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A Simple Technique to INCREASE PROFITS IN WOOD PRODUCTS MARKETING

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Abstract: Mathematical models can be used to solve quickly some simple day-to-day marketing problems. This note explains how a sawmill production manager, who has an essentially fixed-capacity mill, can solve several optimization problems by using pencil and paper, a forecast of market prices, and a simple algorithm. One such problem is to maximize profits in an operating period where total costs are insensitive to the rearrangement of production schedules.

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Additional revenues do not necessarily increase profits when operating costs are also likely to increase. But when operating costs are fixed by pre-planning or inflexible operating budgets any increase of total revenues becomes an additional contribution to total profits. And when operating costs become essentially insensitive to the day-to-day decisions of the production and marketing manager a number of profit maximization problems can be solved simply and quickly by using a pencil and a piece of paper, a forecast of market prices, and a simple mathematical model. Snodgrass and French[1] point out that some problems can be solved by using a "transportation" algorithm that might, for instance, be used to find a least-cost solution for transporting warehouse supplies from 25 different locations to the demands of 25 different delivery points. Supply must equal demand in this typical "transportation" algorithm problem, but problems of this dimension actually have millions of prospective trial-and-error solutions.[2]

This note illustrates how a modified form of the "transportation" algorithm can be used by the wood products production or marketing manager to solve many market-related problems, especially in those cases where revenues can be increased more rapidly than any associated increase in cost.

To illustrate how revenue maximization problems can be solved with a simple algorithm we will assume an example of a sawmill operation that anticipates the production of:

- 4 million board feet of lumber in June
- 5 million board feet of lumber in July
- 7 million board feet of lumber in August
- 4 million board feet of lumber in September

Variation in outputs have been allowed to compensate for lost time for holidays, downtime for maintenance, and slowdowns due to weather. Furthermore, these monthly approximations of production may need to be adjusted owing to the variations in the rates at which different timber species may be manufactured.

The total volume of timber that will supply this production is located in three different sites. One site holds 6 million board feet of ponderosa pine; another, 10 million board feet of white fir; and the third, 4 million board feet of Douglas-fir. Each site is equally accessible to logging. Even if this timber is not equally accessible we may assume that the total cost for logging will be the same regardless of the time sequence in which the different species are delivered to the mill.

The example assumes that the mill manager has a 4-months forecast of the product recovery values for ponderosa pine, white fir, and Douglas-fir for June, July, August, and September. A forecast that turns out to be either high or low will not necessarily influence the solution to the problem in this example. It is the change in the differentials of values between different time periods that determines the results. Thus a forecast may overestimate, or underestimate the level of market prices and still correctly solve a revenue maximization problem.

To maximize revenues, production and marketing activities must be coordinated. The foregoing conditions of supply and demand are illustrated in the working format of a transportation model *(fig. 1)*. The objective of the problem is to sell as much of each species as possible at the highest values. The solution will be an optimal production schedule based upon the expectations of market prices. The following steps provide an optimal solution:

1. Compute for each column the difference between the lowest price in each column and each forecasted price in the same column *(fig. 2)*. Place these values in the corner section of the cell with each price. Differences indicate the range above the lowest price for each price listed in the column.

2. Compute the difference between the largest and second largest values to be found in the corner sections for each row and each column *(fig. 3)*. Place these values around the rim of the model.

3. Select the row or column with the largest rim value and assign as much production as possible to the cell with the corner section holding the highest value *(fig. 3)*. Adjustments of the approximations of production capacities can be made at this point to account for the different rates at which different species may be manufactured.

4. Cross out production capacity scheduled and supplies of timber as they become exhausted *(fig. 3)*.

Time period	Ponderosa pine	White fir	Douglas-fir	Production capacity
June	$109/MBF	$73/MBF	$82/MBF	4MMBF
July	112/MBF	80/MBF	86/MBF	5MMBF
August	111/MBF	76/MBF	84/MBF	7MMBF
September	110/MBF	72/MBF	81/MBF	4MMBF
Timber supply	6MMBF	10MMBF	4MMBF	20MMBF

Figure 1—*Production capacities, timber supplies, and market forecast of prices, by time periods, are stated in the working format of a transportation model or algorithm.*

Time period	Ponderosa pine	White fir	Douglas-fir	Production capacity
June	0 / $109/MBF	1 / $73/MBF	1 / $82/MBF	4MMBF
July	3 / 112/MBF	8 / 80/MBF	5 / 86/MBF	5MMBF
August	2 / 111/MBF	4 / 76/MBF	3 / 84/MBF	7MMBF
September	1 / 110/MBF	0 / 72/MBF	0 / 81/MBF	4MMBF
Timber supply	6MMBF	10MMBF	4MMBF	20MMBF

Figure 2—*The numbers in the corner sections of each cell are the differences between the price forecast for that cell and the lowest price forecast listed in that column. These differences indicate the range above the lowest price for each price forecast in each column.*

1st Assignment

Columns → 1 4 2 — Rows

Time period	Ponderosa pine	White fir	Douglas-fir	Production capacity	Rows
June	0 / $109/MBF	1 / $73/MBF	1 / $82/MBF	4MMBF	1
July	3 / 112/MBF	5 8 / 80/MBF	5 / 86/MBF	~~5MMBF~~	3
August	2 / 111/MBF	4 / 76/MBF	3 / 84/MBF	7MMBF	1
September	1 / 110/MBF	0 / 72/MBF	0 / 81/MBF	4MMBF	1
Timber supply	6MMBF	10MMBF	4MMBF	20MMBF	

Figure 3—*The values placed around the rim of the transportation model are the differences between the largest and second largest values to be found in the corner sections for each row and each column. Select the row or column with the greatest rim value for the first production assignment. Assign as much production as possible to the cell with the largest corner section value. Cross out production capacities and timber supplied as they are depleted.*

5. Re-determine the differences between the two largest corner section values remaining—omitting the row(s) and/or column(s) crossed out *(fig. 4)*.

