Technical Uncertainty and Learning Options in Petroleum

Real Options Valuation in the New Economy
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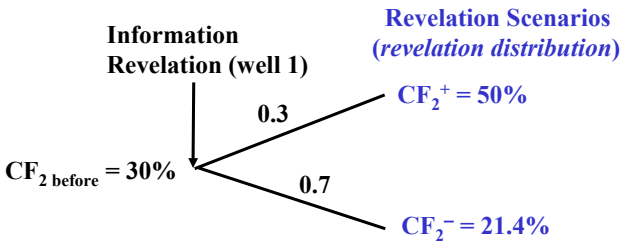
Oil Exploration Example: Information Revelation

- One exploratory tract has two *correlated* and *equal* prospects, both with *chance factor* of 30%, drilling cost of $ 30 million, and both with expected NPV_{DP} = 95 million, in case of success.
  - So, both the *expected monetary values* (EMV) are negatives:
    $EMV_1 = EMV_2 = -30 + (0.3 \times 95) = -1.5$ million
  - Other oil company is offering $ 2 million for the tract. Deal?
- In this traditional EMV calculus is missing an additional hidden benefit: with the first well drilling we get valuable *information revelation* about the chance factor for the *second* prospect. With this information we update CF_2.
  - In case of *good news* (success in first drilling), CF_2 must be updated upward (so, EMV_2 *can* become positive) and vice-versa
  - We have an *option* (not an obligation) to drill the well 2
    - How much is the *value of information* from well 1 given that the second well is optional? How valuable is the entire tract with two prospects?

Chance Factor Update with the Information

- In case of success with well 1, we update the CF_2 to $CF_2^+ > CF_2$.
  In case of failure (well 1 is dry), we update down to $CF_2^- < CF_2$.
  - This updating must obey some probabilistic laws for consistency (*law of iterated expectations* and others), and needs a measure on the degree of correlation between the prospects (a learning measure).
  - Suppose this correlation is so that the revealed CF_2^+ and CF_2^- are:



Updated EMV_2

$EMV_2^+ = -30 + (0.5 \times 95) = +17.5$ million

$EMV_2^- = -30 + (0.214 \times 95) = -9.7$ million

  - Because we have an *option* (not an obligation) to drill the well 2, we will exercise this option only if the revealed EMV_2 is positive (i.e. EMV_2^+)

How Valuable Is the Entire Tract?

- The cost to get information for the CF_2 is the negative EMV that is expected with the well 1 drilling (= – 1.5 $ million)
  - But we saw that there are 30% chances to get a positive revelation ($EMV_2^+ = +17.5$ million) and 70% chances of *negative revelation*
    - But in case of *bad news* the prospect 2 value is zero because we don´t need to drill this optional prospect with $EMV_2 < 0$ (options cause asymmetry).
  - So, the entire tract EMV, including the information revelation plus the optional nature of the prospect 2, is:

$EMV_{tract} = -1.5 + [(30\% \times 17.5) + (70\% \times 0)] = +3.75$ $ million

OBS: Note that if the prospect 2 is obligatory, $EMV_{tract} = -$ $ 3 million

- So, refuse the other company offer of $ 2 million!
- Now, we discuss quickly the technical uncertainty theory and one oilfield development example with remaining technical uncertainties in the oil reserve *volume* (B) and *quality* (q)

Technical Uncertainty: Threat & Opportunity

- Technical uncertainty has zero correlation with the *market portfolio*, then the incremental risk-premium is zero
  - The discount rate is the same if the project owns technical uncertainty or not, because shareholders are diversified investors
- But, in development projects, technical uncertainty decreases both the *net present value* (NPV) and the *real options value*
  - Technical uncertainty *almost surely* will lead to exercise the wrong development project (plant capacity, nº of wells, pipeline diameter)
    - The sub-optimal project generates *overinvestment* or *underinvestment* when compared with the optimal investment level that maximizes NPV or ROV
  - Technical uncertainty can lead to exercise options when the best is not exercise the option (for the *true* value) and vice-versa.
- Hence technical uncertainty decreases value due to sub-optimal decisions not because the discount rate or "manager utility".
- However, it is only *one side of the coin* (the threat side). Technical uncertainty also creates the opportunity to invest in information!

Real Options Valuation with Investment in Information

- M.C. simulation combining market (oil price) and technical uncertainties