

OPTIMIZATION

M.EIC – 2021, 2022

Lecture 3.2

Sensitivity Analysis

EXERCISE

SENSITIVITY ANALYSIS USING THE OPTIMAL SOLUTION OBTAINED BY A SOFTWARE

Consider again the example of Cereals, Ltd.

Due to new market challenges, it was decided to produce a new cereal, barley ('cevada', in Portuguese).

The marginal profits now are of 4 € per ton of wheat, 1 € per ton of corn and 3 € per ton of barley.

In each section (I, II and III) , the production times for each ton of barley are 3.5, 6 and 4 hours, respectively. Also, the company is committed to produce at least 12 tons of wheat and 10 tons of barley each week.

Problem formulation:

$$\begin{aligned} \max \quad & 4x + y + 3z \\ \text{s.to} \quad & 6x + 2y + 3.5z \leq 120 \\ & x + 4y + 6z \leq 100 \\ & 5x + 5y + 4z \leq 150 \\ & x \geq 12 \\ & z \geq 10 \\ & x, y, z \geq 0 \end{aligned}$$

The problem has been solved using Excel, and we obtained the following tableaux for the optimal solution

Variable Cells

Cell	Name	Final Value	Reduced Cost	Objective Coefficient	Allowable Increase	Allowable Decrease
\$C\$3	Decision variables wheat (x)	12	0	4	1.142857143	1E+30
\$D\$3	Decision variables corn (y)	0	-0.714285714	1	0.714285714	1E+30
\$E\$3	Decision variables barley (z)	13.71428571	0	3	1E+30	0.666666667

Constraints

Cell	Name	Final Value	Shadow Price	Constraint R.H. Side	Allowable Increase	Allowable Decrease
\$F\$10	Min wheat production LHS	12	-1.142857143	12	2.166666667	0.615384615
\$F\$11	Min barley production LHS	13.71428571	0	10	3.714285714	1E+30
\$F\$7	Section I LHS	120	0.857142857	120	3.333333333	13
\$F\$8	Section II LHS	94.28571429	0	100	1E+30	5.714285714
\$F\$9	Section III LHS	114.8571429	0	150	1E+30	35.14285714

QUESTIONS

1. What is the profit in the optimal solution? What is the optimal production plan?
2. Suppose that the wheat (x) profit has an increment of 0.75 €/ton. Which is the impact of this change on the optimal production plan and on the profit? And if the increment is of 1.5 €/ton? And if the wheat profit decreases 0.05 €/ton? And if it decreases 2 €/ton?
3. What should be done to make corn production (y) profitable?
4. If the company was forced to produce some corn, which would be the impact of that decision on the company profit?
5. Suppose that there is an additional hour available in section I. What is the impact on profit? And if there are 2 additional hours?
6. Suppose that the number of available hours in section I diminishes to 119 hours. What is the impact on profit? And if we only dispose of 105 hours in this section?
7. Comment the importance of hiring multifunctional employees that can work in different sections.
8. What happens if the minimum amount of wheat to produce increases of 1.5 tons? And if it decreases of 0,29 tons?

CASE STUDY – TTC TRUCK COMPANY

EXERCISE - COFFEE SHOP

In a coffee shop, which is open only on weekdays, workers work four days per week followed by a day off. This scheme is repeated every 5 days and therefore a worker has the same day off every week.

The need for workers is given in the table below and must be met or exceeded in every day.

- i. Formulate a linear programming model for this problem that minimizes the total number of workers needed to meet the daily demand.
- ii. Suppose it is necessary to ensure that at least 40% of workers have a free Friday. Add this restriction to the problem.

Day	Monday	Tuesday	Wednesday	Thursday	Friday
Demand	3	5	9	2	7

A CURTAIN MATERIAL TRIM LOSS PROBLEM

A curtain manufacturer receives three orders for curtain material with widths and lengths as follows:

Rolls of curtain material are produced in two standard widths, 5 and 10 m. These can be cut to the sizes specified by the order. There is no practical length limitation as rolls can be joined together. Determine the production plan that minimizes the curtain material trim loss.

Order	Width	Length (nr. of rolls)
1	2.5	30
2	3.8	50
3	4.9	10

THE CONFERENCE ORGANISER PROBLEM

A conference organizer must cater for lunches for the 5 days of a conference. The organizer is faced with the problem of deciding on the daily supply of clean serviettes. The organizer knows that the number of conference attendees requiring lunch for the 5 days are 130, 220, 180, 120, and 100. The alternatives are:

- to buy new serviettes at 25¢ each piece, or
- to send used serviettes to the laundry where they can receive either a 48 h service at 10¢ a serviette, or a 24 h service at 15¢ a serviette.

If this conference is a once-off activity with respect to the provision of serviettes, how should the organiser provide serviettes to minimize the total cost?