

The Hong Kong University of Science & Technology  
Department of Finance

**FINA 557: Fixed Income Derivatives**  
**Fall 2008**

Instructor: Dr. Chu ZHANG  
Office: Room 2345, HKUST  
Phone: 2358-7684  
E-mail: czhang@ust.hk

### Course Description

This course teaches fixed-income derivatives and related topics. It begins with the traditional bonds with embedded options (callable bonds, puttable bonds and convertible bonds), followed by interbank forward rate agreements and exchange traded interest rate and bond futures. It then covers the standard interest rate swaps and a variety of nonstandard swaps (amortizing swaps, currency swaps, quanto swaps, yield curve swaps, etc.) and swap derivatives (swap forwards, and swap futures). The next topic to be covered is fixed-income options (caps, floors, collars, and swaptions). The last part of the course deals with fixed-income structured notes that have exposure in equity, commodity/inflation, currency, and so on. Both economic intuition and quantitative skills are emphasized.

### Recommended Readings

(MPP) Martellini, L., Priaulet, P. and Priaulet, S., 2003, *Fixed-Income Securities: Valuation, Risk Management and Portfolio Strategies*, The Wiley Finance Series.

Chapter 10, 11, 14, 15, and 16 should be consulted frequently.

### Grading

Midterm exam (100 min.)	40 points	4th week
Final exam (150 min.)	60 points	8th week

## Topics

1. Traditional Bonds with Embedded Options
2. Fixed-income Forwards and Futures
3. Interest-rate Swaps
4. Swap Related Instruments
5. Fixed-income Options
6. Structured Notes

## Miscellany

Knowledge in options pricing helps, but is not required.

Unless I say otherwise, everything discussed in class may appear in the exams.

You may bring to the exams an 11" by 8.5" (A4-size) data sheet, on which you can write anything you like on both sides, but everything has to be hand-written.

The mid-term exam covers the first three lectures. The final exam covers the entire course, but it emphasizes the material after the midterm. The course grade depends on the exam performance relative to the class average.

Homework assignments will not be collected. Solutions will be available before exams.

## Suggested Homework I

MPP end-of-chapter questions

**Ch.10:** 4, 6, 7.

**Ch.11:** 4, 5, 6, 8, 10, 11.

Corrections of the solutions to homework I:

**10.6.6 & 10.7.3** How many swaps must he ~~sell~~ buy to protect his portfolio?

**11.4.2** The investor has to sell 120 contracts as given in the following formula

$$\phi_f = -\frac{10,000,000 \times 112\% \times 9.21}{100,000 \times 105.2\% \times 8} \times 0.981 = -120.24$$

## Suggested Homework 2

1. There is another definition of the payback period in a textbook as follows

$$\text{Payback period} = \frac{\text{bond market conversion price} - \text{stock price}}{\text{coupon per share} - \text{dividend per share}}.$$

Is that definition appropriate? Why or why not? Explain your answers in the simple example given in the notes.

2. Consider the 2.25% 2005.11.03 convertible bond issued by China Mobile. The bond is denominated in US dollar with face amount US\$1000. The bond can be converted to 132.109 shares of China Mobile stocks which is traded on the Hong Kong Stock Exchange with an annual dividend HK\$0.40. On settlement date 2005.04.19, the bond was quoted at 99.51607. The stock price was HK\$26.25 and the exchange rate was 7.799 HK\$/US\$. The bond has a provisional price of HK\$ 70.848. Suppose the cost of carry was 3.14052% and short rebate was 2.51242%.
  - a. Calculate the conversion price, current yield of the bond, dividend yield of the stock, yield advantage of the bond, parity, premium in dollar, premium in percentage, break-even time, and provisional hedge.
  - b. Calculate cash required for a 100% hedged position with long position in the bond and short position in stocks, annual cash flows in dollar, annual cash flows in percentage of cash required, and the break-even time.
3. Consider a 5-year roller-coaster swap where the notional amount is \$10 million for the first two years, \$15 million for the next two years, and \$8 million for the last year. The floating rate is reset every six months in advance. The current semiannually compounded spot rate is described as

$$z(m) = 0.08 - 0.03 \left( \frac{1 - e^{-2m}}{2m} \right)$$

where  $m$  is the term in years. Calculate the fixed rate on the swap.

4. Consider a 3-month forward 5-year swap with a notional amount of \$10 million. The floating rate is reset every six months in advance. The current semiannually compounded spot rate is described as

$$z(m) = 0.08 - 0.03 \left( \frac{1 - e^{-2m}}{2m} \right)$$

where  $m$  is the term in years. Calculate the fixed rate on the swap.

5. Suppose you hold a corporate bond with face amount \$12.5 million and a DV01 0.045 (for \$100 face amount) and suppose you want to sell 5-year swap futures to hedge its risk. The 5-year swap future has a DV01 0.041 (for \$100 face amount).

- a. Suppose the yield on the corporate bond fluctuates with the swap rate on the one-to-one basis. How many swap futures contract should you sell?
- b. Suppose the beta of the corporate bond yield with respect to the 5-year swap rate is 0.85. How many swap futures contract should you sell?
6. (3 pts.) The premium of a cap is \_\_\_\_\_ related to the slope of the spot rate curve and \_\_\_\_\_ related to the strike rate, other things being equal.
- a. positively, positively      b. positively, negatively  
c. negatively, positively      d. negatively, negatively
7. Consider two interest rate collars of the same reference rate, maturity, and reset frequency. Collar 1 has the strike rates  $l_1 < u_1$ . Collar 2 has strike rates  $l_2 < u_2$ . If  $l_1 < l_2 < u_2 < u_1$ , then
- a. Collar 1 is more valuable than Collar 2.  
b. Collar 1 is less valuable than Collar 2.  
c. Collar 1 has the same value as Collar 2.  
d. it is not clear which collar is more valuable.
8. Suppose  $V_c$  is the value of a standard cap and  $V_{koc}$  is the value of a knock-out cap with the same strike rate as that of the standard cap. Suppose  $V_f$  is the value of a standard floor and  $V_{kof}$  is the value of a knock-out floor with the same strike rate as that of the standard floor.
- a.  $V_c < V_{koc}$  and  $V_f < V_{kof}$ .      b.  $V_{koc} < V_c$  and  $V_{kof} < V_f$ .  
c.  $V_c < V_{koc}$  and  $V_{kof} < V_f$ .      d.  $V_{koc} < V_c$  and  $V_f < V_{kof}$ .
9. Comparing a range accrual swap with a standard interest rate swap using the same index as the floating rate, the fixed rate on the range accrual swap should be \_\_\_\_\_ that of the standard swap.
- a. higher than      b. lower than      c. the same as
10. A US TIPS with face amount \$1,000,000 was issued on 2004.10.15 which matures on 2010.04.15. The real coupon rate is  $0\frac{7}{8}$  (i.e., 0.875%). Based on the CPI index values (given in the lecture notes), what was its first nominal coupon payment? On the settlement date 2005.12.14, it was quoted at the price of 95. How much do you need to pay to buy that bond at that time?