LESSON 4

SIMULATING INTEREST RATES: VASICEK MODEL

Derivative Pricing - Module 4

WORLDQUANT UNIVERSITY

Outline

- Vasicek model for interest rates
- Using Monte Carlo techniques to simulate interest rates under the Vasicek model

Vasicek model (1977)

So far, we have focused on modeling stock price behavior. However, the same intuition can be applied to other types of SDE that capture the behavior of other types of assets.

Specifically, in this lesson, we'll look at how we can model interest rates using the Vasicek (1977) model:

- **The Vasicek (1977) model** has the following **mean-reverting risk-neutral process** for interest rates, r_t:

$$dr_t = k\left(\theta - r_t\right)dt + \sigma dZ_t$$

where $dZ_t = \sqrt{dt}z$, with $z \sim \mathcal{N}(0,1)$. The different non-negative parameters proxy for:

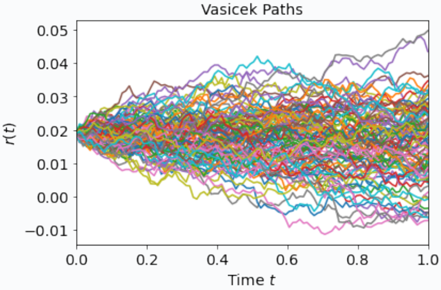
  - θ is long-term mean of interest rates. All paths will evolve around this level.
  - k is the speed of reversion, meaning how quickly rates revert to θ.
  - σ is the instantaneous volatility for interest rates.
  - $\frac{\sigma^2}{2k}$ can be defined as long-term variance.

Simulating interest rates under Vasicek

As we did in previous lessons, given the SDE defined before, we can (under certain parameters) simulate the different paths that interest rates can take in the future.

This, once again, illustrates the power of Monte Carlo techniques once we have an expression for the evolution of the asset.

$$dr_t = k\,(\theta - r_t)\,dt + \sigma dZ_t, \;\; so, \;\; given \; an \; initial \; r_0 \;\; \rightarrow \;\; r_1 = r_0 + dr_1; \ldots$$



Summary of Lesson 4

In Lesson 4, we have looked at:

- Vasicek Model for interest rates
- Simulating interest rates using Vasicek's SDE

$\Rightarrow$ **TO-DO NEXT**: Now, please go to the associated Jupyter Notebook for this lesson to see how to implement the Vasicek model in Python and the simulation of different paths for interest rates.

$\Rightarrow$ In the next module, we will start looking at the flaws associated with modeling strategies based on SDEs.