

## **Real Options Exercise 2**

### **Essay Practice:**

Analyse the use of game theory when considering the effects of competition in the product market on the real option approach to corporate investment appraisal. When answering this question, please pay particular (but not exclusive) attention to papers by Boyer et al (2004), Smit and Ankum (1993), Smit and Trigeorgis (2006), and Imai and Watanabe (2004).

### **Game-theory practice (normal form game).**

Consider a market consisting of two firms, *A* and *B*. There is universal risk-neutrality, and the risk-free rate is zero.

Both firms are simultaneously deciding whether to invest immediately in competing innovative projects, or to delay investment for a period to “wait-and-see” how product market conditions will turn out. Each firm must make an initial investment in its project of  $I = 100$  (regardless of whether the firm invests immediately or delays investment).

If both firms simultaneously invest immediately, the present value of future cash inflows for each firm’s project will be 500. If both firms delay investing, the option to delay adds value, such that the present value of the future cash inflows will be £600 for each project. If one firm invests immediately, and the other delays, the firm that invested immediately gains a competitive advantage, such that the present value of inflows is 800 for the firm that invested immediately, and 200 for the firm that delayed.

Required:

- i) Calculate the net present values for firms *A* and *B* for the various combinations of investing early and delaying.
- ii) Draw this game as a normal form game.
- iii) Calculate the equilibrium of the game. Show that this is a prisoner’s dilemma. What does this tell us about the impact of product market competition on a firm’s attempt to add value by exercising an option to delay a project?
- iv) Consider the same problem, but now the rivals sign a contract agreeing to delay investing in the projects for a period in order to ‘wait-and-see’ how market conditions may turn out. If one firm breaks the agreement, and invests early (while the other firm delays), the firm that delays is able to fine the firm that invested early, such that there is a transfer of 400 from the offending firm to the firm that delayed. If both firms break the agreement, there is no fine (ie there is no transfer).
- v) Analyse the effect on the equilibrium of incorporating this transfer into the payoffs in the normal form game in iii). What does this tell us about the effect of legal contracts on the problem of product market competition when a firm attempts to add value by exercising an option to delay a project?

**References:**

Imai and Watanabe (2004) "A two-stage investment game in real option analysis." working paper (downloadable from Google).

Boyer, Gravel, and Lasserre (2004). "Real Options and Strategic Competition: a survey. working paper (downloadable from Google).

Smit and Ankum. (1993). "A real options and game-theoretic approach to corporate investment strategy under competition." *Financial Management*, 22(3) 241-250.

Smit and Trigeorgis (2006). "Real options and games: Competition, alliances and other applications of valuation and strategy." *Review of financial Economics*. 15, pages 95-112.