Medical Decision Making

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Decision Analysis

- Quantitative, systematic
- Identifies alternatives, outcomes, utility of outcomes
- Uses models
  - Represent structural relationships
    - Deterministic
    - Probabilistic
  - Compute expected outcomes of each alternative
  - Balance feasibility v. reality / simplicity v. complexity
  - Examine robustness

Identify Alternatives

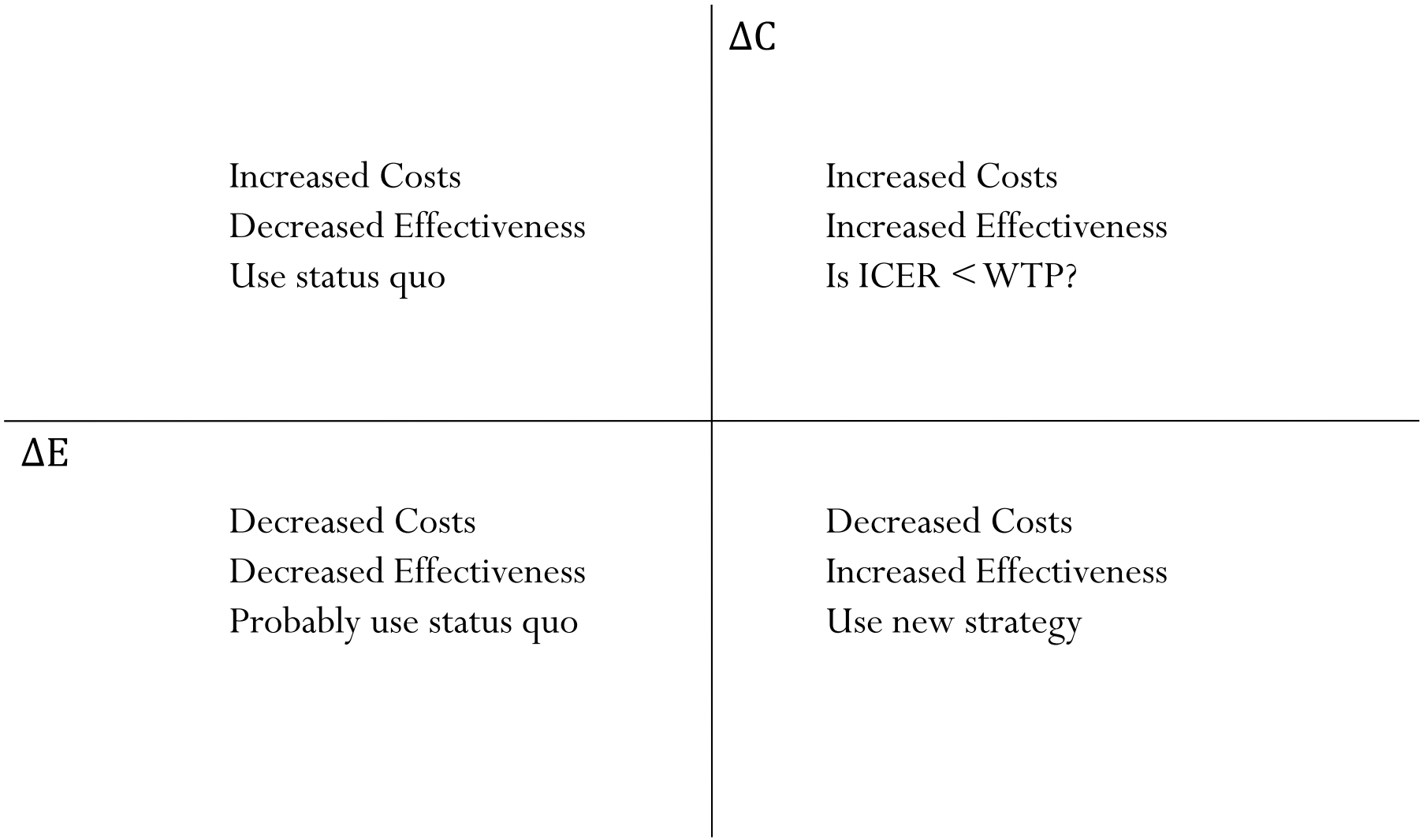
- Mutually exclusive
  - A, B mutually exclusive $\Rightarrow P(A \cap B) = 0$
  - One and only one of the events must occur

- Collectively exhaustive
  - A, B collectively exhaustive $\Rightarrow P(A) + P(B) = 1$
  - Events represent entire outcome space
  - At least one event must occur

Identifying Outcomes

- Multi-dimensional
- Examples:
  - Costs
  - Infections averted
  - Life years (LY) saved
  - Quality adjusted life years (QALY) saved
  - "Effectiveness"
- ~~Ultimately utils – Howard school~~
- Cost-effectiveness
  - Incremental cost to effectiveness ratio (ICER)

Cost-Effectiveness Plane



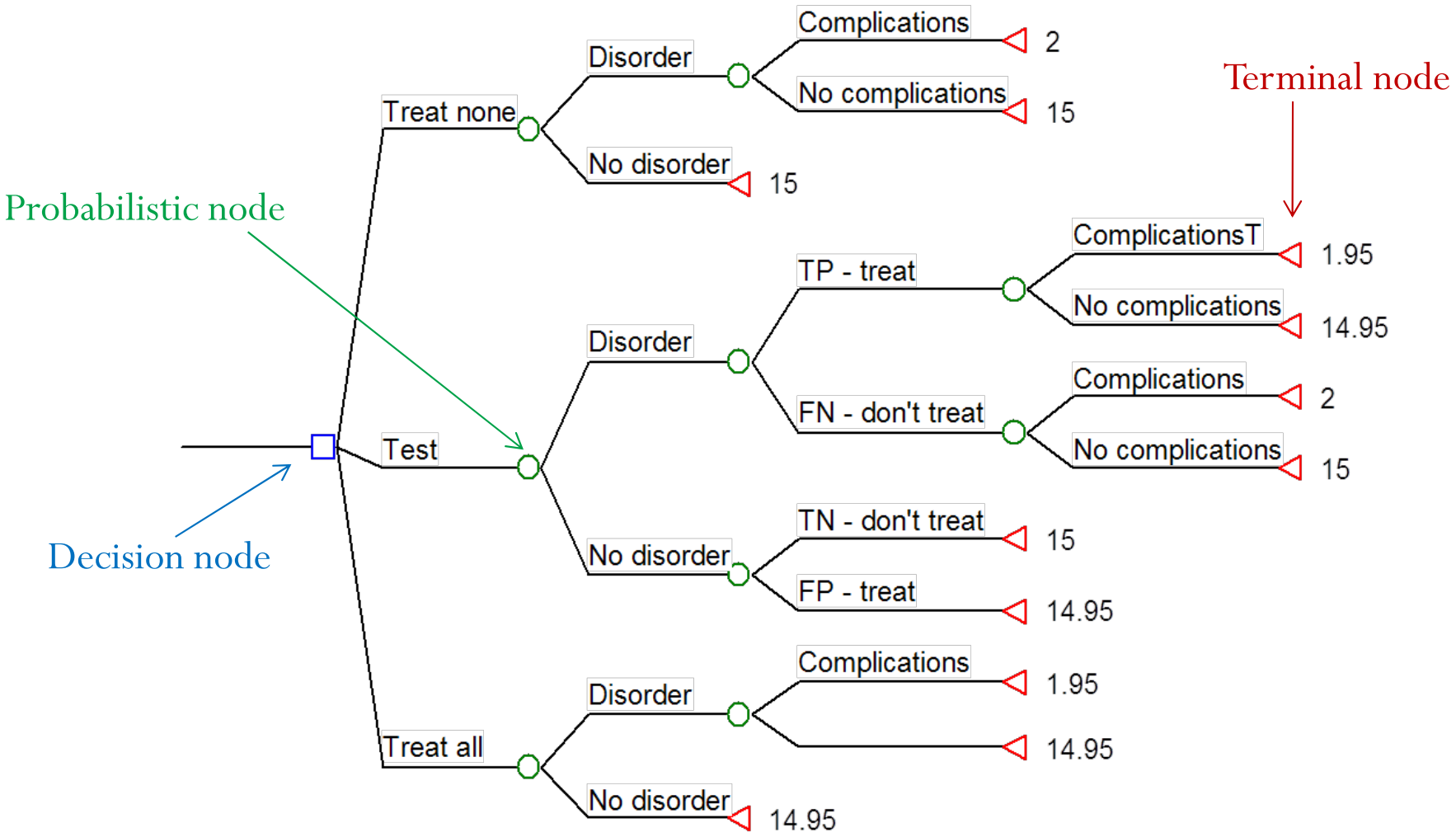
Steps

- Determine problem
- Determine status quo intervention
- Determine alternative interventions
- Analysis
- Sensitivity Analysis

Example

- Hypothetical cohort with prevalent disorder
- Treatment
  - Reduces probability of serious complications
  - Long term side effects
- There is an imperfect test for disorder
- Alternatives:
  - Treat no one
  - Test all and treat positives
  - Treat all

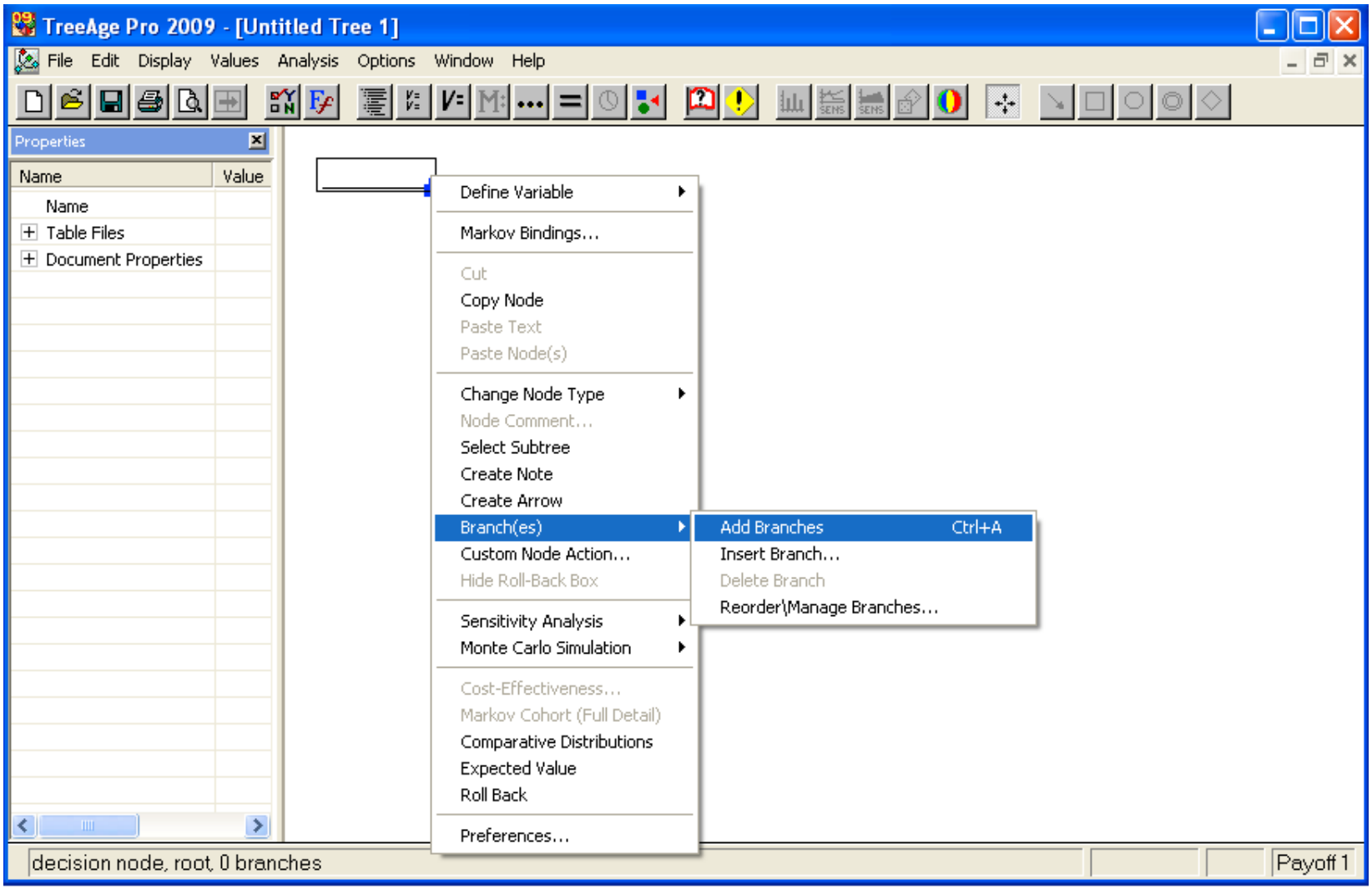
Decision Diagram



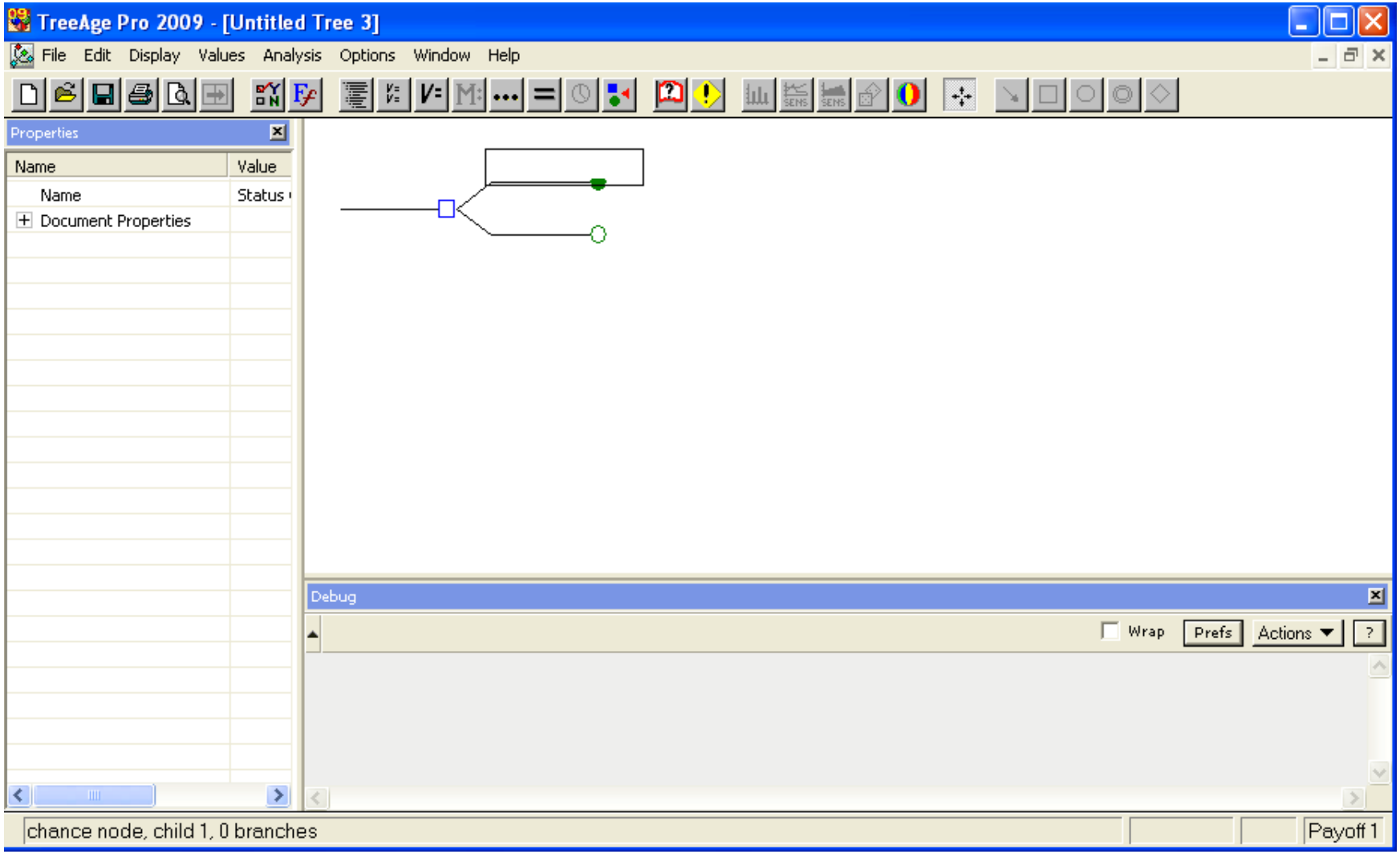
Example cont.

- Outcomes
  - No disorder, no treatment
  - No disorder, treatment
  - Disorder, treatment, complications
  - Disorder, treatment, no complications
  - Disorder, no treatment, complications
  - Disorder, no treatment, no complications
- For each outcome assume known costs and LE (clinical trial)
- Intermediate events
  - Tests
  - Side effects

Create Decision Node



Create Decision Node



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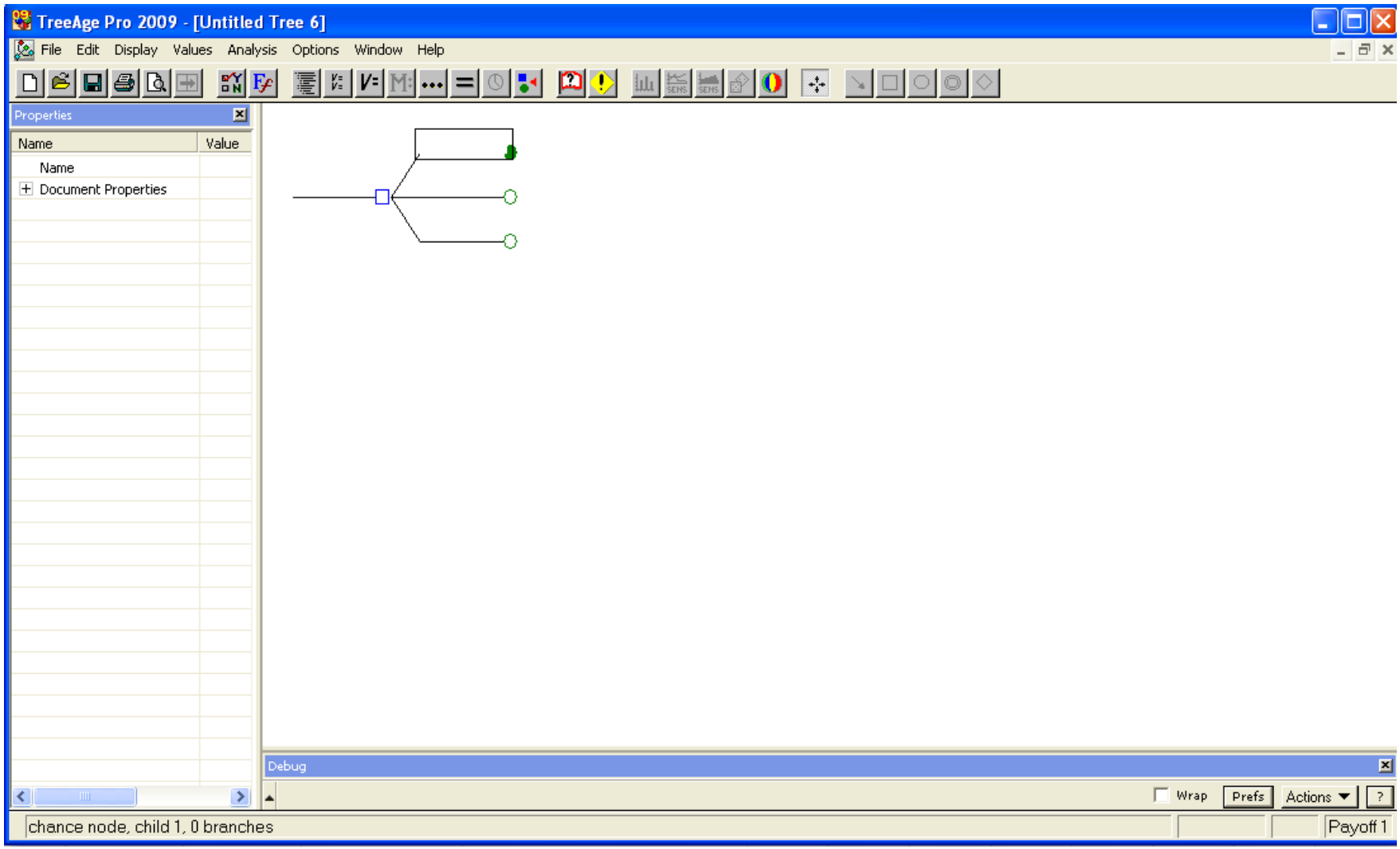
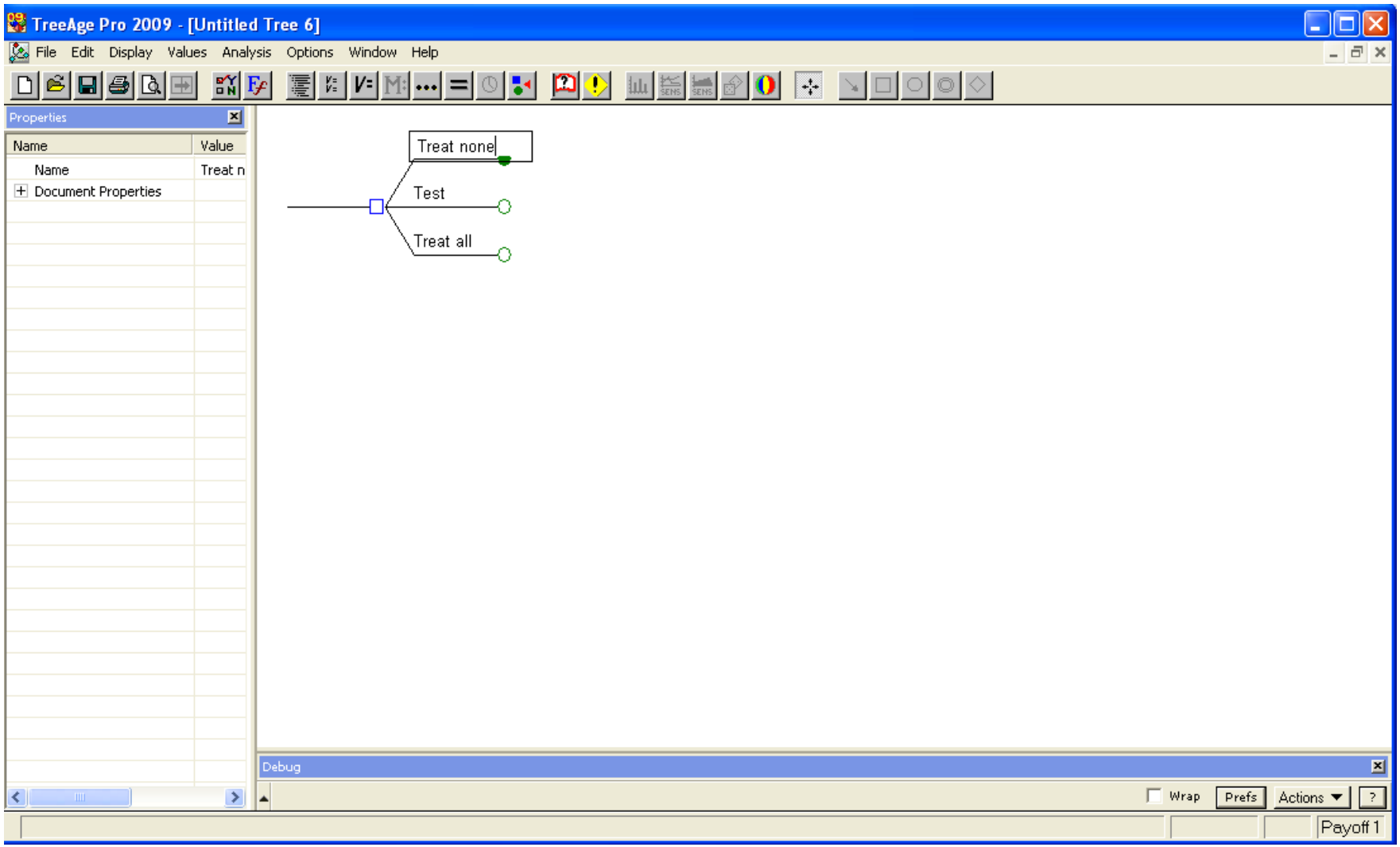
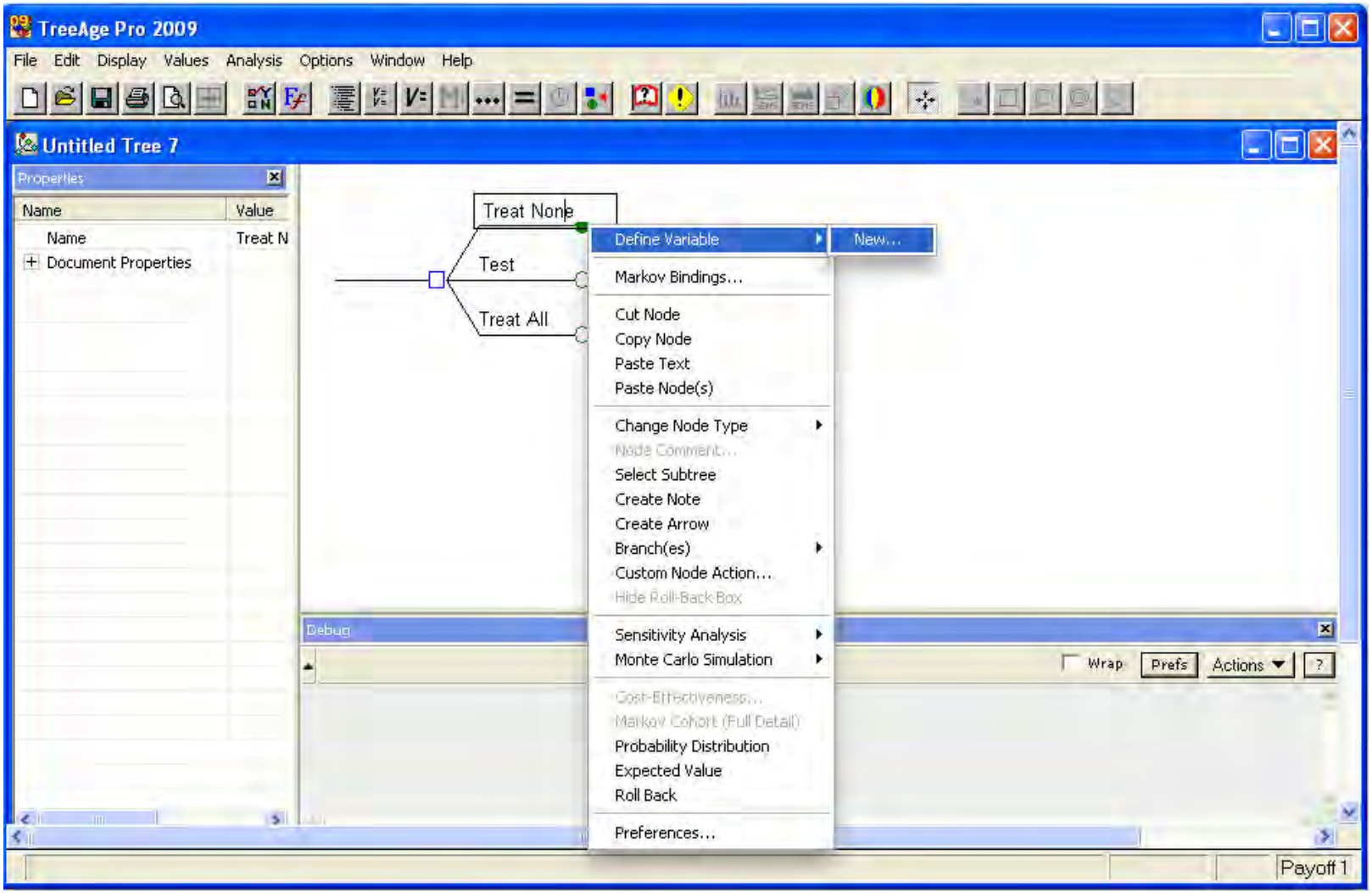


