École de gestion TELFER School of Management

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Midterm Exam #2
ADM 3351 M
Fixed Income Securities
Winter 2013
(1 Hour and 20 minutes)
Prof. C. Guo

Closed-book exam. No material of any kind is allowed. A calculator is required. The formula page can be detached and need not submit.

Name (print legibly) NORA MALKAWI

Student Number 5937016

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I have read the text on academic integrity and I pledge not to have committed or attempted to commit academic fraud in this examination.

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Question	Credit	Mark
1	25	25
2	25	~~20~~ 25
3	25	25
4	25	23
Total	100	~~93~~ 98

Question 1 (25 points)

25

The current term structure of interest rates, expressed as yield-to-maturity (YTM), is given in the table below. The securities with maturities less than or equal to one year are Treasury bills, and the rest are par-valued Treasury coupon bonds. All the quotes are expressed as APR with semiannual compounding. Identify the spot rates and forward rates with necessary calculations. Be accurate on all the rates with five decimals, e.g., 0.03125 or 3.125%. Fill out the relevant blanks of the table.

	Year	YTM (%)	Spot Rate (%)	Forward Rate (%)
1	0.5	2.400	2.400	x
2	1.0	3.000	3.000	3.602
3	1.5	4.000	4.024	6.088
4	2.0	4.200	4.226	4.833

r
0.012
0.015
0.02012

(Extra writing space on the next two pages)

$$Y(1.5) = 100 = \frac{2}{(1.012)^1} + \frac{2}{(1.015)^2} + \frac{102}{\left(1+\frac{x}{2}\right)^3}$$

$$100 = 1.976284585 + 1.941323497 + \frac{102}{\left(1+\frac{x}{2}\right)^3}$$

$$96.082391 92 = \frac{102}{\left(1+\frac{x}{2}\right)^3}$$

$$x = \left[\left(\frac{102}{96.082391 92}\right)^{\frac{1}{3}} - 1\right] \times 2$$

$$x = 0.04024 \text{ or } 4.024$$

$$Y(2) = 100 = \frac{2.1}{(1.012)^1} + \frac{2.1}{(1.015)^2} + \frac{2.1}{(1.02012)^3} + \frac{102.1}{\left(1+\frac{x}{2}\right)^4}$$

$$100 = 2.075098814 + 2.038369672 + 1.978817864 + \frac{102.1}{\left(1+\frac{x}{2}\right)^4}$$

$$93.908332 87 = \frac{102.1}{\left(1+\frac{x}{2}\right)^4}$$

$$x = \left[\left(\frac{102.1}{93.908332 87}\right)^{\frac{1}{4}} - 1\right]^2 \times 2$$

$$x = 0.04226 \text{ or } 4.225$$

(Extra writing space for Question 1)

forward rate $f_t = 2\left[\frac{(1+y_{t+1})^{t+1}}{(1+y_t)^t} - 1\right]$

$$f_1 = 2\left[\frac{\left(1+\frac{3.000}{200}\right)^2}{\left(1+\frac{2.400}{200}\right)^1} - 1\right]$$

$$f_1 = 3.602$$

$$f_2 = 2\left[\frac{\left(1+\frac{4.024}{200}\right)^3}{\left(1+\frac{3.000}{200}\right)^2} - 1\right]$$

$$f_2 = 6.088$$

$$f_3 = 2\left[\frac{\left(1+\frac{4.226}{200}\right)^4}{\left(1+\frac{4.024}{200}\right)^3} - 1\right]$$

$$f_3 = 4.833$$

(Extra writing space for Question 1)

25

Question 2 (25 points)

The term structure of interest rates, expressed equivalently as the YTM and the spot rates, is given below:

Year	YTM (%)	Spot Rate (%)	y
0.5	2.300	2.300	0.0115
1.0	2.800	2.800	0.014
1.5	3.100	3.107	0.015535
2.0	3.400	3.414	0.01707

All the rates are quoted as APR based on semiannual compounding assumption.

