Financial Engineering Lab (MA374)

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Lab - 11

To run the code type **python3 <filename>.py** into the terminal.

Question 1

The Vasicek model has an affine term structure where

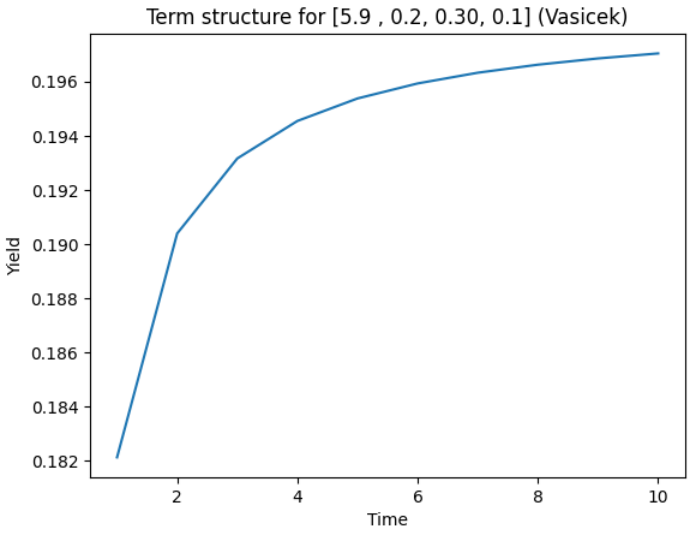
$$p(t,T) = e^{A(t,T)-B(t,T)r(t)}$$
$$B(t,T) = \frac{1}{a}\left(1 - e^{-a(T-t)}\right)$$
$$A(t,T) = \frac{(B(t,T) - T + t)(ab - \frac{1}{2}\sigma^2)}{a^2} - \frac{\sigma^2 B^2(t,T)}{4a}$$

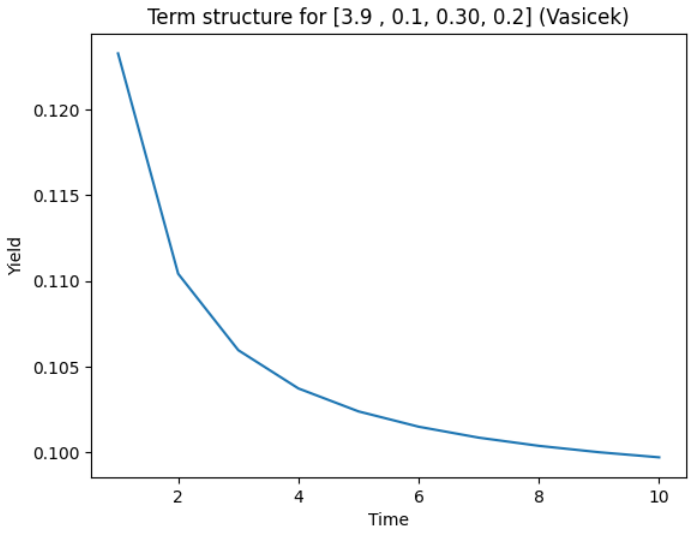
$$Here\ a\ =\ \beta\ and\ b\ =\ \beta\mu$$