Create Decision Node

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Document Properties
Treat None
Test
Treat All
Define Variable
New...
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Cut Node
Copy Node
Paste Text
Paste Node(s)
Change Node Type
Node Comment...
Select Subtree
Create Note
Create Arrow
Branch(es)
Custom Node Action...
Hide Roll-Back Box
Sensitivity Analysis
Monte Carlo Simulation
Cost-Effectiveness...
Markov Cohort (Full Detail)
Probability Distribution
Expected Value
Roll Back
Preferences...
Debug
Wrap
Prefs
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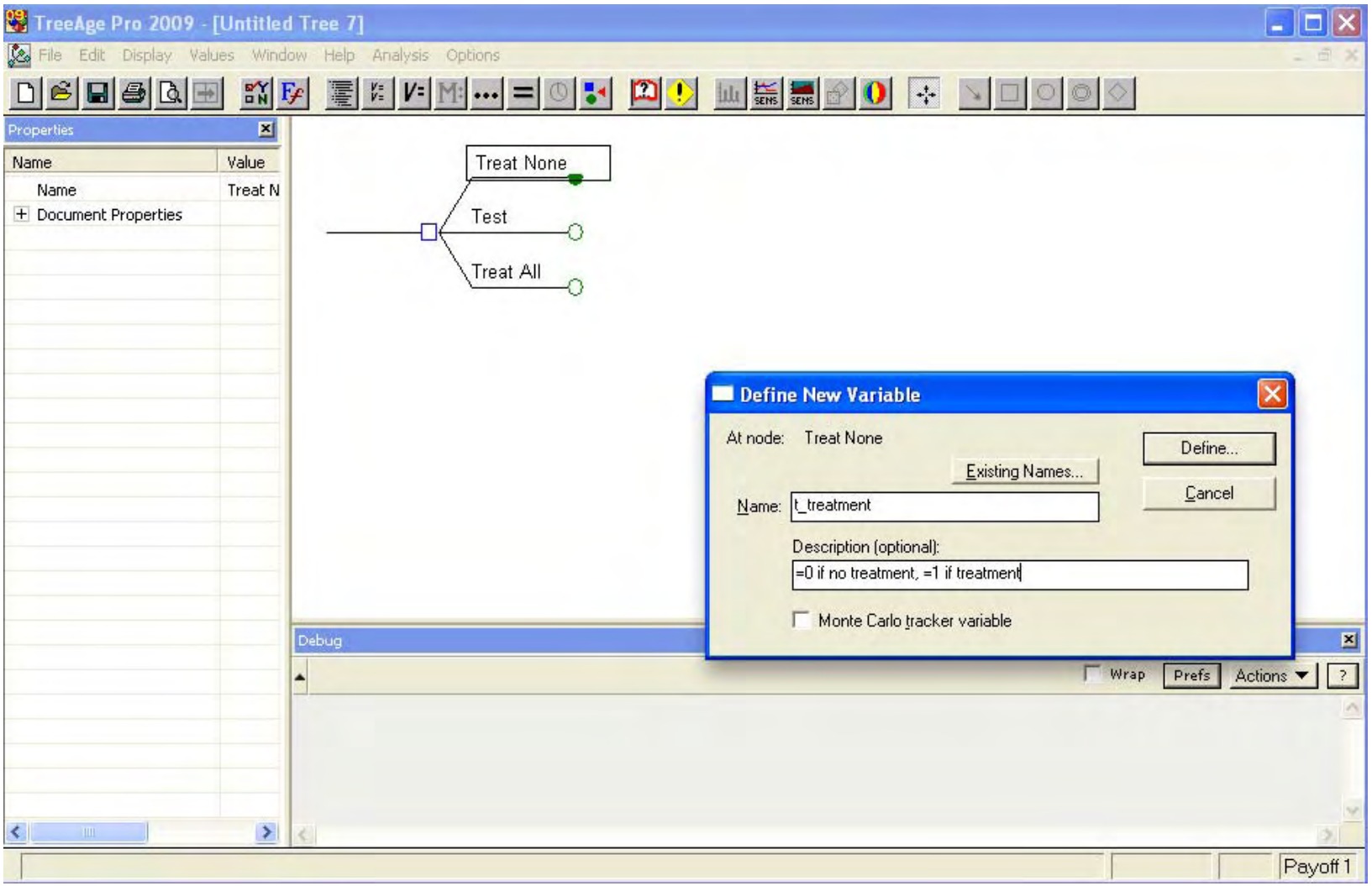
Payoff 1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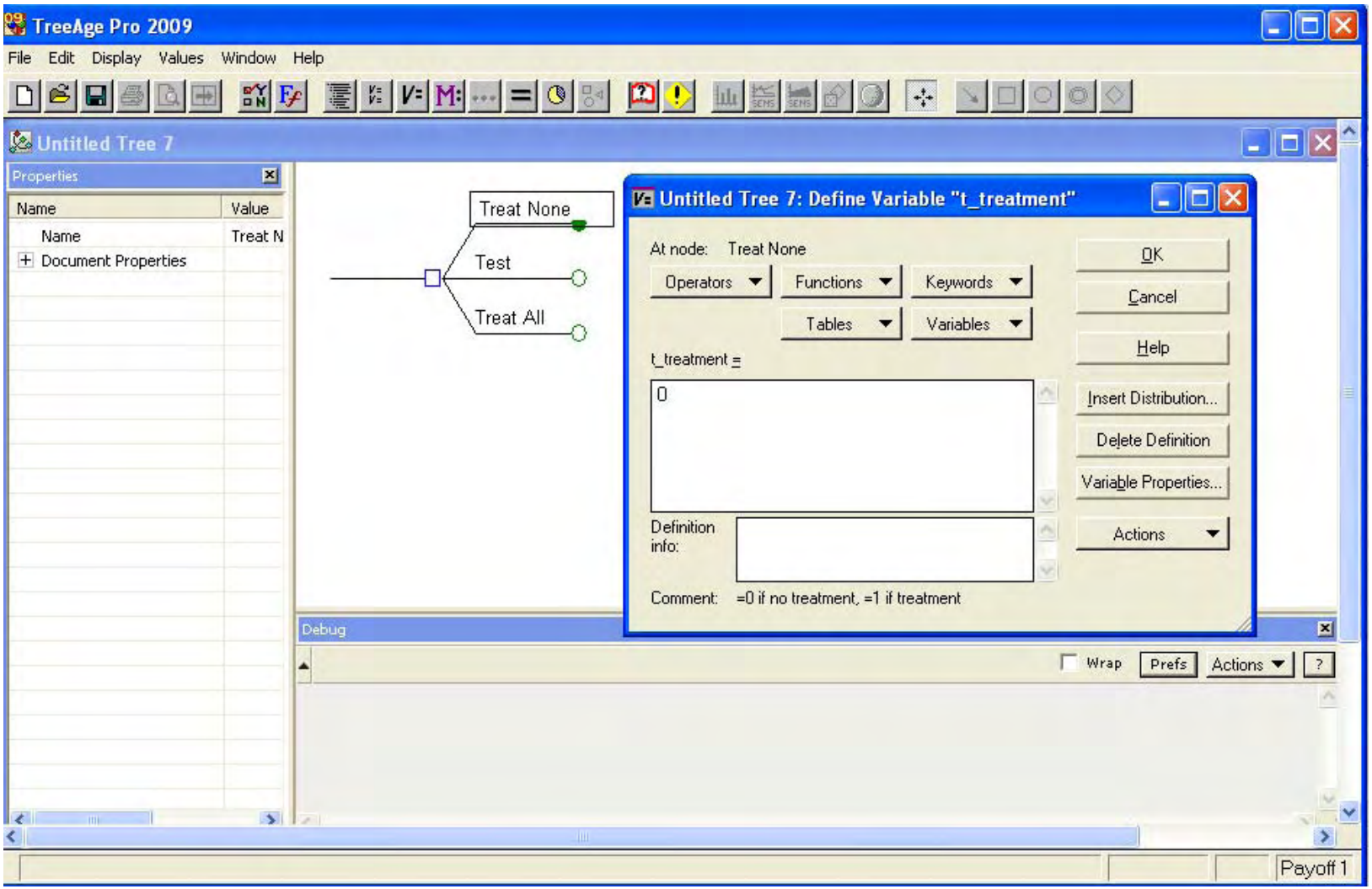
Payoff 1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Comment: =0 if no treatment, =1 if treatment
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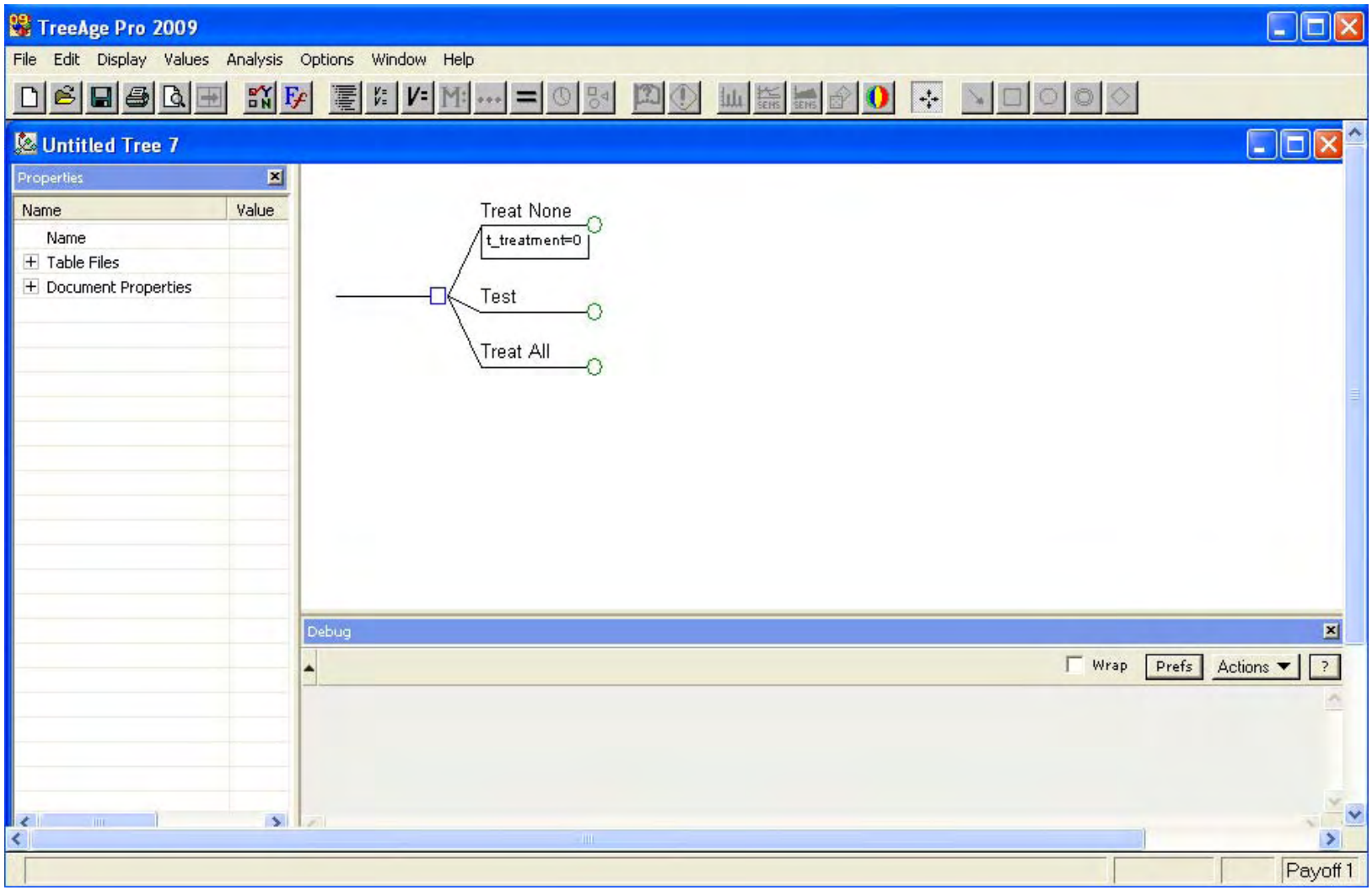
Wrap Prefs Actions ?
Payoff 1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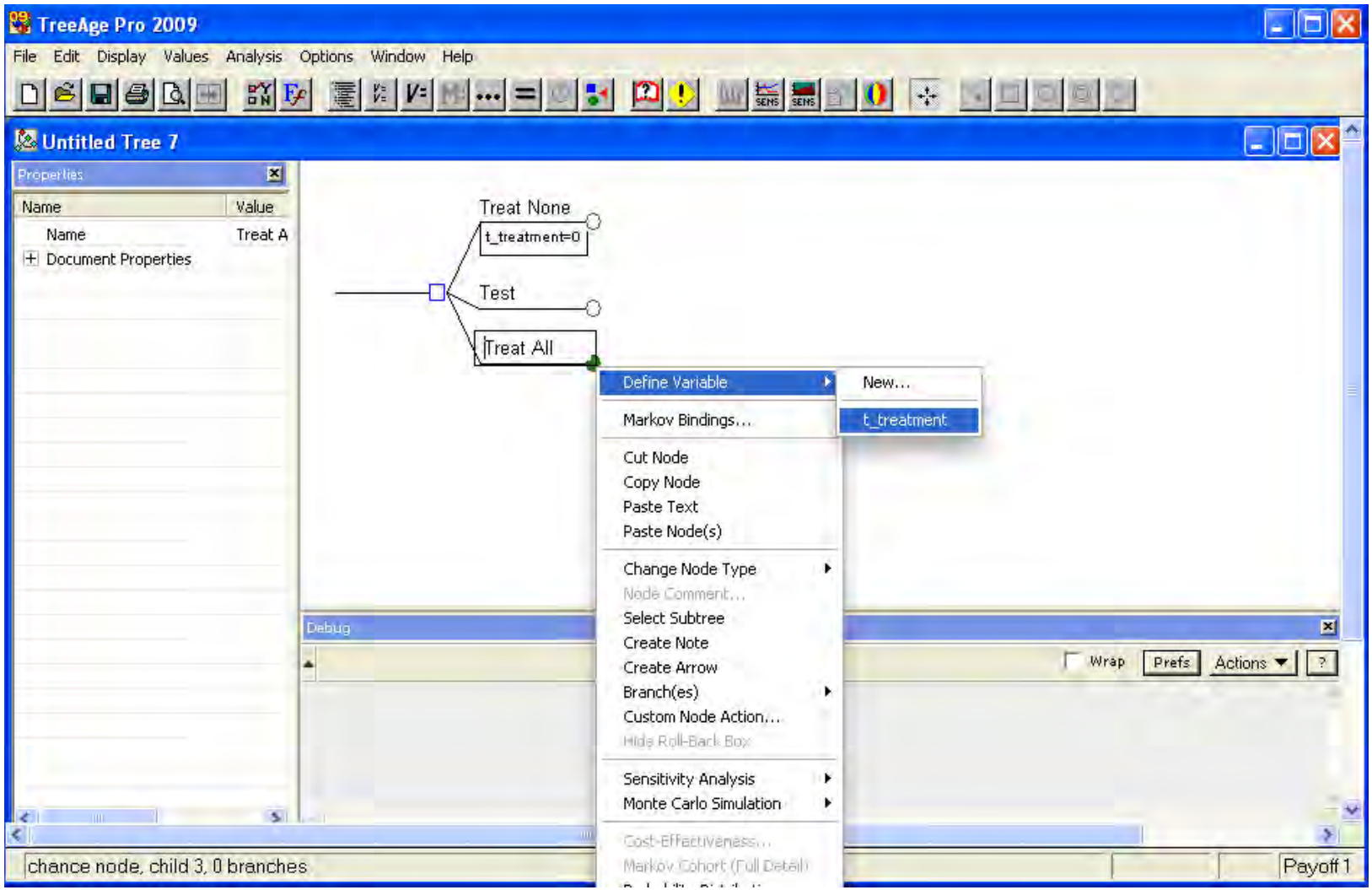
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Cut Node
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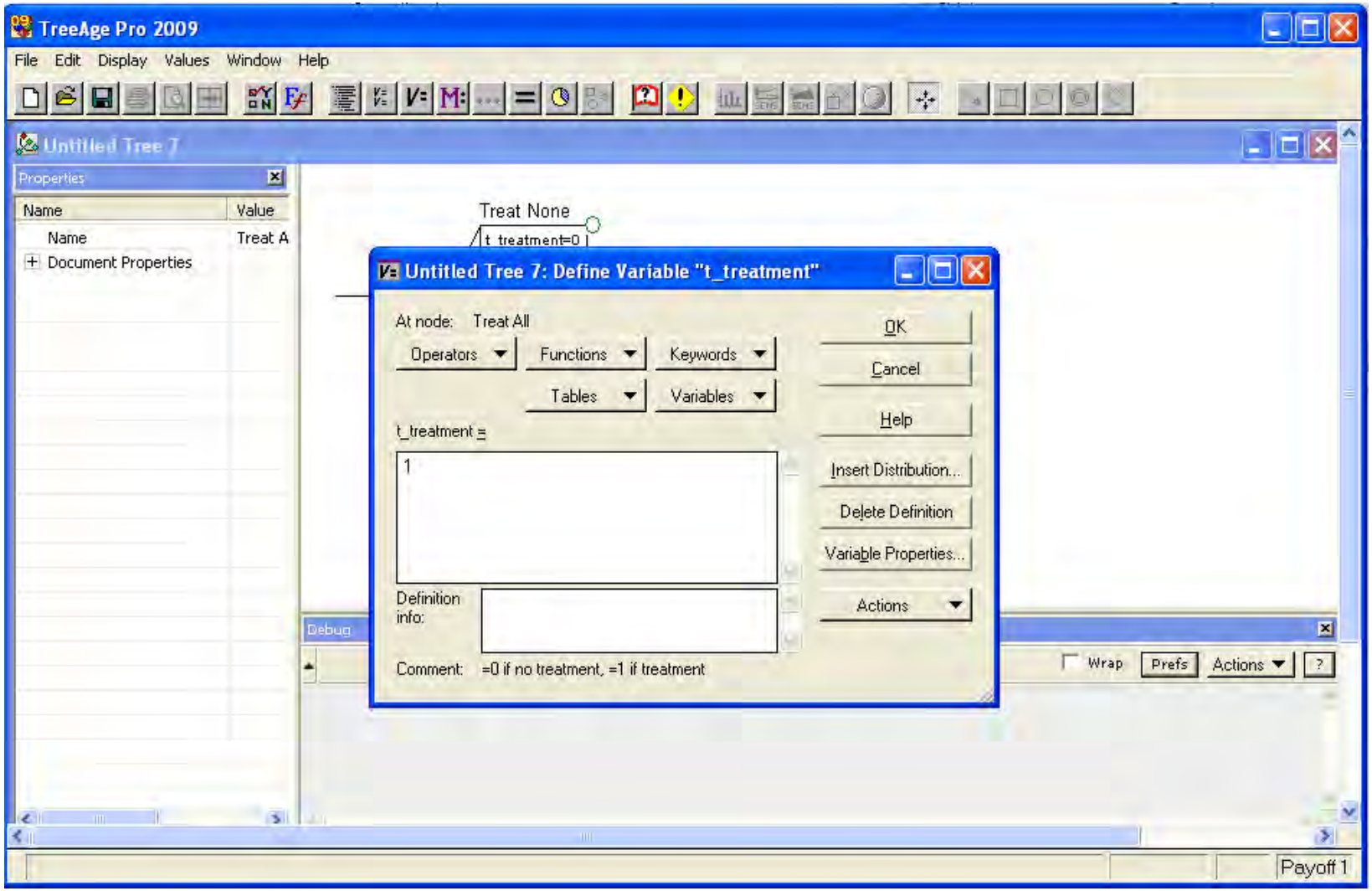
Sensitivity Analysis
Monte Carlo Simulation
Cost-Effectiveness...
Markov Cohort (Full Detail)
Debug
Wrap
Prefs
Actions
chance node, child 3, 0 branches
Payoff 1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At node: Treat All
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Definition info:
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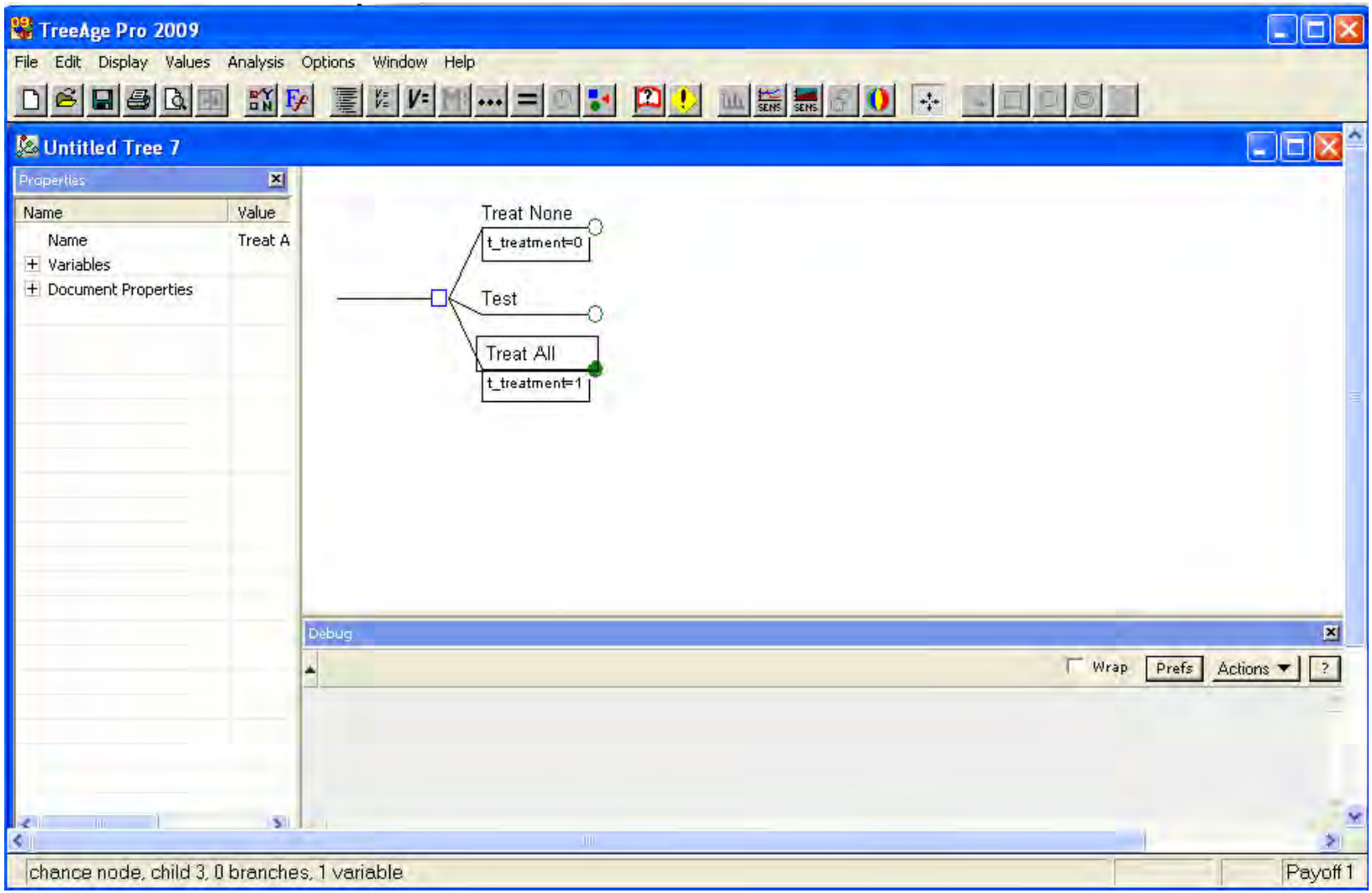
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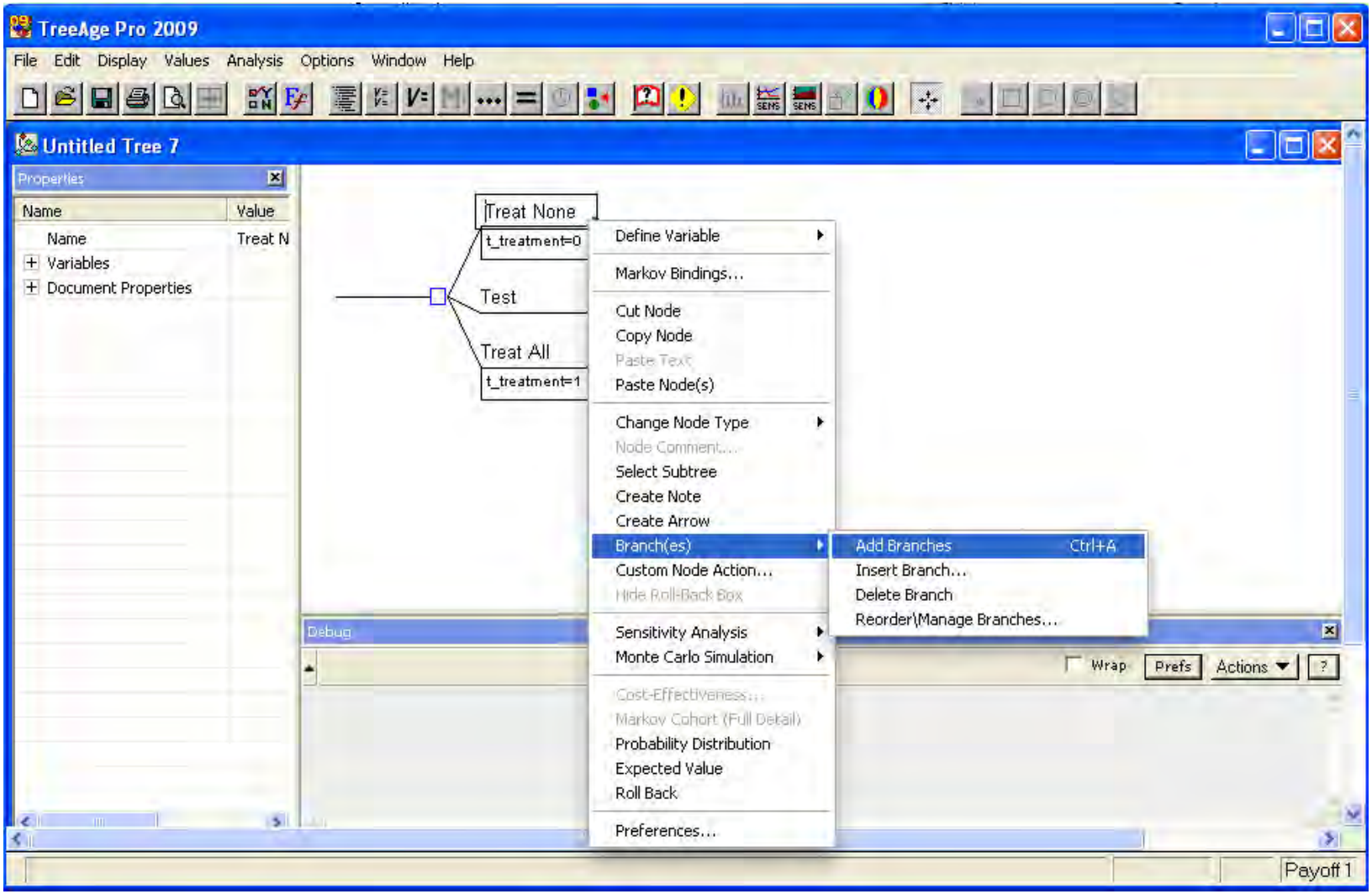
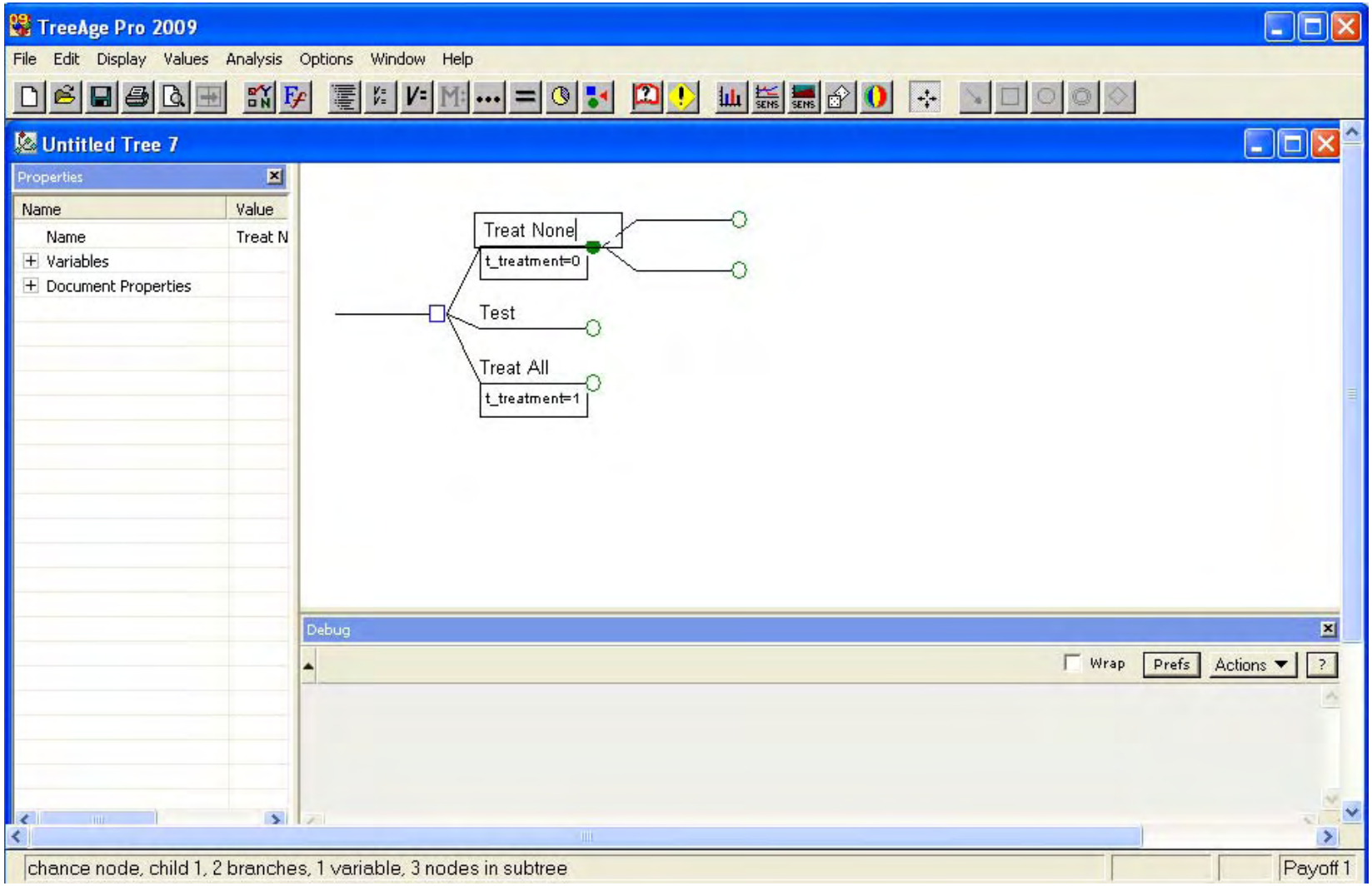
chance node, child 3, 0 branches, 1 variable
Payoff 1

