TIE2140 Engineering Economy
Tutorial #6 (Lab 2)
Engineering Financial Decision Making

Learning Objectives

On completion of this lab-based tutorial, you will be able to:

1. Develop a basic deterministic financial after-tax cash flow model using Excel
2. Perform One-Way Range Sensitivity Analysis using Sensit (Tornado and Spider Diagrams)
3. Perform Break-Even Analysis using Rainbow Diagrams (and Goal Seek).
4. Perform Probabilistic Risk Analysis using Monte Carlo Simulation using @Risk.
5. Interpret Risk Profile and determine risk measures.

Problem Description

A company plans to invest in a flexible manufacturing system (FMS) to mass produce a new product for the market. The relevant information including base estimates for production quantity, price, fixed & variable costs, direct & indirect costs, etc. are given in the table below:

	Variables	Base Value
1	Number of pieces produced/year	550,000
2	Selling Price	$ 12.00
3	Variable labor cost/part	$ 2.20
4	Variable material cost/part	$ 1.50
5	Annual overhead	$ 2,250,000
6	Annual tooling costs	$ 450,000
7	Annual inventory costs	$ 150,000
8	Investment Cost	$ 7,500,000
9	Useful system life	10 years
10	Salvage value	$ 500,000
11	Depreciation scheme	3-Year Capital Allowance
12	Corporate tax rate	17%
13	*MARR*	15%

The company is not sure what to do, and you have been engaged as a consultant to help and advice the company on the feasibility and risk of investing in this project.

1. Base Value Model Development & Analysis

Using Excel, perform ATCF analysis to determine the After-Tax *PW* for the proposed investment based on the base estimates and a study period of 10 years. You may use the Excel template provided.

Some useful formulas:

- Annual Revenue = Number of pieces produced/year × Selling Price
- Annual Labor cost = Number of pieces produced/year × Variable labor cost/part
- Annual material cost = Number of pieces produced/year × Variable material cost/part

Q1(*a*): What is the project after-tax PW?

Q1(*b*): Is the project economically feasible based on the base value estimates?

2. One-Way Range Sensitivity Analysis

The management is not very comfortable with the results as the company does not have any previous experience in operating an FMS, and there are uncertainties in the many of the variables' base values. It is proposed that sensitivity analyses be performed on the base model to raise the company's confidence. Expert's estimates of the possible range of values for each of the uncertain input variables are given in the table below:

	Uncertain Variables	Low Value	Base Value	High Value
1	Number of pieces produced/year	500,000	550,000	600,000
2	Selling Price	$ 10.00	$ 12.00	$ 14.00
3	Variable labor cost/part	$ 2.10	$ 2.20	$ 2.30
4	Variable material cost/part	$ 1.25	$ 1.50	$ 1.75
5	Annual overhead	$ 2,000,000	$ 2,250,000	$ 2,500,000
6	Annual tooling costs	$ 425,000	$ 450,000	$ 475,000
7	Annual inventory costs	$ 130,000	$ 150,000	$ 170,000
8	Investment Cost	$ 7,400,000	$ 7,500,000	$ 7,600,000
9	Salvage value	$ 475,000	$ 500,000	$ 525,000

Perform one-way range sensitivity analysis by generating *Tornado* and *Spider Diagrams* using the Sensit software. Interpret the results.

Q2(*a*): Which are the **Sensitive** variables?

Q2(*b*): Which are the **Insensitive** variables?

3 Break-Even Analysis

Plot a Rainbow Diagram showing how After-Tax *PW* varies with number of pieces produced and sold per year.

Q3(*a*): What is the break-even quantity?

Plot a Rainbow Diagram showing how After-Tax *PW* varies with the price of product.

Q3(*b*): What is the break-even price?

4. Probabilistic Risk Analysis using Monte Carlo Simulation

Risk Profile Generation: For each of the sensitive variables identified in the previous step, access their respective probability distribution, and perform Monte Carlo simulations on them (while keeping the non-sensitive variables at their base values) to generate the **Risk Profile** for the project's after-tax *PW*.

You may assume that each of the variables are uncertain but will have equal annual values that are distributed as follows:

	Variable	Distribution	Parameters	
1	Number of pieces produced/year	Uniform Integer	(500,000, 600,000)	
2	Selling Price	Normal (Truncated)	μ = \$12.00	σ = \$1.000
3	Variable labor cost/part	Normal (Truncated)	μ = \$2.20	σ = \$0.050
4	Variable material cost/part	Normal (Truncated)	μ = \$1.50	σ = \$0.125
5	Annual overhead	Uniform	(\$2,000,000, \$2,500,000)	

Risk Profile Analysis

Q4(*a*): What is the Expected After-Tax *PW* of the project?

Q4(*b*): What is the Standard Deviation of the After-tax *PW* of the project?

Q4(*c*): What is the Downside Risk of the project?

Q4(*d*): Project Upside Potentials**:**

i. What is the probability that project will achieve after-tax *PW* ≥ \$3 million?
ii. What is the probability that project will achieve after-tax *PW* ≥ \$4 million?

Q4(*e*): Project Value-at-Risks:

i. What is the project's equivalent present value-at-risk at 90% confidence?
ii. What is the project's equivalent present value-at-risk at 95% confidence?

5. Homework

Perform Monte Carlo Simulation using After-Tax *IRR* as the output measure and interpret the risk profile generated.