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Opting Out of "Real Options"

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Resource allocation is key to firm performance; valuation is key to resource allocation.[1] "Real options" approaches have at their core a calculation of value.[2] When evaluating an investment, e.g., an R&D investment, from the point of view of a firm, the calculated *option value* should be viewed as a decision threshold: the investment should be "bought" (acted upon) if available for less than the calculated option value or "sold" if marketable for more than the calculated value (or, presumably "abandoned" if not marketable).[3] The application of real option theory to R&D project decision-making has been summarized by Heath and Park in a 1999 article in the *Engineering Economist*.[4]

Some key characteristics of R&D projects suggest that such investment opportunities can be valued using real options theory. R&D investments are staged investments where the initial investments do not yield cash flow but, instead, provide the opportunity (or right) to make further investments.[5] Indeed, real options techniques have been a primary assessment tool for technology portfolio management at Philips Electronics.[6] Yet, a retrospective analysis of the usefulness of real options as a decision-making tool, not only at Philips but also elsewhere, provides some insight into why real options may be a "fading fad."[7] The three R&D investment opportunities that were the subject of this retrospective analysis:

- Development of a new product technology for multi-media applications
- Simultaneous development of two product standards
- Improvement in ferrous production processes

In the mid 1990's, Philips Corporate Research had a research stage project in optical recording using tape.[8] Optical tape was considered a major research opportunity because the associated markets were billions of dollars in annual sales value. However, there were substantial uncertainties around the feasibility of the technology for consumer products. This opportunity was modeled using options theory and the resulting option value was greater than the cost to create it. So, the decision to start the research on optical tape was justified. Fast forward to the end of the 1990's: the development and market introduction of the recordable CD and the recordable DVD, in combination with advanced data compression techniques, *took the wind out of the sails of optical tape recording*.[9] Data storage capacity of DVD appeared sufficient for current and future projected demand in both the PC and consumer electronics segments. In addition, unanticipated technical problems arose in the development of the optical tape, which would have resulted in a much higher consumer retail price for the equipment. So, Philips decided to stop the optical tape project. Why was there a variance between the options modeling result and ultimate reality? In this particular application of real options applied to R&D project decision-making, the options model didn't capture the effect of simultaneous development of competing technology within the firm. Nor did it include the (high) risk of technical failure.[10]

Also at the beginning of the 1990's, Philips was developing both analog and digital video tape recording. Philips had the choice between developing two new standards, analog and digital, for new 8mm tape products for the video recorder market. The investment required was approximately the same for each technology, but the expected cash flows were different. The investment risk was centered on the uncertainty regarding which product standard would eventually prevail.[11] Options analysis supported the decision by Philips to develop both standards simultaneously. However, the options model failed to include a number of fundamental external realities that ultimately led to Philips' rethinking their original decision, e.g.,

- *Installed Base:* the conventional analog standard (VHS) with its large installed base remained a strong technology standard
- *Market Inertia:* Philips' introduction of the Digital Compact Cassette (DCC) in the audio field yielded a lower diffusion rate than initially expected. The product advantages were not disruptive enough to excite customers. This raised the perceived risk of introducing improved analog or new digital technology in the well-established VHS market, where Philips was not a dominant player[12]

The third retrospective involves an early '90's R&D project to develop a new production technology at Corus (the merger of British Steel and Hoogovens IJmuiden). The R&D option was to develop an alternative to the conventional blast furnace

route for coal-based iron making. The alternative route obviated the need for coking and agglomeration. Classic NPV analysis of the project yielded a negative result. Based on this unfavorable outcome, management would not have considered investing in this R&D. Options modeling, however, suggested that it would be worthwhile to create the opportunity for a total conversion of the old production process into the new because of the anticipated volatility of future energy prices (a key variable in the options model itself). What the options model did not include, however, was the effect of successful process optimization and efficiency programs implemented in the existing coking plants. These successes reduced the cost advantages of the new production process. Furthermore, the options model didn't address scale-up risk associated with the radically new technology—scale-up risk that was "top of mind" in Corus management.[13]

If real options theory can't be relied upon for quantitative analyses to support decisions regarding R&D investment, is there an option to real options? An alternative worthy of consideration is presented by Pries, Astebro, and Obeidi.[14] Theirs is a modified NPV model, able to account for the sequential nature of decisions involved in an R&D project. As an example, Figure 1 presents their formula for calculating the present value of a proposed R&D project in the context of a two period decision structure, time "zero" and time "one". Pries et al. also offer a formula (Figure 2) for the situation in which there is uncertainty about the value of "V" (the present value of the future cash flows from commercialization) at "time 1", the point of commercialization or "launch".

This modified NPV alternative to real options requires that the individuals assessing the R&D project develop quantitative estimates of:

- The present value at time 1 of future cash flows if the market is favorable
- The present value at time 1 of future cash flows if the market is unfavorable
- The probability that the market will be favorable

Therefore, this NPV approach directs attention, in a way that a model based on real options may not, to the effect of *favorable and unfavorable markets* on the decision to invest in the R&D project. Understanding the factors that contribute to, or even drive, these different market outcomes can provide guidance and direction to risk monitoring and risk mitigation actions.[15]

Figure 1.

Formula used to calculate the present value of a proposed R&D project, in the context of a two-period decision structure (time 0 and time 1)…

$$NPV = \left\{ \frac{w(V - I_c)}{k} \right\} - I_0$$

where…

NPV is the value of the project

w is the probability of successful R&D outcome (i.e., there is a product to commercialize)

V is the present value at time 1 of the future cash flows from commercialization

I_c is the cost to commercialize at time 1

k is the opportunity cost

I_0 is the R&D investment at time 0

Source: Fred Pries. Thomas Astebro, and Amer Obeidi, Economic Analysis of R&D Projects: Real Options versus NPV Valuation Revisited. Department of Management Sciences, University of Waterloo, Canada, June 10, 2001.

Figure 2.

Formula used to calculate the present value of a proposed R&D project, in the context of a two-period decision structure (time 0 and time 1) AND for the situation in which there is uncertainty about the value of V at time 1…

$$NPV = \left\{ \frac{w\left[qE^{+} + (1-q)E^{-}\right]}{k} \right\} - I_0$$

where…

V^+ is the present value at time 1 of future cash flows if market is favorable

V^- is the present value at time 1 of the future cash flows if market is unfavorable

q is the probability that the market will be favorable

E^+ = $\max[0, V^+ - 1_c]$

E^- = $\max[0, V^- - 1_c]$

Source: Fred Pries. Thomas Astebro, and Amer Obeidi, Economic Analysis of R&D Projects: Real Options versus NPV Valuation Revisited. Department of Management Sciences, University of Waterloo, Canada, June 10, 2001.

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