to maturity

The price of a zero coupon bond can be calculated as:

$$Price = \frac{M}{(1+r)^n}$$

Zero-Coupon Bond Yield Formula

$$YTM = \left(\frac{M}{Price}\right)^1/n - 1$$

Defining Zero-Coupon Bond Class:

In [4]:
```python
%%writefile b0.py

import math

class ZeroBond:
    def __init__(self, n, M):
        self.n = n
        self.M = M

    def Price(self, r): #price
        return self.M/math.pow(1+r,self.n)

    def YTM(self, Price): #Yield To Maturity
        return math.pow(self.M/Price, 1/self.n) - 1
```

Overwriting b0.py

In [6]:
```python
import b0
```

Example 1:

Suppose an investor wants to make a 7% return on a zero-coupon bond with $30,000 par value, that's due to mature in 3 years. The investor will be willing to pay the following price:

In [7]:
```python
price = b0.ZeroBond(3,30000).Price(0.07)
price
```

Out[7]: 24488.936306725558

If the debtor accepts this offer, the bond will be sold to the investor at the price = = 81.62% of the face value:

In [8]:
```python
price/30000 *100
```

Out[8]: 81.62978768908519

Upon maturity, the investor gains:

In [8]: ▶| `30000 - price`

Out[8]: 5511.063693274442

which translates to 6% interest/year.

Example 2:

Suppose a $1,000 zero-coupon bond that has 2 years until maturity.

The bond is currently valued at $900, the price at which it could be purchased today.

In [16]: ▶|
```
ytm = b0.ZeroBond(2,1000).YTM(900)
ytm
```

Out[16]: 0.05409255338945984

When rounded and listed we get a yield of 5.4%.