Fixed Income Asset Pricing

Bus 35130 Spring 2024

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Homework 4

Due at the beginning of Class 5

Note 1: For each section below, there are questions that require a "pencil and paper" (PP) answer, and questions that require actual computations using data and computer programs (CP). You are supposed to do both.

Note 2: As with Homework #1 there are "guides" for doing the homework in Excel, Matlab and Python. In each code provides partial solutions to the questions. To make the code run you are required to complete some formulas or to produce some of the results yourself. You are not required to use any of the guides, but use of one of them is recommended.

Part I: Real and Nominal Bonds

The dataset "*DataTIPS.xlsx*" contains data on nominal bonds and Treasury Inflation Protected Securities (TIPS) on Jan 15, 2013.

1. (PP) Write down the relation between nominal rates and real rates. Interpret each term economically.

2. (PP) What does a negative real rate may imply? Provide an intuition about negative real rates using more than one potential explanation.

3. (PP) In the first quarter of 2013, the median forecast of professional forecaster about the average three month rate for the next 10 years was 2.4%.[1]. Compare this average with your estimated nominal 10-year rate. Is it higher? Is it lower? Explain the difference, if any, in economic terms.

4. (CP) Fit the Nelson Siegel model to the TIPS on Jan 15, 2013. Plot the resulting term structure of real rates. Interpret in light of your answer to point 2.

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[1]See https://www.philadelphiafed.org/research-and-data/real-time-center/survey-of-professional-forecasters/data-files

5. (CP) Fit the Nelson Siegel model to the nominal bonds. Plot the resulting term structure of nominal rates. Interpret in light of your answer to point 3.

6. (CP) Compute breakeven inflation rate, that is, those rate $\pi(\tau)$ such that $r_{nominal}(0, \tau) = r_{real}(0, \tau) + \pi(\tau)$. Interpret your results. What does the break-even rate really capture?

Part II. Swap Spread Trades

Recommended readings:

1. Book. Chapter 5.

2. Harvard Business School Case: "Fixed Income Arbitrage in a Financial Crisis (C): TED Spread and Swap Spread in November 2008"

3. Duarte, Longstaff and Yu, "Risk and Return in Fixed-Income Arbitrage: Nickels in Front of a Steamroller?" on Review of Financial Studies, 2006.

   (http://www.owlnet.rice.edu/~jd10/nickelsRFS.pdf)

Today is February 17, 2009 and you are evaluating the Swap / Treasury curve. You decide to set up 100 million swap spread trade on the thirty year T-Bond / Swap. Daily quote on the 30-year bond, maturing on February 15 2039, are contained in spreadsheet *Daily_Bond_Swaps* in *HW4_Data.xls*. The spreadsheet also contains daily data on the 30-year swap, three month LIBOR and three month Repo rate. You have access to some past data, such as the ones in the *H15_Swap.txt*, which contains daily data on swap rates, LIBOR and Repo, but for a longer sample, as well as Treasury constant maturity rates. (All these data are also collected in the Excel guide *35130_HW4_2022_Guide.xlsx* for Excel users).

1. (PP) Look at the data and decide which direction to set up a swap spread trade. Is there an arbitrage? If so, why do you think there is one? Discuss.

2. (PP) What do you do? Describe the working of the swap spread trade. How do you take positions in the Treasury Bond? What about the swap?

3. (CP) Consider now one quarter after the initiation of the trade (May 18, 2009). Suppose JCH Capital Management needs to liquidate the position immediately, due to large unexpected redemptions from investors. What is the value of the swap-spread trade positions? In particular, the trade has two parts: the T-Bond trade and the Swap trade. Compute the fair valuation of the two parts as follows:

A. The value of the T-bond part is just the value of the bond, multiplied by its position. You can read it right from the data. Recall though the overall position of the bond trade.

B. The value of the swap part should use the standard valuation formula of swaps, as a fixed rate bond minus a floating rate bond (see Teaching Note 4, page 11, Eq.(8)). The floating rate leg should be "easy" (what is the value of floating rate bond at reset dates?). For the fixed leg, proceed as follows:

   (a) Determine what is the appropriate "coupon rate" for the fixed leg of the swap in the valuation.

   (b) Determine how many "coupon" periods there are left.

   (c) To compute the present value of future coupons, you need an appropriate discount function $Z(T)$. *Extract* the LIBOR curve from current swap rates as of May 18, 2009, using the procedure on TN3, page 11. Because for maturity less than one year there are no swap quotes, you can use LIBOR rates themselves in the computation.

       – Note that you need an interpolation of maturities, as data only come on fixed maturities, but you need specific quarters to compute the present value.

   (d) Plot the estimated zero-coupon LIBOR curve.

   (e) Use the estimated $Z(T)$ to compute the value of the fixed leg of the swap.

C. Given your results in [A] and [B], did the trade (so far) made money or lost money? Can you reconcile it with your answer to point 1? What happened to the swap spread between Feb 9 and May 18, 2009?

4. (CP) (Optional: No Grade Given. No hint in the code.) Follow the trading strategy cash flows. What is the sequence of cash flows? Consider only quarterly frequency.

5. (CP) (Optional: No Grade Given. No hint in the code.) Follow also the *value* of the trade over time. Consider only quarterly frequency.