

Introduction

Supertree was designed for use by professional decision analysts; thus, it has many powerful features that can increase the scope and incisiveness of your analysis. These advanced features are discussed in the pages that follow.

The ability to link to spreadsheets is a feature of sufficient importance to be covered separately in Chapter 8, “Endpoint Valuation.” Spreadsheet linking is also discussed in Chapter 2, “Sensitivity Example,” and Chapter 5, “Supertree Example.”

Dependent Probabilities

In the bidding case discussed in Chapter 5, the nodes were all independent of each other—knowing the competitor’s bid would not change the probabilities on cost. However, consider a case where the probabilities are interdependent. If you think the competitor is more experienced at estimating costs than you and it is likely your costs would be high if the competitor bids high, your probabilities would change depending on the competitor’s bid. Supertree easily handles probabilistic dependency.

To see how this works in the bidding example, open the Supertree file that you created in Chapter 5 (Bidding Tree). Select the Input or Change Node Data... option from the Structure menu to edit node 3, Cost. Go to the Probabilities Depend on Nodes field and enter 2, indicating that the probabilities of Cost depend on node 2, Compbid.

Supertree replaces the Probability column with an Enter button as shown in Figure 7.1.

Decision/Chance Node Data, Node Number 3

Node type: Probabilities depend on nodes:

Number of branches: Outcomes depend on nodes:

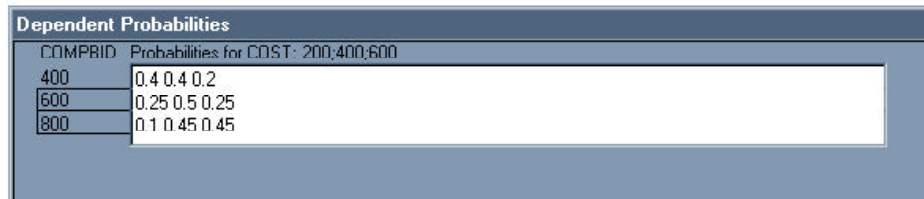
Node name:

Probability	Outcome	Reward	Successor Node
<input type="button" value="Enter"/>	<input type="text" value="200"/>	<input type="text" value="0"/>	<input type="text" value="4"/>
	<input type="text" value="400"/>	<input type="text" value="0"/>	<input type="text" value="4"/>
	<input type="text" value="600"/>	<input type="text" value="0"/>	<input type="text" value="4"/>

Figure 7.1

Dependent Probabilities

Click the Enter button and a screen like that shown in Figure 7.2 will appear. Input the probabilities for COST for each of the three branches of Compbid as shown in Figure 7.2. Make sure that you use a space between probabilities. You can move from row to row by using the mouse or Tab key. The 0.4 0.4 0.2 that you have entered next to the 400 indicates that if your competitors bid 400 there is a 40%, 40%, and 20% chance that your cost will be 200, 400, and 600 respectively.



Dependent Probabilities			
COMPBID	Probabilities for COST: 200,400,600		
400	0.4	0.4	0.2
600	0.25	0.5	0.25
800	0.1	0.45	0.45

Figure 7.2

When you have finished entering all the conditional probabilities, click the OK button to return to the screen shown in Figure 7.1 and then click the OK button to enter the data. You can then choose the Show Tree Structure command from the Structure menu (or toolbar) to see the dependent probability information summarized in tree form at the bottom of the display (see Figure 7.3).

You need not select Evaluate for the tree after changing probabilities. Reevaluation is necessary only when information on tree structure, node names, node outcomes, or rewards has been changed.

Dependent Probabilities

Show Tree Structure

Tree name: Bidding Tree

STRUCTURE	NAMES	OUTCOMES	PROBABILITIES
1D2 2	BID	500 700	
2C3 3 3	COMPRID	400 600 800	.35 .50 .15
3C4 4 4	COST	200 400 600	Depends on 2
4E	E\$c:\super95\bidding.xls& \$Profit\$AA	Depends on 1 2 3	

COMPBID

PROBABILITY, NODE 3

400	0.4 0.4 0.2
600	0.25 0.5 0.25
800	0.1 0.45 0.45

Excel options:

Open linked spreadsheets.

Iterate with 100 maximum iterations and 0.001 maximum change.

Figure 7.3

Using the Rollback Tree and Display Tree commands of the Analyze menu, you will see that, although the optimal bid remains \$500K, the expected value has been reduced from \$65K to \$55K as a result of the change to reflect dependent probabilities.

Note: The following sections in this chapter illustrate several other concepts using the BID file. If you want your screen to agree with the figures that follow, make sure that you change the BID file back to what it used to be (i.e., change the probability dependence of node 3 back to the original values, or close the file without saving changes and reopen it again).

Dependent Outcomes

Instead of making the probabilities dependent, you could reflect changes in costs (outcomes) as the competitor's bid changes. You might believe that if a high bid wins, company management may feel more relaxed and not press as hard to keep costs down. To examine the outcome for this possibility, select the Input or Change Node Data... command from the Structure menu to look at node 3, and enter 2 1 in the Outcomes depend on nodes field. This makes the Cost outcomes depend on node 2 (COMPBID) and node 1 (BID). Supertree replaces the Outcome column with an Enter button as shown in Figure 7.4.