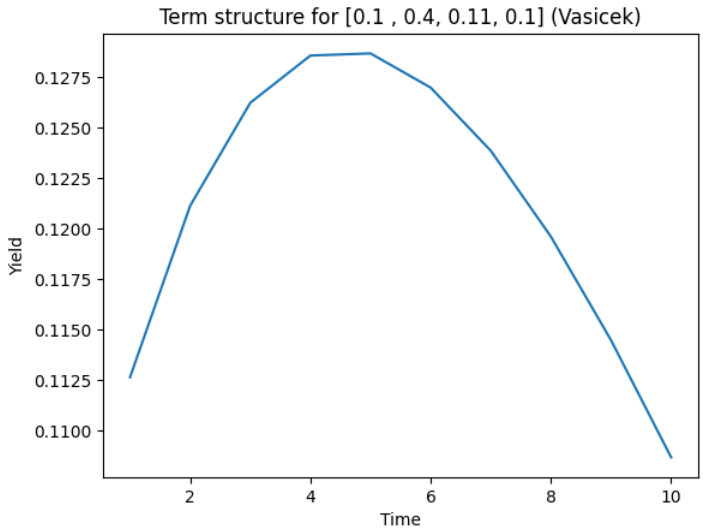
The yield is calculated using -

$$y = -\frac{\log(P(t,T))}{T-t}$$

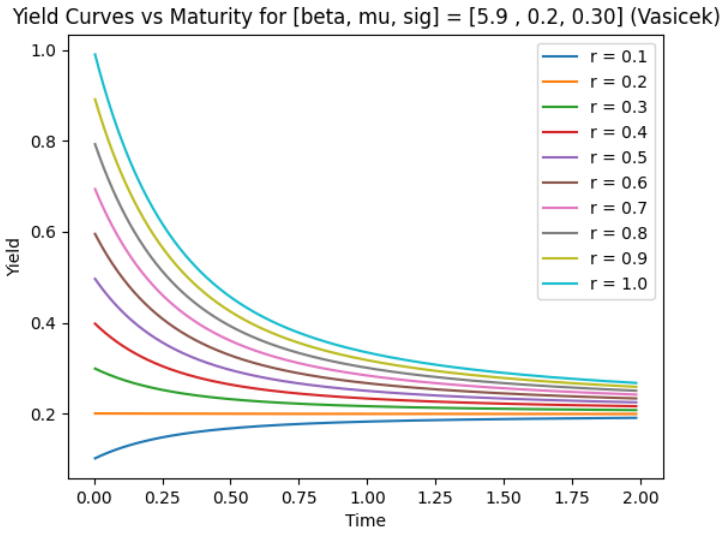
The term structures are given -

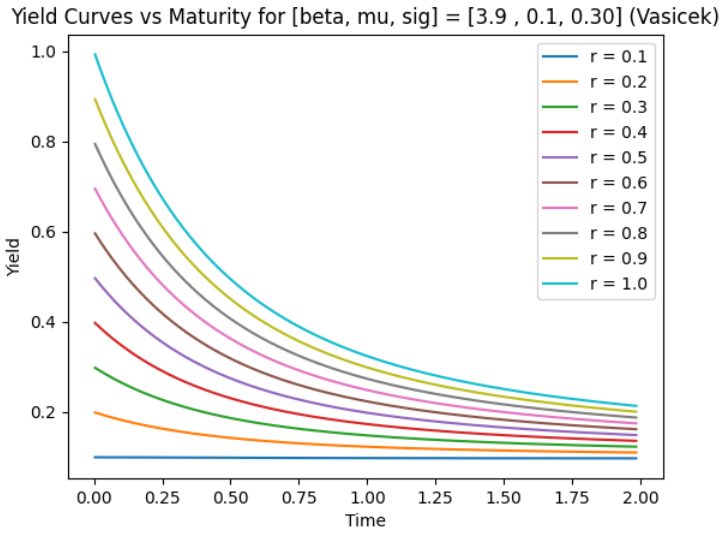


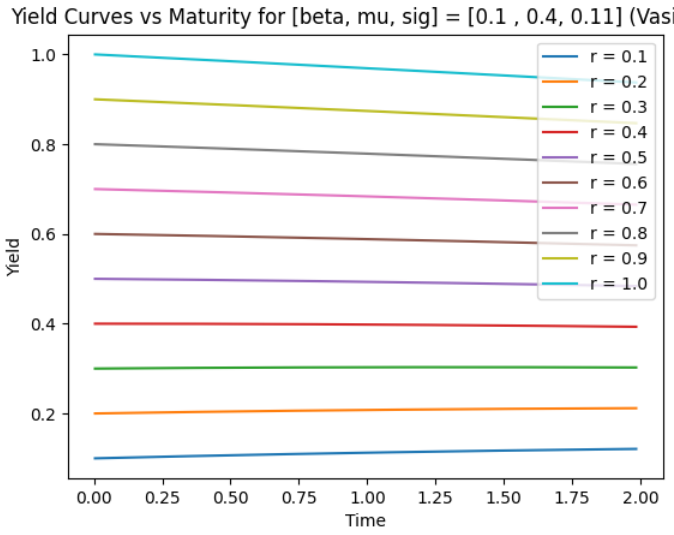




The yield curves vs maturity for 10 different values of r (0.1: 0.1: 1) are plotted -


Yield Curves vs Maturity for [beta, mu, sig] = [5.9 , 0.2, 0.30] (Vasicek)
Yield
Time
r = 0.1
r = 0.2
r = 0.3
r = 0.4
r = 0.5
r = 0.6
r = 0.7
r = 0.8
r = 0.9
r = 1.0


Yield Curves vs Maturity for [beta, mu, sig] = [3.9 , 0.1, 0.30] (Vasicek)
Yield
Time
r = 0.1
r = 0.2
r = 0.3
r = 0.4
r = 0.5
r = 0.6
r = 0.7
r = 0.8
r = 0.9
r = 1.0


Yield Curves vs Maturity for [beta, mu, sig] = [0.1 , 0.4, 0.11] (Vasicek)
Yield
Time
r = 0.1
r = 0.2
r = 0.3
r = 0.4
r = 0.5
r = 0.6
r = 0.7
r = 0.8
r = 0.9
r = 1.0

