ESD.71 / 1.146 / 3.56 / 16.861 Engineering Systems Analysis for Design
Fall 2008

NPV Assignment

Context: You are a homeowner in Cambridge MA looking for a home furnace. You have to choose between a natural gas furnace and an oil burner.

Part 1 – Determine your opportunity cost of capital (OCC)

You now have $15,000 in cash.

You wish to determine your discount rate for the heating device. You evaluate this rate based on other opportunities you would have to give up in order to buy the furnace. Looking at your financial records, the following investment opportunities are available:

- Since you are an avid Patriots fan, you could buy two season tickets for $2,500 and get a 10% discount;
- You could insulate your house for $10,000, which would save about $1,500/yr in fuel cost;
- You could pay off your $50,000 30-year mortgage at a 8% yearly rate; and
- You could lend $10,000 to two MIT alums starting a new business off of their graduate research. They guarantee the amount to double in 10 years.

Given the cash available, and assuming 2% annual inflation, what is your minimum OCC for the heating device?

Part 2 – Choice of technology

Assume that both the natural gas burner costs $ 6,000 and the oil burner only $5,000. Based on U.S. average heating consumption census data[1], you estimate your annual house consumption to about 60 million BTUs. You also estimate the natural gas and heating oil prices using today's spot price on the New York Mercantile EXchange (NYMEX) [2] -- as of the day you are doing the exercise. Since you really enjoy Cambridge, you plan on living here for the next forty years.

1. Since other investment opportunities would provide a return at least equal to your OCC, you use this rate to discount future expenses and find the cost NPV for each technology choice.

2. As done in the Asphalt vs. Concrete lecture, quantify the effect of the choice of discount rate over time. Using Data Tables in Excel®, measure the NPV difference between the two technologies ($NPV_{gas} - NPV_{oil}$) for discount rates between 0% and 25%.

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[1] http://www.eia.doe.gov/emeu/recs/recs97_ce/t2_4c.html
[2] Suggested website: http://www.oilnergy.com/1gnymex.htm. Note that 1 gallon of heating oil is equivalent to 139,000 BTUs.

3. For low discount rates, which technology is best? As the discount rate increases, is it as obvious which one to choose? Discuss the effect of the discount rate on investment choice. How does that relate to technology and policy making?

4. Cut the valuation horizon to twenty years. Using your OCC, how is the NPV affected? Why? For discount rates between 0% and 25%, what do you observe?

Purposes of the assignment:
   1) Determine your OCC and use it in technology investment decision.
   2) Get acquainted with typical NPV calculations.
   3) Get practical feel for the long-term effect of discount rate on choice of technology.
   4) Realize that policy-makers and/or designers may affect this choice through selection of discount rate.