Probability	Outcome	Reward	Successor Node
.25	Enter	0	4
.50		0	4
.25		0	4

Figure 7.4

If you click the Enter button, your screen should look like the one in Figure 7.5. You can enter the numbers shown in Figure 7.5 or enter your own numbers. (Make sure that you leave a space between outcomes and that you use the mouse or the Tab key to move from row to row.)

COMPBID	BID	Outcomes for COST
400	500	170 350 550
	200	190 380 570
600	500	200 400 600
	200	220 420 610
800	500	280 450 650
	200	300 480 680

Figure 7.5

Dependent Outcomes

After you are done, click the OK button to enter the data. You must evaluate the tree again because some of the outcomes that are used in the calculation of the tree endpoints have changed. After evaluating the tree, use the Rollback Tree or Display Tree command from the Analyze menu to see the new expected value. (If you use the numbers shown in Figure 7.5, your new expected value for the 500 Bid should be 56.4.)

When the outcomes of a node depend on other nodes, some displays will have asterisks for the outcomes, as shown in Figure 7.6, when the tree is displayed in the order 1 3 2. The asterisks serve as placeholders for the outcome of node 3—this is necessary because the value of the outcome for node 3 cannot be determined until after node 2, which now appears to the right of (after) node 3.

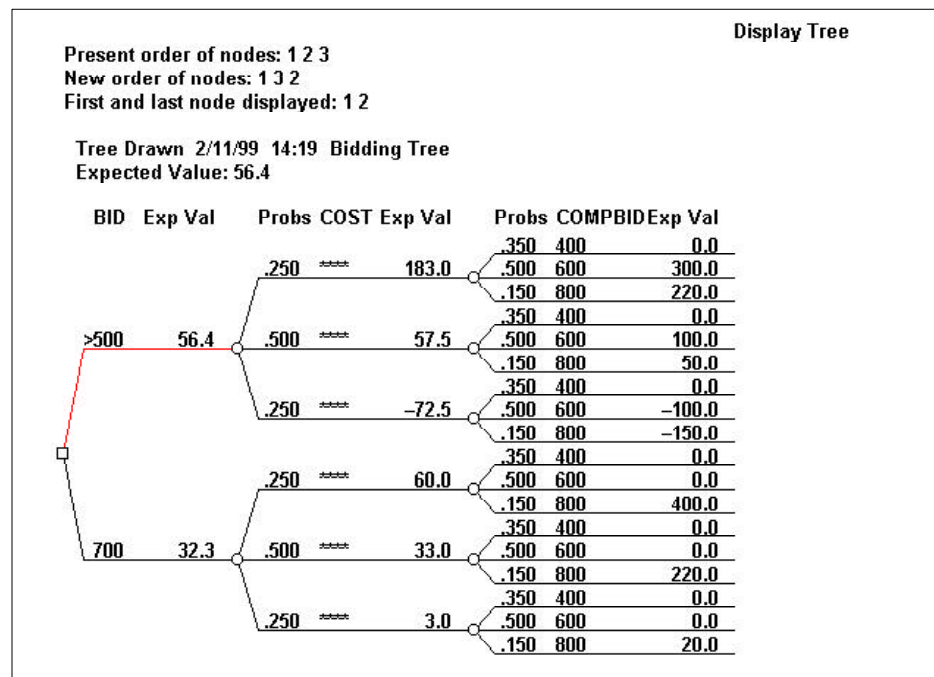
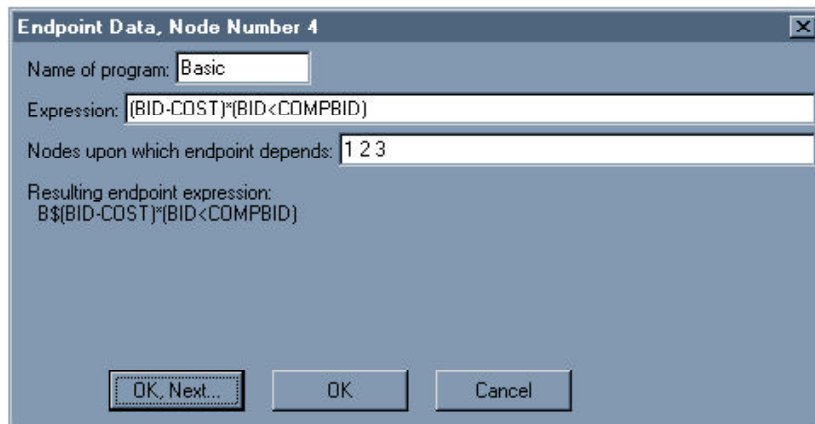


Figure 7.6

Dependent Endpoints

Recall the Endpoint Data entry screen by using the Input or Change Node Data... command from the Structure Menu, and enter 4. Node 4 contains a field called “Nodes upon which endpoint depends.” In the example, the endpoint depends on nodes 1, 2, and 3 (see Figure 7.7).

