ESD.70J / 1.145J Engineering Economy Module

Fall 2009

ESD.70J Engineering Economy

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Session Four

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Questions for “Big vs. small”

The past three sessions have covered ways to model uncertainty. It seems like the big plant is better… Does it feel right?

We had assumed full commitment to building one small plant each year regardless of what demand reality turns out to be

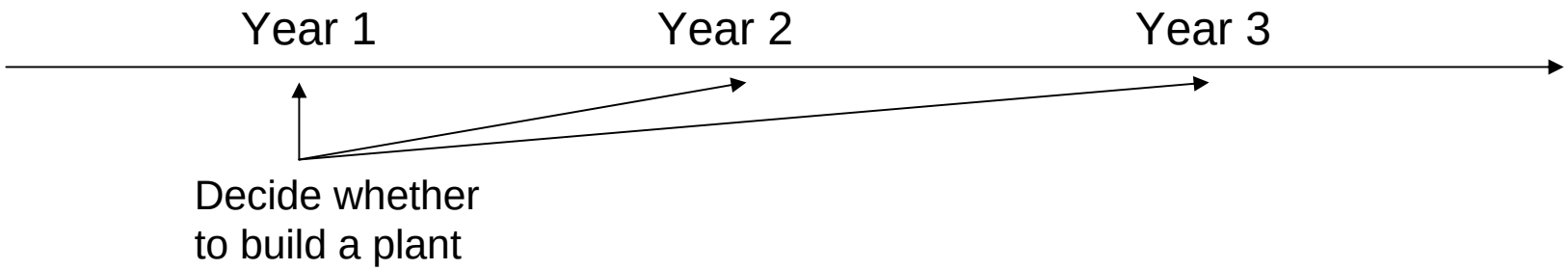
So much for flexibility and common sense. Let’s correct that oversight!

Session four – Flexibility

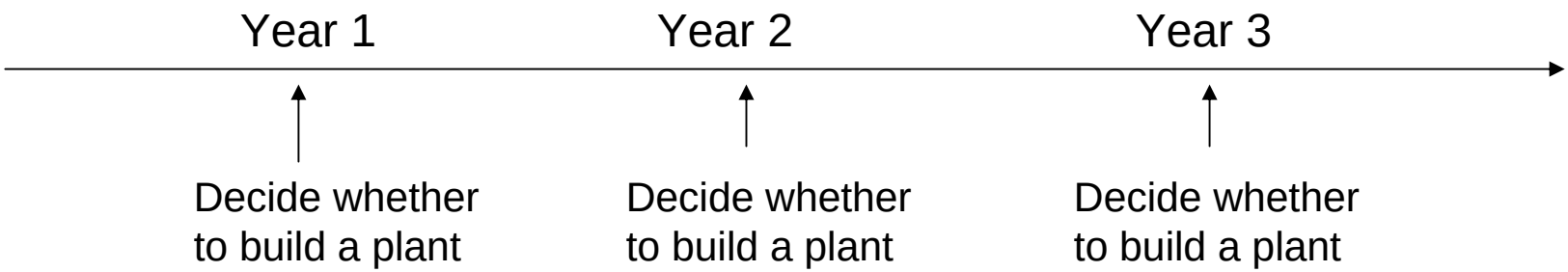
- Objectives:
  - Build flexibility into the cash flow model
  - See how that impacts our decision-making
  - Perform simple breakeven analysis using Goal Seek
  - Introduce Solver
  - Excel self-study references

Key limitation of NPV analysis

- It assumes future decisions are made today, for example for constructing small plants



- But the decisions are actually made each year



Key limitation of NPV analysis

- There is a LOT of value in delaying decisions until:
  - More information becomes available
  - Forecast uncertainty decreases with time and collection of additional data
- Ability to delay decisions into the future is an example of flexibility
- Flexibility is the magic bullet against uncertainty!

Modeling contingency decisions

- Recall the spreadsheet we built for Session Two
  - ESD70session2-2.xls
- Press “command =” or “F9”: which plan is better?
- Now think about the following decision rule:
  - In Plan B, after the first plant is built in year 1, we build an additional small plant only if we observed a bigger demand than capacity
- How do we model that?

Modeling contingency decisions

Open ESD70session4-1.xls

Modeling contingency decisions

- In “Plan B RAND with Flexibility” tab:
  - in Cell G3 type: “=IF(E5>E4,E3+1,E3)”
  - In Cell I3 type: “=IF(G5>G4,G3+1,G3)”
- Press “command =” or “F9”
- Now which plan is better?
- How easily can the traditional analysis be misleading, despite properly simulating the uncertainties!

Logical Functions in Excel

- IF(logical_test, value_if_true, value_if_false): Returns one value if the test evaluates to TRUE and another value if it evaluates to FALSE
- MAX(number1,number2,...): Returns the largest value in a set of values
- When maximizing among the alternatives
- MIN(number1,number2, ...): Returns the smallest number in a set of values

Give it a try!

