E 120: Principles of Engineering Economics

Midterm Exam

March 09, 2011

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Name: ————————————————————— (please print)

SID: —————————————

- **Any communication with other students during the exam (including showing, viewing or sharing any writing) is strictly prohibited. Any violation will result in a score of 0 points for the exam.**

- Clearly state all the mathematical expressions that are needed to solve the problems. **No credit will be given to numerical answers without the proper setup.**

- Answer each of the following questions in the space provided. If you need more space to show major computations you performed to obtain your answer for a particular problem, use the back of the preceding page.

- You can quote and use any result stated in class or in the main body of the textbook as well as well-known general mathematical results but **no** references to other sources (including homework and textbook exercises) are allowed.

- Present your work in an organized and neat fashion.

- Good luck!

Problem	1 (25)	2 (25)	3 (20)	4 (30)	Total (100)
Score					

1. **(25 points)**

   You took out a 30-year loan for $150,000 at an APR of 12%, compounding semiannually. The loan officer has worked out a detail monthly payment plan for you.

   (a) What is the effective monthly rate?

   (b) How much is each monthly payment?

   (c) 5 years from the time you first took out the loan, you decided to make extra monthly payments of $1000 (in addition to what you are paying now). When will the loan be paid off? (**Non-integer solution is okay**)

   Note: the extra payment starts in period 61.

2. **(25 points)** An investor is considering the purchase of zero-coupon bonds with maturities of 1, 3, or 5 years. Currently the spot rates for 1-, 2-, 3-, 4-, and 5-year zero-coupon bonds are, respectively, $0.02, 0.03, 0.04, 0.0425$, and 0.045 per year with annual compounding. A financial analyst has advised this investor that interest rates will increase during the next year and the analyst expects all spot rates to increase by the amount 0.005, so that the one-year spot rate will become 0.025 and so forth. The investor plans to sell the bond at the end of one year and wants the greatest return for the year. This problem does the bond math to see which maturity, 1, 3 or 5 years, will give the best return under two scenarios, interest rates are unchanged and interest rates increase as forecast by the analyst.

(a) What are the current prices of 1-, 3-, and 5-year zero-coupon bonds with face values of 1000?

(b) What will be the prices of these bonds one year from now if spot rates remain unchanged?

(c) What will be the prices of these bonds one year from now if spot rates each increase by 0.005?

(d) If the analyst is correct that spot rates will increase by 0.005 in one year, which maturity, 1, 3, or 5 years, will give the investor the greatest return when the bond is sold after one year? Justify your answer.
Note: Here, we define return as $\frac{P_1 - P_0}{P_0}$, where P_1 is the price of one share of bond at the end of the year, and P_0 is the price of one share of bond now.

(e) If instead the analyst is incorrect and spot rates remain unchanged then which maturity, 1, 3, or 5 years, earn the highest return when the bond is sold after one year? Justify your answer.

Note: Be aware that a bond will not have the same maturity in one year as it has now, so the spot rate that applies to that bond will change.

3. **(20 points)** On the market investors can buy and sell these bonds with face values $100:

- Bond A - maturity: 1 year, zero-coupon, price: $97.
- Bond B - maturity: 2 years, annual coupon, yield to maturity: 4%, price: $100.
- Bond C - maturity: 3 years, annual coupon, 4% coupon rate, price: $95.

Calculate the 1-, 2-, 3-year spot rates.

4. **(30 points)**

Please indicate whether each of the following statements is true or false. If it is true, explain/prove why it is true. If it is false, explain why or provide a counterexample. Credit will not be given unless an explanation is provided.

(a) We have the following information about annual coupon bonds A, B, C, and D:

   i. Bond A: price of $950, duration is 2.5 years.

   ii. Bond B: price of $900, duration is 7 years.

   iii. Bond C: price of $850, duration is 10 years.

   iv. Bond D: price of $1200, duration is 3.5 years.

Assuming all bonds have the same yield to maturity. Then a portfolio containing 1 share of bond A, 1 share of bond B, 1 share of bond C, and 1 share of bond D has duration larger than 5 years.

(b) Of the following cash flows, $(0, 1, 2, 3, 4, 5, 6, \ldots)$ has the highest present value.

   i. $(0, 1, 3, 1, 3, 1, 3, \ldots)$ at $r = 5\%$

   ii. $(0, 2, 2, 2, 2, 2, 2, \ldots)$ at $r = 5\%$

   iii. $(0, 1, 2, 3, 4, 5, 6, \ldots)$ at $r = 10\%$

(c) For any annual coupon bond, its duration is less than or equal to its time to maturity.