When Supertree performs the evaluation, it will use all 18 combinations of the outcomes of nodes 1, 2, and 3 to evaluate the expression ($2 \times 3 \times 3 = 18$). If the endpoint were declared to depend only on nodes 1 and 2, Supertree would display the error message VALUE ERROR because the variable cost would not be defined and its value is needed to evaluate the Basic endpoint expression.



Endpoint Data, Node Number 4

Name of program: Basic

Expression: (BID-COST)*(BID<COMPBID)

Nodes upon which endpoint depends: 1 2 3

Resulting endpoint expression:
B\$(BID-COST)*(BID<COMPBID)

OK, Next... OK Cancel

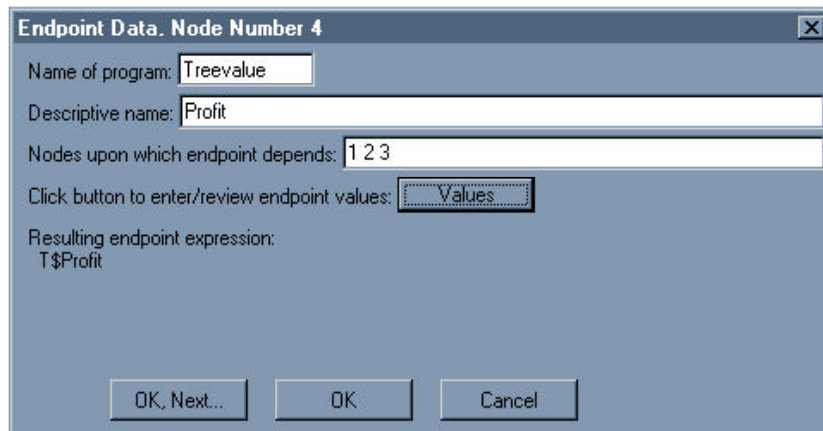
Figure 7.7

Supertree does not assume the endpoint depends on all the nodes because sometimes there are nodes on which the endpoint does *not* depend. For instance, the probabilities for COMPBID might depend on a new three-branch node for “How busy is the competitor?” but the Basic endpoint expression would not depend directly on this new node, which only impacts the value of COMPBID. If it is stated that the endpoint does not depend on the new node, Supertree performs only 18 evaluations of the endpoint instead of the 54 evaluations ($2 \times 3 \times 3 \times 3 = 54$) it would perform if the new node were included. In the present case, this makes little difference. However, if a large model is used to evaluate the endpoint, the time savings could be considerable.

Dependent Endpoints

Note that if a spreadsheet (rather than Basic) is used to value the endpoint, only the outcomes for the nodes on which the endpoint depends are sent to the spreadsheet. Other cells in the spreadsheet retain the values they had when the spreadsheet was last saved. Be careful to make endpoints depend on all nodes whose values should be sent to the spreadsheet, otherwise misleading results occur.

Endpoint dependencies can also be entered directly by using Treevalue for the Name of program option when inputting node 4, the endpoint (see Figure 7.8). This might be useful if values for the endpoints were directly estimated (as in some forms of litigation analysis) or obtained by other means.



Endpoint Data. Node Number 4

Name of program: Treevalue

Descriptive name: Profit

Nodes upon which endpoint depends: 1 2 3

Click button to enter/review endpoint values: Values

Resulting endpoint expression:
T\$Profit

OK, Next... OK Cancel

Figure 7.8

Dependent Endpoints

To directly enter endpoint values, click the Values button. A dependent endpoint screen similar to the screens for dependent probabilities or outcomes will appear, permitting direct entry of endpoint values (see Figure 7.9).

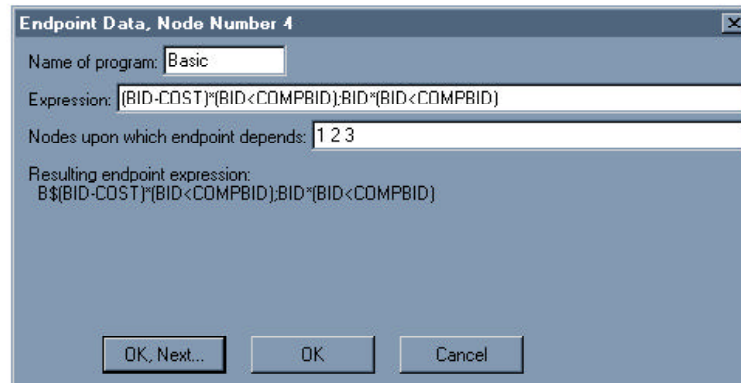
Dependent Endpoint - Use Tab or Shift Tab to scroll through conditioning nodes			
BID	COMP	BID	COST
500	400	200	0
		400	0
		600	0
600		200	0
		400	0
		600	0
800		200	0
		400	0
		600	0
700	400	200	0
		400	0
		600	0
600		200	0
		400	0
		600	0
800		200	0
		400	0
		600	0

Figure 7.9

Multiple Endpoint Values

Suppose you would like to view more than one result—for example, the probability distribution on Revenue while making the Bid decision based on Profit. Supertree's ability to handle multiple endpoint value measures makes this easy to do.

