

# Stochastic Methods + Lab

## Assignment Sheet 3

Due on October 7, 2019

### Problem 1 [4 points]

Suppose you want to immunize a liability at time  $D$  with two bonds of Macaulay durations  $D_1$  and  $D_2$ , respectively. Show that the fraction  $\omega_1$  and  $\omega_2$  of the two bonds in the initial portfolio need to satisfy

$$\begin{aligned}\omega_1 + \omega_2 &= 1, \\ \omega_1 D_1 + \omega_2 D_2 &= D.\end{aligned}$$

### Problem 2 [7 points]

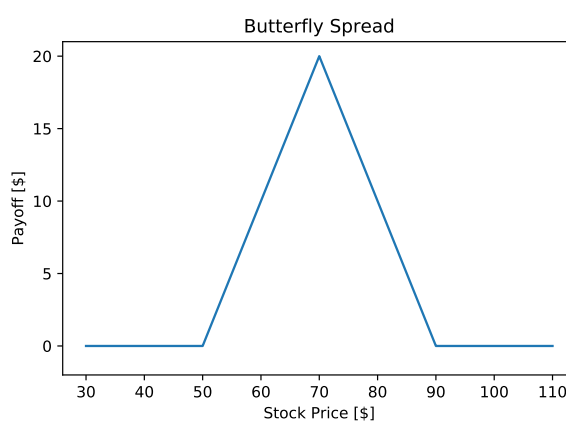
The ECB publishes spot rate data (look for “Euro area yield curves”) in a downloadable CSV file. Look for the latest release and briefly discuss what kind of data you find in the file. Remember from class how to read CSV files in python (or find additional online documentation), read in the ECB spot rates from the CSV file, and plot the yield curve.

### Problem 3 [3 points]

Implement the payoff functions for a European call option and a European put option, and plot them for a strike price of 100 \$.

### Problem 4 [4 points]

Find a linear combination of European put and call options which reproduces the following payoff graph, called the butterfly spread:



### Problem 5 [2 points]

In class, we analyzed how to price an option for a binary model of stock prices with one time step. Would a similar analysis work if we allowed the stock to have three possible values in the future instead of just two? Explain your answer.