Real Options: Dos and Don'ts

Real options in the pharmaceutical industry became popular in the late nineties and in the beginning of the new century. At Merck real options have been in use at least since 1995. "…, enthusiasts of real options analysis predict their approach will become the preferred method of investment valuation in 10 years."[1] Today most large pharmaceutical companies have a real options specialist in their valuation teams. But after about 15 years we can say today that primarily students and professors are enthusiastic about real options valuation; people that have not seen the daily business within the industry. Real options will never replace the good old risk-adjusted net present value method. There are three reasons for our claim:

1. Real options are still too complex for upper management.
2. Real options have lost a lot of their credibility because of wrong, but widely distributed case studies. It is still taught completely wrong at most universities.
3. Real options require data input that is not easily available.

Real options: a good idea

But let us start at the beginning. Real options valuation has been developed because of the rigidity of common DCF methods. People felt uncomfortable giving sharp assumptions needed for a DCF valuation (e.g. sales of "exactly" USD 500 Mio). Everybody struggles estimating sales figures far in the future, therefore it seems much more realistic to assume a certain range. Moreover, a DCF valuation assumes that the project will be continued; in reality management abandons projects that are not profitable. According to DiMasi[2] 33% of abandonment of clinical projects is due to economic reasons. This means that within pharmaceutical companies profitability or value of a project is an important criterion when deciding on continuing or abandoning a project. In real options valuation we therefore consider various scenarios where some parameters, typically the sales expectation, fluctuate. This means that we assume already beforehand that at a later point in time the opinion about the potential of a product might change. These changes can be for the better or for the worse. In case of a sufficiently large deterioration management will stop the projects to prevent further losses.

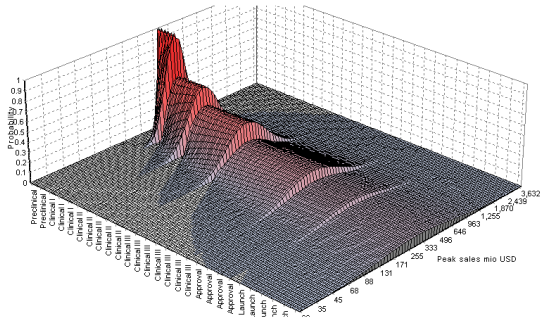

Figure 1: Probability development of a drug development project with real options valuation (calculated with ri:val).

Real options theory assumes a probability distribution of the critical parameters and models the decisions of the management depending on what value these assumptions take. In figure 1 we have visualised the probability of the sales along the development path. We see in the bottom that after each phase some lower branches are cut out of the probability tree. These are the scenarios

[1] Levinsohn, Alan, „When valuation considers real options", Strategic Finance, June 2001.

[2] DiMasi, Joseph, "Risks in new drug development: approval success rates for investigational drugs", Clinical pharmacology and therapeutics, 2001.

where the sales are assumed to be too low to justify a continuation of the project. A precise description of the real options method can be found in the book "Valuation in Life Science. A Practical Guide".

1. Real options are complex

There is no doubt that real options are more complex than straight risk-adjusted net present value (rNPV). Nevertheless real options have a very strong argument in drug development. Real options claim that managers reconsider project plans and kill projects that do not exhibit sufficient economic potential. Consequently, it shouldn't be too difficult to convince upper management of the real option concept as long as the difference in value to rNPV can be quantified and justified. The problem is primarily that the concept is not properly explained and that people get lost in technical details. The main hurdle is the probability distribution that is assumed. We will treat this aspect in more detail in the third point.

2. Real options have been taught the wrong way

When valuing a project with real options it still remains the same project. It is impossible that a previously unprofitable project is all of a sudden worth US$ 100 Mio. Such misevaluations would have become obvious over the years; even without knowledge of real options valuation one must have thought that apparently the common valuation techniques drastically undervalue projects. But this has never happened. Unfortunately academics and would-be specialists from renowned consulting companies tried to grab some attention with such examples.

They tried to convince practitioners to use real options because it's "really simple". Take the Black-Scholes formula from quantitative finance (corporate or quantitative finance, what difference could that make?), fill it with parameters that correspond to your drug development project and you're done, the formula returns you the value of the project. No hassle with Excel sheets, no financial modelling. Pretty tempting, right? The problem was that the values did not convince, too bad; nobody could see why they should be so much larger now. And because the formula is a black-box, you couldn't find out.

We have already previously explained why Black-Scholes is completely unsuitable for corporate finance[3]. First, drug development projects have more than one embedded option; Black-Scholes can only handle one. Second, the Black-Scholes formula does not include the attrition risk, i.e. success rates. Third and most important, the Black-Scholes formula is based on replication of the underlying and therefore a risk-free portfolio. This assumption is complete (!) nonsense in any corporate environment and should immediately ring alarm bells. Very surprisingly Merck seems to have valued their projects using a Black-Scholes approach[4].