Question 2

In the Cox-Ingersoll-Ross model, the bond price is given by -

$$P(t,T) = A(t,T)\exp(-B(t,T)r_t)$$

where

$$A(t,T) = \left(\frac{2h\exp((a+h)(T-t)/2)}{2h+(a+h)(\exp((T-t)h)-1)}\right)^{2ab/\sigma^2}$$

$$B(t,T) = \frac{2(\exp((T-t)h)-1)}{2h+(a+h)(\exp((T-t)h)-1)}$$

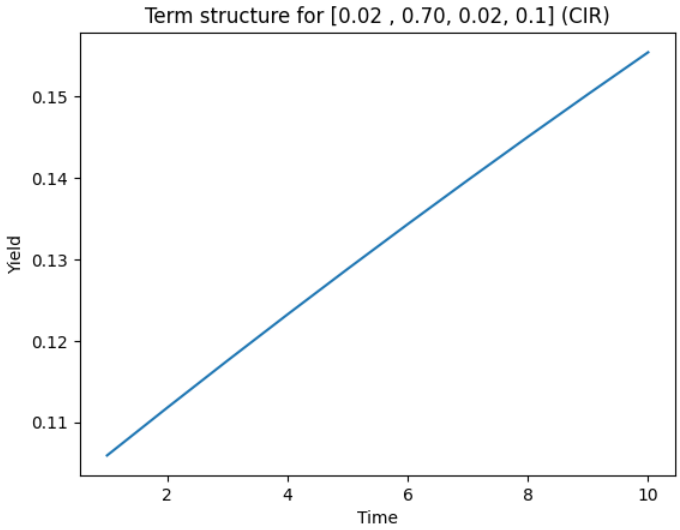
$$h = \sqrt{a^2+2\sigma^2}$$

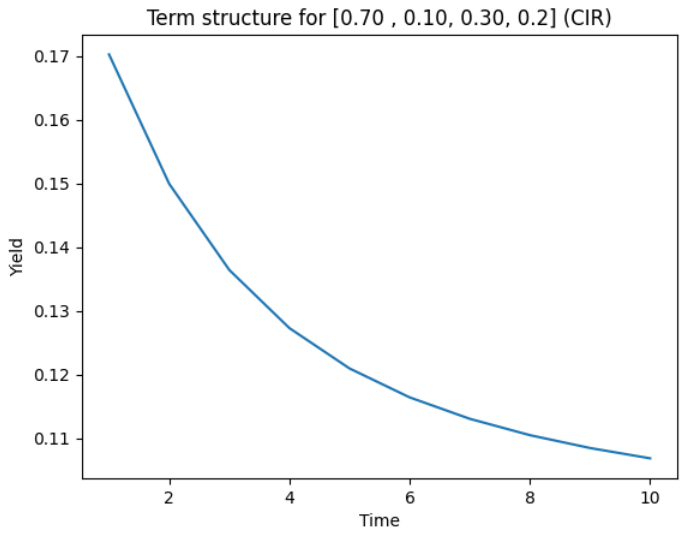
Here $a = \beta$ *and* $b = \mu$

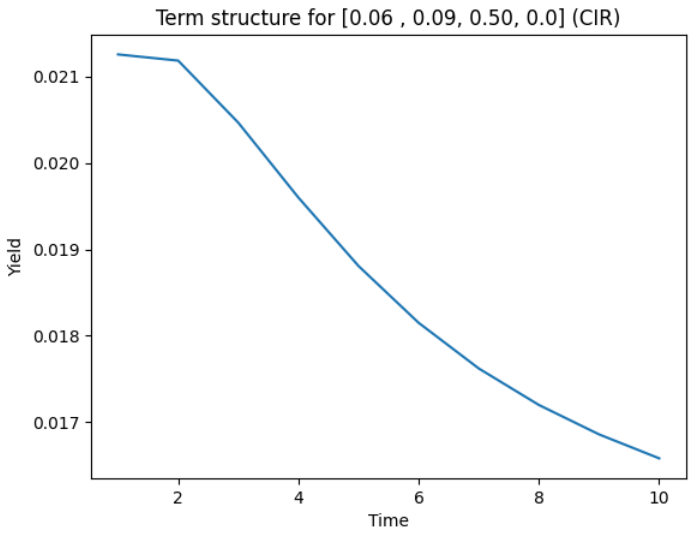
The yield is calculated using -

$$y = -\frac{\log(P(t,T))}{T-t}$$

The term structures are given by -







The yield curves vs maturity for 10 different values of r (0.1: 0.1: 1) are plotted -