



Big Oil Problem – Simpler and Alternate Solution

This is a simpler and alternate solution to a problem that is in the Syllabi of both CA and CMA since the past over 25 years. In most of the books the solutions given are not correct. For the benefit of students at large, a simpler and alternate solution is being presented here.

Reference:

CA Final – SFM (Question 33, Pg. # 2.54, Practice Manual Jan. 2015 Edition);

CMA Final – AFM (Illustration 14, Pg. # 10.65, May 2013 Edition)

The Problem:

Big Oil Ltd. is wondering whether to drill for oil in Westchester Country. The prospects are as follows:

Depth of Well Feet	Total Cost Millions of Dollars	Cu. Prob. of Finding Oil	PV of Oil (If found) Millions of Dollars
2000	4	0.50	10
4000	5	0.60	9
6000	6	0.70	8

Draw a decision tree showing the successive drilling decisions to be made by Big Oil. How deep should it be prepared to drill?

Notes:

1. Students are advised to solve this problem after working a joint probability problem (SFM: Qn. 32, Pg. # 2.52 PM; AFM: Illustration 11, Pg. # 10.60) for better understanding.
2. We worked forward from D1 to D3, whereas in most of the books it is worked backward from D3 to D1 and even then, in most of the cases the solutions given are not correct.
3. Here we used only Probabilities and ignored the Sets Theory totally.

Analysis of the Problem:

Just like any other problem, this problem also needs to be understood first to solve it. It is said that once the problem is understood fully, more than 50% of the solution will be over. Hence, the Analysis.

The issue with the Company is, it has an oil prospecting project that needs to be evaluated for taking a rational decision. It can drill upto 2000 ft. by spending 4Mn. Dollars. Cumulative Probability of finding oil at this depth is .50 and its present value of earning is 10Mn. Dollars if oil is found. Thus net pay off at this point will be 6Mn. Dollars if oil is found and if not found loss will be the expenditure of 4Mn. Dollars.

In case oil is not found at 2000 ft. level, it can go upto 4000 ft. level by incurring additional expenses of 1Mn. Dollars thus making total expenditure as 5Mn. Dollars. Cumulative probability of finding oil at this depth is .60 and its present value of earning is 9Mn. Dollars if oil is found. Thus net pay off at this point will be 4Mn. Dollars if oil is found and if not found loss will be the total expenditure of 5Mn. Dollars.

In case oil is not found at 4000 ft. level also, it can go upto 6000 ft. level also by incurring additional expenses of 1Mn. Dollars thus making total expenditure as 6Mn. Dollars. Cumulative probability of finding oil at this depth is .70 and its present value of earning is 8Mn. Dollars if oil is found. Thus net pay off at this point will be 2Mn. Dollars if oil is found and if not found loss will be the total expenditure of 6Mn. Dollars.

Required:

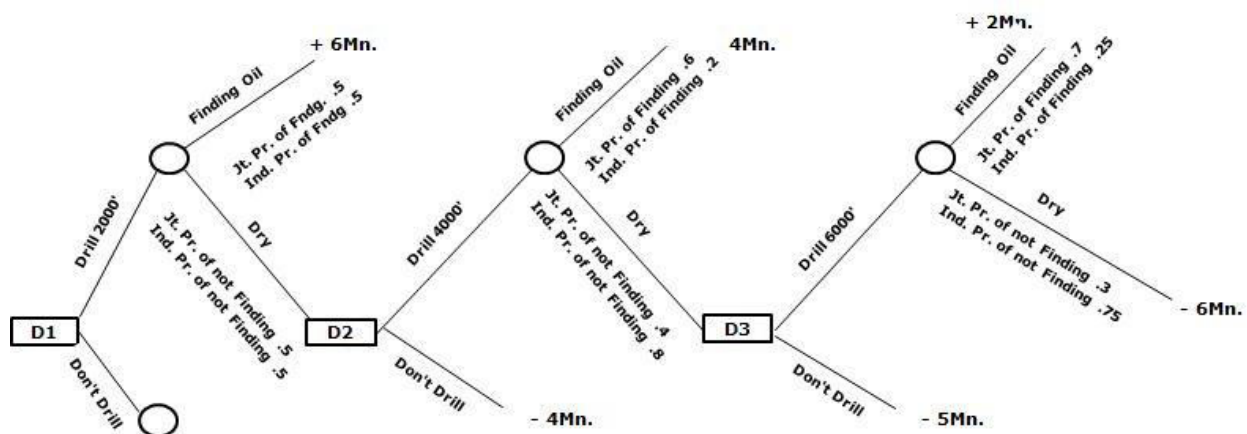
- A Decision Tree for the problem; and
- To find out whether drilling is to be done or not, and if drilled, upto what depth drilling is recommended with suitable workings.