[3] http://www.avance.ch/downloads/avance_on_BlackScholes.pdf
[4] ardent.mit.edu/real_options/RO_current_lectures/Realoptions02.pdf

An article by Shockley et al.[5] wanted to address the black-box issue by introducing the binomial tree model. Unfortunately the article had two major mistakes. First, they assumed that the attrition is inherently modelled by the fluctuation of the sales estimate. This is, of course, wrong. It is well possible that the sales potential of a drug increases because, e.g., a competitor fails; but the trial reveals some severe side effects that do not allow a continuation of the project. It is absolutely necessary to include the success rates in the tree (a detailed description is available in "Valuation in Life Sciences"[6]). The success rates are valuable information about the risk of a project and it would be careless not to make use of theses statistics. Second, Shockley et al. use risk free discounting. Absolutely no investor, not even one, would accept a risk-free cost of capital. Why should one invest in a risky asset (the assets remain risky, no matter which valuation method you apply) if he can get the same return with a treasury bond? Although this seems to be a no-brainer, many academics keep teaching risk-free discounting in real options. This is probably a side effect of the long isolation in the ivory tower. Both errors concern the most value reducing factors, attrition risk and discounting; no wonder that Shockley et al. came up with wonderful values. Unfortunately, those were disconnected from reality.

Risk-free discounting is a left-over from the original idea that real and financial options have some similarity. People that use risk-free discounting focus too much on the similarities instead of the differences. Drug development *is* risky. The risk-free discounting is only justified if the risk can be hedged away as this is the case with financial options (at least to a large extent). In drug development it is not possible to hedge the risk, therefore we have to use a discount rate that includes a risk premium. Feinstein and Lander[7] had the correct idea, that the assumption of adaptive management decisions changes the risk profile of the project to some extent. The downside risk is reduced, because unprofitable projects are not continued. Feinstein and Lander adapt the discount rate to this new risk profile. The method is not practicable because, again, it assumes hedging with something that doesn't exist, but the idea that the risk profile is slightly different and reduces the discount rate a bit is noteworthy and correct.

Interestingly, all these errors – Black-Scholes, risk-free discounting, no success rates – lead to massively too high values. Practitioners looked at the results, judged them to be completely out of any realistic range, and have not cared about real options anymore. An understandable reaction. Nevertheless, the fact that every pharma company employs a real option specialist shows, that the industry presumes that there is value in the managerial flexibility and would like to quantify it.

[5] Shockley, R., Curtis, S., Jafari, J., Tibbs, K., 2003, The option value of an early-stage biotechnology investment. Journal of Applied Corporate Finance, 44–55.

[6] Bogdan, Boris, and Villiger, Ralph, „Valuation in Life Sciences", 2nd edition, 2008, Springer Verlag.

[7] Feinstein, Steven, and Lander, Diane, „A better understanding of why NPV undervalues managerial flexibility", The Engineering Economist, 2002.

3. Data is not readily available for real option valuation

An often-cited problem is the volatility as additional input factor. The volatility is indeed difficult to assess. The parameter is a measure of the reliability of the sales forecasts. This is only observable within large companies that revalue on a regular basis their projects. But to-date we are not aware of any company conducting such an in-house study. Merck for instance used a volatility based on comparable biotech stock prices. This is not useful, because a biotech volatility includes attrition risk, market risk, and operational risk. The real option volatility only refers to market risk. Attrition risk is included in the success rates and operational risk in the discount rate. And this inclusion of these risk factors in the wrong parameter, i.e. in the volatility, leads again to too high valuations. A higher volatility leads to a higher option value. This, of course, is not only counterintuitive, but also wrong. If the volatility is higher, then automatically the discount rate is also higher.

But also the success rates must be adapted if we use real options. Usually success rates are a percentage of the projects that were continued in the next phase. The reasons for abandonment can be either safety, efficiency, or profitability related. Real option valuation takes care of economic abandonment within the model and therefore has to use success rates that only include safety and efficiency related abandonment, but no economic abandonment[8]. This data is only available to few selected big pharma companies.

How real options should really be used

For biotech companies the question of abandoning or continuing is not that important, as voluntary abandonment corresponds to suicide. But the option to license or not is much more important to them. And even some license contracts contain option clauses that can be modelled with real options. But also for pharmaceutical companies the current real option framework of just abandoning or continuing is too rigid. A pharmaceutical company has the options to a) continue, b) abandon, c) put on hold, or d) out-license a project. And the continuation option might even be more complex if there is a choice between formulations and indications. The topic should still be enough food for academics, but please without the mentioned errors.

[8] You find a much more detailed description in Villiger, Ralph, and Bogdan, Boris, "Valuing pharma R&D – a catch-22", Journal of applied corporate finance, 2005.