(a) There is an off-the-run Treasury bond with $100 face value. It carries 5% coupon with 2 years left to maturity. A student suggests that this bond can be priced by the standard bond pricing formula, with the 2-year YTM. What is the bond price according to the suggestion (be accurate to 1/10 of cent)? (5 points)

(b) If the cash flows of this bond in part (a) are sold as STRIPS, what are the prices of each strip (be accurate to 1/10 of cent)? (10 points)

(c) Is the suggestion of the student in (a) correct? Why or why not? What is the equilibrium price of this bond? Why? (10 points).

(Extra space on next page)

a) coupon $= \frac{5\%}{2} \times 100 = 2.5$

Semi annual yeild $= \frac{0.034}{2} = 0.017$

$$\text{Price} = \frac{2.5}{(1.017)^1} + \frac{2.5}{(1.017)^2} + \frac{2.5}{(1.017)^3} + \frac{102.5}{(1.017)^4}$$

$= \$103.068401$ or $\$103.070$

b) $P(0.5) = \frac{2.5}{(1.0115)^1} = \$2.472$

$P(1.0) = \frac{2.5}{(1.014)^2} = \$2.431$

$P(1.5) = \frac{2.5}{(1.015535)^3} = \$2.390$

$P(2) = \frac{2.5}{(1.01707)^4} = \$2.340$

$P(2) = \frac{102.5}{(1.01707)^4} = \$95.790$

$95.790 + 2.340 = \$98.130$

2.3
2.8
3.1
3.4

(Extra space for question 2)

$$\text{Price} = \frac{2.5}{(1.0115)^1} + \frac{2.5}{(1.014)^2} + \frac{2.5}{(1.0155)^3} + \frac{102.5}{(1.017)^4}$$

Price = $103.10672777 or $103.107

Price with YTM ≠ Price with Spot rate

The student is wrong because you can not assume that the YTM will remain the same at each period

also because the YTM must be adjusted each period to get the right price.

the equilibrium price of the bond is 103.107 because we took into consideration the chances of each period in the YTM

Month 2 outstanding balance
= Month 1 outstanding - TP
= 200M - 1248314.842
= 198751685.2

Question 3 (25 points)

25

A mortgage pass-through security of 30-year confirming mortgages is issued with initial balance of $200 million, WAM=345 months, WAC = 8%, and coupon rate 7%. The rates are quoted as monthly simple interest rates (i.e., APR with monthly compounding). Assume that the prepayment speed is according to PSA 200. Calculate the cash flows to investors in the first month and the second month. Fill out the table on the next page.

(Extra space on the next two pages)

Month 2: ① CPR = $6\% \times \frac{17}{30} \times 2 = 0.068$

② SMM = $1-(1-0.068)^{\frac{1}{12}}$
= 0.005851352 45

③ Mortgage payment = $\frac{198751685.2}{\left(\frac{1-\frac{1}{\left(1+\frac{0.08}{12}\right)^{344}}}{\left(\frac{0.08}{12}\right)}\right)}$ = 1475021.738

$r = \frac{wac}{12} =$

$n = 345+1-n$

$12 = 345+1-2$
$= 344$

④ Interest = $\frac{0.07}{12} \times 198751685.2$
= 1159384.83

⑤ scheduled principal = $1475021.738 - \left(\frac{0.08}{12} \times 198751685.2\right)$
= 150010.5033

⑥ Prepayment = $0.005851352 45 \left(198751685.2 - 150010.5033\right)$
= 1162088.396

⑦ TP = 150010.5033 + 1162088.396
= 1312098.899

⑧ cash flow = 1312098.899 + 1159384.83
= 2471483.729

WAM = 345

WAC = 8%

coupon rate = 7%

security of 30 year

PSA = 200

(Area for Question 3)

MONTH 1:

