Managerial Finance Tutorial I EMBA 115

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Topics to Cover

- Mortgage Payments
- Saving for College
- Refinancing a Mortgage
- Annuities
- Inflation
- Saving for College II

Question 1 – Mortgage

- You are thinking of purchasing a house. The house costs $350,000. You have $50,000 in cash that you can use as a down payment on the house, but you need to borrow the rest of the purchase price. The bank is offering a 30-year mortgage that requires annual payments and has an interest rate of 7% per year. What will your annual payment be if you sign up for this mortgage?

- Construct the corresponding annuity table: for each period calculate the remaining balance on the mortgage, the interest paid, and the principal paid

Question 2 – College

- Your son has been accepted into college. This college guarantees that your son's tuition will not increase for the four years he attends college. The first $10,000 tuition payment is due in six months. After that, the same payment is due every six months until you have made a total of eight payments. The college offers a bank account that allows you to withdraw money every six months and has a **fixed APR of 4%** (interest is paid semiannually) guaranteed to remain the same over the next four years. How much money must you deposit today if you intend to make no further deposits and would like to make all the tuition payments from this account, **leaving the account empty when the last payment is made?**

Question 3 -- Refi

- You have decided to refinance your mortgage. You plan to borrow whatever is outstanding on your current mortgage. The current monthly payment is $2356 and you have made every payment on time. The original term of the mortgage was **30 years**, and the mortgage is exactly **four years and eight months** old. You have just made your monthly payment. The mortgage interest rate is 6 3⁄8% (APR). **How much do you owe on the mortgage today?**

- **Construct the corresponding annuity table to check your answer – how would you calculate the original balance on your mortgage?**

Question 4 – Annuity

- Today, Suzie Minion is celebrating her **65th birthday** and her retirement from her very fulfilling movie career (time 0). Due to her diligent savings, she has accumulated **$2 million** in savings (**at time 0**). She has no other source of retirement income. To pay living expenses during her retirement, Suzie needs to withdraw from her savings account at the end of each year (**first withdrawal at time 1**) until her death. Suzie believes that she will live another 19 years (**until age 84**) and therefore plans to make 19 withdrawals from her savings (at time 1, 2, … 19). Suppose that Suzie's retirement savings earns interest annually at a **4%** nominal rate.

Question 4 – Annuity

- If Suzie plans to make equal **nominal withdrawals**, how much can she withdraw in each of the 19 years such that her **savings account balance is zero after the 19th year**?
  - Check that balance is truly zero at t=19!

- (b) Suppose instead that Suzie wanted to make equal real withdrawals and the inflation rate is expected to be 2.3% per year. What real withdrawal can Suzie make in each of the 19 years such that her savings **account balance is zero** after the 19th year?
  - **1+Real rate=(1+nominal)/(1+inflation)**
  - Real rate=[(1+nominal)/(1+inflation)] -1

  - Check that the *nominal* balance is also zero at t=19!

- (c) According to the plan outlined in (b), how many nominal dollars does Suzie withdraw on her 75th birthday (time 10)?

- Now suppose that Suzie is worried that due to her excellent health, she might outlive her savings by living longer than 19 additional years. So, she considers taking some of her savings and purchasing a deferred income annuity. A deferred income annuity costs money today in exchange for an annuity that begins making annual payments at some future date and continues making annual payments until you die. Prices for such products being sold by a number of insurance companies are listed in the table below.

Insurance company	Male Pays $100,000 at Age 65 and Receives $xx,xxx Annually for Life Starting at Age 85.	Female Pays $100,000 at Age 65 and Receives $xx,xxx Annually for Life Starting at Age 85.
American General	$46,654	$39,725
Mass Mutual	$38,014	$32,232
Metlife	$45,841	$38,056
New York Life	$52,278	$41,141

Question 4 – Annuity

- (d) Suppose Suzie wants to protect herself from the possibility that she will live **to age 95**. In such a case, Suzie would collect **11 annuity payments** (at ages 85 through 95, inclusive) by purchasing a deferred income annuity today. Suppose Suzie does in fact live until 95. **What rate of return does she receive if she buys a deferred income annuity from Metlife?**

- (e) Suzie tells her twin brother Herb about deferred income annuities and he, too, contemplates buying from Metlife. How long must Herb live to earn a higher rate of return than Suzie?
  - Easy Way

- (f) Suppose that you were shopping for a deferred income annuity for your grandparents and you collected the various price quotes shown above. Suppose you had to decide in 5 seconds the company from which you would buy the annuity. Which company would you choose and why?
  - Remember – all the plans cost the same, and pay out at the same time.