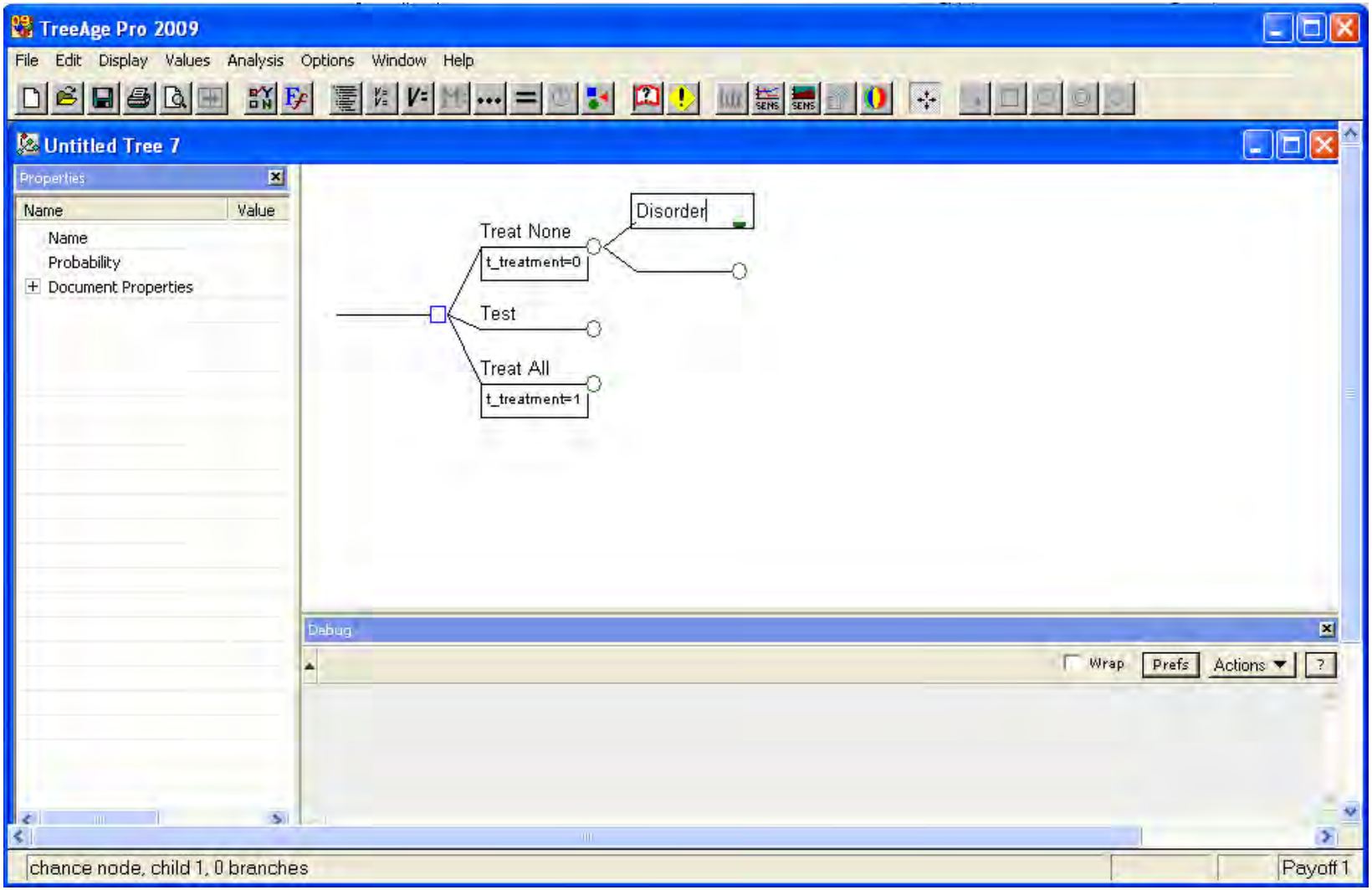
Strategy 1: Treat None



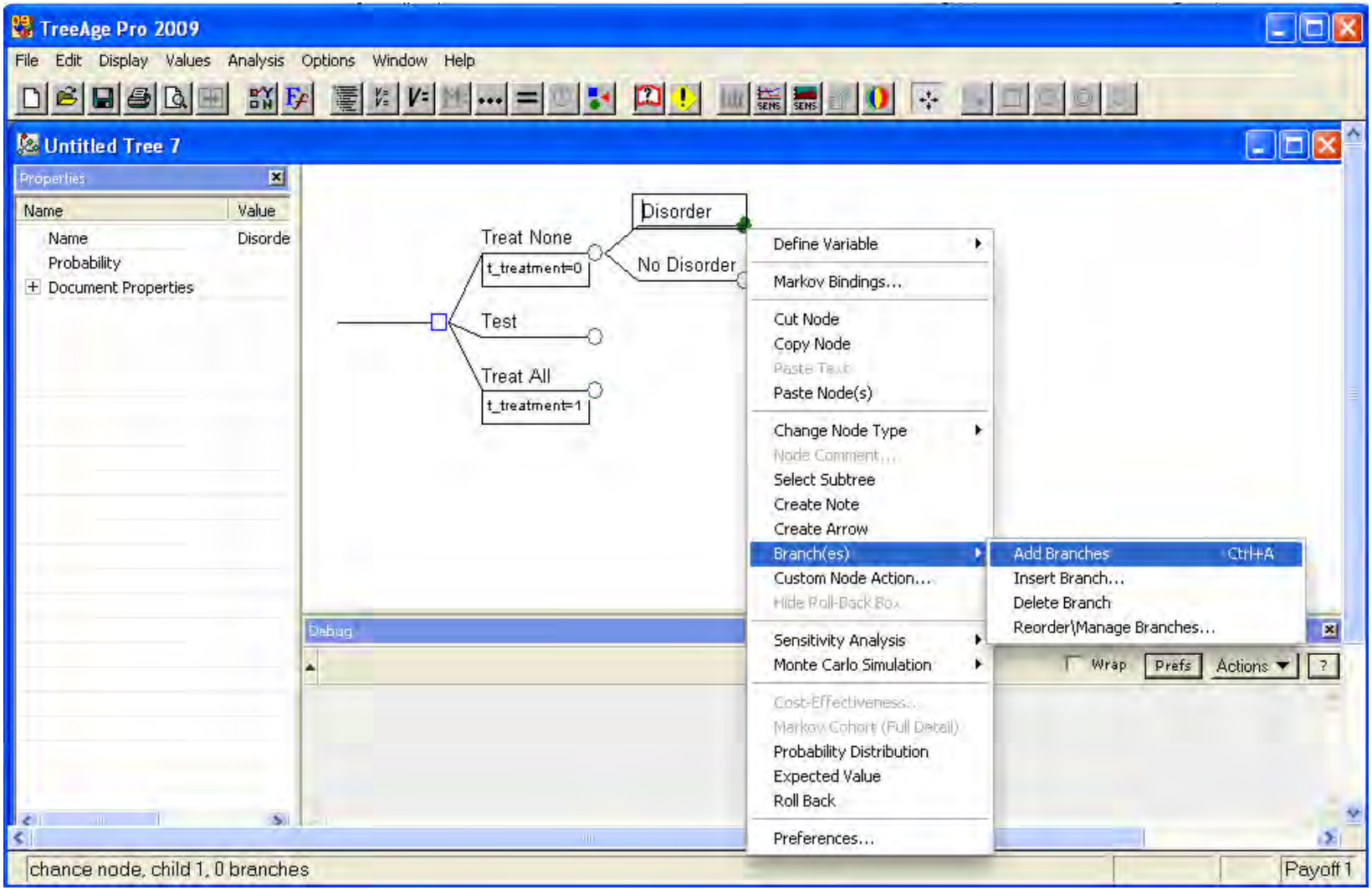
Strategy 1: Treat None



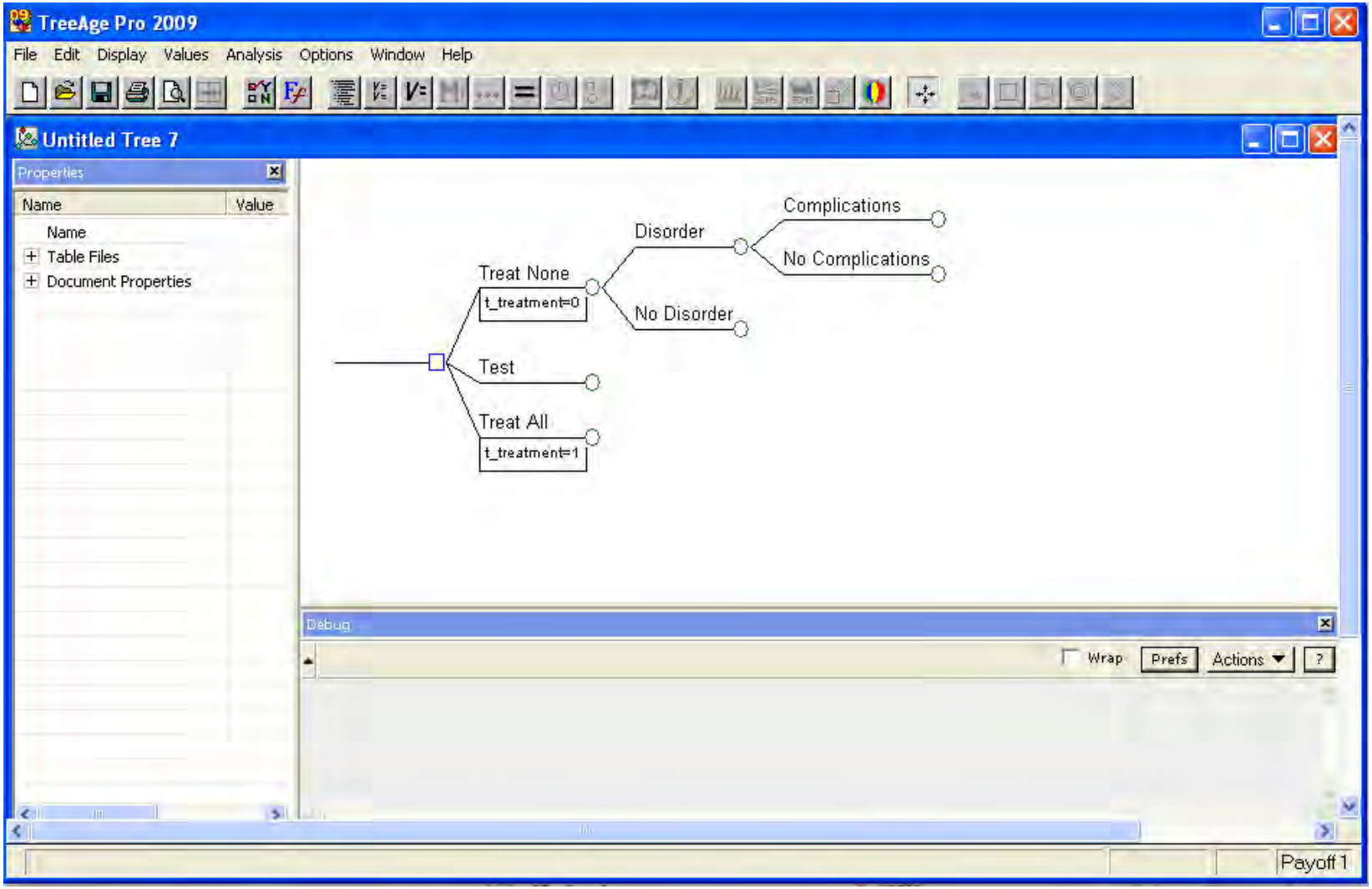
Strategy 1: Treat None



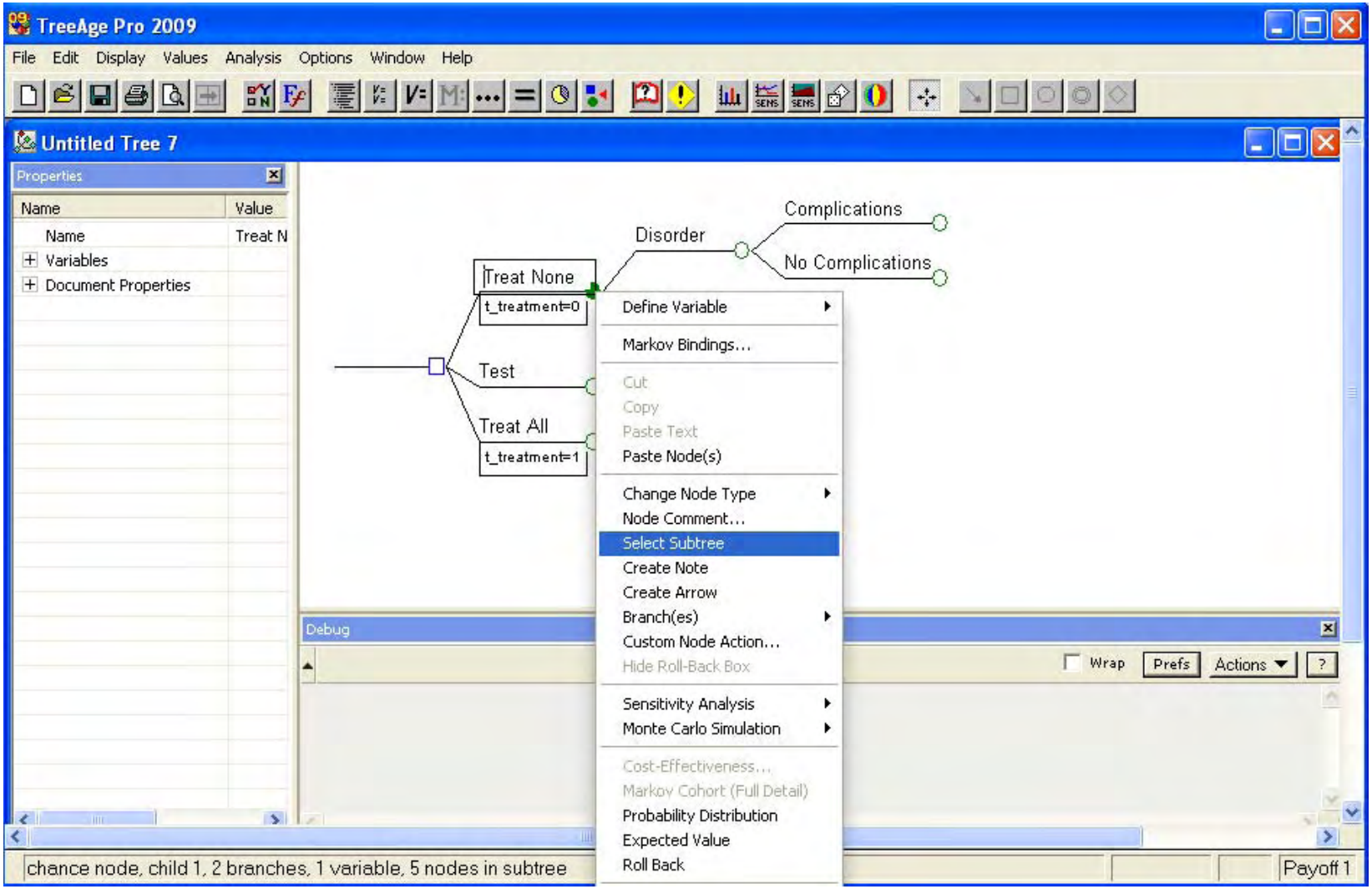
Strategy 1: Treat None



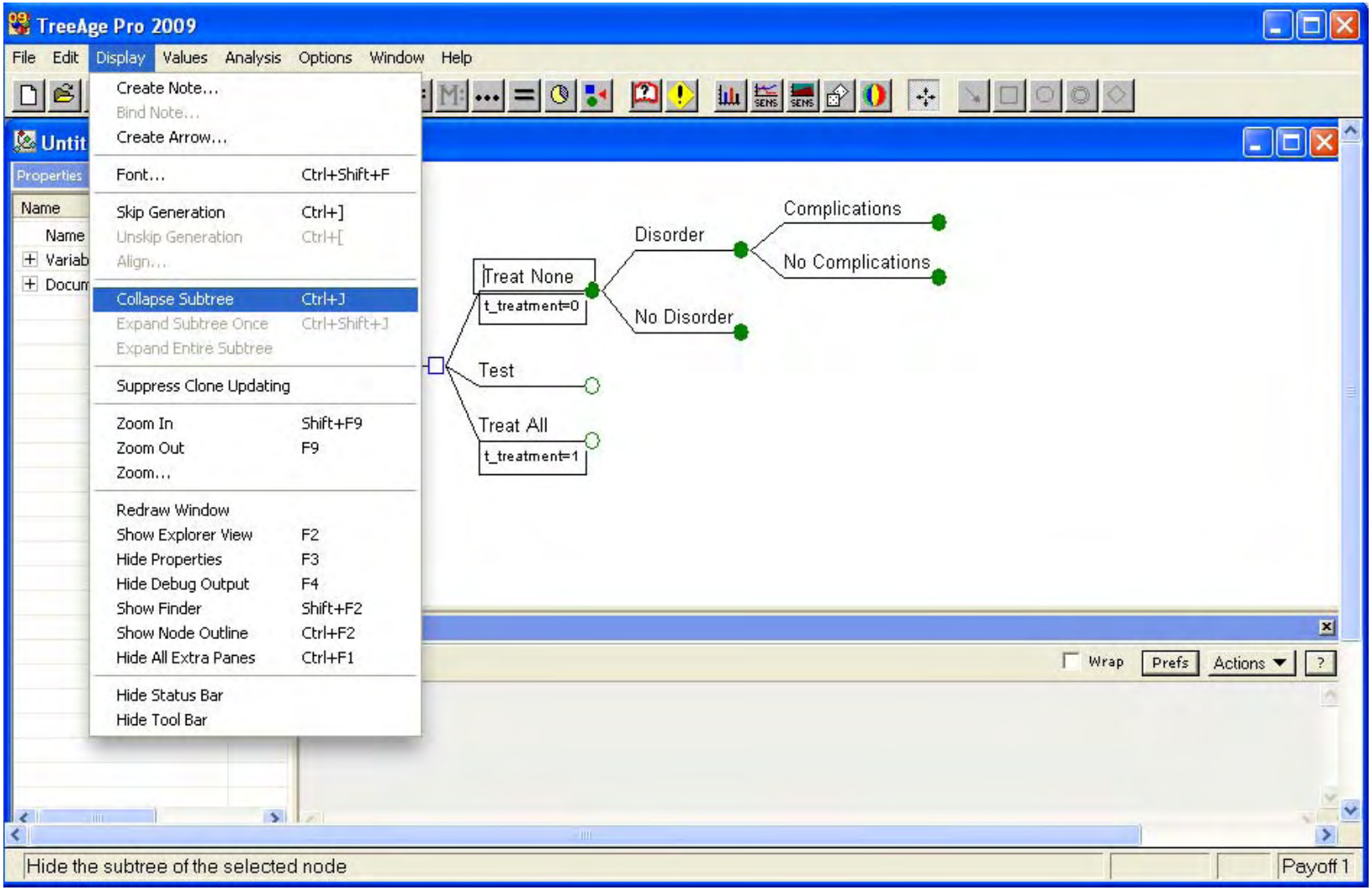
Strategy 1: Treat None

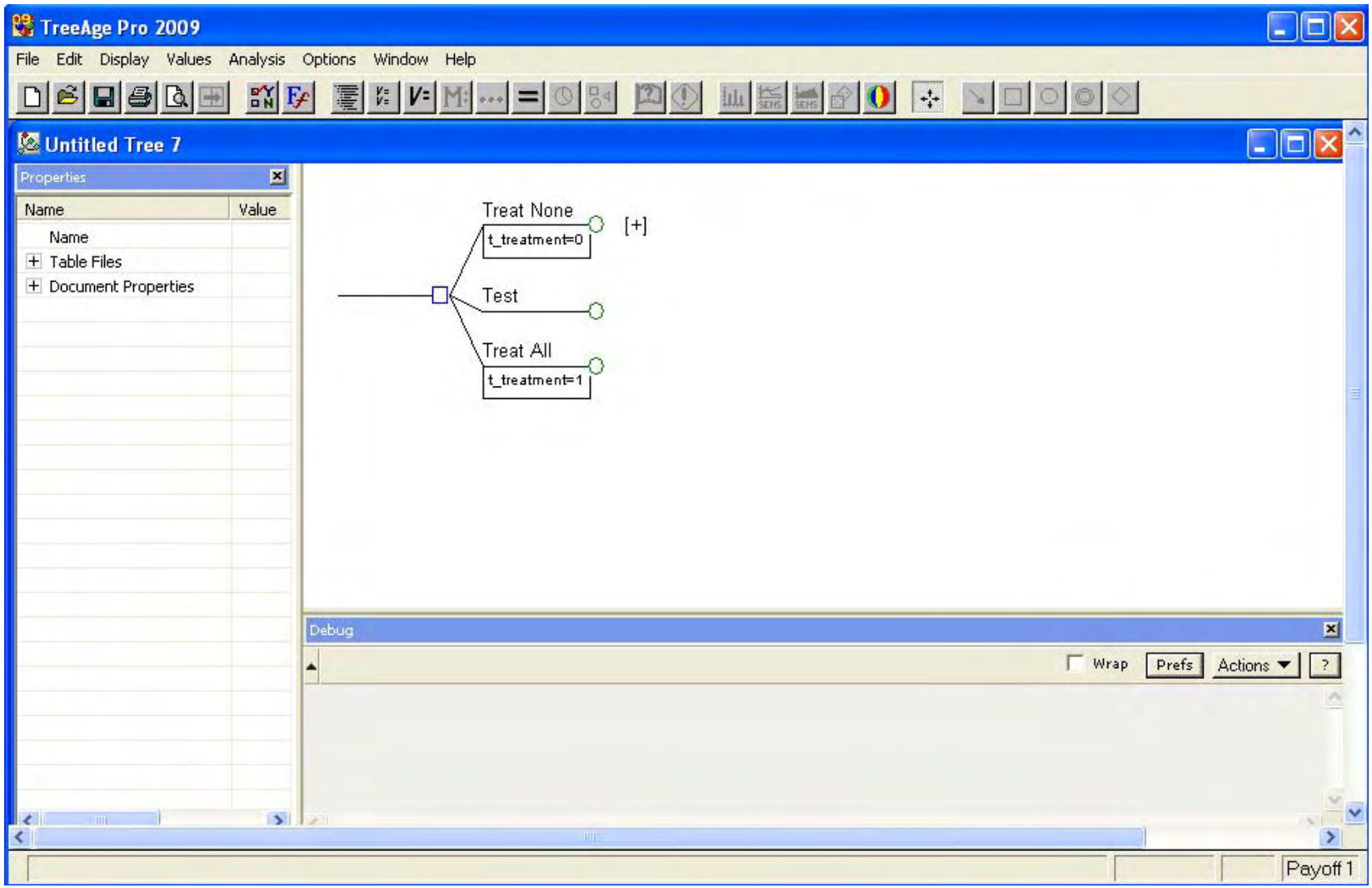


Select Subtree



Collapse Subtree

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Document Properties
Treat None
t_treatment=0
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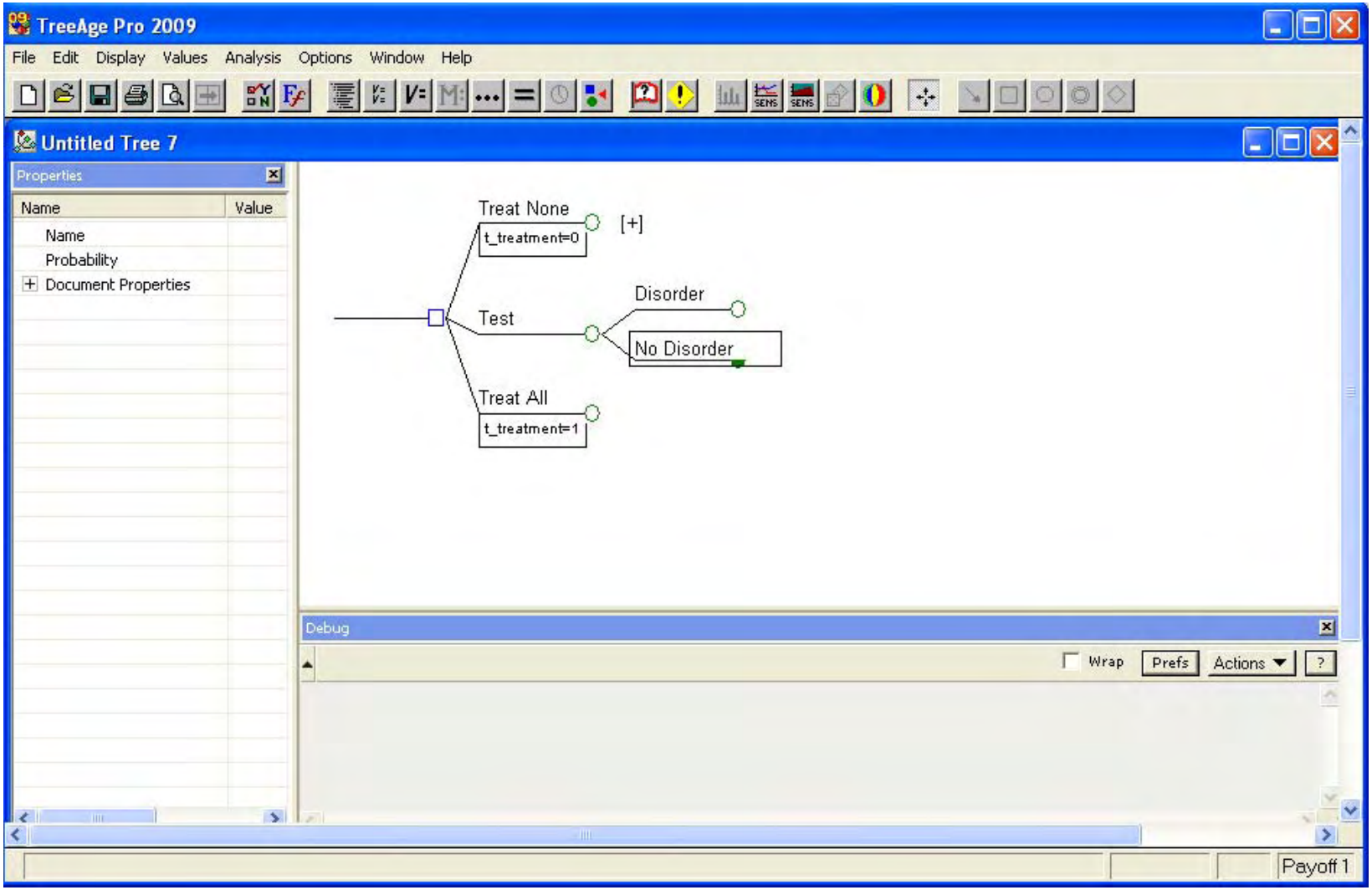
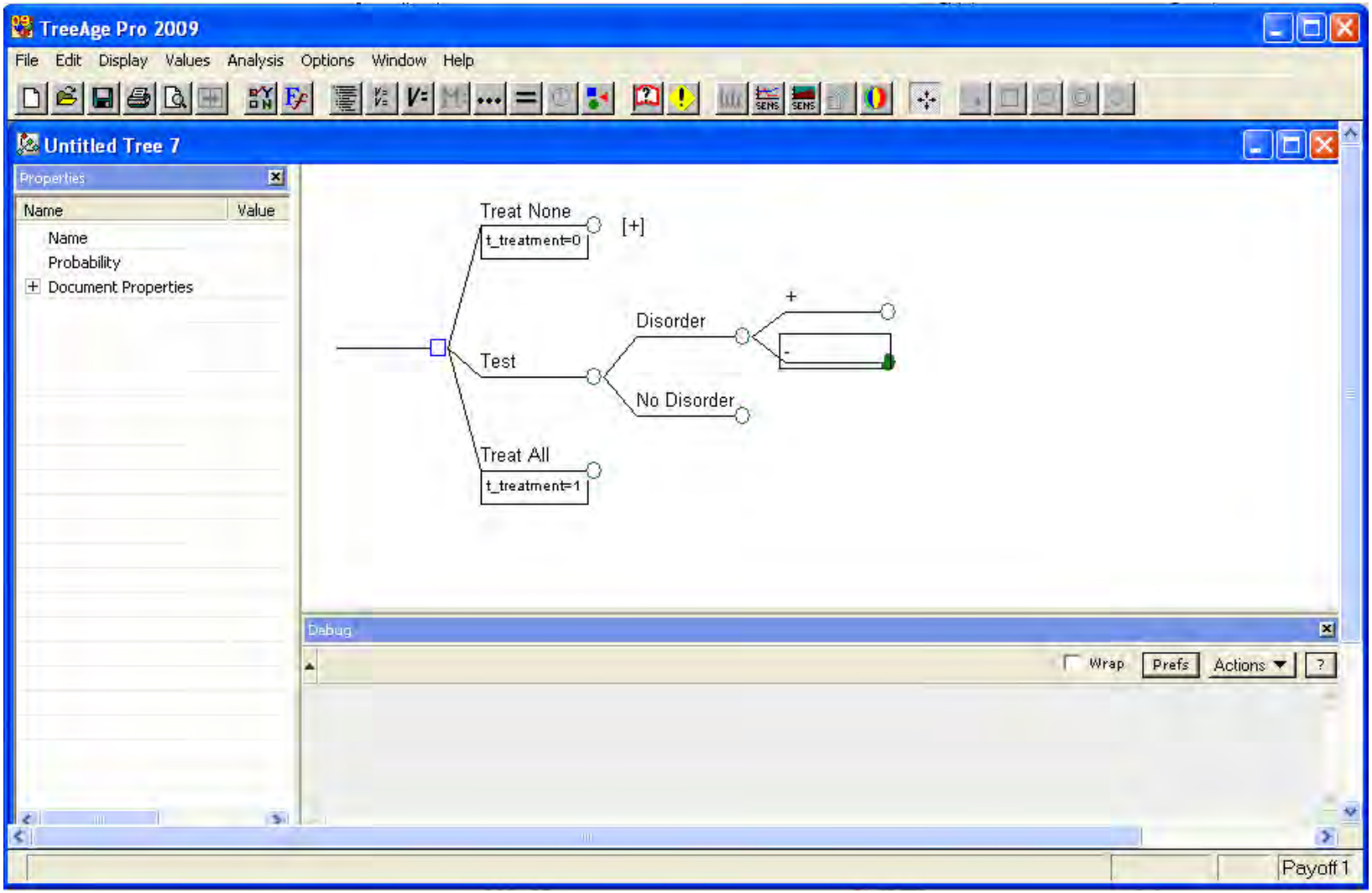
Test
Treat All
t_treatment=1
Debug
Wrap
Prefs
Actions
?
Payoff 1

