Chapter 6. Developing Venture Strategy Using Simulation

Questions and Problems

Note: You should be familiar with using simulation software @RISK or Crystal Ball before attempting these problems. Problems or parts of problems requiring simulation are denoted "SIM".

1. **SIM** A new venture requires $15,000 per month during its prototype development stage. Development time is represented by a triangular distribution with minimum, most likely, and maximum values of 2, 10, and 24 months. Use simulation to estimate how much funding the entrepreneur should raise if he wants to have sufficient capital to meet 75% of the development outcomes?

2. **SIM** Cool Rinks builds and operates outdoor ice skating facilities. They are in the process of evaluating expansion opportunities.

    a. The first option is a new location in Indiana. For the business to be profitable, the average daily temperature needs to be below 32° more than 75% of the time during the 90-day skating season. At the site being considered, the average daily temperature during the season is normally distributed with a mean of 25° and a standard deviation of 11°. Is Indiana a promising market for Cool Rinks?

    b. Now assume Cool Rinks has a second location under consideration in Utah. It is colder, with the average daily temperature during the season normally distributed with a mean of 14° and a standard deviation of 10°. In addition to the 32° requirement, the company projects that a site will not be profitable if more than 40% of the days have an average temperature below 10°. How does the Utah site compare to Indiana as a potential location for a new rink?

3. **SIM** You are planning a new restaurant and have located a site that will accommodate seating and parking for 400 customers. Nightly demand is estimated by a triangular distribution with minimum, most likely, and maximum values of 150, 300, and 600. Use simulation to estimate the percentage of the time this site will be sufficient to meet demand.

4. You have spent the last six months developing a new product for treatment of arthritis. You believe a breakthrough could occur at any time during the next eight months and that the probability of success in any given month is about 10%. If you do not succeed within that eight-month period, you have decided to abandon the project. In the event that your efforts are successful, the clinical testing required for FDA approval will take six to ten additional months from the time of development success. Based on prior experience, if development efforts are successful, there is an 80% probability that approval will be granted. Notice of approval or disapproval in any month is equally likely. During development, your venture has been consuming cash at an average rate of $30,000 per month. You estimate that in any given month there is a 30% probability that the cost will be only $20,000 and a 20% probability that it will be $45,000. The cost of financing the venture will be much lower once FDA approval is obtained. The problem is that you need additional financing right now.

    a. Suppose you want to provide enough financing for the worst case successful outcome. How much money should you raise? (Simulation is not needed to address this.)

    b. **SIM** Construct a simulation model of the development process and use it to determine how much you should raise now so that the probability of running out of money before the FDA acts is 25% or lower.

c. Suppose the cost of financing would also be lower after development was completed. How could you use simulation to determine the best way to stage the financing of the venture? What factors would affect your choice of when and how much capital to raise?

5. **SIM** An entrepreneur who would like to open a retail facility similar to the one discussed in the chapter has approached you. By coincidence, it is the same entrepreneur whose decisions we have been studying. The entrepreneur is offering 1.0% of the equity of the venture for each $10,000 you invest and will contribute $400,000 to the project. Suppose you agree with the entrepreneur's assumptions, as set out in Figure 6.6 for the large facility and elsewhere in the chapter for the small facility, including the PV assumptions. Use simulation to examine the opportunity from your perspective instead of the entrepreneur's (editable model files are available on the website).

   a. What is the NPV of your investment in the large facility if there are no options and investment is immediate?

   b. What is the NPV of your investment in the small facility if there are no options and investment is immediate?

   c. How do the abandonment options with exercise values of $600,000 for the large and $300,000 for the small facility affect the NPVs of your prospective investments?

   d. Suppose that to acquire an abandonment option for either facility, the expected cost is $20,000 higher (which you would pay in exchange for an additional 2.0% of the equity). Would you want the entrepreneur to acquire the option?

   e. Suppose the entrepreneur proposes to initially build the small facility and if expected demand turns out to be more than 300,000 units, to expand capacity to the same as the large facility. The cost of expanding is $300,000, and the entrepreneur proposes that you contribute this in exchange for an additional 15% of the equity. Based on the simulation, would you want to accept this proposal? Why or why not? Is there another alternative under which the entrepreneur could exercise the expansion option that you would find more attractive?

6. **SIM** The monthly standard deviation of the S&P 500 Index is 6.8%. The expected return for investing in the Index is 1.0% each month.

   a. Suppose you invest $100 in the Index today:

      (i) Use simulation to estimate the expected value of the index investment at the end of three months and the standard deviation of the ending value (at that point).

      (ii) What are the estimates of expected value and standard deviation at the end of nine months?

   b. Suppose, instead of investing $100 in the Index, you are interested in an option on an underlying $100 claim on the Index (i.e., the underlying claim has a market value of $100, the same as in part a.

