UNIVERSITY OF PENNSYLVANIA
The Wharton School

FNCE 235/725:
FIXED INCOME SECURITIES

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Assignment 2

Background

In late 1993, Procter & Gamble (P&G) wanted to replace an existing receiver IRS that was about to expire. The company's financial managers expected interest rates to continue to drop and approached Bankers Trust (BT) expressing interest in negotiating a new $200 million swap that would allow P&G to continue to pay a negative spread over the Commercial Paper (CP) rate.

BT proposed an exotic 5-year swap, which included an initial negative spread of 75 basis points over the CP rate for the first 6 months, but with the provision that the spread would be revised after 6 months based on a complex formula that linked the spread to the Treasury term structure prevailing at that date. Figure 1 shows a condensed term sheet for the swap, which was stipulated on November 4, 1993.

On February 4, 1994, the Fed raised the Fed Funds target rate by 25 basis points. As a consequence of the resulting increase in Treasury rates and of the high leverage implicit in the formula used to determine the revised swap spread, P&G faced the prospect of having to pay a huge spread over the CP rate after May 4, 1994 (the date on which the spread was to be revised). In March 1994, P&G decided to unwind the swap at a loss of over $100 million.

In October 1994, P&G sued BT alleging fraud, misrepresentation, breach of fiduciary duty, negligent misrepresentation, and negligence in connection with the swap transaction. During pre-trial discovery, P&G obtained from BT over 6,500 audio tapes of internal telephone conversations. In one tape, two BT employees were recorded having the following conversation regarding the swap:

- Oh, my ever-loving God. Do they [P&G] understand that? What they did?
- No. They understand what they did but they don't understand the leverage, no.

- Are you letting greed get in the way of business decisions? I hope that these people don't get blown up 'cause that's the end of the gravy train. [...] They would never know. They would never be able to know how much money was taken out of that ... That's the beauty of Bankers Trust.

In this Assignment, you will be asked to price the P&G swap and to asses its risk.

Questions

For simplicity, assume throughout that:

- the semi-annually compounded rate used to determine the payments in the floating leg of the P&G swap was determined by the formula

$$\text{CP} - 0.75\% + \text{Spread},$$

  where CP is the 6-month Commercial Paper rate at the start of each interest accrual period (instead of the average 30-day Commercial Paper rate over each interest accrual period);

- the Commercial Paper term structure was the appropriate forwarding term structure for the P&G swap while the Treasury term structure was the appropriate discounting term structure;

- the spread between the continuously compounded Commercial Paper and Treasury rates was equal to 22 basis points for all maturities.

In addition, assume that the Treasury term structure on November 4, 1993 was as estimated in the FEDS 2006-28 paper.[1]

Answer the following questions making sure to clearly explain the procedure you followed to determine your answers.

1. What was the fair swap rate on November 4, 1993 for a vanilla 5-year swap with semi-annual payments on both legs that exchanged the 6-month CP rate for a fixed rate?

2. What was the fair swap rate on November 4, 1993 for a vanilla 5-year swap with semi-annual payments on both legs that exchanged the 6-month CP rate minus 75 basis points for a fixed rate?

[1]The paper and the estimated daily term structures can be downloaded from the Fed's website: http://www.federalreserve.gov/pubs/feds/2006/200628/200628abs.html.

3. It is easy to see that the P&G swap is equivalent to a portfolio that consists of the vanilla receiver swap in part 2 plus a short position in a fixed income derivative that pays the semi-annual Spread, as determined on May 4, 1994, on a notional of $200 million on each of the nine semi-annual payment dates starting November 4, 1994 and ending November 4, 1998. What compensation was P&G receiving under the terms of the swap for selling this derivative to Bankers Trust?

4. Figure 2 shows the weekly time series of the 5-year TCM rate and of the average of the bid and ask clean prices of the 6.25% 8/15/2023 Treasury bond between November 5, 1993 and May 6, 1994. Produce a graph showing what the Spread of the P&G swap would have been if determined on each of the dates in Figure 2.

