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Homework 2

(20 points)

1. Design Bond class: a bond is a security that makes fixed payments on specific dates, based on the expiration date, frequency of payments, and coupon rate. Header File should include:
   - Private elements for expiration date, frequency of payments and coupon rate.
   - Add the #ifndef/#define/#endif statements to avoid multiple inclusion.
   - Default constructor initializing all private elements to zero, Destructor, Copy Constructor, and another constructor that initializes a bond using expiration date, frequency of payments, and coupon rate.
   - A *ToString()* function that returns a string description of the bond. Use the *std::string* class as return type. For example: "*Bond (01/01/2020,0.5,0.07)*" could be the return of a bond with expiration date on *01/01/2020*, a payment every 6 months, and 7% coupon.

Bond
Expiration date (string) Frequency (double) Coupon rate (double)
Default Constructor Destructor Copy Constructor Constructor (Time, Freq, Coup) ToString()

   Implement the class in the main file, creating a default bond and printing its information in the command line. Then create a new semi-annually compounded bond with 7% coupon rate and expiring on November 19th, 2035, and print its characteristics using the ToString() function.

2. Design a Bond Pricing Function for your Bond Class.
   When a bond is issued the price is 100, but after that, the price fluctuates according to the interest rate.

The price of a bond is defined as the present value of the cashflows:

$$Price = \sum_{i=1}^{n} PV(CF_i) = \sum_{i=1}^{n} CF_i * DF_i$$

where

$$CF_i = \begin{cases} coupon, & not\ expiration\ date \\ 100 + coupon, & expiration\ date \end{cases}$$

$$DF_i\ (Discount\ Factor\ at\ i) = e^{-i*Ti}$$

$$Coupon = 100 * \frac{Coupon\ rate}{Number\ of\ payments\ per\ year} * \frac{time\ to\ next\ coupon\ payment}{time\ between\ two\ coupon\ payments}$$

Clarification on task 2: In the above calculation of coupon, assume there is an annually paid coupon at 5% in each December. If we are standing in September, then the next coupon payment would be 100*(5%/1)*(0.25/1).

3. On Aug 3, 2015, you purchased a security for $98, that will pay you the arithmetic average of an underlying security's prices observed on Jan. 1 of each year from 2016 to 2020 with the payment made on December 31, 2020. Specifically, the underlying security is a 10-year bond issued on Jan. 1, 2010, which pays semi-annual coupons (Frequency=0.5) of 5% with face value of $100. The time series of the interest rate data is given in the file Bond_Ex3.csv. Was the purchasing of this security a good investment?

Clarification on task 3:
The following example is for illustration purposes.

For instance, to price the bond at year 2016, the time to maturity is 5, then you can calculate the interest rate as exp(-5*the corresponding rate) where the corresponding rate is found in at the line with ttm (time to maturity) 5 (line 1012 of the csv file).

After getting the arithmetic price of the underlying security's price say, is 110 (just a random number I made up). Then what is the time difference between 3 Aug 2015 and 31 Dec 2020? Let's say the time difference is 5.33 years, then you can check csv file to find the corresponding discount rate (line 926) and use that to discount 110.