IEOR E4706 Foundations of Financial Engineering
Martin Haugh Due: 6pm Monday 5^{th} December 2016

Assignment 9

1. **(Evaluating a More Complex Option on the Simplico Gold Mine)**
   Compute the value of the enhancement option of Example 1 in the "*Introduction to Real Options*" lecture notes when the enhancement costs \$5 million but raises the mine capability by 40% to 14,000 ounces at an operating cost of \$240 per ounce. Moreover, due to technological considerations, you should assume that the enhancement (should it be required) will not be available until the beginning of the 5^{th} year.

2. **(Rough and Ready Calculations are Often Useful!)**
   Returning to the Simplico gold mine example, we saw in the lecture notes *Introduction to Real Options*, that the value of the lease (without the enhancement option) was \$24.1m. Without building a lattice, how could you quickly verify that this price was (approximately) correct? Or to put it another way, can you find a quick way to estimate the price of the lease without building a lattice and using backwards evaluation?

3. **(Utility Indifference Pricing)**
   Read Section 19.8, *"Buying Price Analysis"*, in Luenberger. (A PDF of this section has been posted on Canvas.) This material explains a widely used approach for determining the so-called *buying-price* for a project whose cash-flows depend on both market and private uncertainty with the (fairly reasonable) assumption that the market uncertainty is complete and the additional assumption that the decision-maker has exponential utility. This approach is suitable for projects that need to be purchased in full or not at all. More specifically, the buying price is defined to be the lump sum time $t = 0$ payment that makes the maximum expected utility from the project's cash-flows (allowing for dynamic trading in the financial market) equal to the maximum expected utility without the project (again allowing for dynamic trading in the financial market).

   A similar definition can be given for the selling price and under the assumptions given above, the buying and selling prices will be identical. See Smith and Nau (*Management Science*, 1995) for further details.

   Note that Exercise 4 below does not involve a financial market. It therefore only requires the material in Section 19.8 of Luenberger up to and including Example 19.6.

4. **(Automobile Choice: Exercise 19.9 from Luenberger)**
   Mr Smith wants to buy a car and is deciding between brands A and B. Car A costs \$20,000, and Mr Smith estimates that at the rate he drives he will sell it after 2 years and buy another of the same type for the same price. The resale price will be either \$10,000 or \$5,000, each with probability .5, at the end at each 2-year period. Car B costs \$35,000 and will be sold after 4 years with an estimated resale price of either \$12,000 or \$8,000, each with probability

.5. The yearly maintenance costs of the two cars are constant each year and identical for the two cars. Mr Smith has an exponential utility function with risk aversion coefficient of about $a = 1/\$1,000$ now. Real interest is constant at 5%. Which car should he decide is better from an economic perspective over a 4-year period, and what is the certainty equivalent of the difference?