

**Chapter 12. Designing and Valuing Staged Investment with Real Options**

**Questions and Problems**

1. A software venture you are planning to undertake will need outside capital of \$500,000 per year for four years, beginning at Time 0. Your business plan, which reflects a success scenario, includes a projection of negative earnings of \$400,000 per year during the first three years of development. By the end of Year 4, your plan shows earnings before interest and after tax (EBIAT) of \$1.5 million. You are projecting acquisition by an established software firm at the end of Year 4 and you have estimated that the typical earnings multiple of comparable acquisitions is 8 times. So you are projecting that in the success scenario continuing value as of Year 4 will be \$12.0 million. If you raise all of the needed capital at time 0, the funds can be invested at a rate of 4% per year until they are needed.

Download a copy of Table 12.1, "Valuation Template 6," modify it to use on a four-year project, and use it to summarize the essential information about the venture. The Investor Valuation and Ownership Allocation panel of table 12.1 shows hurdle rates for investments made each year. The rates are consistent with the VC Method rates an investor might use.

How much equity will the outside investor need to provide at Time 0? Based on the Venture Capital method, how much of a dollar-valued return would the investor seek? Assuming your estimate of harvest value is correct, what fraction of the equity would the outside investor seek?

2. Consider the information from problem 1 again. Suppose that instead of investing only at Time 0, the investor proposes to contribute the capital in two stages, an initial investment at Time 0 and a follow-on at Year 2. The amounts to be invested would be enough to fund the operation until the next round or until harvesting. Download a copy of Table 12.1, "Valuation Template 6," modify it to use on a four-year project, and use it to summarize the essential information about the venture.

What amounts will need to be invested at Time 0 and Year 2. What dollar return at Year 4 will the investor require for making the Time 0 investment? What fraction of ending value does this represent? What dollar return at Year 4 do you expect the investor to require for making the Year 2 investment? What fraction of ending value does this represent? Taking account of the dilutive effect of the Year 2 investment, what fraction of equity at Time 0 will the investor require for the Time 0 investment?

3. An entrepreneur expects to need a total of \$5.0 million in investment capital from a super-angel investor, \$2 million now (with a burn rate of \$1 million per year) and an additional \$3 in 2 years (also with a burn rate of \$1 million per year). The probability that the venture will be fully successful is 50%, the probability of success only in Round One is 30%, and the probability of complete failure is 20%, and would return nothing.
  - a. Table 12.3 can be used to compute the expected harvest cash flow and standard deviation of cash flows at each investment round. The expected cash flow and standard deviation by round will become inputs to the valuation. Panel A of Table 12.3 also shows the "burn-rate" assumption for each stage and the expected duration of the stage. Download the table and modify it as needed to compute the Round One and Round Two expected cash flows and standard deviations, and to calculate the present value of the unconditional investment and the expected investment, taking account of the success probabilities.

- b. Under the assumptions from Table 12.3, the investor would consider irrevocably committing all of the needed capital at Time 0. The entrepreneur would use the money to achieve as much success as possible. Table 12.5 can be used to compute the value of the venture from the perspective of the super-angel as a well-diversified investor. Assume that the risk-free rate is 4% per year, the annual market rate is 10%, and the one-year standard deviation of market returns is 18%. The venture's correlation with the market is estimated to be 30%. Since the angel is investing his own money, there is no management fee and no carried interest. Download Table 12.5 and modify it to compute the super-angel's ownership requirement if the investment is all made at Time 0. What is the value of the venture at Time 0? What fraction of the equity would the investor require to justify investing?
  - c. Using the information you developed in part a, download Table 12.6 and modify it to compute the expected values of the venture at each round. What is the estimated value of the venture at the time of Round 1 investment? What is it at the time of the Round 2 investment (if it occurs)? How does the investor's cost of capital change from Round 1 to Round 2?
  - d. Download Table 12.7 and use it with the valuation results from Table 12.6 to determine the minimum equity the investor would need at each stage. What percentage of equity would the investor seek at a minimum in Round 1? What percent in Round 2. If both rounds are invested, what overall percent of equity would the investor seek?? How does this compare to the percentage the investor would seek for investing unconditionally in Round 1?
4. Consider a venture to develop a new video game system for babies. The system is designed to be installed in child-safety car seats. If everything goes according to the entrepreneur's plan, the venture can achieve sales of \$10 million in four years. At that point, based on market information for similar companies, the venture could be offered to the public at a multiple of 6 times annual sales. To complete development of the venture, the entrepreneur anticipates needing \$1 million in capital immediately, \$1.5 million in year 1, \$2 million in year 2, and \$3 million in year 3. Capital that is raised in advance of when it is needed can be invested to earn an annual return of 5%.
    - a. Suppose the investor uses hurdle rates of 75% for current investment, 60% for year-1 investment, 45% for year-2 investment, and 30% for year-3 investment. How much capital does the entrepreneur need if all of the investment is provided now? How much of the equity would the investor require for making such an investment?
    - b. Now, suppose the investor would make annual contributions of the needed amounts of capital (in four stages). How much of the equity would the investor require at each stage? Assuming that the venture is successful and that its projections are on target, how much of the equity would the investor ultimately require?
    - c. Finally, suppose the venture survives but is significantly less successful than the entrepreneur projects it to be. At the time of the year-1 investment, the revenue projection is reduced to \$9 million, at the time of the year-2 investment, it is reduced to \$7.5 million, and at the time of the year-3 investment, it is reduced to \$6 million. All other assumptions are unchanged. What fraction of the equity would the investor ultimately require?
  5. Suppose that for the venture described in problem 4, the projected sales level in year 4 is of a success scenario. It is equally likely that the venture will have sales of \$2 million at that point. Suppose the investor makes the entire cash commitment at time zero. The entrepreneur plans to contribute \$400,000 of human capital, from his total wealth of \$1.5 million, and will invest the balance in the market. The expected market return is 11% per year. The market standard deviation

