

## Corporate Finance, Module 22: "Real Options"

### *Homework Assignment*

(The attached PDF file has better formatting.)

Use the practice problem on trade shows and real options to answer this homework assignment.

Ten pharmaceutical firms compete to produce a drug to cure Alzheimer's disease. The capitalization rate is 12% per annum. The time needed to develop the product varies from 10 to 20 years. If the firm's research is good, it may develop the drug in 10 years and obtain the patent; if its research is not good, it may take 20 years and its research will be wasted, since a different firm will have obtained the patent.

- ! The firms are certain that one of them will obtain a patent and the drug will be successful, but they don't know which firm will obtain the patent.
  - ! The expected cost for research and development is \$1.77 billion a year. For simplicity, assume this cost is paid at the end of the year.
  - ! The first firm that obtains a patent gains the entire market; all other firms get no return.
  - ! After 10 years, one firm obtains the patent and all research stops.
  - ! The expected profit from selling the drug after 10 years has a present value of \$85 billion.
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- A. If a firm obtains a government monopoly now to sell the drug, it will take about 15 years to develop the drug. What is the NPV of this project with a monopoly on selling the drug?
  - B. If the firms compete, what is the NPV of this project for the successful firm which completes its research in 10 years and obtains the patent?
  - C. If the firms compete and they keep their research secret, what is the expected NPV of this project for each firm? (All ten firms spend the research costs for ten years, but only one firm obtains the patent.)
  - D. Assume that firms have a good idea how their research is going and whether it is likely to succeed. If the firms know the relative research progress of all the competitors, after the first year, the least successful firm realizes it has little chance of obtaining the patent and drops out; after the second year, a second firm drops out, and so forth. Why might a firm want to publicize its research findings if all the other firms agree to publicize theirs? Assume the firms announce their progress, not their methods, so they cannot steal research ideas from each other. They are learning who is likely to succeed, not how to produce the drug. If one firm informs a competitor that it has a promising drug, how might both firms gain?
  - E. If an annual trade fair informs all firms of the research progress of each, is the research a positive NPV investment? (With the annual trade, one firm spends one year of research, a second firm spends two years, a third firm spends three years, and so forth; the winning firm spends 10 years. Derive the present value for all ten firms. The research is a negative NPV project for nine firms and a positive NPV project for one firm; the average is positive.)

*Question:* One candidate writes on the discussion forum: "I believe there is a problem with the answer that problems C and D are trying to extract. If the company that drops out has no chance of success, then the probabilities of success for your company does NOT change. This is a classic Monte Hall problem. The company that drops out is the door with the goat. All the other companies are the other doors. Their chance increase...your chances do not.

Of course, your chance does go up if the company that dropped out still had some chances left." What does this mean?

*Answer:* Suppose ten firms compete in the market; each has a 10% chance of producing the medication first. Firm Z's lead researcher quits, and it now has no chance of being first. It drops out of the market, leaving nine firms with an 11.1% chance for each to be first. The candidate correctly points out that

- ! The other firms' chances increased when the lead researcher quit.
- ! Nothing happens when Firm Z pulls out of the market.

*Question:* How does this relate to the homework assignment?

*Answer:* The homework assignment differs. For the homework assignment, the lead researcher for the Firm Z gets a bad flu and spends two weeks in bed. When he comes back to work, the firm realizes that it has fallen behind its competitors. Firm Z reasons:

- ! With a 10% chance of being first, our research project has a positive NPV.
- ! With an 8% chance of being first, our research project has a negative NPV.

Firm Z stops its research and pulls out of this market. In this case, the lead researcher's illness has a slight effect on the chances of the other firms. The major effect comes when Firm Z ends its research efforts.

*Question:* How does Firm Z estimate its chances?

*Answer:* The homework assignment deals with this question. The trade fairs and other inter-company activities let each firm know where the others stand.

*Question:* Can you give an insurance (actuarial) example of this?

*Answer:* Suppose General Motors wants to buy insurance: group health, general liability, workers' compensation, commercial automobile, and executive life insurance. It seeks proposals from the major insurers in the United States.

Each insurer considers three items:

- ! The cost of preparing a proposal.
- ! The chance of winning the contract.
- ! The expected profit if it wins the contract.

The NPV depends on who is competing.

- # If no other firms compete, it can submit a short proposal, it has a high chance of winning, and it can charge a high premium and make a large profit.
- # If many other firms compete, it must prepare a better proposal, it has a small chance of winning, and it will have to propose a lower premium.

Each firm wants one of two things:

- ! Other firms should give up.
- ! If another firm will not give up, it should make its intentions clear, so the first firm may decide to give up.