

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

PROJECT EVALUATION (1.011)

Spring 2011

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Assignment 1.2 – Basic Concepts 2

Distributed: Lecture 5
Due: Lecture 9

The problems on this assignment are drawn from Martland's text, with some minor editing.

Chapter 7 (Martland)

(Problem 7.1)

1. Create a spreadsheet that you can use to estimate equivalent cash flows for an arbitrary sequence of cash flows over 50 periods. You want to be able to use this spreadsheet to convert an arbitrary sequence of cash flows into a present worth PW, a future worth FW at any time t , or an annual worth AW over N periods. You want to be able to do this using both discrete and continuous compounding factors and you want to be able to compute effective interest rates. Take some care in designing your spreadsheet so you can easily do sensitivity analysis on interest rates and N , and so you can easily print out a compact and attractive report showing results. Test your spreadsheet:
 - a. Salvage value: You are involved with a project that is expected to last 50 years and have a salvage value of \$10 million. A consultant has advised your company that an expenditure of only \$100,000 at the end of every 5 years will double the salvage value. Your company generally uses a MARR of 15%—do you buy the consultant's recommendation?
 - b. Bonds: A bond has an initial purchase price of \$1,000 and an interest rate of 6% paid at the end of each year for 30 years. At the end of year 30, the bond is redeemed and the owner is repaid the initial payment of \$1,000.

- i. What is the value of the bond at the beginning of year 6 to someone with a MARR of 7%? At the beginning of year 29?
- ii. What is the value of the bond at the beginning of year 6 to someone with a MARR of 5%? At the beginning of year 29?

(10% of assignment)

(Problem 7.6)

2. Congratulations! You have just won the Mass Millions Lottery with a jackpot of \$15 million! The prize is payable in 30 equal annual payments of \$500,000, beginning right now. If your opportunity cost is 12%, how much is this lottery really worth?

(5% of assignment)

(Problem 7.7)

3. Having won the lottery (as described in Question 6), your only (financial) problem now is that you are just 20 years old and expect to live (in grand style) for well over 30 years. How much of your first year's installment would you have to invest in order to ensure that you could earn \$500,000 per year for another 30 years after the Mass Millions bonanza comes to an end? Assume that you can invest in stock mutual funds and earn 15% per year until it is time to start the annuity. Assume that the annuity will be calculated based upon 30 end-of-the-year payments and an interest rate of 8%.

(10 % of assignment)

(Problem 7.8)

4. A student takes an education loan from a bank. He expects to borrow \$40,000 a year for the next 4 years (the first amount is drawn immediately, on 2/28/2010). The annual interest rate being charged is 8%; for the first several years, the interest is not paid, but it is added to the loan at the end of each year. He is required to repay the loan in equal annual payments starting 7 years from the date of the loan (i.e., the first payment will be made on 2/28/2017), with one payment per year for 15 years.
 - a. What will be the amount of each loan payment?
 - b. Right after making the fifth annual payment, he decides to repay his entire loan. How much will he have to pay?
 - c. How much interest will he end up paying?

(10% of assignment)

(Problem 7.10)

5. You are trying to decide whether to bid on a construction contract for a new bridge. You think that it will take 30 months to build and that construction costs will be \$2 million per month. You expect tolls to be \$10 million per year once the bridge opens, which will be offset by toll collection and maintenance costs of \$2 million per year. Your MARR is 15% per year. To bid on the project, you specify the price you are willing to pay to the state (in cash, at time 0) for the right to build the bridge and operate it for a period of 30 years. At the end of 30 years, the ownership and operation of the bridge revert to the state.
- You can obtain a construction line of credit at 10% per year that can be used to cover all the construction expenses plus all of the accrued interest. What will be the outstanding balance when the bridge is completed?
 - Once the bridge is open, you will have a steady stream of income, so that you can refinance the construction loan at a lower interest rate, say 8% per year, and pay off the loan in 30 years. What will the annual payments be on this loan?
 - What is the cash flow (toll revenue minus payments on your loan) from operating the bridge worth to you at the end of month 30 when the bridge opens?
 - What are you willing to bid for the bridge?

(18% of assignment)

Chapter 8 (Martland)

(Problem 8.8)

6. Mortgage Crisis—the Home Buyer: A bank has a policy that it will approve a mortgage for someone only if they have a steady income that is sufficient to cover the costs of home ownership. In addition to monthly payments of interest and principal, the bank requires the homeowner to make monthly payments into an escrow account that the bank will use to pay property taxes, property insurance, and mortgage insurance. The bank requires this arrangement so that it can be certain that the property taxes are in fact paid on time, that the property is insured in the case of fire or other disaster, and that the mortgage payments will be made even if the homeowner dies. The bank uses two common rules of thumb in reviewing mortgage applications. First, the buyer should make a down payment of at least 20% of the cost of house (and homeowners are not allowed to borrow this money from someone else—they must be able to produce the cash from their own resources). Second, the sum of the mortgage payment plus the escrow payment should be no more than 30% of the homeowner's income.