6. Repeat steps 3 through 5 until all possible assignments are made *(figs. 5, 6, 7)*. The final solution is to be found in *figure 7*.

7. If the greatest difference occurs at the same time in both a row and a column, and the corner

2nd Assignment

Columns → 1 3 2 — Rows

Time period	Ponderosa pine	White fir	Douglas-fir	Production capacity	Rows
June	0 / $109/MBF	1 / $73/MBF	1 / $82/MBF	4MMBF	1
July	3 / 112/MBF	5 8 / 80/MBF	5 / 86/MBF	~~5MMBF~~	X
August	2 / 111/MBF	5 4 / 76/MBF	3 / 84/MBF	7MMBF	1
September	1 / 110/MBF	0 / 72/MBF	0 / 81/MBF	4MMBF	1
Timber supply	6MMBF	~~10MMBF~~	4MMBF	20MMBF	

Figure 4—*After completing the first assignment re-determine the rim values for the rows and columns that have not been depleted by assignments. Again, select the row or column with the greatest rim value and assign as much production as possible to the cell with the greatest corner section value. Cross out the depleted timber supply.*

3rd Assignment

Columns → 1 X 2 — Rows

Time period	Ponderosa pine	White fir	Douglas-fir	Production capacity	Rows
June	0 / $109/MBF	1 / $73/MBF	1 / $82/MBF	4MMBF	1
July	3 / 112/MBF	5 8 / 80/MBF	5 / 86/MBF	~~5MMBF~~	X
August	2 / 111/MBF	5 4 / 76/MBF	2 3 / 84/MBF	7MMBF	1
September	1 / 110/MBF	0 / 72/MBF	0 / 81/MBF	4MMBF	1
Timber supply	6MMBF	10MMBF	4MMBF	20MMBF	

Figure 5—*Repeat steps illustrated in figures 3 and 4 until all possible assignments are made.*

Columns → 1 X 1 — Rows

Time period	Ponderosa pine	White fir	Douglas-fir	Production capacity	Rows
June	0 / $109/MBF	1 / $73/MBF	1 / $82/MBF	4MMBF	1
July	3 / 112/MBF	5 8 / 80/MBF	5 / 86/MBF	~~5MMBF~~	X
August	2 / 111/MBF	5 4 / 76/MBF	2 3 / 84/MBF	~~7MMBF~~	X
September	1 / 110/MBF	0 / 73/MBF	0 / 81/MBF	4MMBF	1
Timber supply	6MMBF	10MMBF	4MMBF	20MMBF	

Figure 6—*When the greatest rim value occurs at the same time in both a row and a column, and the corner section value in the cell at the junction is the largest in either the row or column, then assign as much volume to this junction cell as possible. In this example, two cells satisfy this rule. Either cell can be assigned first.*

Time period	Ponderosa pine	White fir	Douglas-fir	Production capacity
June	2 0 $109/MBF	1 $73/MBF	2 1 $82/MBF	4MMBF
July	3 112/MBF	5 8 80/MBF	5 86/MBF	5MMBF
August	2 111/MBF	5 4 76/MBF	2 3 84/MBF	7MMBF
September	4 1 110/MBF	0 73/MBF	0 81/MBF	4MMBF
Timber supply	6MMBF	10MMBF	4MMBF	20MMBF

Figure 7—*An optimal solution is finally arrived at with all production capacities satisfied by an equal amount of timber supply.*

section value in the cell at the junction is the largest in either the row or column then assign as much volume to this junction cell as possible. If not, assign as much volume in either the row or column, wherever the algebraically largest element exists.

8. If the greatest difference occurs at the same time in two or more rows (or columns), then assign as much volume as possible to the cell with the greatest corner section value.

If the forecast in our example is correct, the optimal solution will generate a total revenue of $1,770,000:

2MM board feet X $109.00/M board feet = $218,000.00
2MM board feet X 82.00/M board feet = 164,000.00
5MM board feet X 80.00/M board feet = 400,000.00
5MM board feet X 76.00/M board feet = 380,000.00
2MM board feet X 84.00/M board feet = 168,000.00
4MM board feet X 110.00/M board feet = 440,000.00

Total revenue = $1,770,000.00

If equal amounts of each species are produced and sold at each price level, the total revenue will be $1,759,480.00. Selling equal amounts of each species at each price level may tend to avoid the uncertainties of the market, but in the example an optimal program would generate an extra $10,520.00 of revenue at no extra costs.

This example illustrates an optimal solution. Sometimes the first answer may not be an only solution. Extensions of this technique can provide alternative solutions where they exist. Also, in some problems, evaluations can be made where costs do vary with the alternative decisions that are available. This can be accomplished by first deducting variable costs from the price forecast of the products in the time periods to which the cost accrue.

The approach described in this note is most useful when approximate solutions are sufficient, and when the additional time and cost of using other methods cannot be accommodated.

NOTES

[1]Snodgrass, Milton M., and Charles E. French. *Simplified presentation of "Transportation-problem procedure" in linear programming.* J. Farm Econ. 39(1): 40-51. 1957.

[2]Metzger, R. W. *Elementary mathematical programming.* New York: John Wiley & Sons, Inc., 246 p., illus. 1958.

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