TIE2140 Engineering Economy
Solutions to Assignment #4

- *MARR* = 10%
- Study period = 5 years

	Project *A*	Project *B*
Initial investment cost	$120,000	$80,000
Equivalent Uniform Annual Benefits	$30,000	$20,000
Salvage Value	$18,000	$10,000
Useful Life	5 years	5 years

(*a*) Base Value Analysis:

- *PW*(10%) for Project *A* = – 120,000 + 30,000 [*P*/*A*, 10%, 5] + 18,000 [*P*/*F*, 10%, 5]
  = – 120,000 + 30,000 (3.7907868) + 18,000 (0.6209213)
  = **$ <u>4,900.19</u>**

- *PW*(10%) for Project *B* = – 80,000 + 20,000 [*P*/*A*, 10%, 5] + 10,000 [*P*/*F*, 10%, 5]
  = – 80,000 + 20,000 (3.7907868) + 10,000 (0.6209213)
  = **$ <u>2,024.95</u>**

- Project *A* should be selected.

(*b*) Break-Even Cost of Project B's Initial Cost.

- Based on base values Project A is preferred as it has a higher PW.

- The Initial cost of Project *B* must to be **<u>decreased</u>** by at least $4,900.19 – $ 2,024.95 = **$ <u>2,875.24</u>** to reverse the decision in (*a*).

(c) Probabilistic Risk Analysis for Project A

- Initial Investment:
  Mean = \$120,000 // from base value
  Variance = 0 // no uncertainty

- Salvage value: Uniform (\$16,000, \$20,000)
  Mean = (16,000 + 20,000)/2 = \$18,000 // same as base value
  Variance = $(20{,}000 - 16{,}000)^2 / 12$
  = \$\$ 1,333,333.33

- Annual profits: Discrete Distribution

Cash Flow	Probability
\$25,000	0.25
\$30,000	0.50
\$35,000	0.25

Mean = 0.25 (25,000) + 0.5 (30,000) + 0.25 (35,000) = \$30,000 // same as base value
Variance = $0.25\,(25{,}000 - 30{,}000)^2 + 0.5\,(30{,}000 - 30{,}000)^2 + 0.25\,(35{,}000 - 30{,}000)^2$
= \$\$ 12,500,000

- $E[PW$ of Project $A]$ = **\$ <u>4,900.19</u>** // from part (a)

- $Var\ [PW$ of Project $A]$
  $= 0 + 12{,}500{,}000\ [P/A, 10\%, 5]^2 + 1{,}333{,}333.33\ [P/F, 10\%, 5]^2$
  $= 0 + 12{,}500{,}000\ (3.7907868)^2 + 1{,}333{,}333.33\ (0.6209213)^2$
  = \$\$ **<u>180,139,861.86</u>**

- Standard Deviation of PW of Project A = $\sqrt{180{,}139{,}861.86}$ = **\$ <u>13,421.62</u>**

(d) Probabilistic Risk Analysis for Project B

- Salvage value: Triangular (8,000, 12,000, 10,000)
  Mean = (8,000 + 12,000 + 10,000) / 3 = \$10,000 // same as base value
  Var = $(8{,}000^2 + 12{,}000^2 + 10{,}000^2 - 8{,}000 \times 12{,}000 - 8{,}000 \times 10{,}000 - 12{,}000 \times 10{,}000)/18$
  = \$\$ 666,666.67

- Equivalent uniform annual profits: Normal (\$20,000, \$5,000)
  Mean = \$20,000 // same as base case
  Var = $5{,}000^2$ = \$\$ 25,000,000

- $E[PW$ of Project B] = **\$ <u>2,024.95</u>** // from part (a)

- $Var\ [PW$ of Project B]
  $= 0 + 25{,}000{,}000\ [P/A, 10\%, 5]^2 + 666{,}666.67[P/F, 10\%, 5]^2$
  $= 0 + 25{,}000{,}000\ (3.7907868)^2 + 666{,}666.67\ (0.6209213)^2$
  = \$\$ **<u>359,508,637.14</u>**

- Standard Deviation of PW of Project B = $\sqrt{359{,}508{,}637.14}$ = **\$ <u>18,960.71</u>**

