OPTIMUM CAPACITY EXPANSION -- INTRODUCING UNCERTAINTY (Part 1)

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GOALS:

1. To introduce uncertainty in the capacity expansion problem and identify possible solutions
2. To practice simulation tools and understand their use in decision making

GENERAL PROBLEM DESCRIPTION:

So far you have defined optimal policy based on different but known demand growth scenarios. However, in real life you won't be able to know in advance the demand growth with certainty. You will often forecast a demand growth pattern and decide your policy in advance based on your forecasts. In this exercise you will forecast a demand growth of 5 units/year/year and you will have to define your policy according to the optimum strategy suggested by the base case model. This way you will check how uncertainty affects the optimum policy calculated with certain demand scenarios. The actual demand growth pattern is moving randomly between two growth rates (8 and 2 units/year/year with equal or different probabilities). So in this exercise you will find an optimum policy under uncertain demand growth patterns.

PROBLEM OUTLINE:

In this exercise you will experiment with a new "simulation model" (Optimal Capacity Expansion simulation 1.xls) built upon the base case model. Click here to access the simulation model. Under an uncertain demand growth pattern the model samples randomly between the two growth rates every time you press F9, calculating a different NPV each time. Using 10,000 samples of different possible NPVs a graph of the distribution of costs and a graph of the cumulative probability of the costs have been created. You will use these graphs to make observations on costs and benefits of adopting particular policies.

Based on the knowledge you have gained so far on the capacity expansion problem you will try to compare different strategies under uncertainty. Hence,

- You will compare the distribution of NPVs using a fixed small (20 units/year) versus a fixed large (70 units/year) plant size with equal and different probabilities of growth rates.

ACTIONS:

Open the simulation model and in the worksheet fixed policy enter the following assumptions in the green cells.

1. Start with equal probabilities (50%, 50%), growth rates 2 and 8 units/year/year, and a fixed plant size of 35 units/year which is the optimum size suggested by the base case model under average growth rate of 5 units/year/year. Note that every time you press F9 a new random growth scenario is generated and a new value for NPV is calculated. Hence, observe the distributions and the average NPV of 10,000 samples.
2. Enter plant sizes 20 and 70 (units /year) and observe how the graphs change with alternative plant sizes.
3. Change the probabilities of growth rates to 80% for the smallest growth rate and 20 % for the biggest growth rate and repeat steps 1 to 2 above. Note that the average growth rate is no longer 5%. The first round considered variability in timing of growth, this round looks at variability in the growth rate itself.

DISCUSSION QUESTIONS:

1. How do the distributions of NPVs compare with each other with 35 units/year, 20 units/year and 70 units/year? (Hint: focus on average NPVs and values at the extremes).
2. How do these policies compare when the probability of the smallest growth rate has changed to 80%?
3. What is the optimum strategy under uncertainty?

TAKE AWAY:

1. By building a fixed smaller plant size through the time horizon you need to build sooner. This will not affect very much the distribution of costs on average but will introduce long tails in the cumulative distribution which mean that the project becomes riskier. Although there is a small possibility to incur extremely low costs there is also a small possibility of incurring very large costs. This should become clear when you superimpose the cumulative distribution curves on each other.
2. Under uncertainty there is not only one optimum strategy. The best strategy depends on the risk perception and unique concerns of each decision maker given a distribution of possible costs.