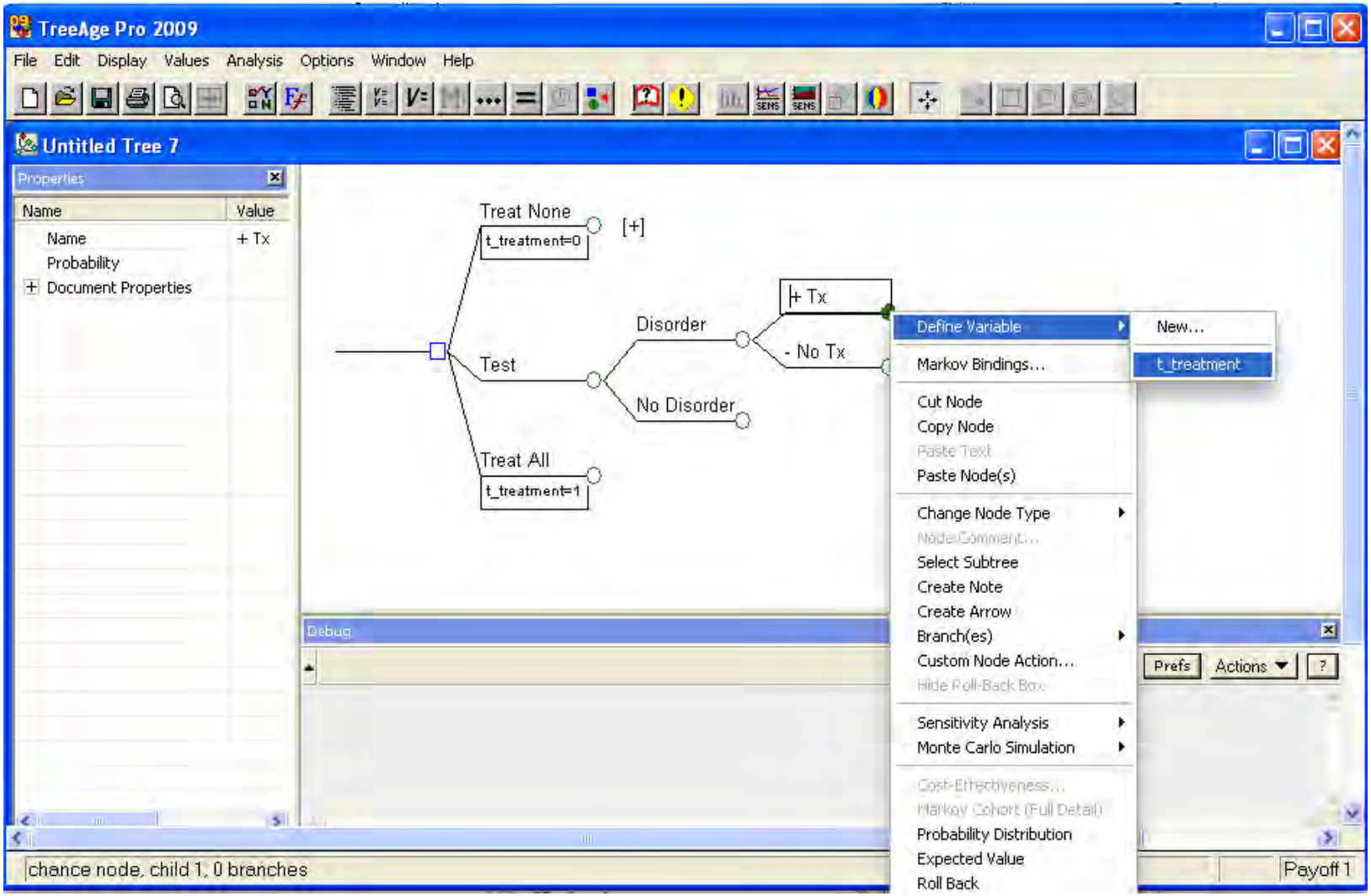
Strategy 2 - Test

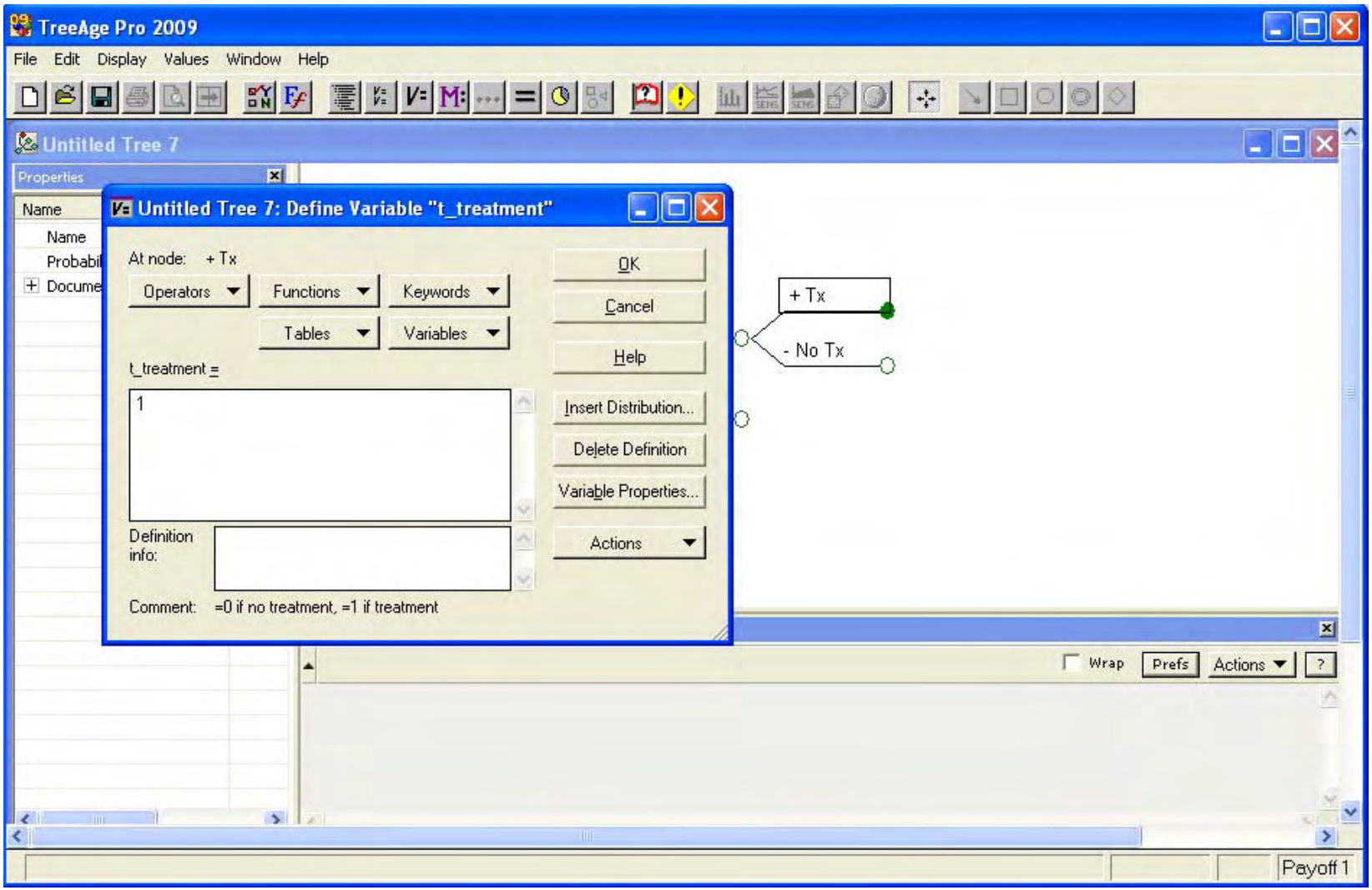


Strategy 2 - Test



Strategy 2 - Test

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Definition info:
Comment: =0 if no treatment, =1 if treatment
OK
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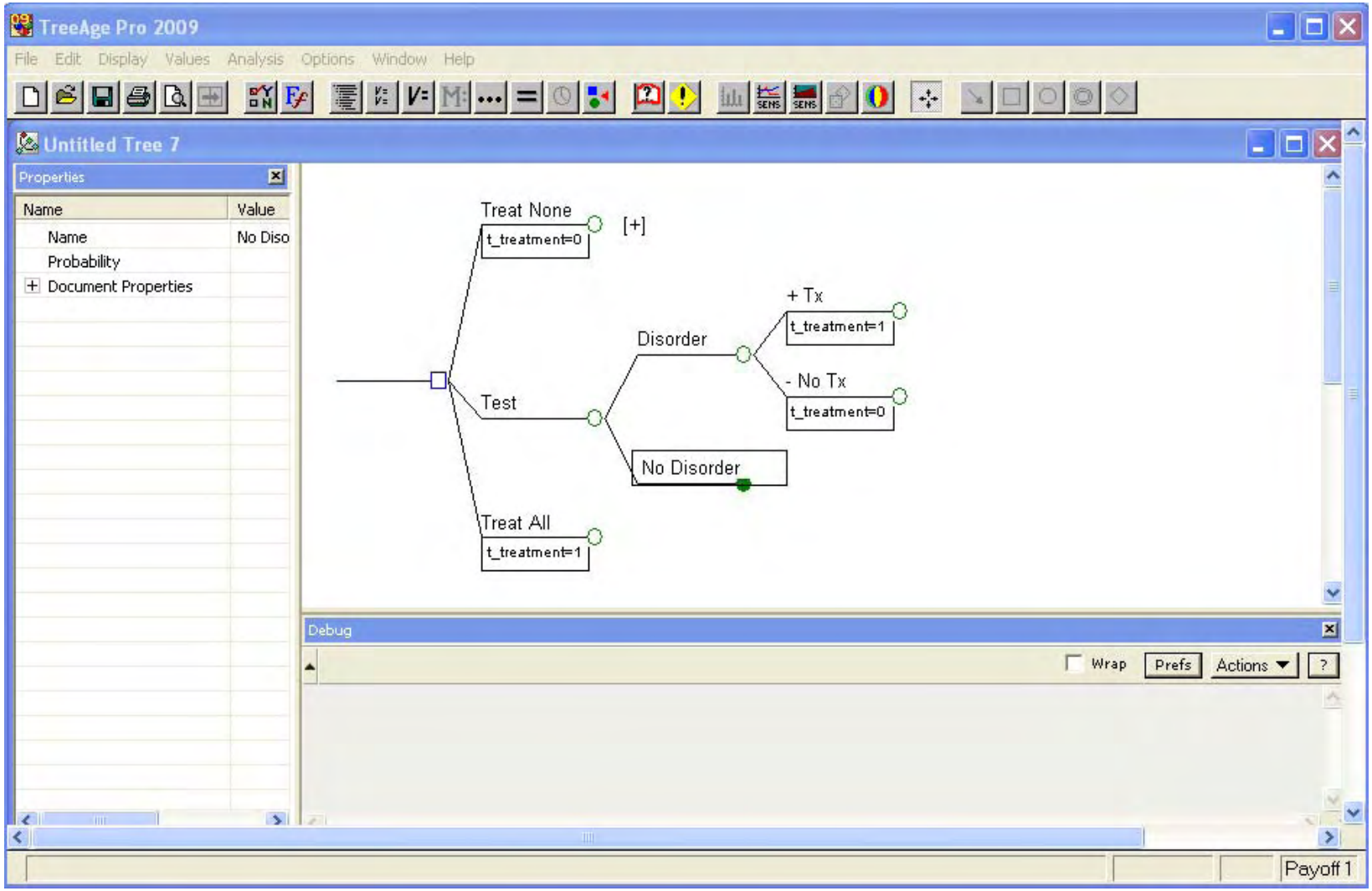
Payoff 1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t_treatment=1
Debug
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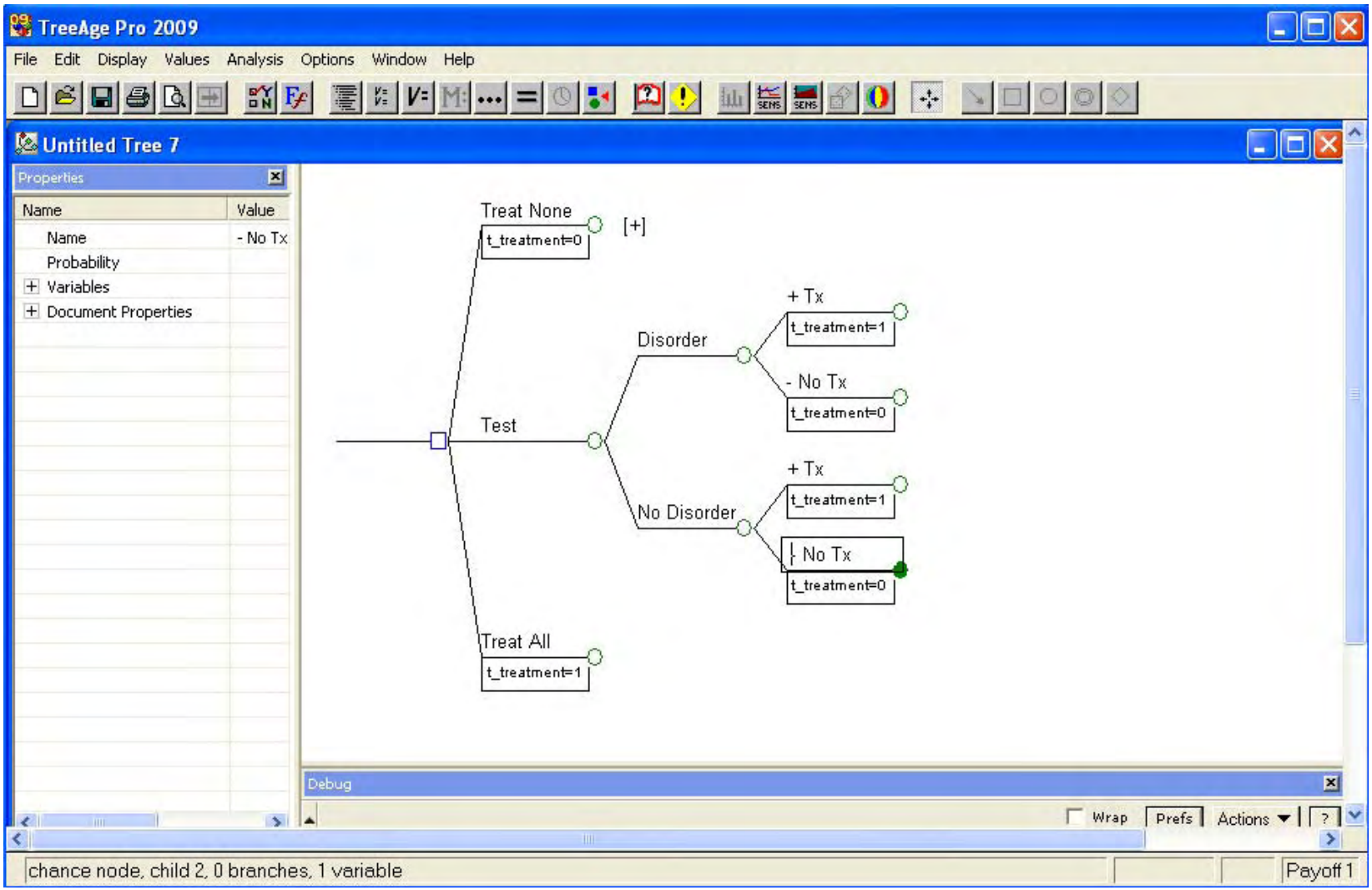
Payoff 1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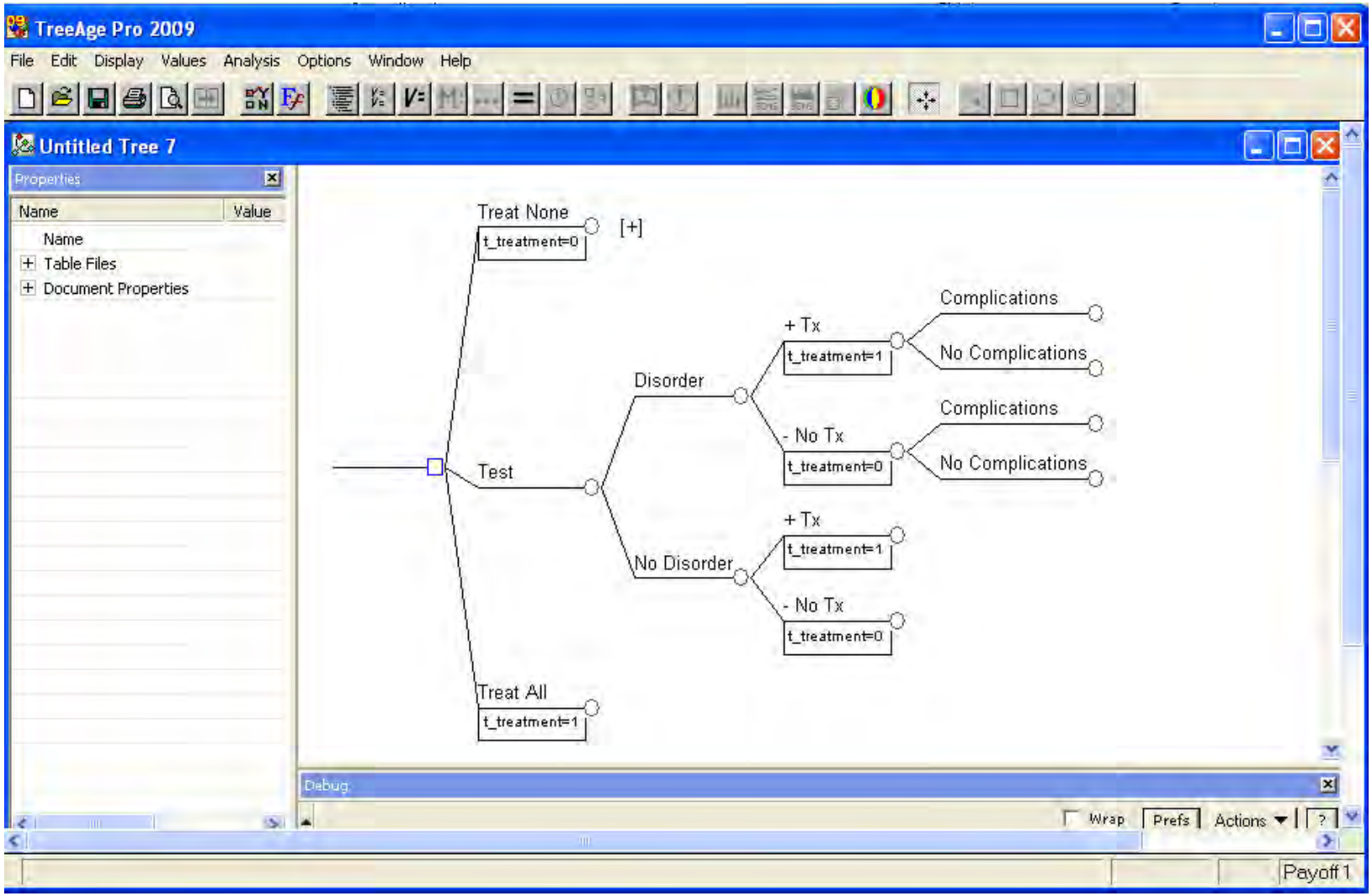
chance node, child 2, 0 branches, 1 variable
Payoff 1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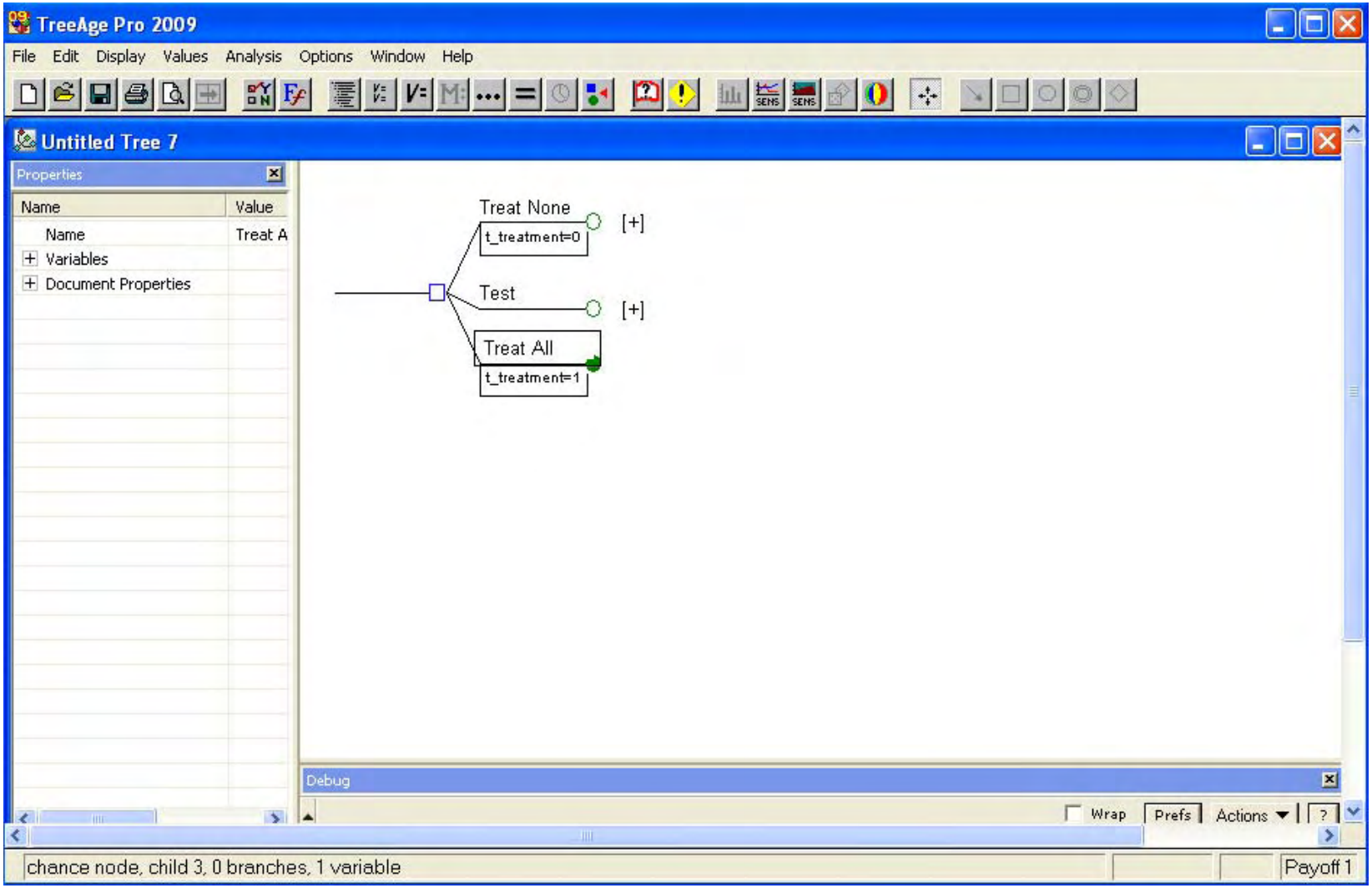
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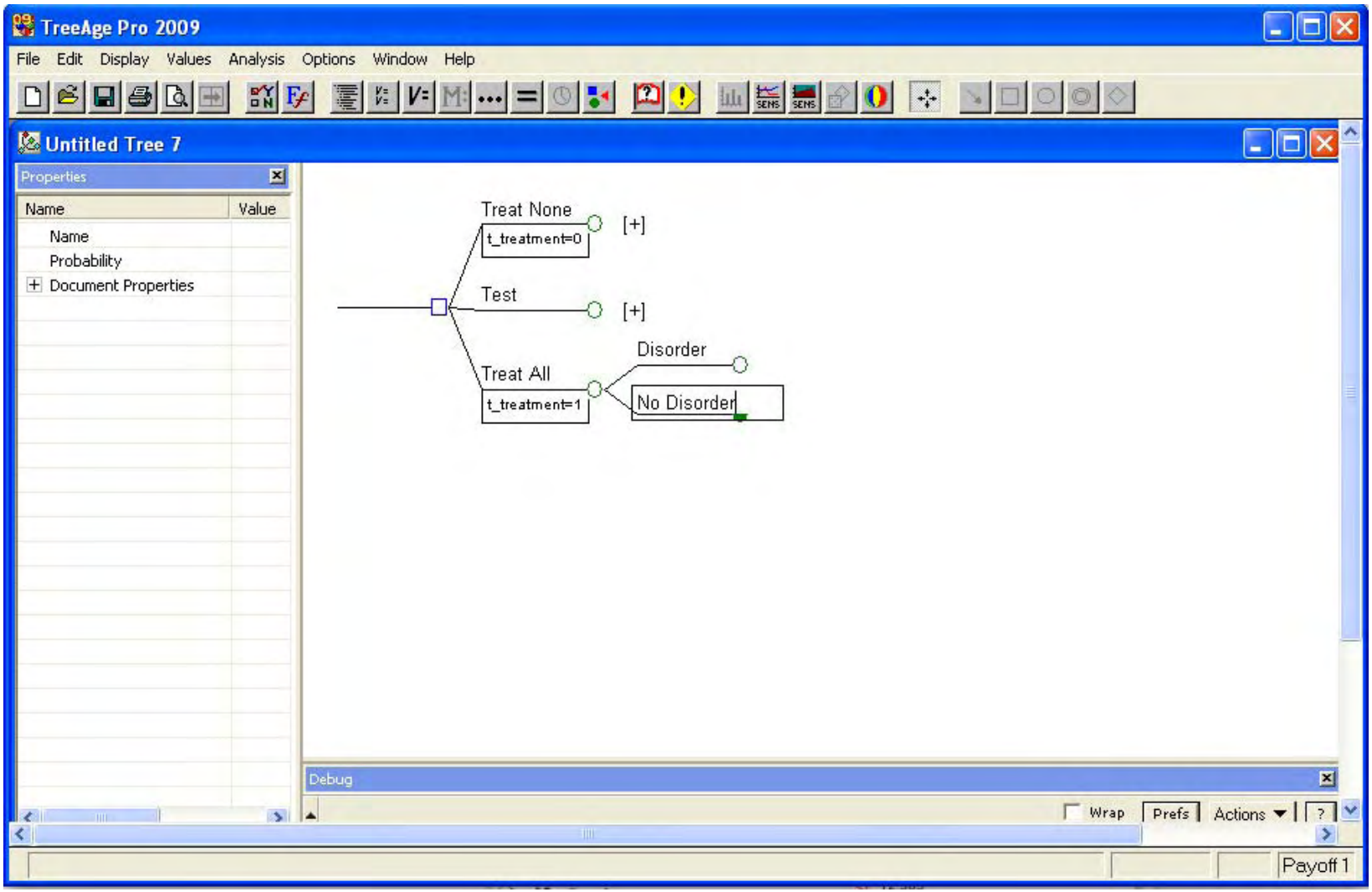
Payoff 1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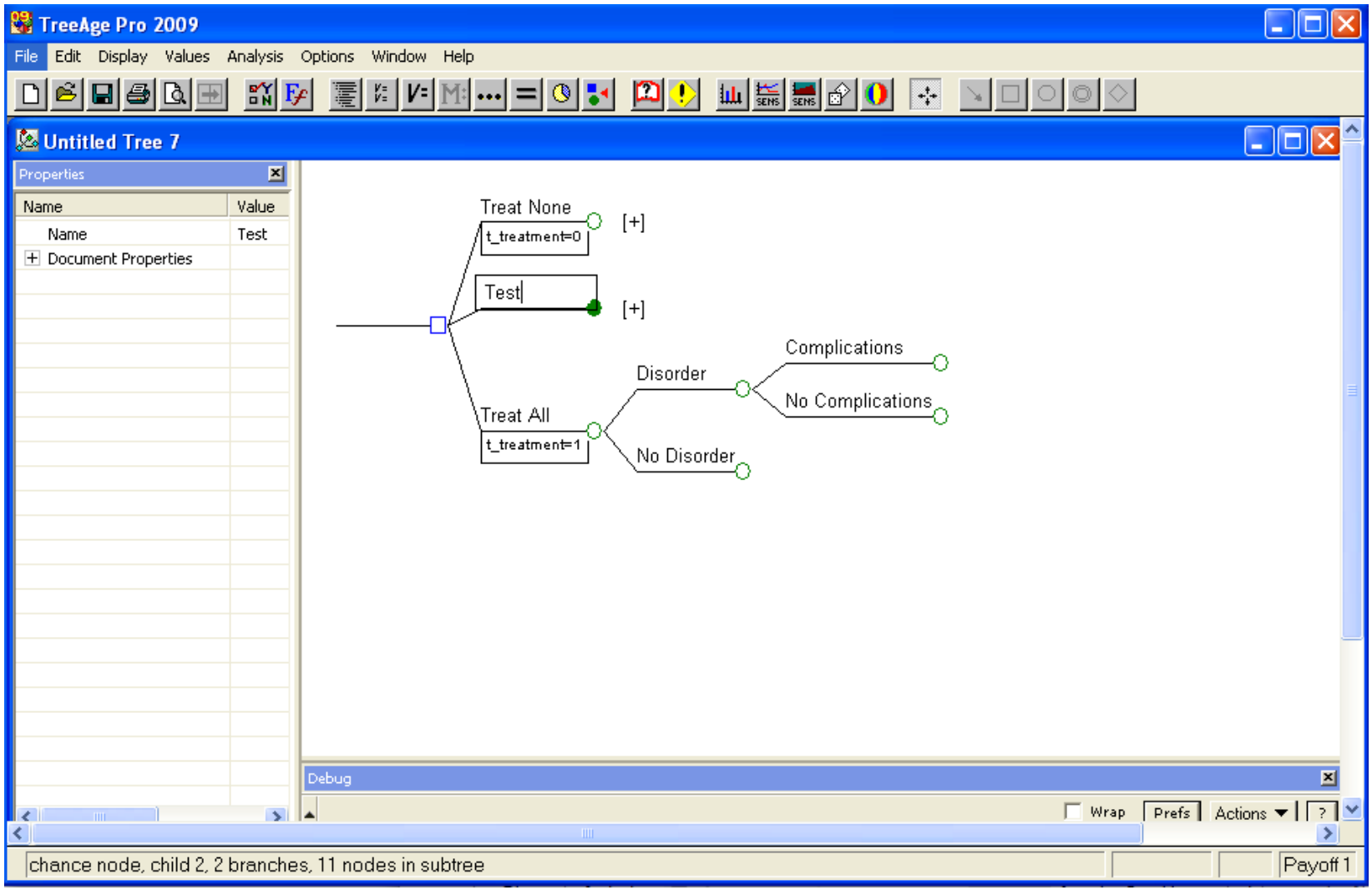
Payoff 1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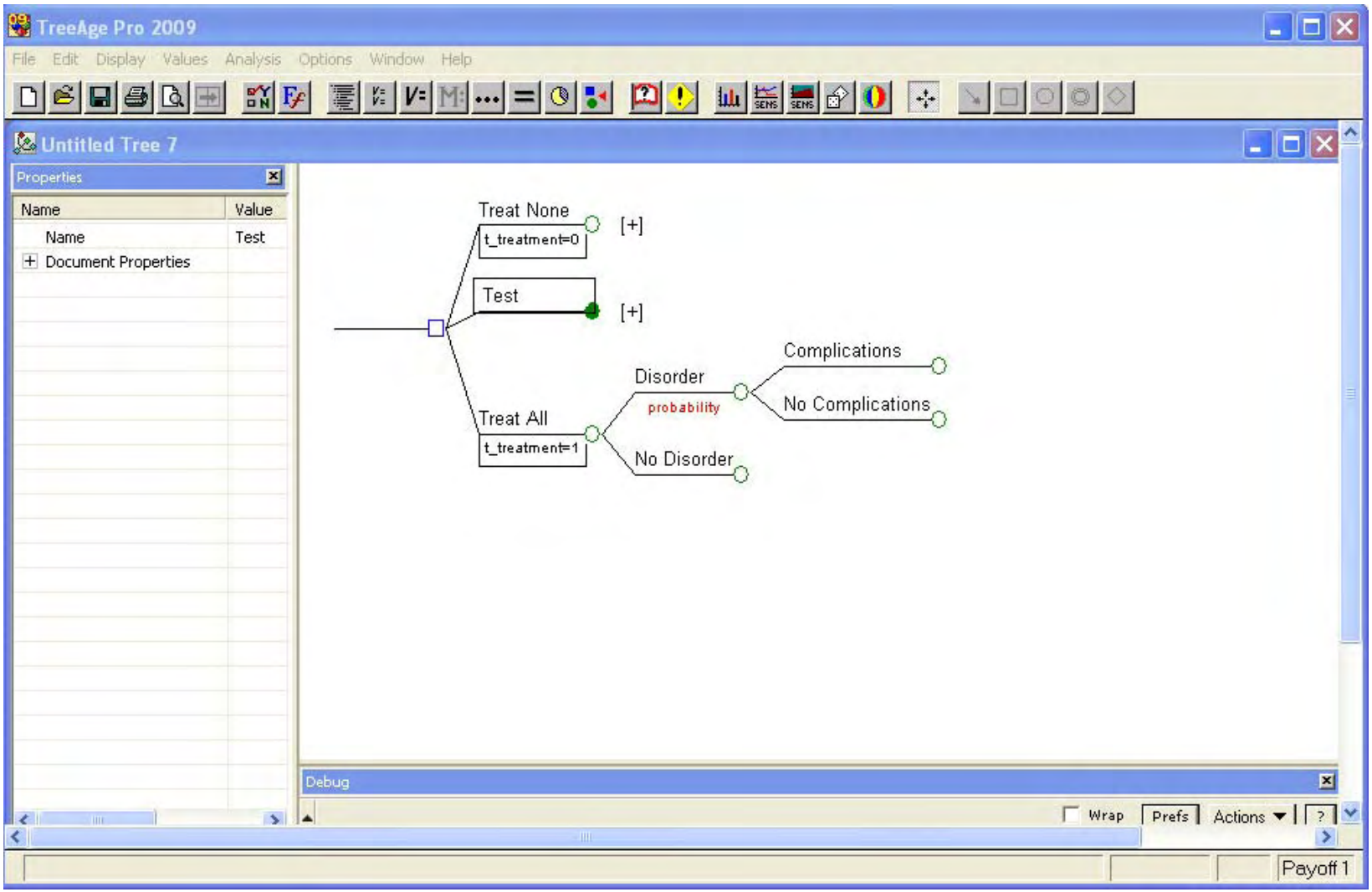
Wrap Prefs Actions ?
chance node, child 2, 2 branches, 11 nodes in subtree
Payoff 1

Now What?