Solution:

The issues that need to be depicted in the Decision Tree are:

- a. The consequences of drilling upto different depths;
- b. Corresponding payoffs in case of success as well as failures with corresponding probabilities at different levels.

The Decision Tree along with probabilities of finding and not finding oil at different Decision Points along with payoffs can be drawn as below:



There are 3 Decision Points D1, D2 & D3 where the economics of the project is to be evaluated.

Firstly we need to understand that in this problem the words Cumulative Probability (here it is not used with the exact meaning) and the Joint Probability what we often call are used synonymously. Based on this let us evaluate the project at the 3 Decision points.

Evaluation at D1 (2000'):

Joint Probability of finding Oil : .50

So, Joint Probability of not finding Oil : .50 (1-.50)

As this is the first branch of the tree, Joint Probability and independent probability happen to be the same.

i.e. Independent Probability of finding Oil : .5 and

independent probability of not finding Oil : .5 (1-.50)

Pay off will be as below:

When Oil is found $6 \times .5 = 3.00 \text{ Mn.}$

When Oil is not found $4 \times .5 = (2.00) \text{ Mn.}$

Net Pay Off = 1.00 Mn.

As net Pay off is +ve, it is worth to start the project of Drilling.

Evaluation at D2 (4000'):

Joint Probability of finding Oil : .60

So, Joint Probability of not finding Oil : .40 (1-.60)

Independent Prob. of not finding Oil @ D2 $\frac{\text{Jt. Prob. of not finding oil @ D2}}{\text{Jt. Prob. of not finding oil @ D1}}$

$$\frac{.40}{.50} = .80$$

So, independent prob. of finding Oil @ D2 : .20 (1-.80)

Pay off will be as below in case Drilled upto 4000':

When Oil is found $4 \times .2 = .80 \text{ Mn.}$

When Oil is not found $5 \times .8 = (4.00) \text{ Mn.}$

Expected Net Pay Off = (3.20) Mn.

In case Drilling is stopped at 2000', the loss will be the Sunk Cost of 4 Mn. For drilling upto 2000'.

As Expected net Pay off of 3.20 Mn. Loss in case drilled upto 4000' is less than the certain loss of 4 Mn. by abandoning the project after drilling 2000', it is worth to drill upto 4000'.

Evaluation at D3 (6000'):

Joint Probability of finding Oil : .70

So, Joint Probability of not finding Oil : .30 (1-.70)

Independent Prob. of not finding Oil @ D3 $\frac{\text{Jt. Prob. of not finding oil @ D3}}{\text{Jt. Prob. of not finding oil @ D2}}$

$$\frac{.30}{.40} = .75$$

So, independent prob. of finding Oil @ D2 : .25 (1-.75)

Pay off will be as below in case Drilled upto 6000':

When Oil is found $2X .25 = .50$ Mn.

When Oil is not found $6 X .75 = \underline{(4.50)}$ Mn.

Expected Net Pay Off = (4.00) Mn.

In case Drilling is stopped at 4000', the loss will be the Sunk Cost of 5 Mn. For drilling upto 4000'.

As Expected net Pay off of 4 Mn. loss in case drilled upto 6000' is less than the certain loss of 5 Mn. by abandoning the project after drilling 4000', it is worth to drill upto 6000'.

Best Wishes

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