FIT3158 Business Decision Modelling

Tutorial 3

Sensitivity Analysis

- Download FIT3158 Tutorial 3.xlsm. This file has worksheets for: ElectroTech, Sanderson and ElectroPoly

Exercise 1 (Ragsdale Chapter 4, Q7 8E/9E)

Use Solver to create Sensitivity Reports for the model in ElectroTech worksheet and answer the following questions (re-name the report created):

a) How much excess wiring and testing capacity exists in the optimal solution?
b) What is the company's total profit if it has 10 additional hours of wiring capacity?
c) By how much does the profit on alternators need to increase before their production is justified?
d) Does the optimal solution change if the marginal profit on generators decreases by $50 and the marginal profit on alternators increase by $75?
e) Suppose the marginal profit on generators decrease by $25. What is the maximum profit that can be earned on alternators without changing the optimal solution?
f) Suppose the amount of wiring required on alternators is reduced to 1.5 hours. Does this change the optimal solution? Why or why not?

Exercise 2 (Ragsdale Chapter 4, Q10 8E/9E)

Use Solver to create Sensitivity Reports for the model in Sanderson worksheet and answer the following questions (re-name the report created):

a) If the profit on doors increased to $700 would the optimal solution change?
b) If the profit on windows decreased to $200 would the optimal solution change?
c) Explain the shadow price for the finishing process.
d) If 20 additional hours of cutting capacity became available how much additional profit could the company earn?
e) Suppose another company wanted to use 15 hours of Sanderson's sanding capacity and was willing to pay $400 per hour to acquire it. Should Sanderson agree to this? How (if at all) would your answer change if the company instead wanted 25 hours of sanding capacity?

Exercise 3 (Ragsdale Chapter 4, Q11 8E/9E)

Use Solver to create Sensitivity Reports for the model in ElectorPoly worksheet and answer the following questions (re-name the report created):

a) Is the solution degenerate?
b) How much can the cost of making model 1 slip rings increase before it becomes more economical to buy some of them?
c) Suppose the cost of buying model 2 rings decreased by $9 per unit. Would the optimal solution change?
d) Assume workers in the wiring are normally make $12 per hour and get 50% more when they work overtime. Should ElectroPoly schedule these employees to work overtime to complete this job? If so, how much money would this save?
e) Assume workers in the harnessing area normally make $12 per hour and get 50% more when they work overtime. Should ElectroPoly schedule these employees to work overtime to complete this job? If so, how much money would this save?
f) Create a spider plot that shows the effect ofvarying each of the wiring and harnessing requirements (in cells B17 thru D18) to 90% of their current levels in 1% increments. If Electro-Poly wanted to invest in training or new technology to reduce one of these values, which one offers the greatest potential for cost savings?

<u>Extra Questions</u>: Ragsdale Chapter 4, Ex 3, 5 & 6 (in both 8E and 9E).
Open FIT3158 Tutorial 3_Extra Ex. For Questions 3 (use Prb04_03), Question 5 (use Prb04_05), and Question 6 (use Prb04_06).

<u>Solutions:</u>

Exercise 1

a) There is 0 excess wiring capacity and 10 excess units of testing.
b) $32,500 + $125×10 = $33,750
c) $225
d) 50/150 + 75/225 = 2/3 < 100%. The solution would not change.
e) Let X = the increase in the price of alternators. We can be sure the optimal solution will not change as long as 25/150 + X/225 < 1 or X < 225(125/150) = 187.5. So the maximum profit on alternators would be $150+$187.5 = $337.5.
f) The new reduced cost on alternators would be 150 - 125×1.5 - 0×2 = -37.5. Thus, it would still be unprofitable to produce alternators and the solution would not change.

Exercise 2

a) No, the objective coefficient on doors could increase to $800 without changing the optimal solution.
b) Yes, the objective coefficient on windows can only decrease to $250 without changing the optimal solution.
c) The shadow price (marginal value) is $0 because there is a surplus of this resource.
d) $350*20=$7000.
e) Yes. 15 hours is within the Allowable Decrease and $400 is more than the shadow price of $300. However 25 hours is beyond the Allowance Decrease range, therefore shadow price of $300 will not hold. So unsure if $400 is sufficient.

Exercise 3

a) No.
b) The cost of making model 1 slip rings can increase by $4 without changing the solution.
c) No. The maximum allowable decrease on the objective coefficient for making model 2 slip rings is $14.
d) No. There is presently a surplus of 475 hours in the wiring department. Overtime would only add to this surplus.
e) Yes. Harnessing represents a binding constraint with a shadow price of -$7. Each additional unit of this resource (up to 633.33) will reduce costs by $7. Since workers are paid an additional $6 per hour for overtime, the company could save $633.33.
f) See spider chart in the file. Costs are most sensitive to reductions in the harnessing requirements for model 1 slip rings.

