Real Options: Investment Timing, Growth, and Flexibility

In Chapter 12, Sections 12.7 and 12.8, we presented an overview of real options and discussed how to analyze abandonment options. However, there are several other types of real options: investment timing, growth, and flexibility options. We discuss these real options in this Web appendix.

Investment Timing Options

A conventional NPV analysis assumes that projects will either be accepted or rejected, which implies that they will be undertaken now or never. However, in practice companies sometimes have a third choice—delay the decision until later, when more information becomes available. Such investment timing options can affect a project’s estimated profitability and risk.

To illustrate timing options, assume that Williams Inc. is considering a project that requires an initial investment of $5 million at the beginning of 2006 (or t = 0). The project will generate positive net cash flows at the end of each of the next four years (t = 1, 2, 3, and 4). However, the size of each annual cash flow will depend on what happens to market conditions in the future. Table 12G-1 shows two decision trees that illustrate the problem. As shown in the top section, there is a 50 percent probability that market conditions will be strong, in which case the project will generate cash flows of $2.5 million at the end of each of the next four years. There is also a 50 percent probability that demand for the product will be weak, in which case the expected annual cash flows will be only $1.2 million.

The expected value is found as a weighted average of the NPVs of the two possible outcomes, with each outcome’s weight being its 50 percent probability. The expected NPV, if the project is undertaken today, is $0.864 million. As the project has a positive NPV, it appears that the company should proceed with it, even though there is some risk, and there is a 50–50 chance that it will actually turn out to be a loser.

However, suppose Williams can delay the project until next year, when more information will be available about market conditions, before making the decision. If conditions are good, the firm will proceed, but if they are bad, it will not make the investment, hence the NPV will be zero. The probability of each outcome is 50 percent, and the expected NPV is $1.462 million, almost twice that as if we go ahead right now and possibly have the low cash flows under the bad conditions. Note, though, that if the firm waits, the expected NPV will come a year later. Therefore, we discount the expected NPV under the delay option at the WACC to get an adjusted NPV of $1.329 million. Because this exceeds the NPV under the proceed immediately decision, Williams should delay the project for a year.

When making go versus wait decisions, financial managers need to consider several other factors. First, if a firm decides to wait, it may lose strategic advantages associated with being the first supplier in a new line of business, and this could reduce the cash flows. On the other hand, as we saw in the preceding example, waiting may enable the company to avoid a costly mistake. In general, the more uncertainty there is about future
market conditions, the more attractive it becomes to wait, but this risk reduction may be offset by the loss of the “first mover advantage.” Again, any such first mover advantage can be compared with the value of the option.

**Growth Options**

We can illustrate growth options with a distribution center in mainland China being considered by the Crum Corporation. An investment of $3 million would be required at t = 0. Under good conditions the project would generate cash flows of $1.5 million during each of the next three years (t = 1, 2, and 3), but under bad conditions its cash flows would be only $0.75 million. There is a 50 percent probability of each outcome. Crum uses a WACC of 12 percent for international investments.

As shown in the top section of Table 12G-2, the distribution center’s NPV is −$0.298 million, so under a traditional analysis it would be rejected. However, Crum believes that if it invests in the distribution center and conditions are good, it will gain experience that will give it the opportunity to make another investment in China. The new venture would cost $10 million at t = 2, and it could be sold for cash one year after it is completed, at t = 3, for $20 million.

As we show in the top section of the table, taken alone the distribution center does not appear to be a good investment. However, when the growth opportunity is considered, the project has a positive NPV and thus should be accepted.

**Flexibility Options**

Many projects offer flexibility options that permit the firm to alter operations depending on how conditions change during the project’s life. Typically, inputs,
outputs, or both can be changed. BMW’s Spartanburg, South Carolina, auto assembly plant provides a good example of a flexibility option. BMW needed the plant to produce sports coupes. If it built the plant configured optimally to produce these vehicles, the construction cost would be minimized. However, the company thought that later on it might want to switch production to some other type of vehicle, and that would be difficult if the plant were designed just for coupes. Therefore, BMW decided to spend additional funds to construct a more flexible plant, one that could produce several different models should demand patterns shift. Sure enough, things did change. The demand for coupes dropped, while the demand for sports utility vehicles soared. But BMW was ready, and the Spartanburg plant is now spewing out hot-selling SUVs. The plant’s cash flows are much higher than they would have been without the flexibility option that BMW “bought” by building a more flexible plant.

Electric utilities provide a good example of building input flexibility into their capital budgeting projects. Utilities can build plants that generate electricity by burning coal, oil, or natural gas. The prices of those fuels change over time depending on developments such as actions in Iraq or Iran, changing environmental policies, and weather conditions. Some years ago, virtually all power plants were designed to burn one type of fuel because this resulted in the lowest construction cost. However, as fuel cost volatility increased, power companies began to build higher-cost but more flexible plants, especially ones that could switch from oil to gas and back again, depending on relative fuel prices.

Flexibility options tend to reduce the risk of a bad outcome, and this increases the expected NPV and reduces risk. Of course, flexibility options do have costs, but those costs can be compared with the benefits of the options as we have demonstrated in the examples presented.
**QUESTIONS**

12G-1 Briefly describe what investment timing options are and why they are valuable.