Check with your neighbors…

Check the solution sheet…

Ask me questions…

Questions

- How different is this kind of analysis from Sensitivity Analysis?
- What is the effect on the target curve and histogram for Plan B?
- What is the value of flexibility?

Question for “Big vs. small”

Since Plan B with flexibility is better than Plan A, the manager is tempted to go with small plants. Just then the Chief Operations Officer reports the variable cost for the big plant can be further cut (the variable cost for a small plant remains the same)

What is the breakeven variable cost point for Plan A where the two plans are equivalent?

Breakeven analysis

- A breakeven level for a parameter – a target value where some particularly interesting event occurs
- In a deterministic case, a breakeven point can be determined using “Goal Seek”
- We cannot use Goal Seek with Data Tables (sim on sim). We can still can do trial-and-error search!

Spinner

1. In “Entries” tab, enter “=Simulation!D4-Simulation!D1” next to “mean NPV_B – mean NPV_A” in cell H3
2. Choose menu “View” ⇒ “Toolbar” ⇒ “Forms”
   - Menu “Developer” ⇒ “Insert” in Excel 2007
3. Click  button and draw a Spinner from E18 to E19
4. Spinner works with integers, so modify Plan A variable cost in cell C18 to equal = C17/100. Set C17 to 128
5. Right click the spinner and click “Format Control”
6. Change “Current value:” to “128”, put “C17” in “Cell link:”

Spinner

7. Hit “command =“ or “F9” and see how “mean NPV_B – mean NPV_A” values change

8. Somewhere around 1.24 this value approaches 0

9. Note: what we are really trying to do is run a “simulation on simulation” to find Plan A’s variable cost where mean NPVs for both plans are equal
   - Excel does not support recursive simulations
   - Spinner gives an approximate answer, but requires manual input

Give it a try!

Check with your neighbors…

Check the solution sheet…

Ask me questions…

Goal Seek → Solver

- In Session 1 we used Goal Seek to get the exact breakeven point

- Solver supports constrained optimization
  - Now maximize NPV for Plan B by varying size of constructed plant
  - Assume 1:1 correlation between small plant's cost and manufacturing capacity ($300M ⇒ 300K units)
  - Set C23 = C15 on the "Entries" sheet
  - Change demand expectations to {200, 600, 800}
  - Erase Data Tables to speed up analysis
  - In "Plan B - Solver", set Salvage value cell I12 to "=MIN(Entries!C29, MAX(C11,E11,G11))"

Solver

- $\Rightarrow$ use Solver to find optimum plant size
- Go to “Tools” $\Rightarrow$ “Solver”
  - Menu “Data” in Excel 2007, look to the right
- In “Entries” tab, set target cell to “H5” “equal to” “MAX”
- Set “By changing cells” to “C15”
- “Subject to the Constraints:” C15 >= 0
- Hit “Solve”…
- Optimal small plant size is?

Give it a try!

Check with your neighbors…

Check the solution sheet…

Ask me questions…

Summary

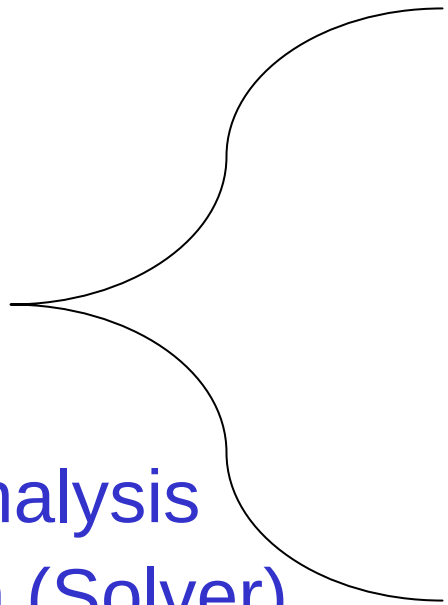
- Incorporated flexibility into the models
- Breakeven analysis
- Excel is a powerful modeling tool. It will accompany you throughout your career
- We hope this short course increased your awareness of Excel's functionality
- Uncertainty/risk management is way cool and… very profitable!

Excel self-study references

- “Advanced Excel for Scientific Data Analysis” by Robert De Levie
- “Advanced modeling in finance using Excel and VBA” by Mary Jackson, Mike Staunton
- Available on Amazon

Big picture of Excel

- Basics
  - Names
  - References
  - Formula
  - Functions
- Charts
- Statistical analysis
- Optimization (Solver)
- Macros
- Visual Basic – now sky is the limit!



Database integration
Date and time f'ns
Engineering f'ns
Financial f'ns
Information f'ns
Logical f'ns
Lookup and reference f'ns
Math and trigonometry f'ns
Text f'ns

Using Excel Help

- Ways to search
  - Contents
  - Answer wizard
  - Index
  - Online at http://support.microsoft.com
  - Google your questions
- Explore links to related topics