To use the multiple value measures feature, enter a list of values separated by semicolons. The following endpoint data screen (Figure 7.10) shows entries where Basic expressions are used to calculate two different value measures: Profit $(\text{BID} - \text{COST}) * (\text{BID} < \text{COMPBID})$ and Revenue $\text{BID} * (\text{BID} < \text{COMPBID})$. Click OK.



Endpoint Data, Node Number 4

Name of program: Basic

Expression: $(\text{BID} - \text{COST}) * (\text{BID} < \text{COMPBID}); \text{BID} * (\text{BID} < \text{COMPBID})$

Nodes upon which endpoint depends: 1 2 3

Resulting endpoint expression:
 $\text{B} * (\text{BID} - \text{COST}) * (\text{BID} < \text{COMPBID}); \text{BID} * (\text{BID} < \text{COMPBID})$

OK, Next... OK Cancel

Figure 7.10

Multiple Endpoint Values

After you run Evaluate, the options within the Analyze menu require that you select the value measure to be displayed and—if appropriate—the value measure to be used to make any decisions.

The Display Tree example in Figure 7.11 shows Revenue when the Bid decision is based on Profit.

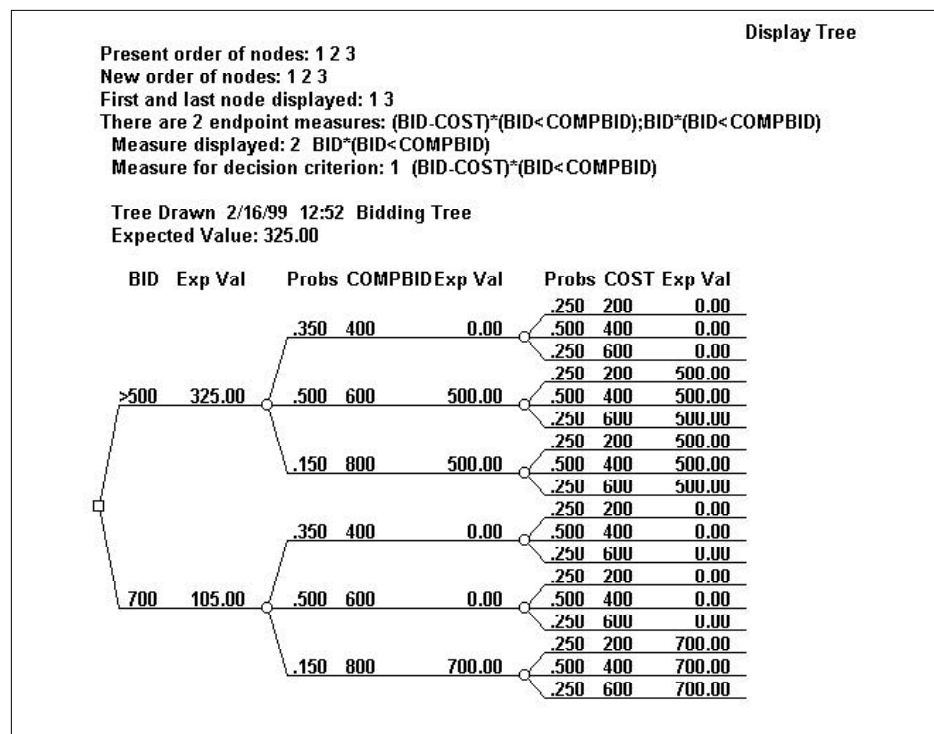


Figure 7.11

Rewards

The Rewards feature provides an additional means to enter values into a decision tree. A reward is a value associated with a specific node branch. The reward is added to the endpoint whenever the path passes through that branch.

For example, if you wished to include a cost of \$20K for preparing the \$500K bid and a \$35K cost for preparing the \$700K bid, the entry would be made as shown in Figure 7.12. (Costs are negative rewards.)

Outcome	Reward	Successor Node
500	-20	2
700	-35	2

Figure 7.12

Rewards

After using the Evaluate option, the Display Tree option factors in the impact of the rewards (see Figure 7.13).

In this example, the preparation costs (negative rewards) are shown at the Bid Node. If the box next to "Show rewards at the nodes" was not checked, then the preparation costs would have been subtracted from the expected values (rightmost column).