- Now we have our tree structure
- Lets start filling in probabilities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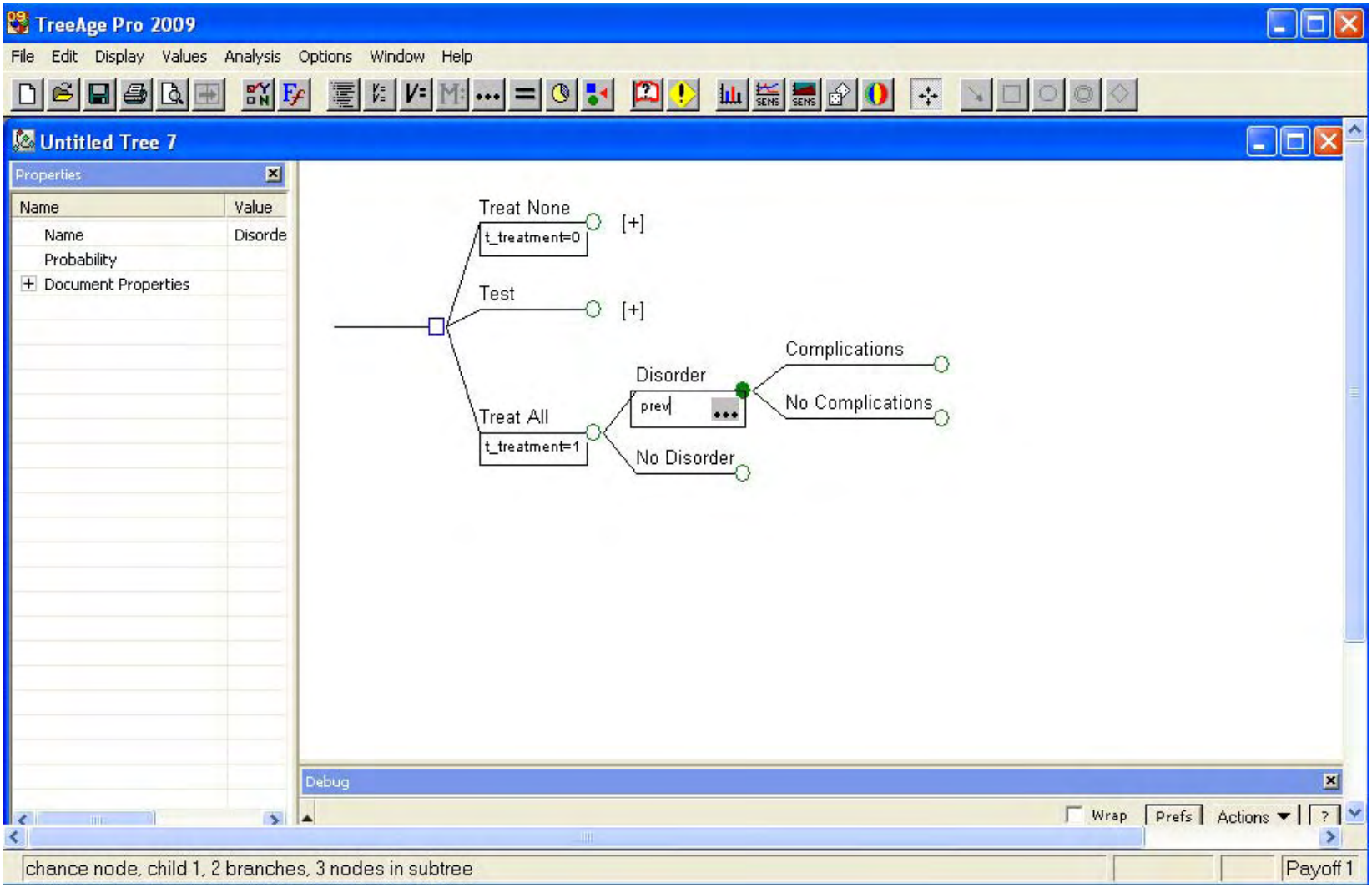
Payoff 1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Wrap
Prefs
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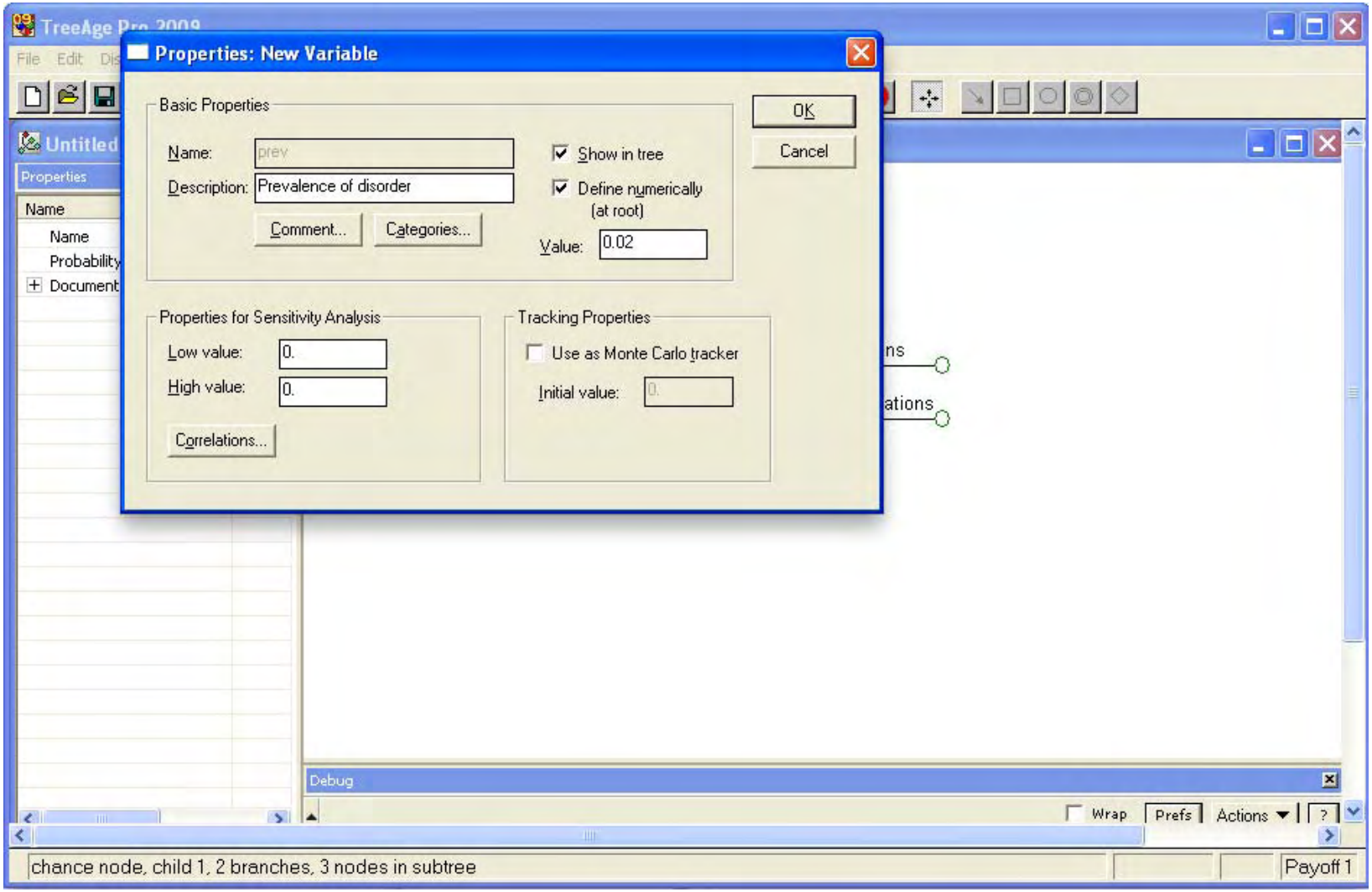
chance node, child 1, 2 branches, 3 nodes in subtree
Payoff 1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Basic Properties
Name: prev
Description: Prevalence of disorder
Comment...
Categories...
Show in tree
Define numerically (at root)
Value: 0.02
OK
Cancel
Properties for Sensitivity Analysis
Low value: 0.
High value: 0.
Correlations...
Tracking Properties
Use as Monte Carlo tracker
Initial value: 0.
