COST-BENEFIT ANALYSIS
Exercise 3. Incorporating Risk

Answers to this exercise are due back by class on Wednesday, May 6, at jhaughton@suffolk.edu.

1. High-Yielding Rice

A farmer is considering planting a new rice hybrid on a hectare of land. By purchasing seeds from a reputable source – you need the equivalent of quarter of a tonne of rice, at the market price – applying more water (cost of $20), working longer hours (an extra $16 worth of time, equally divided between the two periods) and applying an extra 0.6 tonnes of fertilizer, the farmer can expect to get an extra 1.5 tonnes of paddy rice. Fertilizer is expected to cost $237.18 per tonne, and the farmer believes that the paddy rice can be sold for $432.25 per tonne. The seeds need to be purchased in January, when the crop is planted out; labor is needed in equal amounts for planting (January, period 1) and harvesting (May, period 2); and the extra water will be needed in May. The revenue will accrue in May when the crop is sold. The annual cost of funds to the farmer is 20%.

a. What is the expected net present value of this project?
b. Conduct a sensitivity analysis. Vary each of the major variables by 10%, and create a table that shows how each of these changes affects the NPV of the project, and another with the “NPV elasticities”. To which variables is the NPV most sensitive?
c. Conduct a scenario analysis. Here are the scenarios:
   i. Optimistic outcome. Yield increase is 1.7; price of paddy rice is 25% higher; fertilizer costs are 35% lower.
   ii. Middle-of-the-road-outcome. This is the base case.
   iii. Pessimistic outcome. Yield increase is 1.2; price of paddy rice is 30% lower; fertilizer costs are 35% higher.
   Present the results, and comment on their usefulness.
d. Undertake a Monte Carlo (risk) analysis, using Oracle Crystal Ball.
   i. For the price of paddy rice, assume a Minimum Extreme Distribution with a likeliest value of $432.25 and a scale parameter of $44.
   ii. Download information on the price of urea fertilizer from here:
      http://www.indexmundi.com/commodities/?commodity=urea&months=60
      Fit a distribution to these data, and use this distribution in your analysis. The information gives the price of urea fertilizer in dollars per tonne.
   iii. The yield increase is beta distributed, with alpha=4, beta=2, and values ranging from 0 to 2.
   iv. Download information on the price of rice from
      http://www.indexmundi.com/commodities/?commodity=rice&months=60
      and compute the correlation coefficient between these prices and the price of urea. Use this correlation coefficient in your analysis.
   Use 100,000 simulations, and present the results, including a sensitivity analysis (i.e. a tornado graph).
e. Should the farmer grow high-yielding rice? Explain your reasoning.
f. Compare the expected NPV in a. with the expected NPV in b. Why do they differ (if they do)?
g. [Optional] Now suppose that for a premium of $40 payable at the start of the harvest season, the National Cereal Bank will provide the farmer with \((1.3-X)\) tonnes of paddy rice whenever \(X<1.3\), where \(X\) is the incremental yield of paddy rice. In other words, if the harvest is good, the farmer receives nothing from the Cereal Bank, but if the harvest is bad, the bank will make up the difference (up to 1.3 tonnes). What effect would this have on the risk and return for the project? Is the policy sustainable?

h. [Optional] If you were a farmer, would you buy the insurance? Justify your answer.

i. [Optional] Concerned about volatile rice prices, the government will provide rice price insurance. If the price of rice falls below $350/tonne, the government will make up the difference. For instance, if the market price is $300 per tonne, the government will pay the farmer $50 per tonne. The cost of this insurance is $25, payable at the start of the harvest. Should the farmer buy this insurance? Justify your answer.

j. [Optional] Has the government set the cost of rice-price insurance too high or too low, if the payoff is to be actuarially fair? Explain.

2. Risk Distributions

a. You have been asked to undertake a cost-benefit analysis of a project that would drill for oil off the coast of Nigeria. For each of the following, indicate which form of distribution you would apply to the risks, and why:
   a. The amount of crude oil found in an oil field.
   b. The risk of a coup d'état in Nigeria.
   c. The world price of crude oil.

b. You are trying to estimate the value of the CFA franc (in CFA/USD) for 2021, which is currently 605 CFA/USD. The exchange rate will depend on the resolution to the COVID-19 crisis, the speed of economic growth, the reactions of other countries, and other factors. For your estimate, you will rely on the views of 3 experts. Gather information from three “experts” and combine them into an appropriate risk distribution. Comment on the plausibility of the results, and set out the details of the methodology you used. [Hint: The experts could be faculty or students in economics or a relevant field, or even family or friends (for this exercise at least). The experts may need to be provided with some background information, to help them make an informed judgment.]