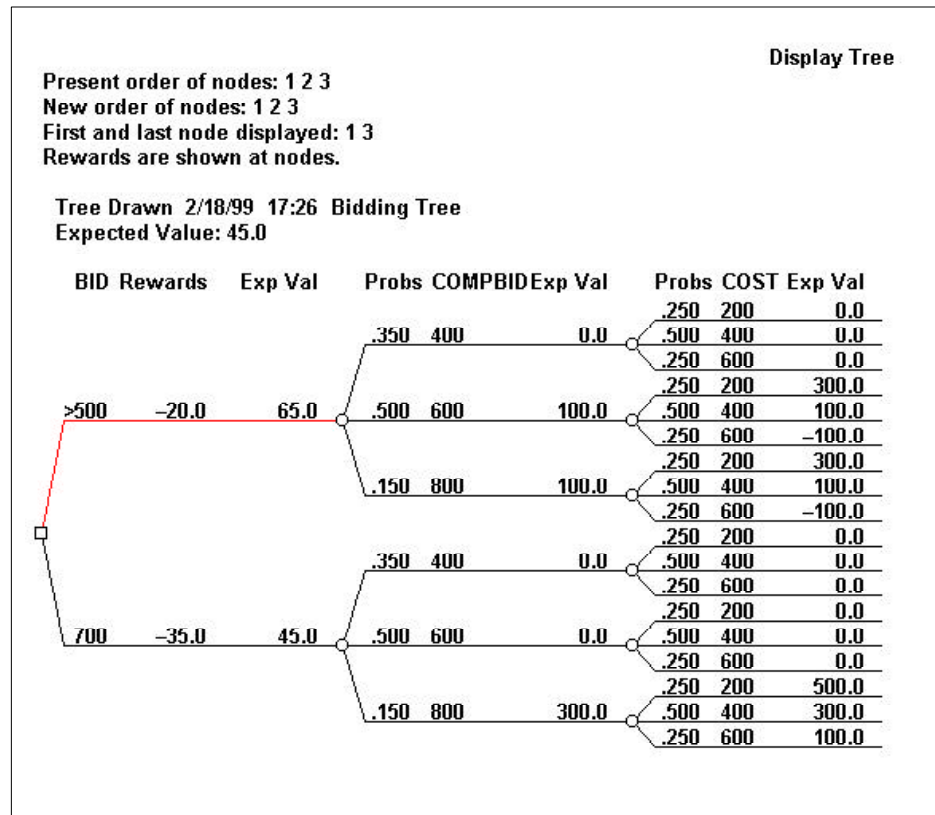


Figure 7.13

Node Reordering

Note: Before reordering the Bidding Tree, change the rewards back to zero. Most of the Analyze menu options ask you to enter the order of nodes to be used in the calculation or display. The ability to reorder nodes in the decision tree, regardless of the tree's shape, can be extremely useful. Reordering nodes permits you to display information in different ways. Most important in decision analysis, however, is the use of node reordering to calculate the values of information and control.

Value of Information

Suppose you could ethically learn the competitor's bid before submitting your bid. What would this information be worth? This information would resolve the COMPBID uncertainty before the BID decision—i.e., node 2 would come before (to the left of) node 1. Figure 7.14 shows the new order of nodes to be 2 1 3. To save time, just enter 2, press Return, and Supertree will supply the missing node numbers.

Value of Control

The value of control is a similar concept to the value of information. It measures the value that would result from having control over an uncertain variable, e.g., buying out a competitor to reduce market share uncertainty. By reordering the nodes in the tree, you could possibly determine the maximum value that would accrue from purchasing the competitor and thus set an upper bound on the amount of money that you would be willing to pay to purchase the competing company.

Node Reordering

In reviewing the decision tree in Figure 7.14, you can see that when COMPBID is 400, the decision to bid 500 or 700 is irrelevant—you've already lost. On the other hand, knowing that the COMPBID is 800, you will bid 700. The tree reveals that making the decision with information is worth \$95K to you—\$30K more than the \$65K result of the previous situation. The value of the information therefore is \$30K (\$95K – \$65K). If you were able to *control* a competitor's bid to be 800, that would give you a decision worth \$300K to you—\$235 more than the \$65K result with no control. The value of perfect control therefore is \$235K (\$300K – \$65K).

For additional discussion of the value of information and value of control, see *Decision Analysis for the Professional*.