12G-2 Explain why the following statement is true: “In general, the more uncertainty there is about future market conditions, the more attractive it is to delay the decision.”

12G-3 If a firm fails to consider growth options, would this cause it to underestimate or overestimate projects’ NPVs? Explain.

12G-4 What are “input flexibility options” and “output flexibility options?”

12G-5 How do flexibility options affect projects’ NPVs and risk?

12G-6 Explain in general terms what each of the following real options is and how it could change projects’ NPVs relative to what would have been estimated if the options were not considered and their corresponding risk.
   a. Abandonment
   b. Timing
   c. Growth
   d. Flexibility

12G-7 Would a failure to recognize growth options cause a firm’s actual capital budget to be above or below the optimal level? Would your answer be the same for abandonment, timing, and flexibility options? Explain.

12G-8 Companies often have to increase their investment costs to obtain real options. Why might this be so, and how could a firm decide if it was worth the cost to obtain a given real option?

**PROBLEMS**

12G-1 **Growth option** Martin Development Co. is deciding whether to proceed with Project X. The cost would be $9 million in Year 0. There is a 50 percent chance that X would be hugely successful and would generate annual after-tax cash flows of $6 million per year during Years 1, 2, and 3. However, there is a 50 percent chance that X would be less successful and would generate only $1 million per year for the 3 years. If Project X is hugely successful, it would open the door to another investment, Project Y, that would require $10 million outlay at the end of Year 2. Project Y would then be sold to another company at a price of $20 million at the end of Year 3. Martin’s WACC is 11 percent.
   a. If the company does not consider real options, what is Project X’s NPV?
   b. What is X’s NPV considering the growth option?
   c. How valuable is the growth option?

12G-2 **Investment timing option** Digital Inc. is considering production of a new cell phone. The project would require an investment of $20 million. If the phone were well received, then the project would produce cash flows of $10 million a year for 3 years, but if the market did not like the product, the cash flows would be only $5 million per year. There is a 50 percent probability of both good and bad market conditions. Digital could delay the project for a year while it conducted a test to determine if demand would be strong or weak. The delay would not affect either the project’s cost or its cash flows. Digital’s WACC is 10 percent. What action would you recommend?

12G-3 **Investment timing option** The Bush Oil Company is deciding whether to drill for oil on a tract of land that the company owns. The company estimates that the project would cost $8 million today. Bush estimates that once drilled, the oil will generate positive net cash flows of $4 million a year at the end of each of the next 4 years. While the company is fairly confident about its cash flow forecast, it recognizes that if it waits 2 years, it would have more information about the local geology as well as the price of oil. Bush estimates that if it...
waits 2 years, the project would cost $9 million. Moreover, if it waits 2 years, there is a 90 percent chance that the net cash flows would be $4.2 million a year for 4 years, and there is a 10 percent chance that the cash flows would be $2.2 million a year for 4 years. Assume that all cash flows are discounted at 10 percent.

a. If the company chooses to drill today, what is the project’s net present value?

b. Would it make sense to wait 2 years before deciding whether to drill? Explain.

c. What is the value of the investment timing option?

d. What disadvantages might arise from delaying a project like this drilling project?

12G-4 Real options Nevada Enterprises is considering buying a vacant lot that sells for $1.2 million. If the property is purchased, the company’s plan is to spend another $5 million today (t = 0) to build a hotel on the property. The after-tax cash flows from the hotel will depend critically on whether the state imposes a tourism tax in this year’s legislative session. If the tax is imposed, the hotel is expected to produce after-tax cash inflows of $600,000 at the end of each of the next 15 years. If the tax is not imposed, the hotel is expected to produce after-tax cash inflows of $1,200,000 at the end of each of the next 15 years. The project has a 12 percent WACC. Assume at the outset that the company does not have the option to delay the project.

a. What is the project’s expected NPV if the tax is imposed?

b. What is the project’s expected NPV if the tax is not imposed?

c. Given that there is a 50 percent chance that the tax will be imposed, what is the project’s expected NPV if they proceed with it today?

d. While the company does not have an option to delay construction, it does have the option to abandon the project 1 year from now if the tax is imposed. If it abandons the project, it would sell the complete property 1 year from now at an expected price of $6 million. Once the project is abandoned the company would no longer receive any cash inflows from it. Assuming that all cash flows are discounted at 12 percent, would the existence of this abandonment option affect the company’s decision to proceed with the project today? Explain.

e. Finally, assume that there is no option to abandon or delay the project, but that the company has an option to purchase an adjacent property in 1 year at a price of $1.5 million. If the tourism tax is imposed, the net present value of developing this property (as of t = 1) is only $300,000 (so it wouldn’t make sense to purchase the property for $1.5 million). However, if the tax is not imposed, the net present value of the future opportunities from developing the property would be $4 million (as of t = 1). Thus, under this scenario it would make sense to purchase the property for $1.5 million. Assume that these cash flows are discounted at 12 percent, and the probability that the tax will be imposed is still 50 percent. How much would the company pay today for the option to purchase this property 1 year from now for $1.5 million?