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3/30/2020

DSA 8420

# Project 2

***Original Model and Solution:***

```
:       x   marginal_value item_profit
A    200          .          10
B    587.5        .          12
C    787.5        .           8
D    662.5        .          15
E    400          .          18
F      0          .          10
G      0          .          19
P1     .       137.5          .
P2     .         0            .
R1     .        12.5          .
R2     .         0            .
R3     .        41.25         .
;

profit = 32487.5
```

***mod file:***

```
# model project2.mod

# Bill Sadoo
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reset;

set products;
set inputs;
param item_profit {j in products};
param RHS {inputs};
param lower {j in products};
param upper {j in products};
param units {inputs, products};
var x {j in products} >= 0;
maximize profit: sum {j in products} item_profit[j]*x[j];
subject to marginal_value {I in inputs}: sum {j in products} units[I,j]*x[j] <=
RHS[i];
limit {j in products}: lower[j] <= x[j] <= upper[j];

data project2.dat;
option solver cplex;
option show_stats 1;
```

```
option cplex_options ‘sensitivity primalopt’;
solve;

printf “\n\n\n--------------Problems 1-3-------------\n\n”;
display inputs, x, marginal_value, item_profit, profit, _var.down, _var.up;
printf “\n\n 1. The marginal values and relative profits are defined and meaningful.
We can see that the marginal values are\n P1 = 137.50\n P2 = 0\n R1=12.50\n R2=0\n
R3=41.25\n\n 2. The suppliers price of $15 per unit exceeds the marginal value in
producing it ($12.50), so additional supplies of R1 should not be ordered\n\n 3.
Given the price of the additional hours is $150 which exceeds the marginal value of
an additional hour of $137.50, it is NOT worth accepting the arrangement.”;

printf “\n\n\n--------------Problem 4--------------\n\n”;
printf “ The relative contribution (in terms of percentage of profit) of each item is
as follows:\n A=6.2 \n B=21.7 \n C=19.4 \n D=30.6 \n E=22.2, with F and G
contributing nothing\n\n\n”;


printf “\n\n\n--------------Problem 5--------------\n\n”;
let item_profit[“C”] := 10;
option solver cplex;
option show_stats 1;
solve;
display inputs, x, marginal_value, item_profit, profit, _var.down, _var.up;
printf “\n\n Upon increasing the profit by $2, we can see that profits increase due
to the fact that the optimal mix remains unchanged. Working on the assumption that
supply equally matches demand, you can let the sales manager know that demand will in
NOT decrease to 600 units, but remain at 787.5”;


printf “\n\n\n--------------Problem 6--------------\n\n”;
reset data;
data project2.dat;
let units[“P1”,”G”] := 0.04*.5;
solve;
display inputs, x, marginal_value, item_profit, profit, _var.down, _var.up;
printf “\n\n Upon making the price of P1 for product G, the optimal mix has changed
to as follows:\n A=200\n B=800\n C=381.818\n D=527.273\n E=400\n F=0\n G=154.545\n
Total profit increases by $212.50 to $32,700. All of this assumes that the company
can produce and sell fractional parts of a product.”;


printf “\n\n\n--------------Problem 7--------------\n\n”;
reset data;
data project2.dat;
let units[“R1”,”B”] := 0.30*.6666;
solve;
display inputs, x, marginal_value, item_profit, profit, _var.down, _var.up;
printf “\n\n Upon making the price of R1 for product B, the optimal mix has changed
to as follows:\n A=200\n B=783.386\n C=983.386\n D=466.614\n E=400\n F=0\n G=0\n
Total profit increases by $979.40 to $33,466.90. All of this assumes that the company
can produce and sell fractional parts of a product.”;


printf “\n\n\n--------------Problem 8--------------\n\n”;
```

```
printf " ***Please see project2-8.mod for the model and answer to this question***";


printf "\n\n\n--------------Problem 9--------------\n\n";
reset data;
data project2.dat;
let item_profit["F"] := 12;
option solver cplex;
option show_stats 1;
solve;
display inputs, x, marginal_value, item_profit, profit, _var.down, _var.up;
printf "\n\n Upon increasing the profit/price of product F by $2 to $12, we can see
that there is still not optimal to produce this product. The profit needs to be
$12.25 in order for it to be attractive and change the optimal mix.";
```

***Dat file:***

```
set products := A B C D E F G;

set inputs := R1 R2 R3 P1 P2;
param units default 0 :=
[R1,A] 0.1 [R1,B] 0.3 [R1,C] 0.2 [R1,D] 0.1 [R1,E] 0.2 [R1,F] 0.1 [R1,G] 0.2
[R2,A] 0.2 [R2,B] 0.1 [R2,C] 0.4 [R2,D] 0.2 [R2,E] 0.2 [R2,F] 0.3 [R2,G] 0.4
[R3,A] 0.2 [R3,B] 0.1 [R3,C] 0.1 [R3,D] 0.2 [R3,E] 0.1 [R3,F] 0.2 [R3,G] 0.3
[P1,A] 0.02 [P1,B] 0.03 [P1,C] 0.01 [P1,D] 0.04 [P1,E] 0.01 [P1,F] 0.02 [P1,G] 0.04
[P2,A] 0.04 [P2,C] 0.02 [P2,D] 0.02 [P2,E] 0.06 [P2,F] 0.03 [P2,G] 0.05;
param item_profit:=
A 10 B 12 C 8 D 15 E 18 F 10 G 19;
param RHS :=
R1 500 R2 750 R3 350 P1 60 P2 80;
param lower default 0 :=
A 200;
param upper   default Infinity :=
B 800 E 400;
```