      (i) What is the expected value in three months of a three-month call option with an exercise price of $100, and what is the corresponding standard deviation of possible values?

      (ii) What is the expected value in nine months of a nine-month call option with an exercise price of $100, and what is the standard deviation?

      (iii) What is the expected value in three months of a three-month put option with an exercise price of $100, and what is the corresponding standard deviation of possible values?

(iv) What is the expected value in nine months of a nine-month put option with an exercise price of $100, and what is the standard deviation?

(v) What is the expected value in nine months of a nine-month call option with an exercise price of $80, and what is the standard deviation?

7. Think about an aspect of your current situation (possibly related to your career, education, or personal life).

   a. What are the most important decisions you will have to make as you go forward?

   b. Try describing the alternatives in terms of a decision tree.

   c. What real options are reflected in the choices you will have to make?

   d. The outcomes of the different branches of the tree should be describable in terms such as dollars, utility, and happiness. See if you can write a model, similar to the one in the chapter, which describes how the outcomes relate to your possible choices.

   e. Now, supposing that you wanted to simulate the results of your decisions, how might you go about specifying the assumptions of your model?

   f. **SIM** If you feel ambitious, try setting up the model in an Excel spreadsheet and use simulation to evaluate the choices. (Feel free to take some liberties with the specific assumptions.)

8. Refer to the facility example in the chapter. "If the investor is astute, the terms of the deal will be different for the large facility than for the small one." Why and how do you think they might be different?

9. The origin of the term "real options" is traceable to Professor Stewart Myers ("Determinants of Capital Borrowing," *Journal of Financial Economics*, 1977), who noted that many corporate real assets can be viewed as call options. What do you think he means? Why might it be useful to think of corporate real assets as call options? Provide examples to illustrate your answer. Try to identify, at least conceptually, the underlying asset, the exercise price, and the expiration date.

10. **SIM** Reevaluate the local delivery service example in Section 6.4.

    a. Using simulation, estimate the expected NPV if Year 1 revenue is assumed to be drawn from a triangular distribution with minimum of 65,000, mode of 95,000, and maximum of 125,000?

    b. Using simulation, what is the expected NPV if, in addition to the change in part (a), variable cost is assumed to be normally distributed with a mean of 45% and standard deviation of 3%?

11. **SIM** The common stock of Unron is selling today for $50 per share. The stock is expected to appreciate at a rate of 1.0% per month with a standard deviation of 15.0% per month. As an Unron employee, you have just been awarded executive stock options to acquire 1000 shares. The options have an exercise price of $50 but cannot be sold or exercised for 5 years (60 months). The monthly risk-free rate is 0.3%.

    a. Construct a spreadsheet to simulate the price of Unron stock at the end of the five years and the value of the call option at expiration. Run the simulation and plot the results for the stock price.

    b. How likely is the option to be in the money at expiration?

    c. What is the expected stock price in five years? What is the expected value of the call option at that time?

d. As you cannot trade the options, you cannot use conventional option pricing models to determine their value. What is the present value of the options if you discount their expiration-date value by 1.0% per month? What is it if you discount by the risk-free rate?

12. Download the Black-Scholes Option Value Template from the text website and use it to value the following options on Unron stock (see Question 11):

    a. One-year calls with exercise price of $50.

    b. One-year calls with exercise price of $40.

    c. One-year puts with the same exercise prices.

    d. Six-month calls and puts with the same exercise prices.

    e. For one-year puts and calls with exercise price of $50, how does value change if the risk-free rate increases to 0.5% per month?

    f. For one-year puts and calls with exercise price of $50, how does value change if the monthly standard deviation decreases to 10%?

    g. Discuss the consistency of your findings with the principles of option valuation.

13. **SIM** For the facility example in the Chapter 6, evaluate the combined effects of the following assumption changes on the values of the large and small facilities and the effects of the various options on value: (i) The standard deviation of unit prices is $2. (ii) The preliminary market size estimate has a triangular distribution with (8, 2.6, and 0.5 million units). (iii) The preliminary estimate of market share has a standard deviation of 2.0%.

    a. How do these assumptions of increased risk affect the optimal strategy?

    b. Why do you think the effects are as you find them to be?

14. **SIM** For the retail facility example in Chapter 6, evaluate the combined effects of the following assumption changes on the values of the large and small facilities and the effects of the various options on value: (i) The expected variable cost per unit is $4. (ii) Expected fixed cost of the large facility is $750,000. (iii) Expected fixed cost of the small facility is $600,000.

    a. How do these assumptions about the variable and fixed cost structures affect the optimal strategy?

    b. Why do you think the effects are as you find them to be?