# MFE 405 Project 8
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## *1. Vasicek Model*

### *(a) Pricing Pure Discount Bond*

Using the Vasicek Model for short-term interest rates, we can find the price of a pure discount bond by using Monte Carlo Simulation and simulating many different paths of the interest rate movements, then discounting the bond value by the relevant interest rates. Using the given parameters, the computed price of the pure discount bond is **$975.46**.

### *(b) Pricing Coupon Bond*

Similar to part (a), we use Monte Carlo Simulation. To price coupon bonds, we imagine if a coupon bond is basically a sum of different pure discount bonds with different maturities, corresponding with the coupon payment dates. Using this, we can compute the price of the coupon bond to be **$1081.87**.

### *(c) Pricing Call Option on Pure Discount Bond*

Similar to part (a), we use Monte Carlo Simulation to simulate many paths of the interest rate until time $T$. Here, using the simulated interest rates $r_{T,i}$, we compute the value of the bond at time $T$ with maturity $S - T$, using the method from part (a). However, in this case, we use the explicit formula for the price of a pure discount bond under the Vasicek model. We now can find the expected payoff of the call option. Our computed price is **$11.74**.

### *(d) Pricing Call Option on Coupon Bond*

We can price a call option on a coupon bond similar to the method in part (c). The main modification is that we compute the value of the coupon bond by Monte Carlo simulation instead of a closed form solution. The computed price is **$144.44**.

## *2. CIR Model*

### *(a) Pricing Call Option on Pure Discount Bond, Monte Carlo*

We can use the exact same method from part 1(c), but in this case, we simulate interest rates movement using the CIR model instead. The computed price, using prices of bonds from Monte Carlo Simulation, is **$1.03**.

### *(b) Pricing Call Option on Pure Discount Bond, Explicit Formula*

Instead of using Monte Carlo computed bond prices in part (a), we use the closed-form solutions for pure discount bonds under the CIR model. Our computed price is now **$1.11**. This is a bit more accurate, as the prices are now exact. However, the Monte Carlo simulation does provide a good estimate. If we have more computing power and add the number of intervals and simulated paths, we should converge to a more accurate result.

### *3. G2++ Model: Pricing Put Option on Pure Discount Bond*

Again, we use a similar approach to the previous parts. We now use the G2++ model to simulate interest rate movement. The computed price of the put option is **$28.60** if we use "Monte Carlo on Monte Carlo". However, if we use the explicit formula to price bonds, our simulated put option price would be around 11.7 – 11.8. The closed-form solution for the put is **$11.85**.