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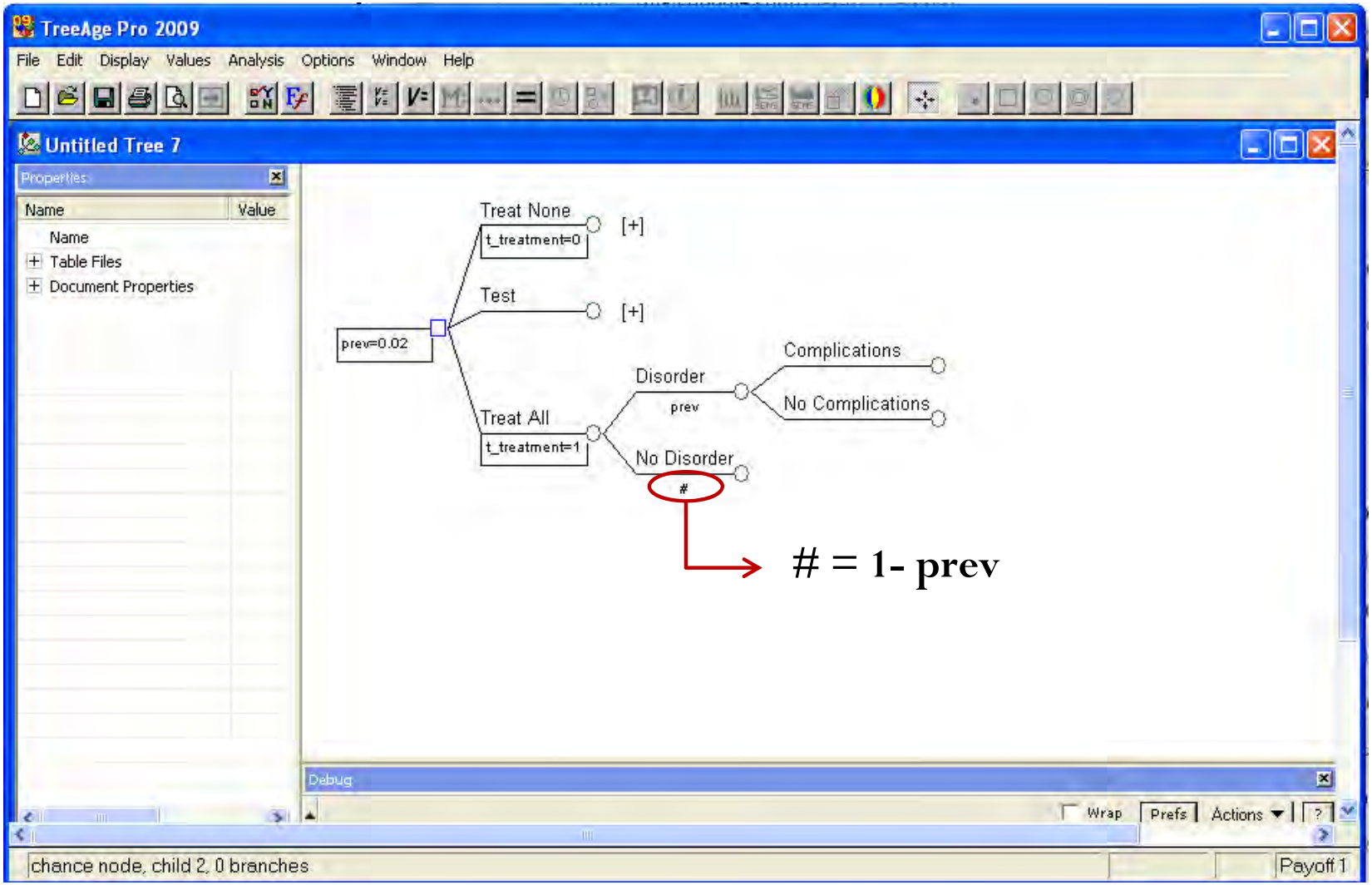
chance node, child 1, 2 branches, 3 nodes in subtree
Payoff 1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Debug
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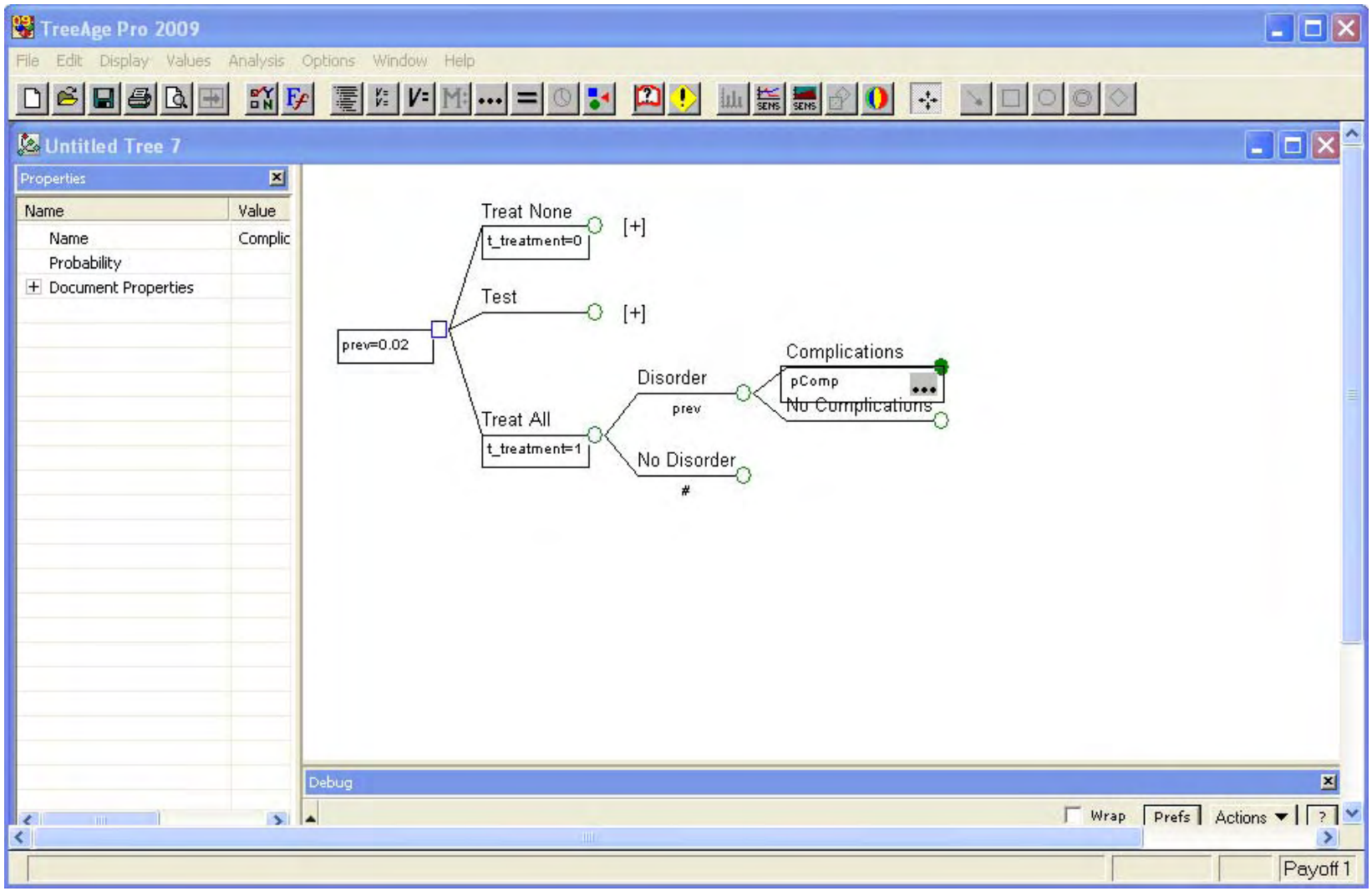
Prefs
Actions
chance node, child 2, 0 branches
Payoff 1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t_treatment=1
No Disorder
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Debug
Wrap
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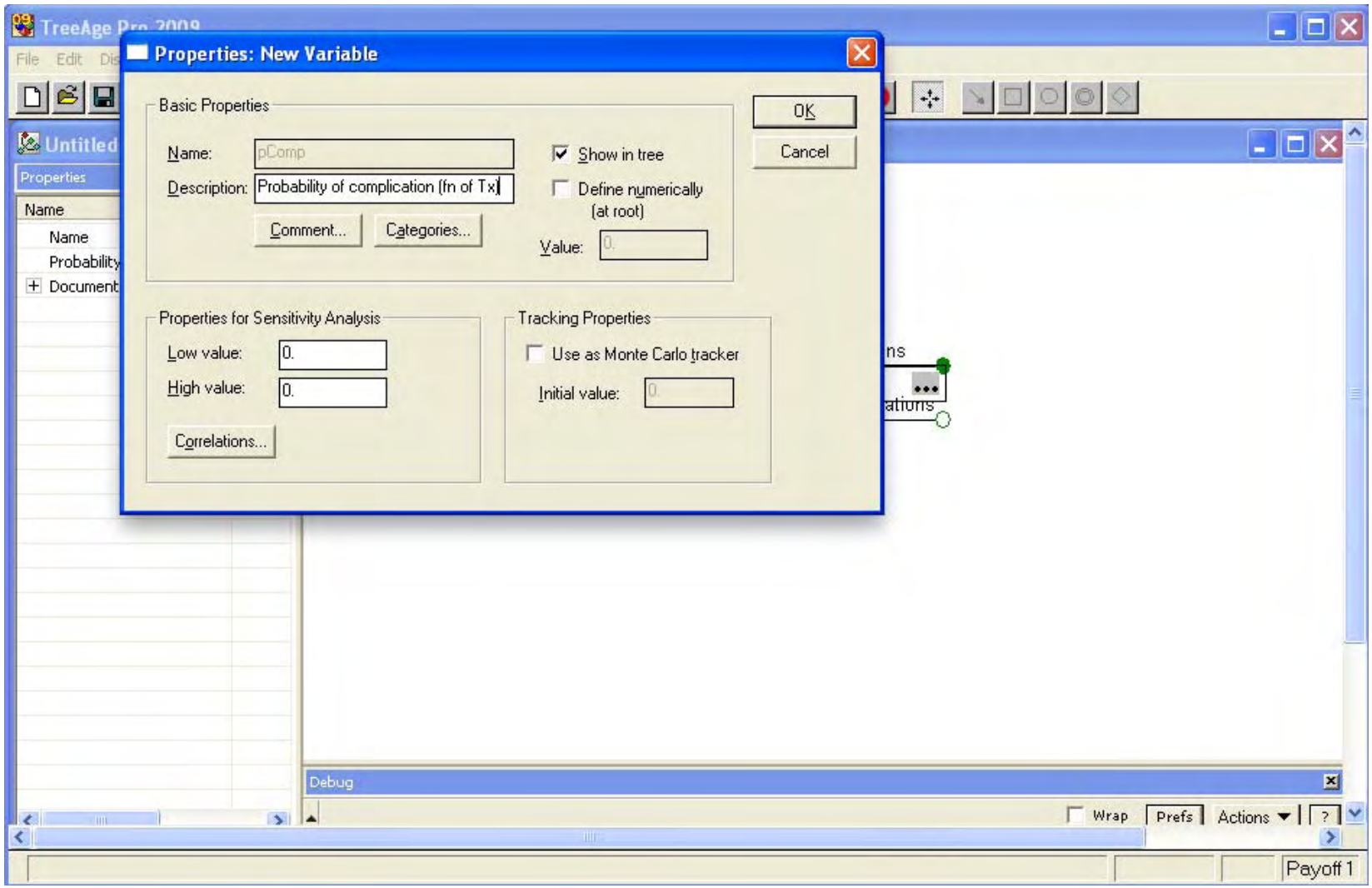
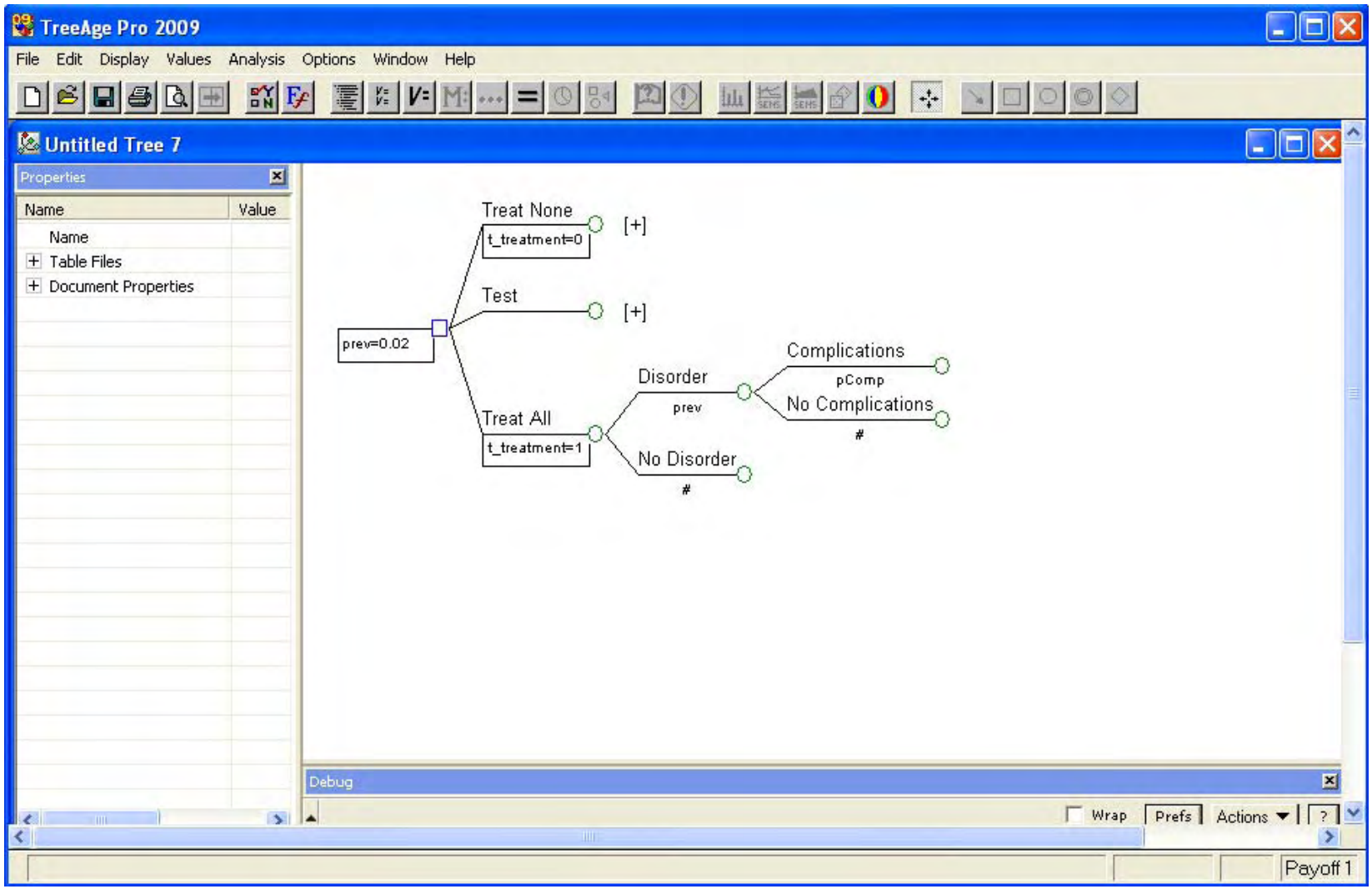
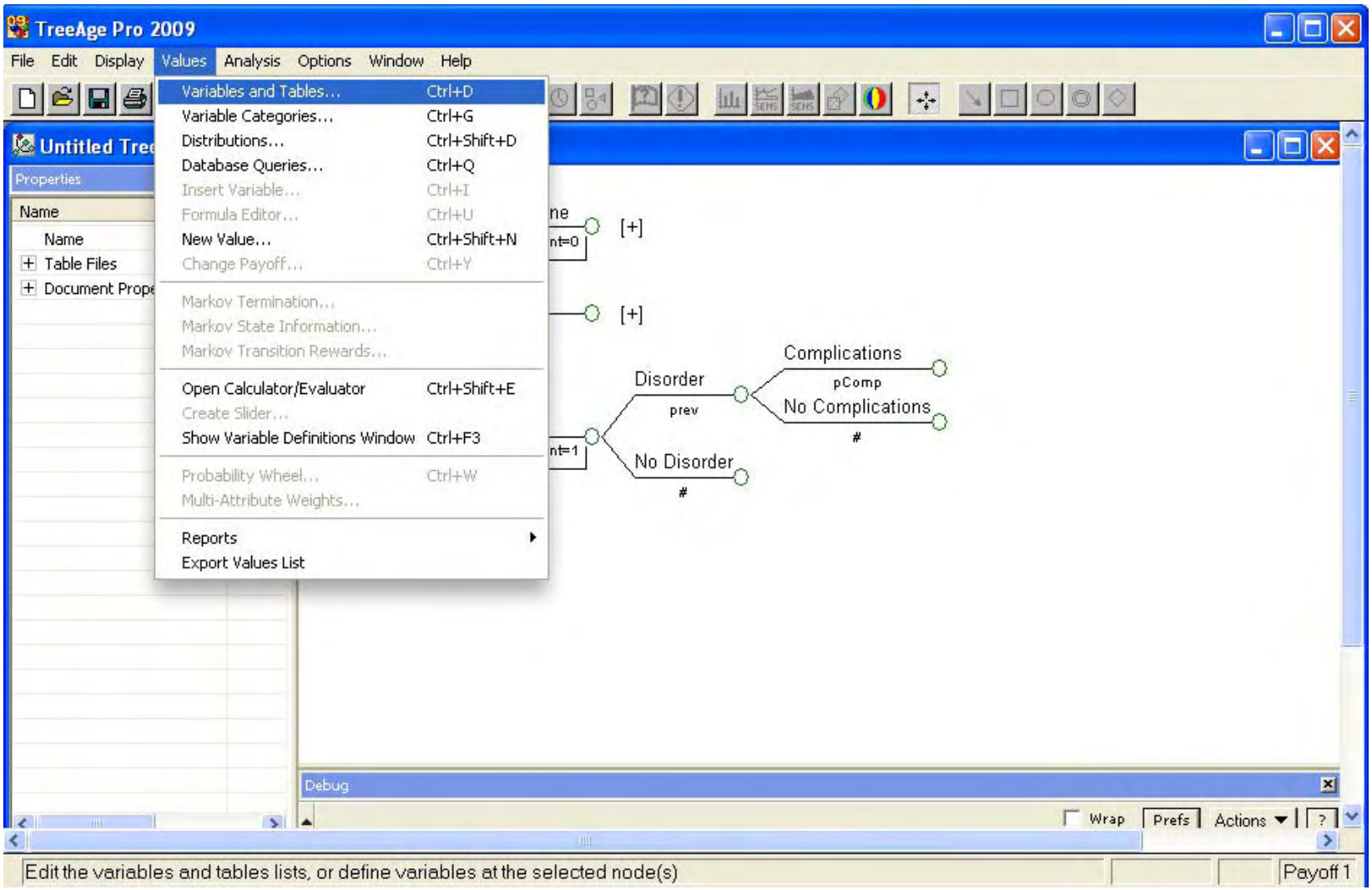
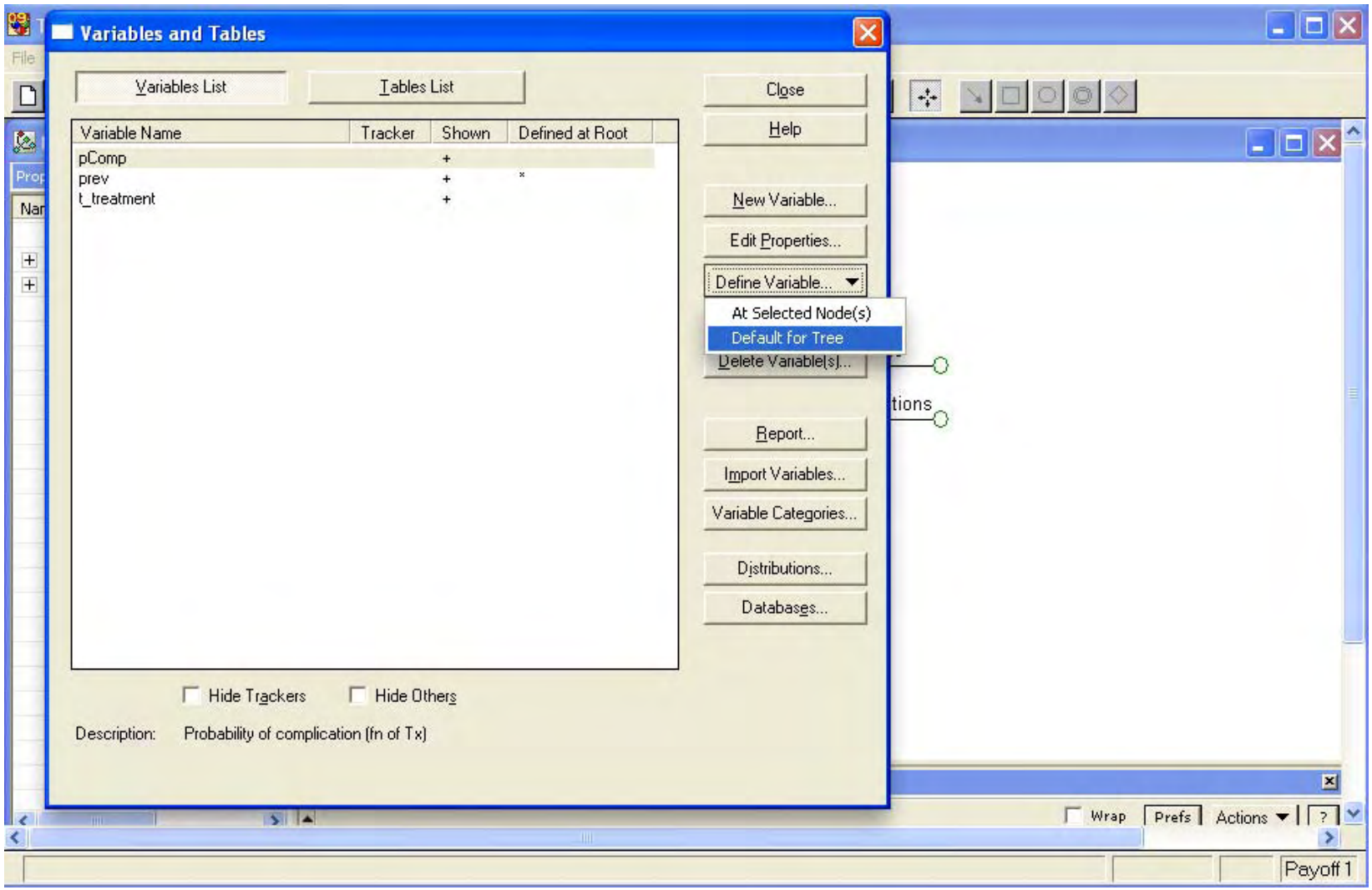
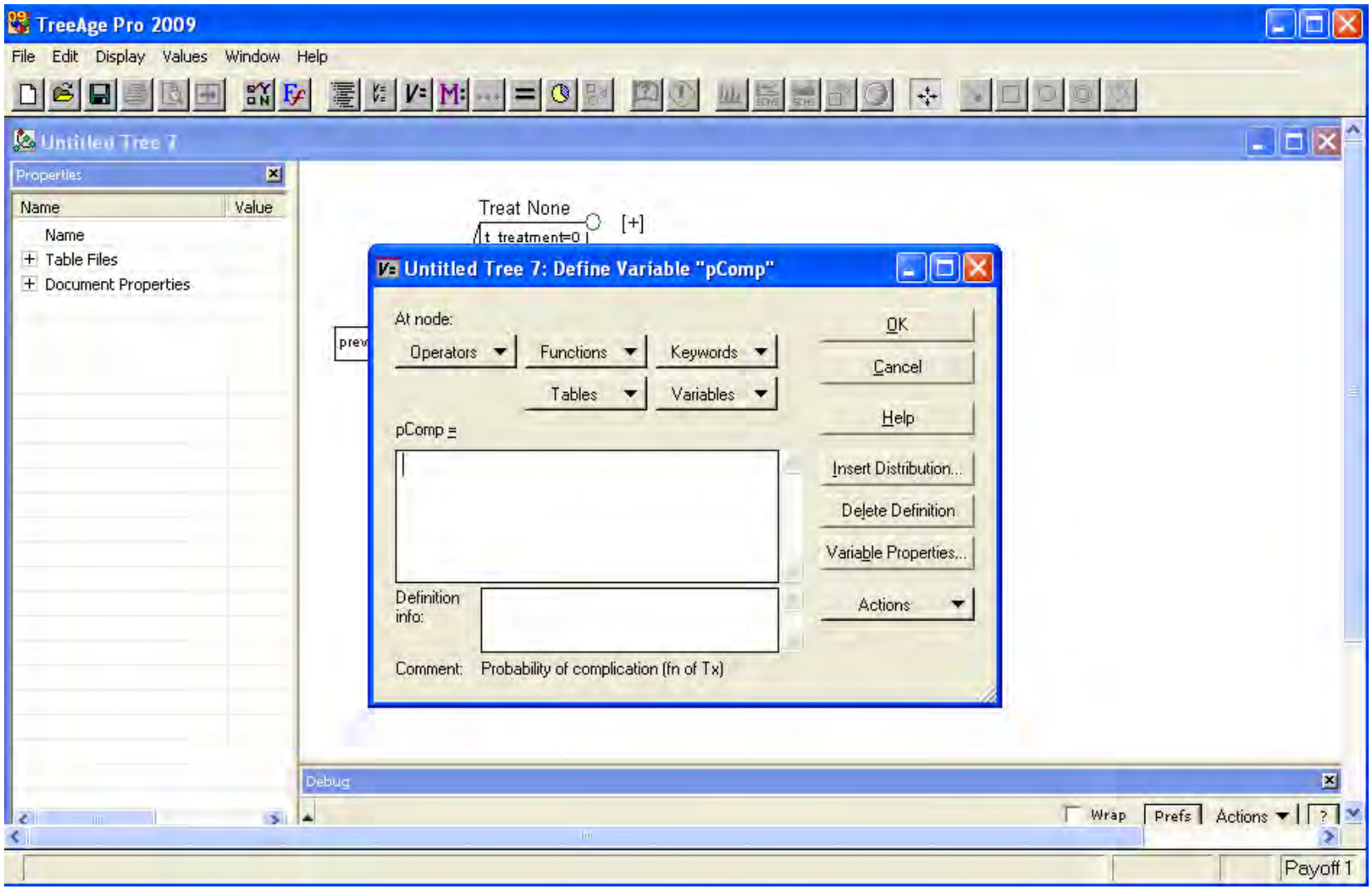
Actions
Payoff 1