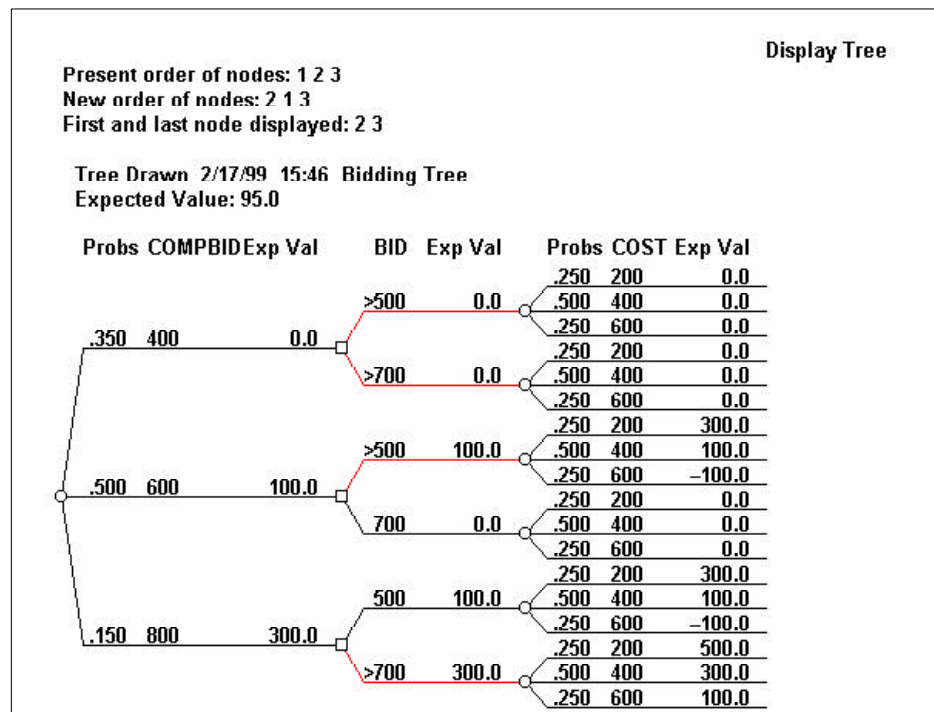


Figure 7.14

Plot Distribution at Node

Conditional Distributions

Suppose you want to see the cumulative probability distribution for a bid of \$700K when the competitive bid is \$800K. Rather than plotting the distribution at node 1, plot it at node 3 and specify the path through the preceding nodes. In Figure 7.15, branch numbers for nodes 1 and 2 are entered as 2 and 3, respectively (branches are numbered from the top down in Supertree displays). If the decision tree is a complex one, considerable insight can be obtained by plotting distributions at various nodes.

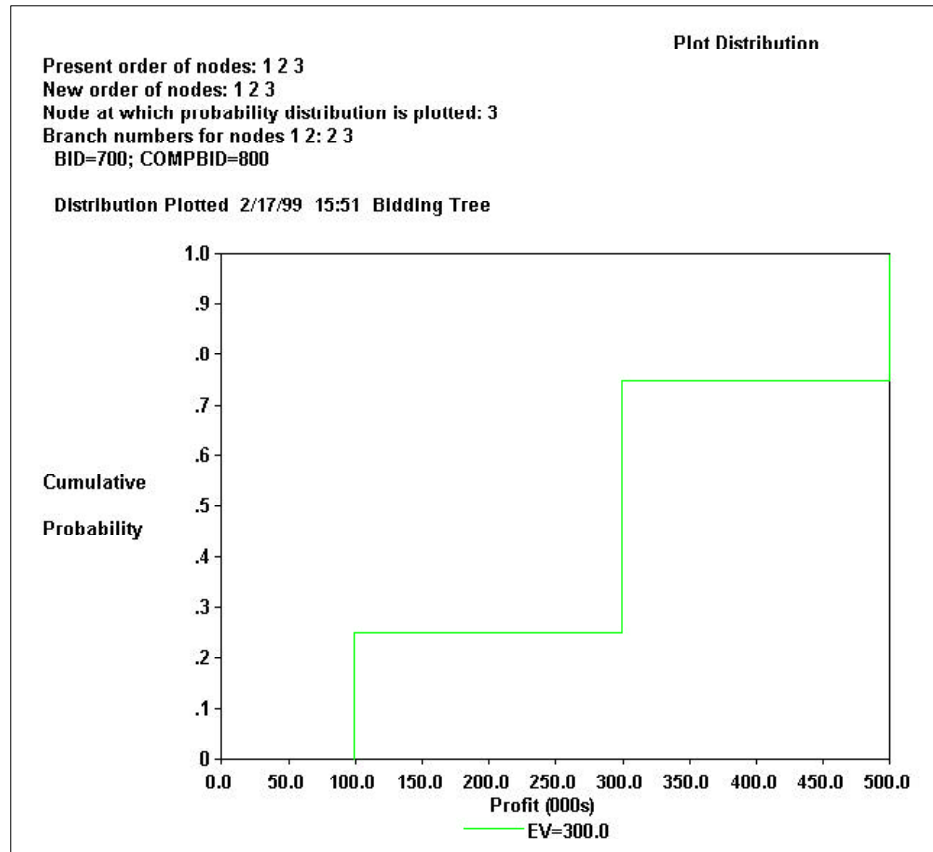


Figure 7.15

Probabilistic Sensitivity

The general philosophy of decision analysis is that decision-makers provide probabilities that accurately reflect their current state of knowledge. Unless opportunities exist to improve the state of knowledge, there is no point in further questioning the probability values that the decision-maker has assigned.

In the corporate setting, however, the interested parties may have different states of knowledge and hence might provide different sets of probabilities for the decision tree. It can be useful to compare the different outcomes based on different sets of probabilities.

The Sensitivity to Probability option of the Analyze menu enables you to easily perform probabilistic sensitivity analysis answering the question “How sensitive is the result to the assignment of probabilities?” Figure 7.16 shows the input screens.

