Chapter 484

Transportation

Introduction

The object of the transportation algorithm is to find the amounts shipped from *m* sources to *n* destinations that will minimize the total cost of distribution while meeting the demands at each destination and staying within the amount that can be supplied from each source. The problem assumes that only whole units can be shipped. Although special transportation algorithms exist, **NCSS** solves the problem using the Mixed Integer Programming algorithm available in the *Extreme Optimization* mathematical subroutine package.

Transportation Model

Suppose a company assembles televisions at three locations: Oakland, Chicago, and Pittsburgh. Further suppose that this company has two distribution warehouses: Denver and Atlanta. The following table gives the unit transportation costs, the amounts produced at each assembly location (supply), and the amounts needed at each warehouse (demand). The challenge is to find solution that will minimize the total transportation costs.

Sample Transportation Problem

Source	Denver	Atlanta	Supply
Oakland	$30	$56	1500
Chicago	$36	$28	1800
Pittsburgh	$66	$29	1900
Demand	2200	3000	

The solution will be given as Example 1 below.

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Balancing the Transportation Model

A *balanced* transportation model is one in which the total supply equals the total demand. In the example above, the total supply and the total demand are both 5200 units. If the model is unbalanced, a dummy source or a dummy destination is added to take up the slack.

For example, suppose the capacity of the Chicago assembly facility is actually 1950 units. A dummy destination with a demand of 150 units is added with zero costs.

Sample Transportation Problem

Source	Denver	Atlanta	Dummy	Supply
Oakland	$30	$56	$0	1500
Chicago	$36	$28	$0	1950
Pittsburgh	$66	$29	$0	1900
Demand	2200	3000	150	

Data Structure

This technique requires a special data format which will be discussed under the *Specifications* tab. Here is the way the above example would be entered. It is stored in the dataset *Transport*.

Transport dataset

Label	Type	Supply	Denver	Atlanta
	D		2200	3000
Oakland	S	1500	30	56
Chicago	S	1800	36	28
Pittsburgh	S	1900	66	29

Procedure Options

This section describes the options available in this procedure.

Specifications Tab

Set the specifications for the analysis.

Optimum Type

Type of Optimum

Specify whether to find the minimum or the maximum.

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Demand, Supply, and Costs

Row Type Column

This column indicates the type of information (demand or cost and source) that is contained on each row. It should contain either an 'S' or 'D' in each row. Note that the order of the rows does not matter.

The possible entries are:

- **D**
  This row contains demand values. There should be only one demand row.
- **S**
  This row contains cost and supply values for the source contained on this row.

Destination Columns

Specify the columns containing 'destination' variables. Each column represents a possible destination for the goods shipped from the sources (represented by rows) in the problem. The rows are interpreted as costs (per unit) or demands according to the value of the Row Type Column.

If the Row Type Column cell is 'D', the values entered across the row are interpreted as demands (goods needed) at each destination.

If the Row Type Column cell is 'S', the values entered across the row are interpreted as the costs (per unit) of producing and transporting the goods from the source to the destination.

The values in the Supply Column represent the amount produced by each source.

Usually, the cost values are positive, as are the demand and supply values. Blanks are treated as zeros.

Supply Column

Specify the column containing the supply amounts for each source. This value is not needed for the row in which the Row Type is 'D'.

Labels of Source Column

Optionally, you can specify a column containing a label for each row (Row Type = 'S'). These labels are used to make the output easier to interpret.

The label in the demand row is ignored.

Reports Tab

Select Reports

Transportation Costs Matrix, Amount Transported (Solution)

Indicate which reports you want to view.

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Report Options

Variable Names

This option lets you select whether to display only variable names, variable labels, or both.

Precision

Specify the precision of numbers in the report. Single precision will display seven-place accuracy, while double precision will display thirteen-place accuracy.

Report Options – Decimal Places

Input Coefficients – Calculated Values

These options let you designate the number of decimal places to be displayed for each type of variable.

Example 1 – Transportation Model

This section presents an example of how to run the data presented in the example given above. The data are contained in the Transport database. Here is the specification of the problem.

Transport dataset

Label	Type	Supply	Denver	Atlanta
	D		2200	3000
Oakland	S	1500	30	56
Chicago	S	1800	36	28
Pittsburgh	S	1900	66	29

You may follow along here by making the appropriate entries or load the completed template **Example 1** by clicking on Open Example Template from the File menu of the Transportation window.

1 Open the Transport dataset.

- From the **File** menu of the NCSS Data window, select **Open Example Data**.
- Click on the file **Transport.NCSS**.
- Click **Open**.

2 Open the Transportation window.

- Using the Analysis menu or the Procedure Navigator, find and select the **Transportation** procedure.
- On the menus, select **File**, then **New Template**. This will fill the procedure with the default template.

3 Specify the problem.

- On the Transportation window, select the **Specifications tab**.
- Set **Type of Optimum** to **Minimum**.
- Double-click in the **Row Type Column** text box. This will bring up the column selection window.
- Select **Type** from the list of columns and then click **Ok**. “Type” will appear in this box.
- Double-click in the **Destination Columns** text box. This will bring up the column selection window.
- Select columns **Denver-Atlanta** from the list of columns and then click **Ok**. “Denver-Atlanta” will appear in this box.
- Double-click in the **Supply Column** text box. This will bring up the column selection window.
- Select **Supply** from the list of columns and then click **Ok**. “Supply” will appear in this box.
- Double-click in the **Labels of Source Column** text box. This will bring up the column selection window.
- Select **Label** from the list of columns and then click **Ok**. “Label” will appear in this box.

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4 Run the procedure.

- From the **Run** menu, select **Run Procedure**. Alternatively, just click the green Run button.

Costs from Source to Destination

	Destination	
Source	**Denver**	**Atlanta**
Oakland	30	56
Chicago	36	28
Pittsburgh	66	29

This report lists costs per unit.

Solution

Solution (Amount Transported)

Destination			
Source	**Denver**	**Atlanta**	**Total**
Oakland	1500	0	1500
Chicago	700	1100	1800
Pittsburgh	0	1900	1900
Total	2200	3000	5200
Total Cost	156100		

This report presents the solution. The entries are the number of units to be shipped from each source to each destination. The Total Cost is the minimum cost that is achieved by this allocation method.

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