- is 20% per year. The correlation between the venture and the market is .25. Suppose the investor and the entrepreneur both receive equity claims.
- a. Assume the market for outside investment capital is highly competitive. How much would the investor require in exchange for the investment? What is the NPV of the investor's interest? What is the NPV of the entrepreneur's interest in the venture?
  - b. Now, assume that there is only one suitable investor for the venture and that there are dozens of other people who could develop the concept just as effectively as the entrepreneur. How much equity would the entrepreneur require, at a minimum? What is the NPV of the entrepreneur's interest? What is the NPV of the investor's interest?
  - c. Finally, suppose the investor provides the capital at time zero in exchange for a certain payment at year 4, with an annual return of 10%. How much is the payment the investor will require? What is the NPV of the investor's financial claim? What is the NPV of the entrepreneur's financial claim?
6. Continue with the same venture as in problems 4 and 5. Try to design a contract for second-stage investment by the investor at year 2. Initially, the investor would contribute enough for the first 2 years. Later, the investor would contribute enough for the last 2 years. Suppose that at the time of the second-stage investment, the investor will know that the probability of the success scenario is either 0.8 or 0.2. Assume that if no second-stage investment is made, the venture is terminated with no liquidation value.
- a. Try to select equity stakes of the investor so that the investor will invest if success is likely, but not if failure is likely, and such that the investor's overall decision has a NPV of zero. To do this, you need to compare the investors NPV from investing or not investing in both the success and failure scenarios. Also, you need to value the investor's claim with rational exercise of the stage-two option.
  - b. What is the value of the entrepreneur's financial claim on the venture?
7. Now, continuing problems 4 through 6, suppose a third investor, who has no other investment in the venture, provides the second-stage investment in the previous problem.
- a. Determine the amount of equity the second-stage investor would require to achieve a NPV of zero for investing if success is likely.
  - b. Determine the amount of equity the first-stage investor would require to achieve a NPV of zero, assuming the probability of second-stage investment is 0.5.
  - c. What is the value of the entrepreneur's residual position?
8. **SIM** Continue with 7 problem and assumptions, except use simulation to evaluate the venture instead of discrete scenarios. Suppose expected sales potential in year 4 is \$6 million and is normally distributed with a standard deviation of \$5.657 million. Assume that market value at the end of year 4 is 6 times potential sales revenue, as long as potential sales revenue is positive, and zero otherwise.
- a. Suppose the investor provides all outside capital at time zero. How much equity would the investor need to achieve a NPV of zero?
  - b. What would be the resulting value of the entrepreneur's claim?
9. **SIM** Suppose, in problem 8, that a second-stage investment can be made at year 2. The investment decision depends on a forecast of year-4 sales, which is made at year 2. Assume that the expected

forecast in year 2 is that sales potential will be \$6 million and that the forecast has a standard deviation of \$4 million. Assume, further, that the actual sales level in year 4 is drawn from a normal distribution with expected value equal to the forecast and a standard deviation of \$4 million.

- a. Suppose a new well-diversified investor who requires a zero NPV makes the investment. What fraction of the equity would the investor need to justify investing whenever the simulated forecast of sales is at least \$4 million? \$6 million?
- b. Suppose the first-stage investor also requires a zero NPV. How much equity would the first-stage investor need at time zero if the second-stage investor invests whenever the forecast of sales is \$4 million? \$6 million?
- c. In both cases, how much equity does the entrepreneur retain? What is the NPV of the entrepreneur's interest?
- d. How would you recommend that the entrepreneur try to determine the optimal amount of equity to offer the second-stage investor?