① CPR = $6\% \times \frac{t}{30} \times 2$

$= 0.06 \times \frac{16}{30} \times 2 = 0.064$

② SMM = $1-(1-CPR)^{\frac{1}{12}}$

$1-(1-0.064)^{\frac{1}{12}}$

$= 0.005496486893$

③ Mortgage payment = $\frac{\text{outstanding}}{PVIFA(r,n)}$

$r = \frac{wac}{12} = \frac{0.08}{12} = 0.0066666$

$n = WAM + 1 - n$

$n1 = 345 + 1 - 1 = 345$

Month	Outstanding balance	CPR	SMM	Mortgage Payment	Interest	Scheduled Principal	Prepayment	Total Principal	Cash Flow
1	200,000,000	0.064	0.005496	1483173.987	1166666.67	149840.65	1098474.189	1248314.84	24149815
2	198751685.2	0.068	0.005851	1475021.73	1159384.8	150010.503	1162088.396	1312098.89	2471483.7

$\frac{200M}{\left(\frac{1-\frac{1}{\left(1+\frac{0.08}{12}\right)^{345}}}{\frac{0.08}{12}}\right)}$

$= 1483173.987$

④ Interest = $\frac{\text{coupon rate}}{12} \times \text{outstanding}$

$= \frac{0.07}{12} \times 200M = 1166666.67$

⑤ Scheduled Principal =

Mortgage payment $- \left(\frac{wac}{12} \times \text{outstanding}\right)$

$1483173.987 - \left(\frac{0.08}{12} \times 200M\right)$

$= 149840.6537$

⑥ Prepayment = $SMM\left(\text{outstanding} - \text{scheduled principal}\right)$

$= 0.005496486893\left(200M - 149840.6537\right)$

$= 1098474.189$

⑦ TP = Scheduled + prepayment

$= 149840.6537 + 1098474.189$

$= 1248314.842$

⑧ Cash flow = TP + Interest

$= 1248314.842 + 1166666.67$

$= 2414981.512$

(More space for Question 3)

Question 4 (25)

Answer the following 5 short questions, 5 points each.

5

4-1. What is the absolute priority rule? In what form of bankruptcy process does the rule hold? What is the name of another process in which the rule rarely holds?

- absolute priority rule : the principle in which senior creditors are paid in full before junior creditors are even paid anything.
- It can occur due to the liquidation of assets and that can be because the company's liabilities are paid down
- The name of another process is Reorganization.

3

4-2. A Treasury Inflation Protection Security (TIPS) carries 3% annual coupon, payable semiannually on inflation adjusted principle. The initial principle is $100,000. If the annualized Consumer Price Index in the first half year is reported as 4%, what is the coupon payment (in dollar)?

TIPS = 3%

amount adjusted Year 1 = $100000 \times 1.04 = 104000$

$\frac{TIPS}{2} \times 104000 = \frac{0.03}{2} \times 104000 = 1560$

$100000\left(1+\frac{0.04}{2}\right)(0.015)$

4-3. In a Treasury auction there are $1 billion Treasury bills for competitive bid. The bids are submitted as follows:

Bid (Bank Discount Rate as %)	Quantity (Million)
4.82	100
4.93	100
4.98	200
5.01	300 ←
5.03 ←	400
5.06	500

What is the stop-out yield? What amount does the last successful bidder get?

the stop-out yeld is the highest yield that the treasury is going to accept as a bill.

the last successful bidder gets 300M in treasury bills and 5.03 in stop-out yield

4-4. Name the three major U.S. bond rating agencies. Who pays for the bond rating services? Why is bond rating relevant to bond investors?

- Moody's
- Fitch's
- Standard and Poor's

- Corporations and entities who wish to issue bonds are the ones that pay for the bond rating services
- the bond rating is relevant to bond Investorss

4-5. Why are the yields on commercial papers higher than the Treasury bills of equal maturities?

Liquidity : commercial papers are less liquid

Risk : commercial papers are risky
Less risk for treasury bills.

taxes : no taxes in treasury bills