(*e*) Mean-Variance Dominance Analysis

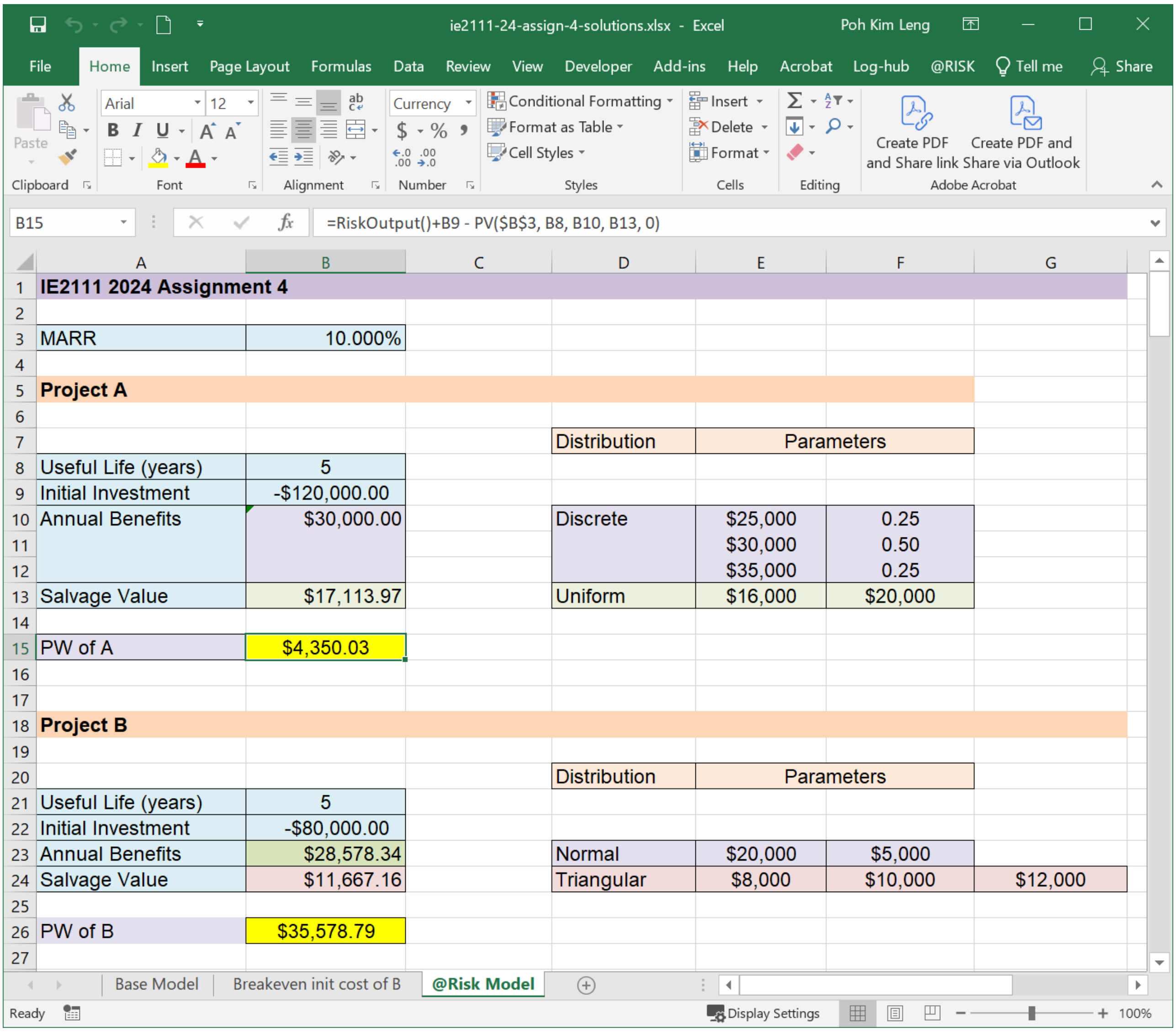
- Comparing the Mean and Standard Deviation of *PW* of Projects *A* and *B*:

	Mean	Standard Deviation
Project *A*	$4,900.19	$13,421.62
Project *B*	$2,024.95	$18,960.71

- Choose Project *A* as it has a higher Expected *PW* and a Smaller Standard Deviation of *PW*.