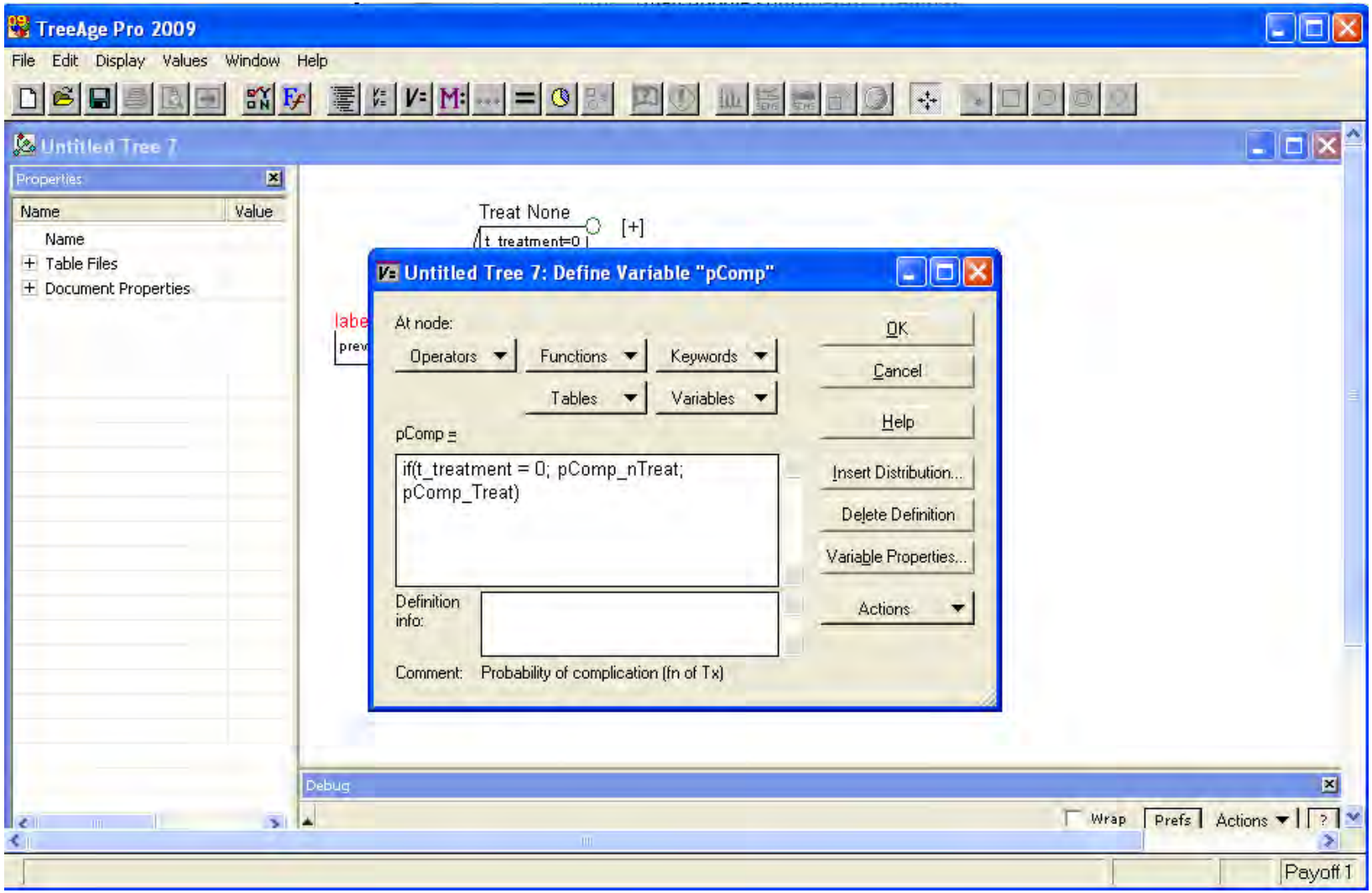

TreeAge Pro 2009
File Edit
Properties: New Variable
Basic Properties
Name: pComp
Description: Probability of complication (fn of Tx)
Comment...
Categories...
Show in tree
Define numerically (at root)
Value: 0.
OK
Cancel
Properties for Sensitivity Analysis
Low value: 0.
High value: 0.
Correlations...
Tracking Properties
Use as Monte Carlo tracker
Initial value: 0.
Untitled
Properties
Name
Name
Probability
Document
Debug
Wrap
Prefs
Actions
Payoff 1

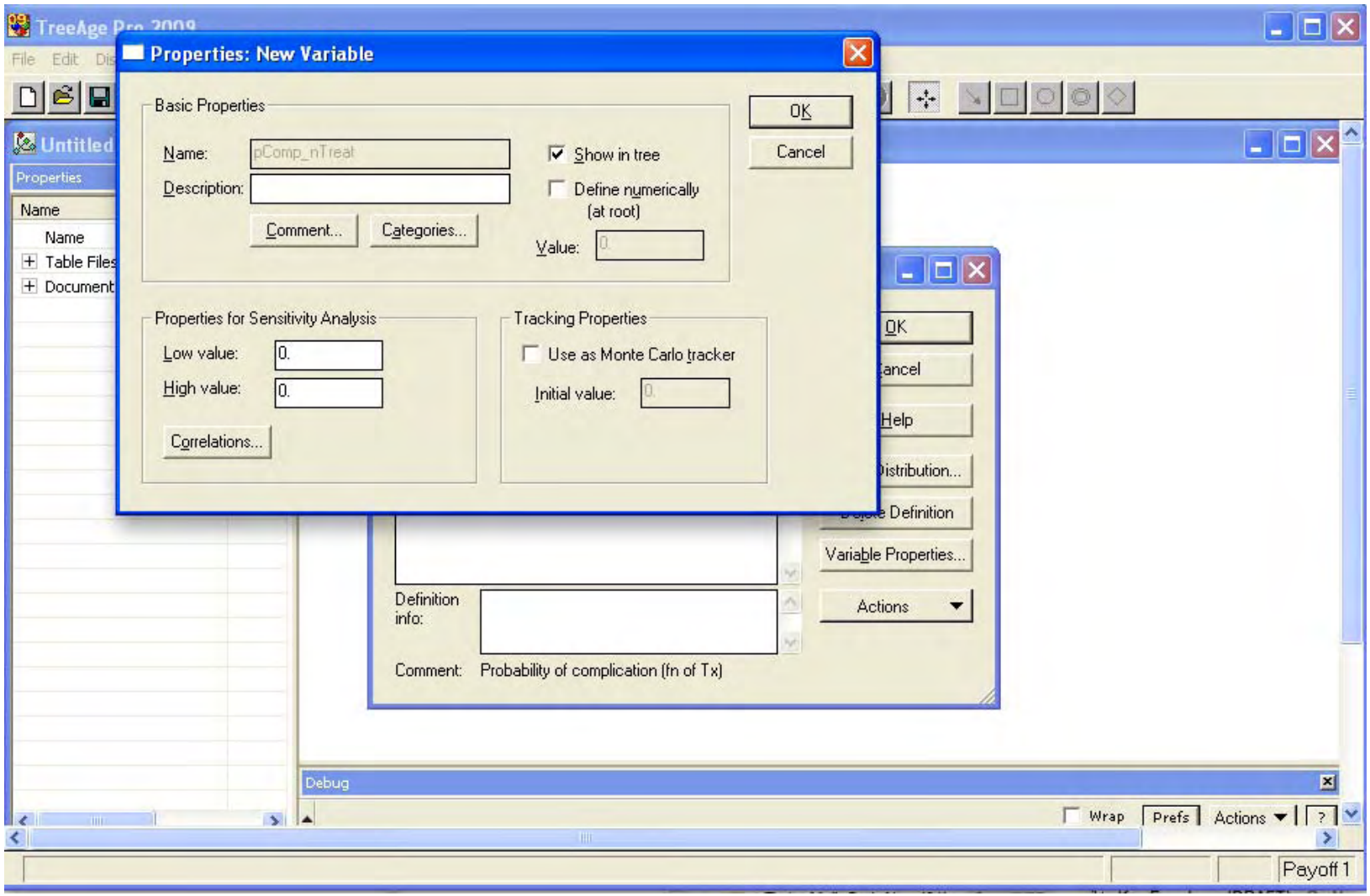

TreeAge Pro 2009
File Edit Display Values Analysis Options Window Help
Untitled Tree 7
Properties
Name
Value
Name
Table Files
Document Properties
Treat None
t_treatment=0
[+]
Test
[+]
prev=0.02
Treat All
t_treatment=1
Disorder
prev
Complications
pComp
No Complications
#
No Disorder
#
Debug
Wrap
Prefs
Actions
Payoff 1