Question 5 – Inflation

- Suppose Mr. and Mrs. Smith are both 25 years old and have just started working. The Smiths' combined annual (nominal) salary will be $80,000 at the end of this year (i.e. at age 26). Inflation is expected to be 4% per year. Currently, the nominal interest rate for borrowing and lending and for mortgages is 6.08% per year. Ignore taxes.

- (a) The Smiths decide to buy a house such that the first (nominal) mortgage payment is 40% of their combined salary of $80,000 at age 26. Given this, what is the (largest) house price the Smiths can afford if they buy a house at age 25 (time 0) and take out a 30 year mortgage with annual mortgage payments where the first payment is at age 26 (time 1)? (Annual mortgage payments are constant in nominal terms).

- (b) The Smiths expect their combined salary to increase by 1% per year in real terms and plan to work until age 65. What is the PV of the Smiths' salary income as of today (age 25)? Hint: Start by working out the real interest rate and the real value of the nominal $80,000 salary they receive at age 26.
  - Remember – the 80,000 is in time t=1 nominal dollars. We are trying to convert to t=0 dollars.
  - Remember to use real rates!

- (c) The Smiths buy the most expensive house they can afford (you worked out its price in (a)) and start thinking about retirement planning. They expect to live until age 85 and plan to live in the house until then and bequeath it to their children. They would like to consume a constant real amount, C, each year on items other than their house. The first consumption will be at age 26 and the last at age 85. What real amount, C, can they afford to consume per year based on their salary and their mortgage payments?

- Suppose now that inflation increases to 5% per year and that the real interest rate stays un affected (you calculated what it was in (b)). Let us think about how this would affect house prices. Assume that the first salary of $80,000 is unaffected by the increase in inflation.

- (d) What is the nominal interest rate (and thus the interest rate on mortgages) now using these new assumptions? What is the largest house price the Smiths can afford now if their first (nominal) mortgage payment is to remain at 40% of their combined salary of $80,000 at age 26? (Note: You have just worked out how much house prices may fall if nominal interest rates increase!)

Question 6 – College II

- You are advising a wealthy client who has a two-year-old child. The client's dream is for her child to attend an elite four-year college in her hometown (Chicago) in 16 years. However, she is concerned about the rising cost of education. You agree to help advise her.

- Your research uncovers the following information:

- An elite private university like Northwestern currently costs $70,000 per year.

- Colleges charge students at the **start of the school year.**

- College costs are expected to **grow at 5% annually** in nominal terms.

- The annual market interest rate is 4%.

  - Assume this is an **EAR [Answer will be different if you assumed it was an APR]**

- (a) Assuming that your client stops saving when her child goes to college, what is the present value of the child's college education costs as of 16 years from now? Equivalently, how much money should your client have in the bank just before her child goes to college?

- (b) Your client is considering two savings plans. The first is a lump sum payment today and the second is a monthly installment plan with fixed payments.
  - **(i) What is the size of the lump sum payment today that would finance the child's college education?**
  - **(ii) What is the size of the monthly payments (starting at the end of the month) that would finance the child's college education? Hint: What is the effective monthly rate of interest? What is the number of payments?**
    - <u>Remember, the 4% quoted previously was an EAR</u>

$$\frac{P}{r-g}\left[1 - \left(\frac{1+g}{1+r}\right)^n\right]$$

$P = First\ Payment$
$r = rate\ per\ period$
$g = growth\ rate$
$n = number\ of\ periods$

- (c) Your client's business empire grows at 0.2% a month, so she is therefore considering a monthly savings plan with this same growth rate. Assuming that she prefers a monthly installment plan, how much does she save in the first month?