Lecture 27

Breakeven Analysis for Two Projects

In the last lecture, we examined questions such as "What production volumes do I need in order to turn a profit?" and "How much revenue must I earn in order to earn my MARR?"

In this lecture, we'll look at questions involving trade-offs between two alternatives, such as "What production volumes favor Option A over Option B?" or "Should I lease or buy?"

The general procedure, as outlined in the textbook, is as follows:

1. Define the variable for which we want to determine the breakeven value
2. Write the PW or AW equation for each project as a function of that variable
3. Set the two equations equal and solve for the breakeven value of that variable.
4. Determine which project is best under which scenario.

Let's look at an example you might encounter in your personal life:

Honda Gas-Hybrid Example

Shelby is trying to decide between buying a gas-powered Honda Civic LX ($19,550 and 31 mpg) or a hybrid Honda Insight LX ($22,830 and 55 mpg). According to Kelly Blue Book, the annual cost of maintenance and repairs is nearly identical and, after five years of ownership, both vehicles will have a salvage value of approximately $9000. If gas costs $2.50 per gallon, how many miles per year must Shelby drive to justify the added cost of the hybrid? Assume she can earn 4% per year on her investments, so we'll use that as her personal MARR.

The Honda Insight costs $3280 more than the Honda Civic but gets 77% better gas mileage. The more miles Shelby drives each year, the more she'll save on fuel and the easier it will be to justify the added cost of the hybrid.

Let X be the number of miles driven each year. Then the annual fuel costs for the Civic are $2.50 (X/31) = $0.0807 X and the fuel costs for the Insight are $2.50 (X/55) = $0.0455 X.

To answer this question, let calculate the present worth of each car over the next 5 years:

$$PW_{\text{Civic}} = \$19,550 + \$0.0807X\overbrace{(P\,|\,A,4\%,5)}^{4.4518} = \$19,550 + 0.359X$$

$$PW_{\text{Insignt}} = \$22,830 + \$0.0455X\overbrace{(P\,|\,A,4\%,5)}^{4.4518} = \$22,830 + 0.203X$$

Setting these two equations equal and solving for X:

$$\begin{aligned} \$19,550 + 0.359X &= \$22,830 + 0.203X \\ 0.156X &= \$3280 \\ X &= 21,000 \text{ miles/year} \end{aligned}$$

Next, let's look at an example involving production volumes in a manufacturing setting:

Widget Example 3

ACME Corporation is considering making widgets to diversify their product line. They are comparing two widget-making machines whose costs and capacities are shown below.

Cash Flow	*Machine A*	*Machine B*
Initial Cost	*$2,000,000*	*$2,300,000*
Salvage Value	*$200,000*	*$250,000*
Service Life	*10 yrs*	*12 yrs*
O&M Cost	*$140,000/yr*	*$80,000/yr*
Variable Cost	*$100/each*	*$110/each.*

Assuming a 15% MARR, at what annual production level would you choose Machine B over Machine A?

In this problem, the variable of interest is the production volume:

Let X = production volume (widgets per year)

Because the service lives of the two machines are different, we'll assume repeatability and compare the EUAC of Machine A to the EUAC of Machine B.

Remember, the EUAC is just the negative of the annual worth.

The EUAC of Machine A can be written as

$$\text{EUAC}_A = \$2{,}000{,}000\overset{0.19925}{\left(A\,|\,P,15\%,10\right)} + \$140{,}000 + \$100X - \$200{,}000\overset{0.04925}{\left(A\,|\,F,15\%,10\right)}$$

$$\text{EUAC}_A = \$528{,}650 + \$100X$$

The EUAC of Machine B can be written as

$$\text{EUAC}_B = \$2{,}300{,}000\overset{0.18448}{\left(A\,|\,P,15\%,12\right)} + \$80{,}000 + \$110X - \$250{,}000\overset{0.03448}{\left(A\,|\,F,15\%,12\right)}$$

$$\text{EUAC}_B = \$495{,}680 + \$110X$$

Setting these equal to each other and solving for X:

$$\$528{,}650 + \$100X = \$495{,}680 + \$110X$$

$$\$32{,}970 = \$10X$$

$$X = 3297$$

To determine which machine to purchase if ACME is going to make less than 3297 widgets per year, we simply need to calculate the EUAC of both options for some value of X less than 3297. We could choose any value we want, but the most convenient one is X = 0:

$$\text{EUAC}_A = \$528,650 + \$100(0) = \$528,650$$

$$\text{EUAC}_B = \$495,680 + \$110(0) = \$495,680$$

So Machine B has the lower EUAC if the production quantity is less than 3297, which means Machine A will be the better option if the production quantity is more than 3297. If the volume is equal to 3297, then it doesn't matter either way:

$$\text{EUAC}_A = \$528,650 + \$100(3297) = \$858,350$$

$$\text{EUAC}_B = \$495,680 + \$110(3297) = \$858,350$$

Breakeven analysis is also very useful for making ***buy-or-lease*** decisions. These are also called "***make-or-buy*** decisions" because, in manufacturing, a common trade-off is between making a part in-house or buying the part from an outside vendor.

Let's look at an example that involves a trade-off between performing work in-house and contracting the work out:

Combine Harvester Example

A farmer is considering buying a new combine rather than hiring a contract harvester. The purchase price of the new combine is $400,000 and it is expected to last 15 years. The new combine will cost $12 per hour to operate and the farmer can harvest 6 acres per hour. The contract harvester charges a flat rate of $24.00 per acre. How many acres must be harvested per year to justify the cost of the new combine? Assume a 6% MARR.

Let X represent the acreage to be harvested each year. If the farmer can harvest 6 acres per hour the cost to operate the new combine, on a per-acre basis, is $12/6 = $2/acre.

If he purchases the combine, the EUAC of the combine is

$$\text{EUAC} = \$400,000\overset{0.10296}{(A \mid P, 6\%, 15)} + \$2\text{ X} = \$41,184 + \$2\text{ X}$$

If he contracts out the work, the EUAC is simply

EUAC = $24 X

Setting these equal to each other and solving for X:

$41,184 + $2 X = $24 X

$$\$41{,}184 = \$22\ X$$

$$X = \$41{,}184\ /\ \$22 = 1872 \text{ acres}$$

So if the farmer has less than 1872 acres to harvest, he’s better off contracting out the work and if he has more than 1872 acres to harvest, he’s better off buying the combine. (If the farmer has 0 acres to harvest, the contract harvester will cost nothing but the combine will cost $400,000).