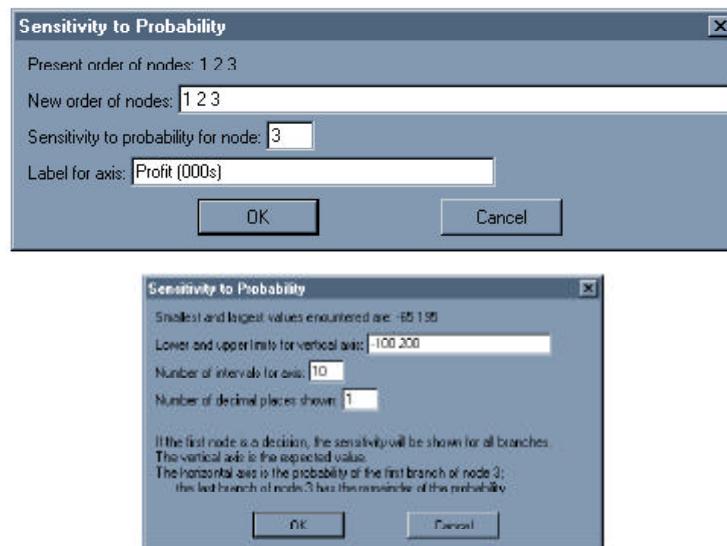


Figure 7.16

Figure 7.17 shows the sensitivity of the decision to probabilities at node 3, COST. The horizontal axis is the probability the top branch (COST = 200) will occur. Graphs are shown for each decision branch of the BID node (BID = 500 and BID = 700).

Probabilistic Sensitivity

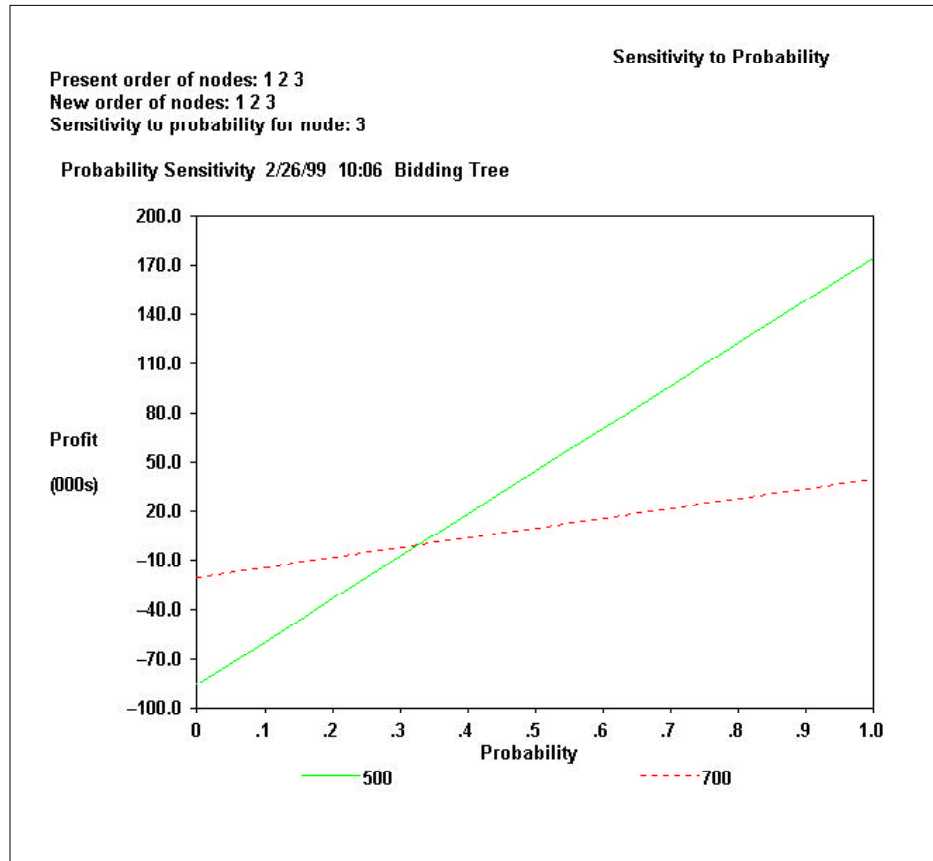


Figure 7.17

If the probability for the low cost is below .4, you should go with the bid of \$700K; above .4, you should bid \$500K. (The current information in the tree has equal probabilities for low and high cost. Since the middle branch has zero probability in probabilistic sensitivity, the current tree is equivalent to a .5 probability of low cost.) There should be little disagreement over the results—unless someone thinks the probability is below .4. In the range of .3 to .5, there is very little difference in the expected profit of the two bid alternatives, 500 and 700.

Risk Attitude and Sensitivity

Supertree has a built-in exponential utility function that is used to calculate Certain Equivalents—the discounting of the expected value to reflect risk attitude.

The sensitivity of the model to risk tolerance can be displayed using the Sensitivity to Risk Attitude... command from the Analyze menu. Figure 7.18 shows the Sensitivity Input Screens.

