Home Assignment 1

Assignment Objective

Use Spyder running Python 3 to develop the code that

1. Generates stochastic scenarios for the short term interest rate process $r(t)$ yielded by the Vasicek model. [See Eq.(1) on Page 3 of Deck 2]
2. Calculates prices of zero coupon bonds $z(t,\tau)$ derived from the Vasicek stochastic process. [See Eq.(7),(8) on Page 9 of Deck 2]

Assignment Requirements

Use Spyder running Python 3 to develop the code featuring the following functionality:

1. Read the *Run Parameters* from the file `FNCE5344_2020F_Asgn1-Params.csv` which contains the following table.

Param	Value
Mu	0.06
Kappa	0.16
Sigma	0.018
r0	0.06
Nmb Scens	10
dt (in years)	0.25
t term (in years)	5
dtau (in years)	0.25
tau term (in years)	5

Table 1.

2. Write a script that takes those parameters and generates `10` stochastic scenarios for short term interest rates $r(n,t_i)$, where $n = 1,\dots,10$ and $t_i = dt, 2dt, \dots, Idt,\ I = \frac{\text{t term (in years)}}{dt}$ using the discreet form of the Vasicek model. [See Page 14 of Deck 2.]

   Note that

   - The vale r0 = 0.06 serves as initial value for all the scenarios. $\mathrm{dt} = \Delta t$ [See Page 15 of Deck 2.]
   - For every scenario n and iteration i, the random number $\omega(n,t_i)$ is from the standard normal distribution $N(0,1)$. It is expected to be calculated by
     i. First generating a random number $xRnd$ from the interval $(0,1)$ and then
     ii. Applying the inverse of the cumulative standard normal distribution function Φ^{-1} to $xRnd$. I.e., $\omega(n,t_i) = \Phi^{-1}(xRnd(n,i))$.
     iii. Python 3 features several methods for generating a random number and implementing Φ^{-1}, you can use any of them.

3. Write a script that takes the parameters in Table 1 and the generated short term interest rates $r(n, t_i)$, and calculates prices of zero coupon bonds $z(n, t_i, \tau_j)$,

   for $n = 1, \dots, 10$; $t_i = 0, dt, 2dt, \dots, Idt,\ I = \frac{\text{t term (in years)}}{dt}$;

   $\tau_j = 1 \cdot dtau, 2 \cdot dtau, \dots, J \cdot dtau,\ J = \frac{\text{tau term (in years)}}{dtau}$

   derived from the Vasicek stochastic process. [See Page 15 of Deck 2.]

   IMPORTANT: Note that for all scenarios n, the prices $z(n, 0, \tau_j)$, $\tau_j = 1 \cdot dtau, 2 \cdot dtau, \dots, J \cdot dtau$ should be exactly the same. I.e., for every $\tau_j = 1 \cdot dtau, 2 \cdot dtau, \dots, J \cdot dtau$

   $$z(1, 0, \tau_j) = z(2, 0, \tau_j) = \cdots z(10, 0, \tau_j)$$

4. Write a script that puts rates $r(n, t_i)$ and zero coupon bonds $z(n, t_i, \tau_j)$ you calculated into a .csv output file that should be named as Asgn1_Out_<YourGroupID>.csv

   This file should have with the following columns: **"Scen", "Time", "Short Rate", "Price Tau 1", " Price Tau 2", " Price Tau 3", " Price Tau 4", "Price Tau 5", "Price Tau 6", "Price Tau 7", "Price Tau 8", "Price Tau 9", "Price Tau 10", "Price Tau 11", "Price Tau 12", "Price Tau 13", "Price Tau 14", "Price Tau 15", "Price Tau 16", "Price Tau 17", "Price Tau 18", "Price Tau 19", "Price Tau 20"**

   Note that

   - The values in the column "Scen" should go from 0 to 9.
   - For each scenario there should be 21 rows with values in the column "Time" equal to 0, 0.25, 0.5, .., 5
   - The column "Short Rate" should show the short term interest rate for the corresponding scenario and time.
   - The columns "Price Tau 1", …, "Price Tau 20" should show the corresponding prices $z(n, t_i, \tau_j)$.

Assignment Delivery

- The assignment code should be saved as a python file that can be run in Spyder.
- The file should be named following the following convention: Asgn1_<YourGroupID>.py. For example,
  - For students in Stamford Cohort 1's group with ID **S1G04** the file should be named as `Asgn1_S1G04.py`
  - For students in Stamford Cohort 2's group with ID **S2G08** the file should be named as `Asgn1_S2G08.py`
  - For students in Hartford's group with ID **HG03** the file should be named as `Asgn1_HG03.py`
- **The file should be submitted via BlackBoard no later than**

  6:30 pm, Wednesday, November 4, 2020
- **It is expected that for each group the submission is done by the group leader. There should be ONE and ONLY ONE submission for each group.**