***1. Are the marginal values (shadow prices, relative profits) of the various items well defined and meaningful? What might make you suspect they might not be? If they are, what are their values and interpretation?***

The calculated profit is $32,487.5 and the marginal values are P1=137.5, P2=0, R1=12.5, R2=0, R3=41.25. These values are defined and are meaningful as they suggest ways to increase the profit. The way to interpret them is we can increase the profit for P1, R1, and R3 by increasing by one unit.

***2. Is it worth increasing the supply of R1 beyond the present 500 units/day? The current supplier for R1 is unable to supply any more than the current amount. The procurement manager has identified a new supplier for R1, but that supplier's price is $15/unit higher than the current suppliers. Should additional supplies of R1 be ordered from this new supplier?***

As calculated above we know that an increase in the supply of R1 will increase our profits. However, with the profit originally at $32487.50 with 500 units and a profit of $32500.00 with 1 more unit, we know that the difference in price of one unit is only $12.50, which would mean that to produce it at a new factory for $15.00 you would be paying an additional $2.50 per a unit and would not be worth the profit. It would be beneficial to not order additional supplies.

***3. The production manager has identified an arrangement by which 20 hours/day of either P1- or P2-time can be made available at a cost of $150/day. Is it worth accepting this arrangement?***

By changing the P1 value from 60 to 80 we see an increase in profit from 32,487.50 to $33,266.67 with a difference of $779.17. So, if we subtract the cost of $150.00 from the $779.17, we get a $629.17 increase, and it makes the arrangement worth pursuing. P2 we already know has a marginal value of 0 and would not result in any additional profit and thus making it not worth accepting the arrangement for P2.

***4. The sales manager would like to know the relative contributions to the various products to the company's total profit. What are they?***

The contributions of each product to the overall profit are defined in percentages below.

A = 7.58%

B = 22.27%

C = 29.86%

D = 25.12%

E = 15.17%

F = 0

G = 0

***5. The sales manager believes that product C is priced too low for a good image. This manager claims that if the selling price of C were increased by $2/unit, the demand for it would be 600 units/day. What is the effect of this change?***

After increasing the price of product C from $8 to $10, we can see that profits increase because the optimal mix remains unchanged. Working on the assumption that supply equally matches demand, you can let the sales manager know that demand will in NOT decrease to 600 units and will remain at 787.5.

***6. The production manager claims that the manufacturing process for G can be changed so that its need for P1-time goes down by 50% without affecting quality, demand, or selling price. What will be the effect of this change on the optimum product mix and total profit?***

Changing [P1,G] value from 0.4 to 0.2, we get the new profit of $32700, which is an increase from $32487.5 by $212.50. The new optimal mix is:

A = 200

B = 800

C = 381.818

D = 527.273

E = 400

F = 0

G = 154.545

***7. The production manager believes that by changing specifications, it should be possible to make product B with 33.3% less of R1, and this would have no effect on the salability of this product. What will be the effect of this change on the optimum product mix and total profit?***

After changing the [R1,B] value from 0.3 to 0.2 we get the new profit of 33466.67, which is an increase from 32487.50 by 979.17. The new optimal mix is:

A = 200

B = 783.333

C = 983.333

D = 466.667

E = 400

F = 0

G = 0

***8. The company's research division has formulated a new product, H, which they believe can yield a profit of $8–10/unit made. The input requirements to make one unit of this product will be as follows.***

| ***Item*** | ***R1*** | ***R2*** | ***R3*** | ***P1-time*** | ***P − 2-time*** |
|---|---|---|---|---|---|
| ***Input*** | ***0.10*** | ***0.20*** | ***0.10*** | ***0.02*** | ***0.02*** |

***Is this product worth further consideration?***

After adding the new product H, we will test the different prices listed for $8 and $10. Using 8$/unit we see no changes in profit which remained at 32487.5. After changing the price to $10/unit we see an increase in profit to 35800, which is an increase of 3,312.5, which makes this product worth further consideration at $10/unit. In order to observe what the upper and lower bounds of the price of product H that would necessitate a mix change, we set the initial profit to 0 and observer the var.up value. We can see from the output that the minimum profit needed to make product H and necessitate a mix change must be greater than $8.125.

***9. The sales manager feels that the selling price/unit of product F can be increased by $2 without affecting the demand for it. Would this lead to any changes in the optimum production plan? What is the effect of this change on the total profit?***

For this problem we change the price/unit of F from $10 to $12. This gives us a new profit that is unchanged from the original and an unchanged optimum mix as well.