Extra Questions:

3. See: Prb4_3.xls

Microsoft Excel Sensitivity Report

Adjustable Cells

Cell	Name	Final Value	Reduced Cost	Objective Coefficient	Allowable Increase	Allowable Decrease
C4	Value: X1	5	0	4	1E+30	2.8
D4	Value: X2	0	-4.666666667	2	4.666666667	1E+30

Constraints

Cell	Name	Final Value	Shadow Price	Constraint R.H. Side	Allowable Increase	Allowable Decrease
E8	Used:	10	0	20	1E+30	10
E9	Used:	15	1.333333333	15	15	15

a. The objective function coefficient for X_1 can decrease by 2.8 or increase by any amount without changing the optimal solution.
b. The optimal solution is unique. None of the allowable increase or decrease values for the objective coefficients are zero.
c. 4.67
d. If X_2 were forced to equal 1, the optimal objective function value would be approximately $20 - 4.67 = 15.33$.
e. An increase of 10 in the RHS value of the second constraint is within the allowable range of increase for the shadow price of this constraint. Therefore, if the RHS for the second constraint increases from 15 to 25 the new objective function value would be approximately $20 + 1.33 \times 10 = 33.33$.
f. The new reduced cost for X_2 would be $2 - (4 \times 0 + 1 \times 1.333) = 0.67$. Therefore, it would be profitable to increase the value of X_2 and the current solution would no longer be optimal.

5. See: Prb4_5.xls

Microsoft Excel Sensitivity Report

Adjustable Cells

Cell	Name	Final Value	Reduced Cost	Objective Coefficient	Allowable Increase	Allowable Decrease
C4	Value: X1	0	3	5	1E+30	3
D4	Value: X2	0	1	3	1E+30	1
E4	Value: X3	1	0	4	2	4

Constraints

Cell	Name	Final Value	Shadow Price	Constraint R.H. Side	Allowable Increase	Allowable Decrease
F8	Produced:	2	2	2	1E+30	1
F9	Produced:	2	0	1	1	1E+30

a. 0
b. The new objective would be unbounded.
c. Increasing the RHS of the first constraint reduces the feasible region. Therefore, the objective function would be increased (made worse) at a rate of 2 per unit increase in the RHS value. Thus, the new objective function value would be $4 + 2 \times 5 = 14$.
d. $4 - 2\times 1 = 2$
e. Yes, $1/3 + 1/4 = 7/12 < 100\%$

6. a. MIN: $260X_{13} + 220X_{14} + 290X_{15} + 230X_{23} + 240X_{24} + 310X_{25}$

   S.T.:

   $X_{13} + X_{14} + X15 \leq 20$

   $X_{23} + X_{24} + X25 \leq 20$

   $X_{13} + X_{23} \geq 10$

   $X_{14} + X_{24} \geq 15$

   $X_{15} + X_{25} \geq 10$

   $X_{ij} \geq 0$

   b. See: Prb4_6.xls

   c. See below

Microsoft Excel Sensitivity Report

Adjustable Cells

Cell	Name	Final Value	Reduced Cost	Objective Coefficient	Allowable Increase	Allowable Decrease
C10	Eustis Miami	0	50	260	1E+30	50
D10	Eustis Orlando	10	0	220	20	0
E10	Eustis Tallahassee	10	0	290	0	310
C11	Clermont Miami	10	0	230	50	230
D11	Clermont Orlando	5	0	240	0	20
E11	Clermont Tallahassee	0	0	310	1E+30	0

Constraints

Cell	Name	Final Value	Shadow Price	Constraint R.H. Side	Allowable Increase	Allowable Decrease
C12	Shipped Miami	10	230	10	5	10
D12	Shipped Orlando	15	240	15	5	5
E12	Shipped Tallahassee	10	310	10	5	5
F10	Eustis Used	20	-20	20	5	5
F11	Clermont Used	15	0	20	1E+30	5

d. No.
e. No.

	Miami	Orlando	Tallahassee	Used	Capacity Available
Eustis	0	15	5	20	20
Clermont	10	0	5	15	20
Shipped	10	15	10		
Demand	10	15	10		

Total Cost $\boxed{\$8,600}$

f. The solution would not change. The current solution uses only 15 of the 20 tons of capacity available at Clermont.
g. Reducing the capacity in Eustis would increase costs by $20 per unit decrease yielding an objective function value of $\$8,600+20\times5 = \$8,700$
h. Every additional ton of concentrate unit shipped from Eustis to Miami would increase costs by $50.