- a. Consider a family with annual income of \$60,000. Will they be able to obtain a 6%, 30-year mortgage for a house that costs \$100,000, has property taxes of \$3,000 per year, and will cost \$1,200 per year for property insurance and mortgage insurance?
- b. The couple decides they would like a bigger house. What is the largest amount that the bank would be willing to lend this family for purchasing a house with taxes and insurance that total \$4,200 per year?
- c. The family goes ahead and buys a bigger house for \$300,000, and they take out a \$200,000 mortgage at 6% for 30 years. After 10 years, they decide to move to California in order to get high-paying, high-tech IT jobs. If property values have risen 11% per year, how much will they be able to gain from the sale of their house? Assume that closing costs such as the real estate agent's fee will be 5% of the sale price. Also assume that a portion of the proceeds from the sale will be used to pay off a total of \$300,000, consisting of the remaining portion of their original mortgage plus the outstanding balance on their home equity loan.
- d. When they reach California, the family finds that the housing market is much more expensive than they expected, but they have all that money from the sale of their previous house, and they now make \$300,000 per year. They conclude that they really are rich, so they should buy the best house they can afford, maybe something with a view of the mountains. If they are willing to put all of their profits from the sale of their previous house into their new house, how much will they be able to afford to pay per year for mortgage and escrow payments?
- e. Unfortunately, what the bank offers is not enough for them to purchase the \$4 million house of their dreams, which has \$30,000 per year for taxes and insurance. So they decide to go to a mortgage company. What they would like is a mortgage with only a 10% down payment, so that they could afford their dream house (and, it must be added, they decided to include their expected bonuses of \$41,000 and \$72,000) in their application, stating their income as \$413,000 per year, even though they knew they were unlikely to get such good bonuses again.) They were not concerned about stretching to make ends meet, and the agent noted that the old 30% limit had been increased to 35%, reflecting the fact that housing prices were rising faster in California than anywhere else in the country. The agent and the couple agreed that even if things were tight for a couple of years, housing prices would rise, their salaries would rise, and they would be able to refinance their mortgage for an even larger amount. The agent for the mortgage company agreed to provide the mortgage under the suggested terms, and they bought their dream house. And, it turns out, the agent quietly rounded off their income to \$450,000 per year when he forwarded their mortgage application to his home office for approval. Assuming the company

required a 10% down payment and limited mortgage plus escrow to 35% of what was reported to be their income, how much would they be able to borrow?

- f. Unfortunately for our intrepid IT experts, they happened to buy their dream house at the top of the market. Three years later, housing prices had dropped by 25%. And then their company went through a massive restructuring, and both of them lost their jobs, along with a great many others in the region. Their only option was to sell the house at a loss, move back to the east, and take up their old jobs at a huge cut in pay. Approximately how much will they lose?

(32% of assignment)

Chapter 9 (Martland)

(Problem 9.9)

7. You are a summer intern working for a hot-shot project evaluation firm, and your supervisor admits to having a problem. At first he thought his project was really a terrible idea because it had only a 2% IRR; but then he discovered that it also had an IRR of 18%, which is well above the firm's hurdle rate of 10%. He checked his numbers, and the calculations (shown below) were in fact correct. He also did a few side calculations using the firm's hurdle rate of 10% (also shown below). Explain the problem, complete the analysis, and tell your supervisor whether this is a good project.

Problem 9.9 Cash Flows for a Project with Two Different IRRs

Discount rate:	1.89%							
Year	1	5	10	15	20	25	50	Total
Cash flow	-100	180	-50	-200	75	2000	-3000	-1095
NPV	-98.1	163.9	-41.5	-151.1	51.6	1253.3	-1178.1	0.0
Discount rate:	18.24%							
Year	1	5	10	15	20	25	50	Total
Cash flow	-100	180	-50	-200	75	2000	-3000	-1095
NPV	-84.5	77.9	-9.4	-16.2	2.6	30.3	-0.7	0.0

Additional calculations for these cash flows:

- Present worth of construction (year 1) plus rehabilitation (years 10 and 15) is \$183.62 million, assuming MARR of 10%.
- Future worth of all revenues (years 5, 20, and 25) will be \$36.098 billion at the end of year 50, assuming MARR of 10%.

(15% of assignment)

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