Exercises Sheet #2

Introduction to Financial Engineering 2022

Note: The choice of software is up to the students. We recommend that you work in Python, but you can also choose to in R or Matlab. We do not provide solutions for all exercises in all languages.

The scope of today's exercises is to learn about bonds and relevant key figures related to bonds.

1. (yields, cash flows, clean and dirty prices) Go to the Danish stock exchange's home page `http://www.nasdaqomxnordic.com/bonds/denmark`. Pick all the Danish government bullet loans ("stående obligationer") – exclude the ones from Faroe Islands and the SKBVs ("Skatkammerbeviser") and note down the name, the price for the last trading day (we can call this the calculation date), the coupon and the maturity. (For simplicity you may assume that the maturity date for "7 St.I 24 GB" to be "2024-11-15"). The price you should note down is "Nasdaq CPH consolidated reference price". Use the most recent price and assume that it's the price that's valid also for the calculation date.

   (a) Set up the cash flow for each bond

   (b) Calculate the yield to maturity (YtM) for each bond. Note: Use the correct price (clean/dirty) for calculating YtM.

   (c) Plot the bonds' yields for each maturity a function of time to maturity. Do they look as you would expect? Why/why not?

   Hint: In R, you may find uniroot() and difftime() useful. In Matlab, similar functions are called fzero() and yearfrac(). You can find libraries/scripts/build-in functions for all programs to calculate YtM, but coding it yourself might provide better intuition. In Matlab, the build-in functions are called "yldmat()" or "cfyield()". For other programs, you will probably need to load some libraries and investigate the syntax.

2. (yield curve) Use the results from Question 1

   (a) Modify the yield curve by taking out the odd-looking bonds

   (b) Calculate the Nelson-Siegel coefficients and fitted interest rates

   (c) Plot the the Nelson-Siegel fitted yield curve in the same plot as before and compare

   Note: You may have to remove one of the bonds from your data before computing the Nelson-Siegel coefficients. In R, the following functions are useful: "YieldCurve" package (explore the documentation yourself), Nelson.Siegel() – for computing Nelson-Siegel coefficients (look at examples and pay attention to how data is formatted for input into function), NSrates() – for computing the interest rates by Nelson-Siegel's model. In Matlab, you might consider the functions (needs to be downloaded from the file exchange) nelsonfit.m etc. For Python, you can check: `https://pypi.org/project/nelson-siegel-svensson/`.

3. (duration, convexity) Use the results from Questions 1 and 2

   (a) Compute the Macaulay duration and the modified duration for all bonds

   (b) Compute the convexity for all bonds

   (c) Compute Fisher-Weil durations and convexities using the obtained Nelson-Siegel model from Question 2

4. (duration, convexity) Use the results from Questions 3

   (a) Use formula (8) from the note on duration to calculate the change in the bonds' prices if the interest rate goes up by 1%.

   (b) Use formula (10) from the note on duration to calculate the change in the bonds' prices if the interest rate goes up by 1%.

   (c) Will the use of (8) instead of (10) over- or underestimate the change in price?