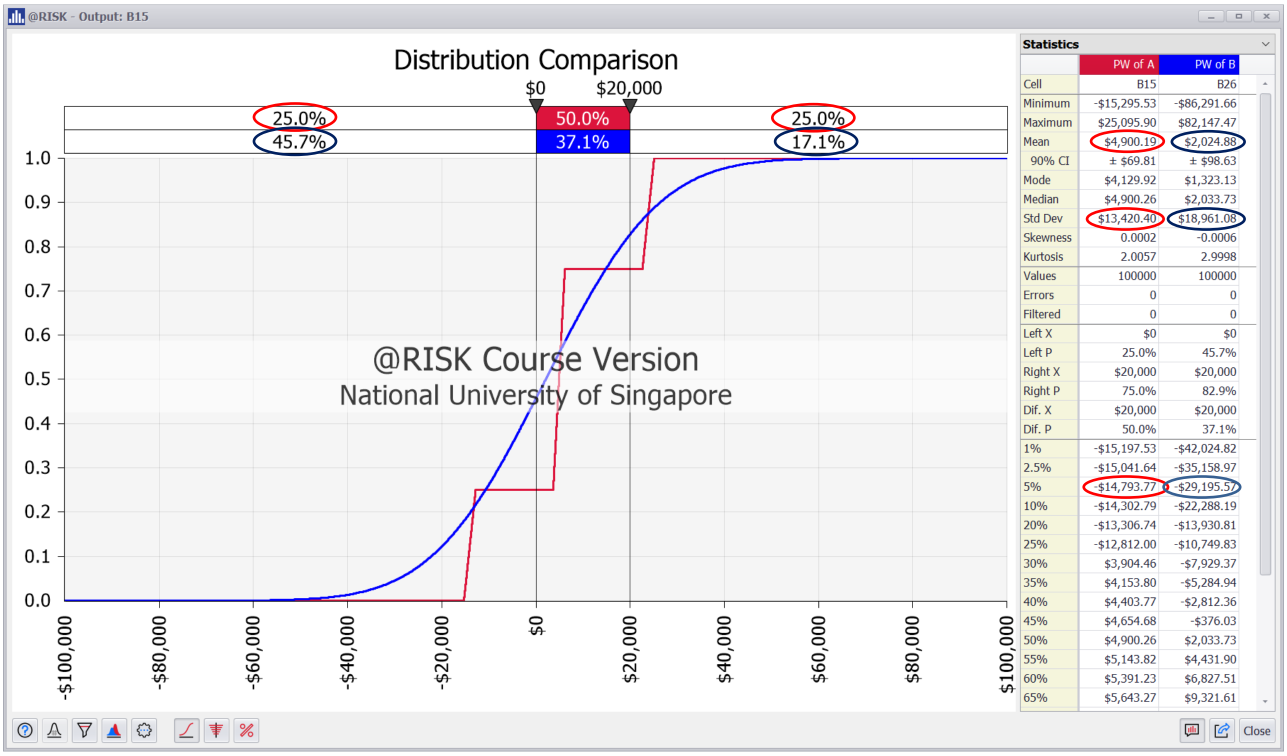
(*f*) Risk Analysis using @Risk

@Risk Model (See Excel Files for details)



	A	B	C	D	E	F	G
1	IE2111 2024 Assignment 4						
2							
3	MARR	10.000%					
4							
5	Project A						
6							
7				Distribution	Parameters		
8	Useful Life (years)	5					
9	Initial Investment	-$120,000.00					
10	Annual Benefits	$30,000.00		Discrete	$25,000	0.25	
11					$30,000	0.50	
12					$35,000	0.25	
13	Salvage Value	$17,113.97		Uniform	$16,000	$20,000	
14							
15	PW of A	$4,350.03					
16							
17							
18	Project B						
19							
20				Distribution	Parameters		
21	Useful Life (years)	5					
22	Initial Investment	-$80,000.00					
23	Annual Benefits	$28,578.34		Normal	$20,000	$5,000	
24	Salvage Value	$11,667.16		Triangular	$8,000	$10,000	$12,000
25							
26	PW of B	$35,578.79					
27							

Risk Profiles Generated by @Risk (100,000 trials)



Stochastic Dominance Analysis

- There is no First Order Stochastic Dominance.
- Need to check for higher orders Stochastic Dominance.

Comparing Simulation and Analytical Results

Method	EV of Project A	Std Dev of Project A
Monte Carlo Simulation	$ 4,900.19	$ 13,420.40
Analytical	$ 4,900.19	$ 13,421.62
Method	**EV of Project B**	**Std Dev of Project B**
Monte Carlo Simulation	$ 2,024.88	$ 18,961.08
Analytical	$2,024.95	$ 18,960.71

Downside Risks

- Project *A*: 25.0%
- Project *B*: 45.7%

Upside Potentials for *PW*=$20,000

- Project *A*: 25.0%
- Project *B*: 17.1%

Equivalent Present VaR(95%)

- Project *A*: $ 14,793.77
- Project *B*: $ 29,195.57

Recommendation:

- Although there is no Mean-Var dominance, we would recommend Project *A* as it has a lower downside risk, a higher upside potential for a realistic target, and a lower VaR.