5. Compute the semi-annually compounded 5-year Treasury rate on November 4, 1993 based on the FEDS term structure. On November 4, 1993, the 5-year TCM rate was 5.03%. What was the spread between the 5-year Treasury rate and the 5-year TCM rate? What was the reason for this spread?

6. Compute the fair clean price on November 4, 1993 of the 6.25% 8/15/2023 Treasury bond.

7. Compute the fair clean prices on November 4, 1993 of two 6.25% Treasury bonds, with maturities 5/4/2023 and 11/4/2023, respectively. What is the error of approximating the fair clean price of the 8/15/2023 bond using linear interpolation and the fair clean prices of the 5/4/2023 and 11/4/2023 bonds?

8. Use the weekly time series of the 6-month TCM rate between January 8, 1982 and October 29, 1993 posted on Canvas to estimate the annualized standard deviation of the changes in the 6-month TCM rate and the annualized volatility of the 6-month TCM rate.

9. Calibrate the Ho-Lee model to the 6-month Treasury rate and construct the tree for this rate out to 30 years (assume that the standard deviation of the changes in the 6-month Treasury rate is the same as the standard deviation of the changes in the 6-month TCM rate estimated in part 8).

10. Compute the tree for the price of a Treasury STRIP maturing on May 4, 1999.

11. Compute the trees for the prices of the two Treasury bonds in part 7.

12. Compute the tree for the price of a deferred annuity that makes semi-annual payments of $1, with the first payment occurring on November 4, 1994 and the last payment on November 4, 1998.

1. General Terms

Contract date	November 4, 1993
Maturity date	November 4, 1998
Notional amount	$200 million
Fixed rate payer	Bankers Trust
Floating rate payer	Procter & Gamble

2. Fixed Payments

Dates	May 4 and November 4, starting May 4, 1994
Rate	5.30% semi-annually compounded

3. Floating Payments

Dates	May 4 and November 4, starting May 4, 1994
Rate	The semi-annually compounded floating rate is determined by the following formula: $$\mathrm{CP} - 0.75\% + \mathrm{Spread},$$ where CP is the average of the 30-day Commercial Paper rate over each interest accrual period.
Spread	The Spread is 0% for the first floating payment. The spread for each floating payment after the first will be determined on May 4, 1994 by the following formula: $$\max\left[0, \frac{\frac{98.5}{5.78\%} \times \mathrm{TCM}_5 - \mathrm{P}_{30}}{100}\right],$$ where TCM_5 is the 5-year Treasury Constant Maturity yield, and P_{30} the average of the bid and ask clean prices of the 6.25% 8/15/2023 Treasury bond (for example, the Spread will be set to 0% if $\mathrm{TCM}_5 = 5\%$ and $\mathrm{P}_{30} = 100$ and to 12.2491% if $\mathrm{TCM}_5 = 6\%$ and $\mathrm{P}_{30} = 90$).

Figure 1: Condensed term sheet for the P&G swap

Date	TCM_5	P_{30}
11/05/1993	5.03%	100.56
11/12/1993	5.04%	101.44
11/19/1993	5.04%	98.81
11/26/1993	5.13%	100.09
12/03/1993	5.14%	100.06
12/10/1993	5.10%	100.66
12/17/1993	5.18%	99.59
12/24/1993	5.16%	100.50
12/31/1993	5.14%	98.75
01/07/1994	5.21%	100.28
01/14/1994	5.03%	99.41
01/21/1994	5.06%	99.56
01/28/1994	5.05%	100.44
02/04/1994	5.14%	98.69
02/11/1994	5.36%	97.97
02/18/1994	5.40%	95.19
02/25/1994	5.60%	94.13
03/04/1994	5.74%	92.59
03/11/1994	5.85%	91.81
03/18/1994	5.91%	91.72
03/25/1994	6.00%	90.44
04/01/1994	6.19%	87.66
04/08/1994	6.47%	87.84
04/15/1994	6.47%	87.53
04/22/1994	6.60%	88.16
04/29/1994	6.56%	87.34
05/06/1994	6.76%	84.81

Figure 2: Weekly values of the 5-year TCM rate and of the clean mid price of the 6.25% 8/15/2023 Treasury bond