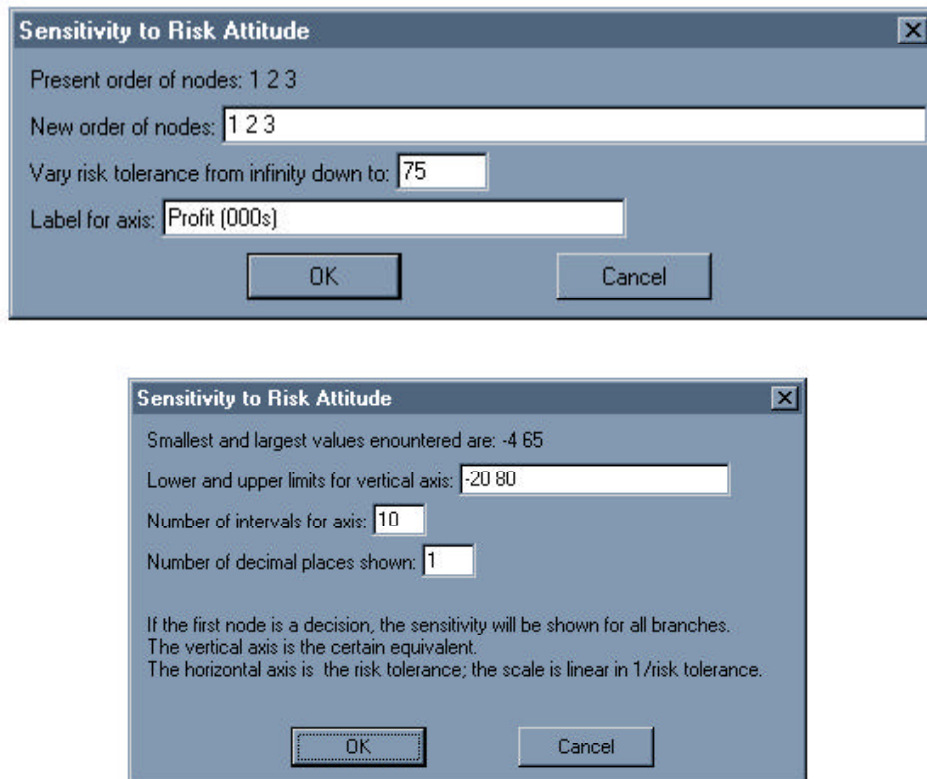


Figure 7.18

Risk Attitude and Sensitivity

Figure 7.19 shows that for infinite risk tolerance (expected values), a bid of \$500K (branch 1 of the decision tree) is preferred to a bid of \$700K (branch 2). If risk tolerance, however, is below \$100K, you would prefer to bid \$700K.

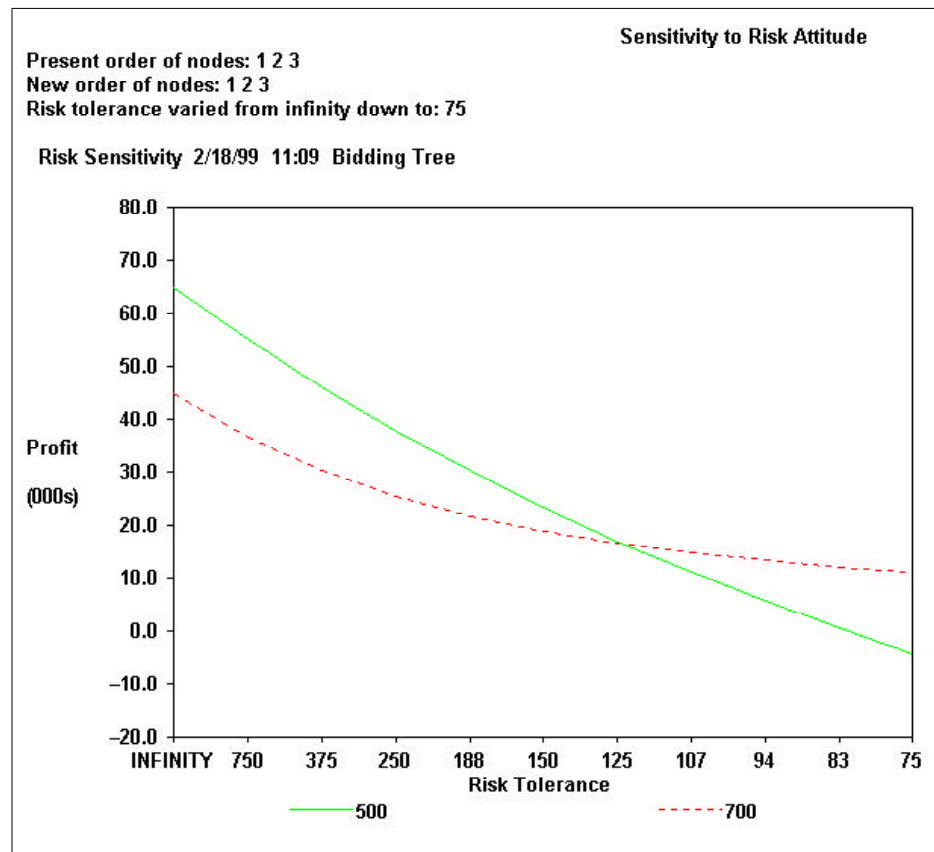


Figure 7.19

Risk tolerance is a complex subject beyond the scope of this guide. An introduction to risk tolerance can be found in *Decision Analysis for the Professional*, and detailed discussions can be found in *Readings on the Principles and Applications of Decision Analysis*.