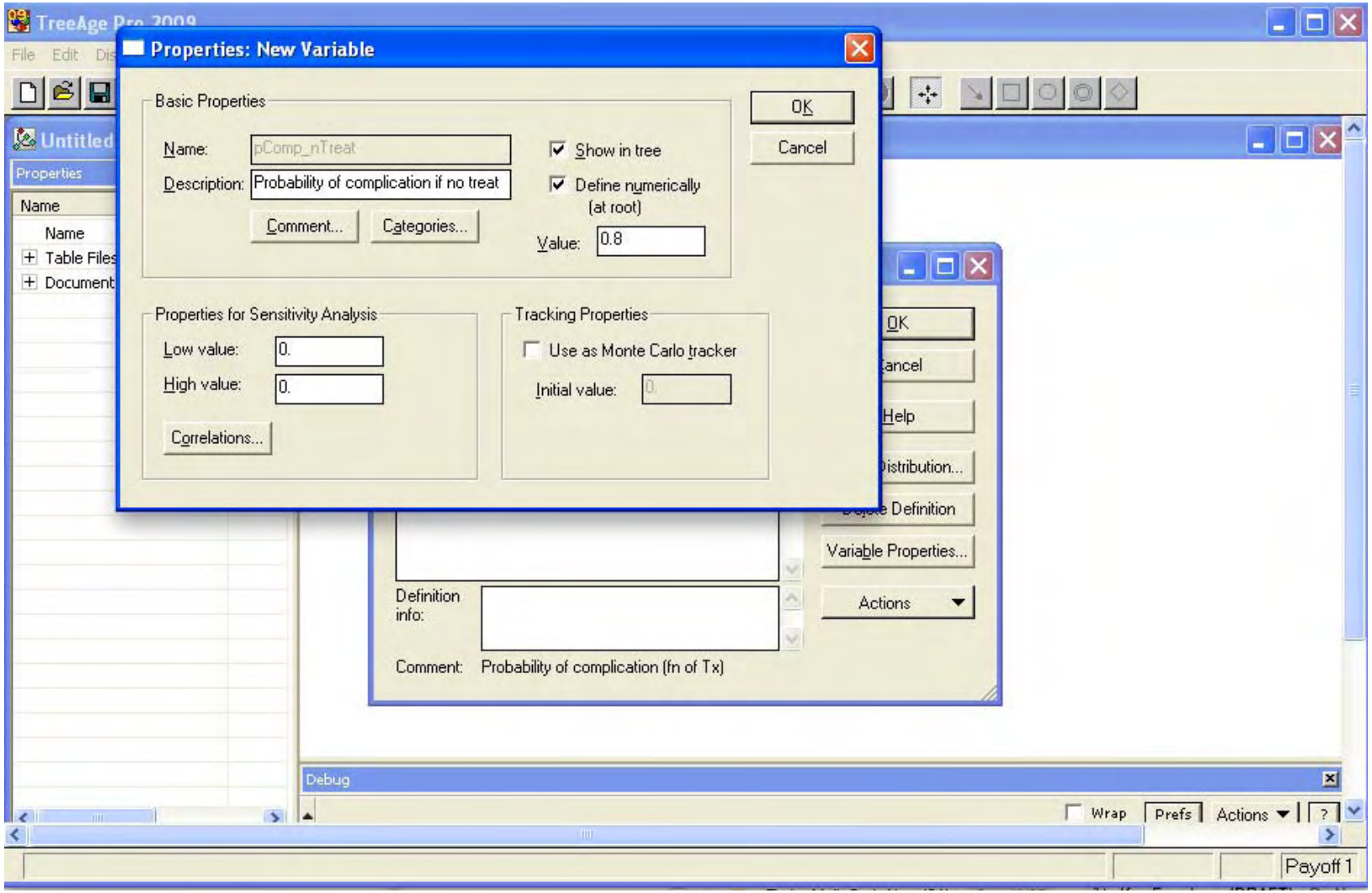

TreeAge Pro 2009
File Edit Display Values Analysis Options Window Help
Variables and Tables... Ctrl+D
Variable Categories... Ctrl+G
Distributions... Ctrl+Shift+D
Database Queries... Ctrl+Q
Insert Variable... Ctrl+I
Formula Editor... Ctrl+U
New Value... Ctrl+Shift+N
Change Payoff... Ctrl+Y
Markov Termination...
Markov State Information...
Markov Transition Rewards...
Open Calculator/Evaluator Ctrl+Shift+E
Create Slider...
Show Variable Definitions Window Ctrl+F3
Probability Wheel... Ctrl+W
Multi-Attribute Weights...
Reports
Export Values List
Properties
Name
Table Files
[+]
[+]
Disorder
prev
Complications
pComp
No Complications
#
No Disorder
#
Debug
Wrap
Prefs
Actions
Edit the variables and tables lists, or define variables at the selected node(s)
Payoff 1

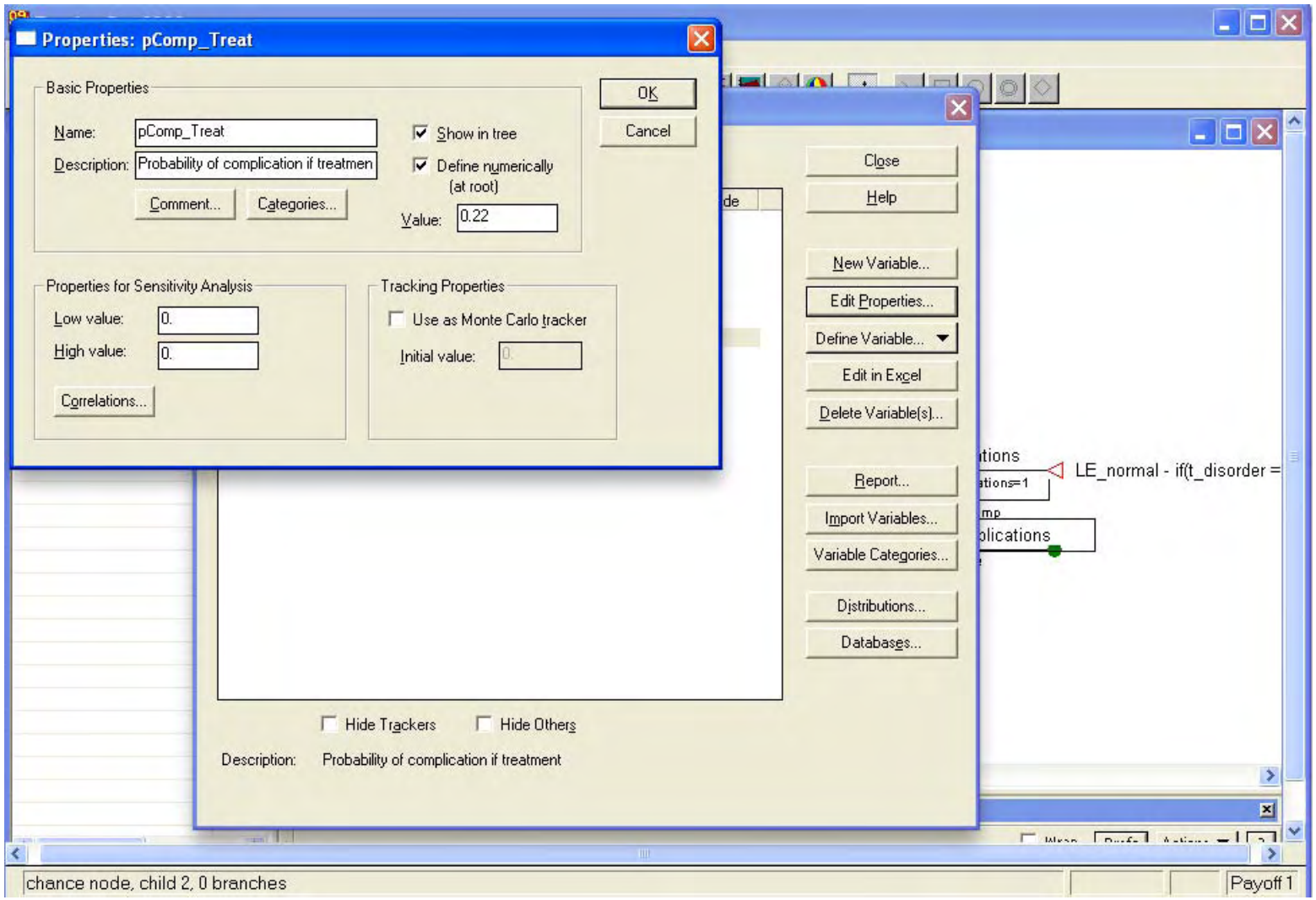

Variables and Tables
Variables List
Tables List
Close
Help
Variable Name
Tracker
Shown
Defined at Root
pComp
prev
t_treatment
New Variable...
Edit Properties...
Define Variable...
At Selected Node(s)
Default for Tree
Delete Variable(s)...
Report...
Import Variables...
Variable Categories...
Distributions...
Databases...
Hide Trackers
Hide Others
Description:
Probability of complication (fn of Tx)
Wrap
Prefs
Actions
Payoff 1

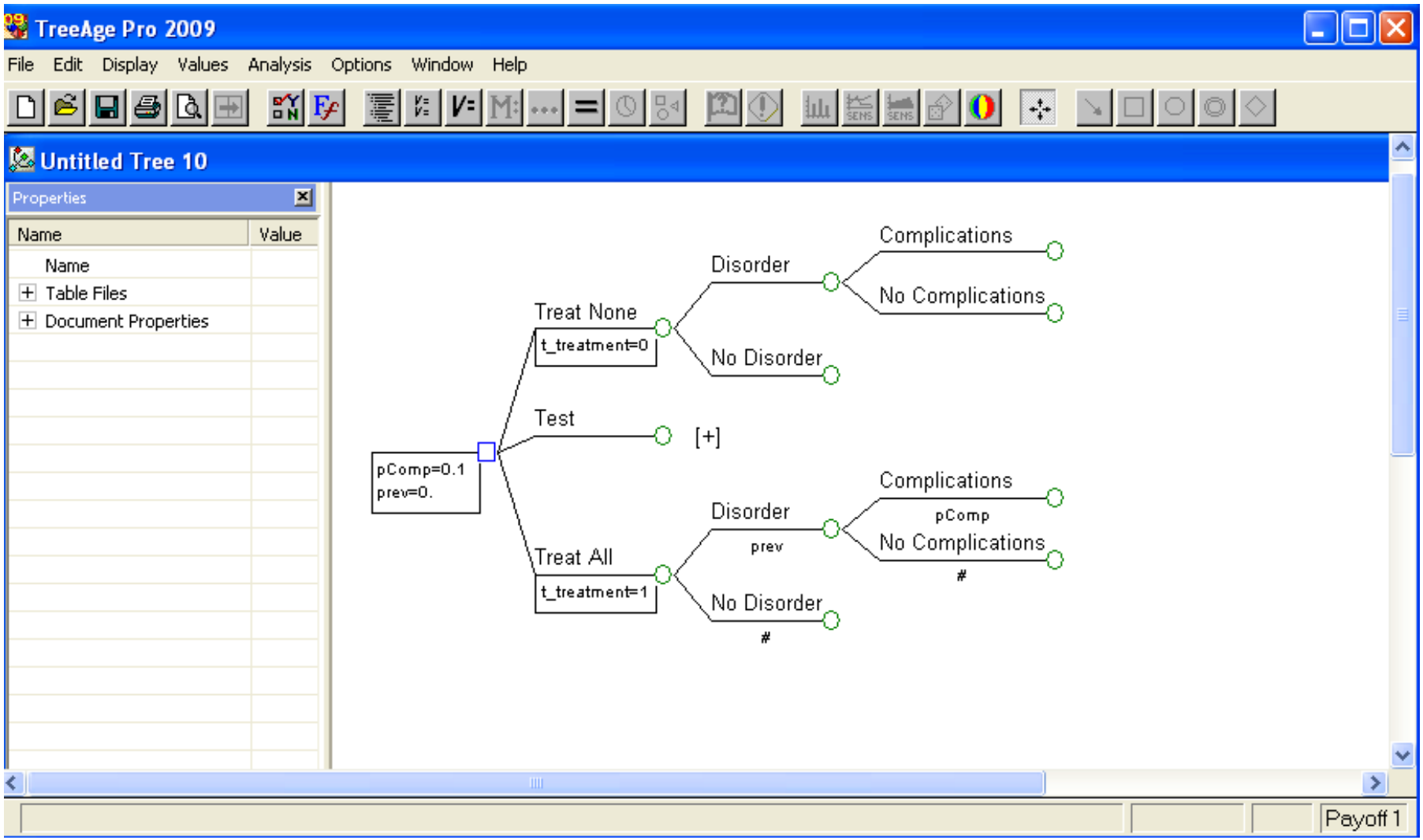

TreeAge Pro 2009
File Edit Display Values Window Help
Untitled Tree 7
Properties
Name Value
Name
Table Files
Document Properties
Treat None
t_treatment=0
[+]
Untitled Tree 7: Define Variable "pComp"
At node:
Operators
Functions
Keywords
Tables
Variables
OK
Cancel
Help
pComp =
Insert Distribution...
Delete Definition
Variable Properties...
Definition info:
Actions
Comment: Probability of complication (fn of Tx)
Debug
Wrap
Prefs
Actions
Payoff 1

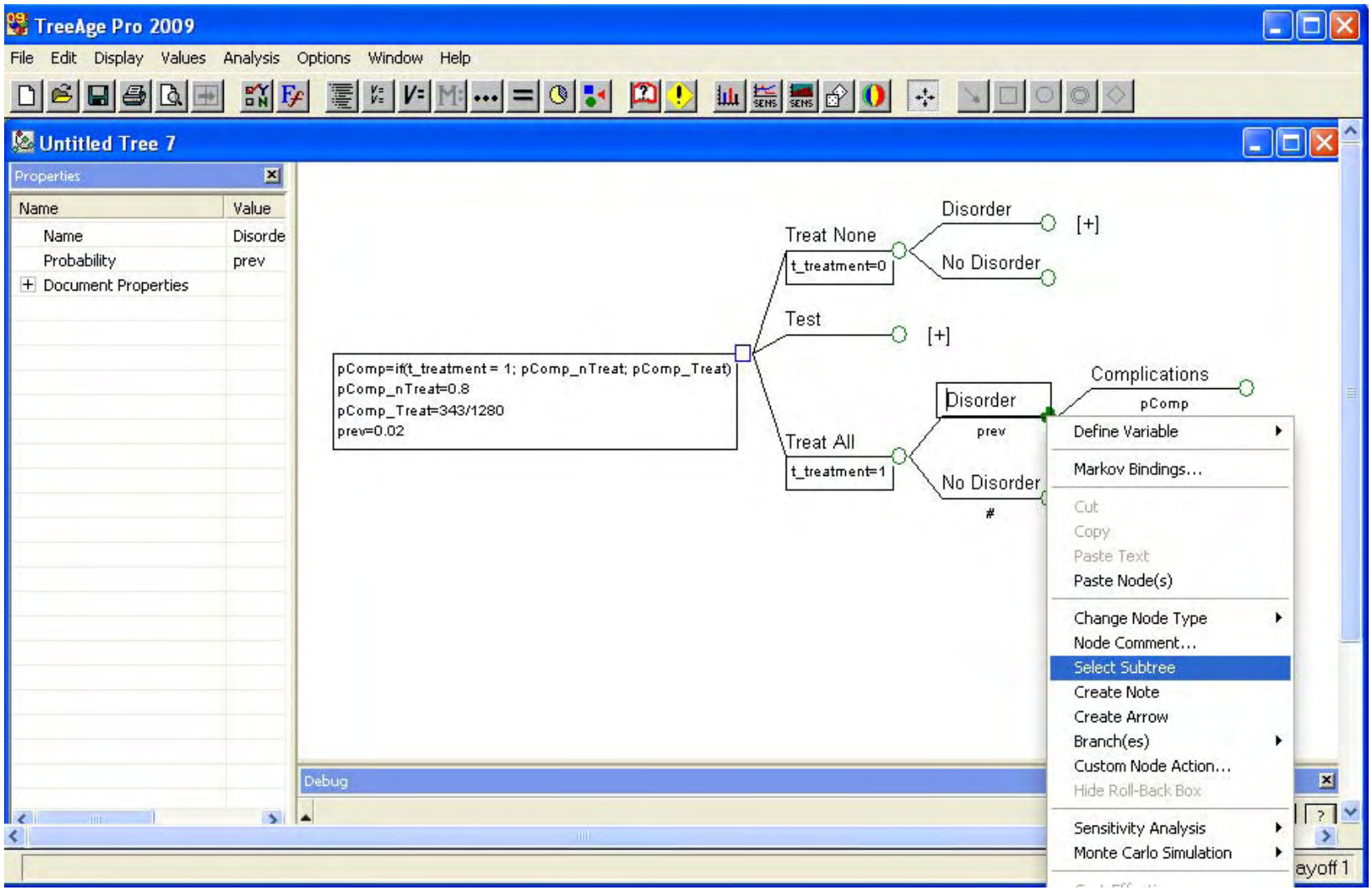

TreeAge Pro 2009
File Edit Display Values Window Help
Untitled Tree 7
Properties
Name Value
Name
Table Files
Document Properties
Treat None
[+]
t_treatment=0
Untitled Tree 7: Define Variable "pComp"
At node:
Operators
Functions
Keywords
Tables
Variables
pComp =
if(t_treatment = 0; pComp_nTreat; pComp_Treat)
Definition info:
Comment: Probability of complication (fn of Tx)
OK
Cancel
Help
Insert Distribution...
Delete Definition
Variable Properties...
Actions
Debug
Wrap
Prefs
Actions
Payoff 1

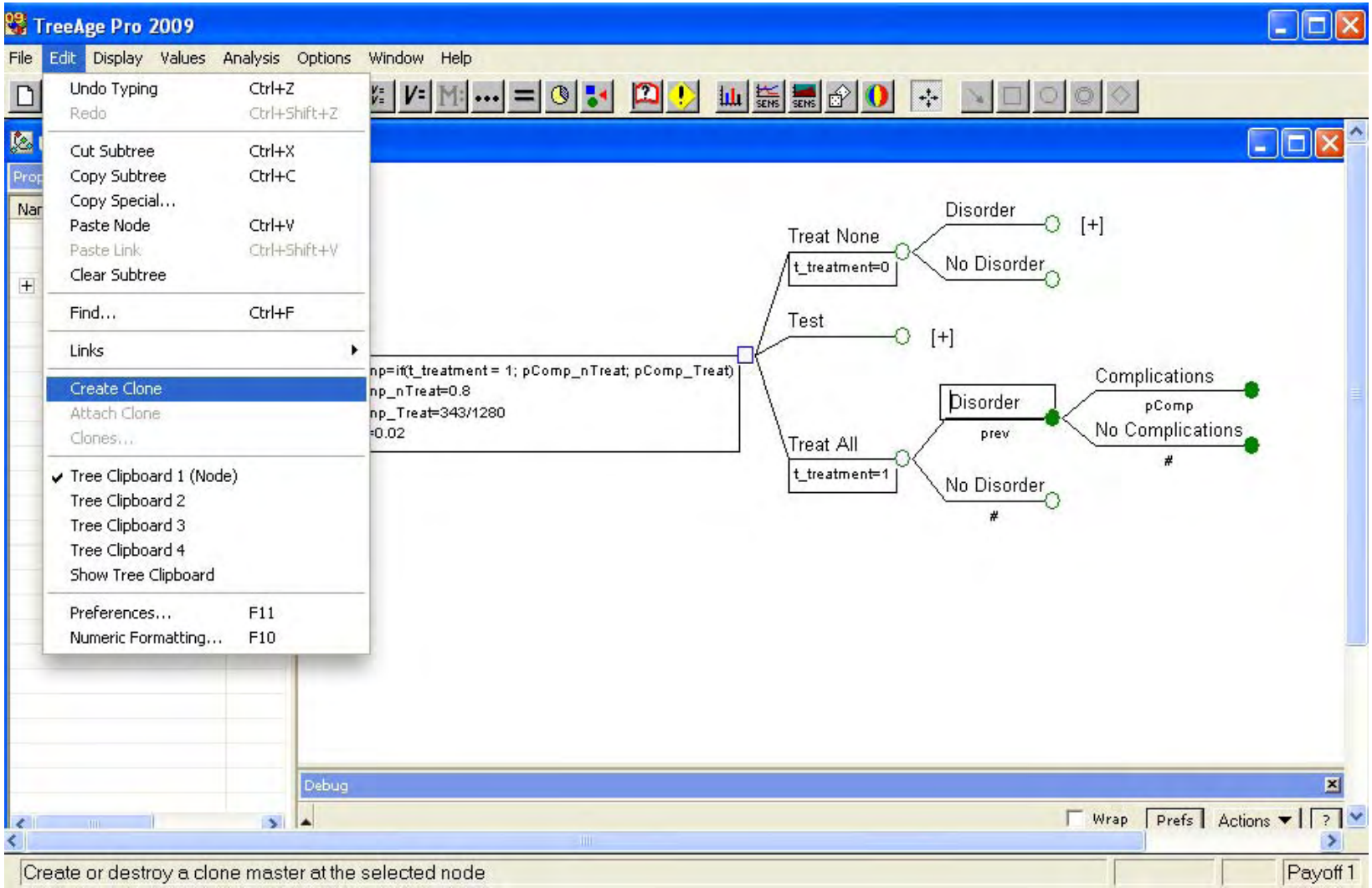

Properties: New Variable
Basic Properties
Name:
pComp_nTreat
Description:
Comment...
Categories...
Show in tree
Define numerically (at root)
Value:
OK
Cancel
Properties for Sensitivity Analysis
Low value:
0.
High value:
0.
Correlations...
Tracking Properties
Use as Monte Carlo tracker
Initial value:
Definition info:
Comment:
Probability of complication (fn of Tx)
Variable Properties...
Actions
Debug
Wrap
Prefs
Payoff 1

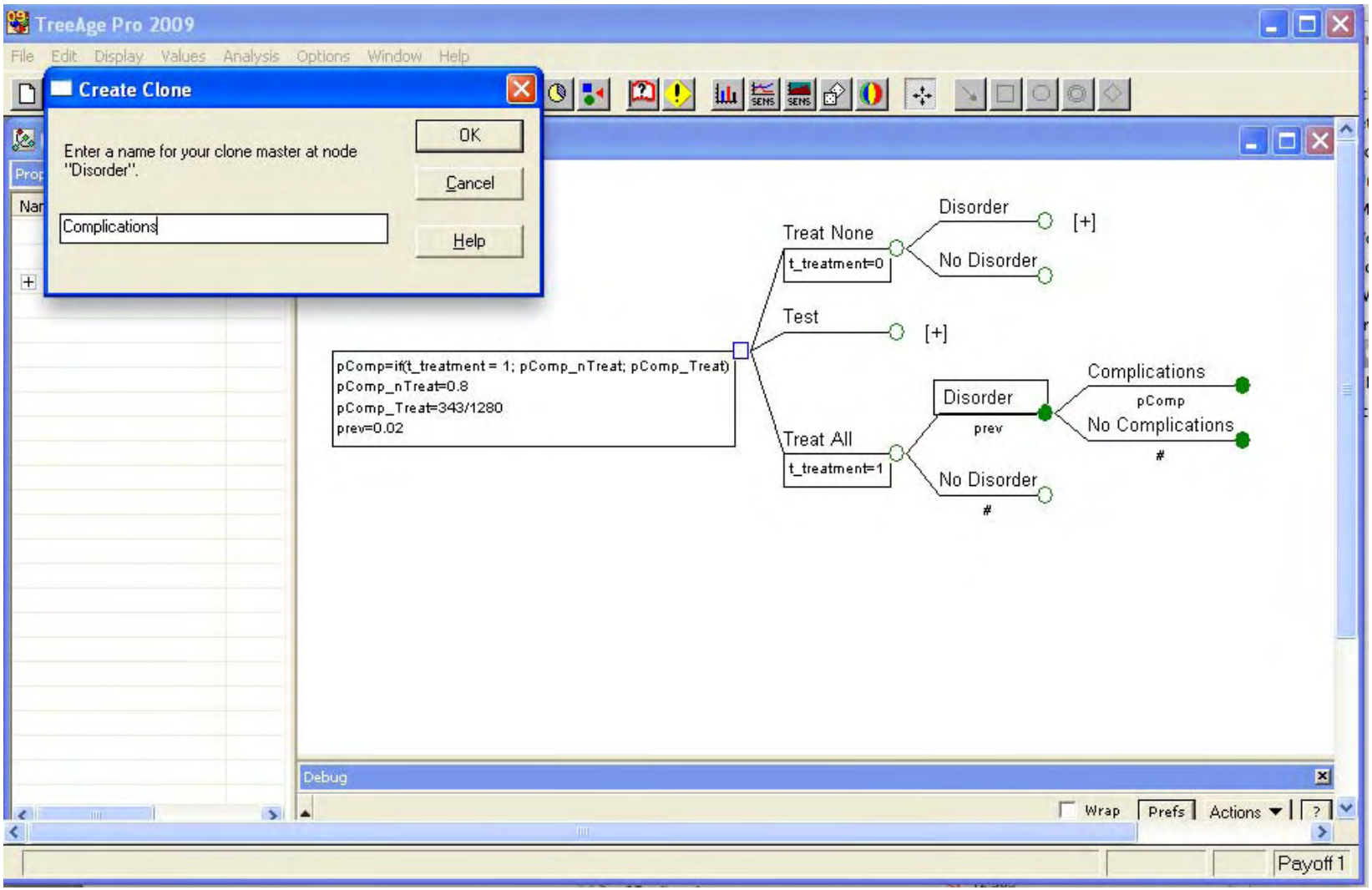

Properties: New Variable
Basic Properties
Name: pComp_nTreat
Description: Probability of complication if no treat
Comment...
Categories...
Show in tree
Define numerically (at root)
Value: 0.8
OK
Cancel
Properties for Sensitivity Analysis
Low value: 0.
High value: 0.
Correlations...
Tracking Properties
Use as Monte Carlo tracker
Initial value: 0.
Untitled
Properties
Name
Table Files
Document
Definition info:
Comment: Probability of complication (fn of Tx)
Variable Properties...
Actions
Debug
Wrap
Prefs
Payoff 1

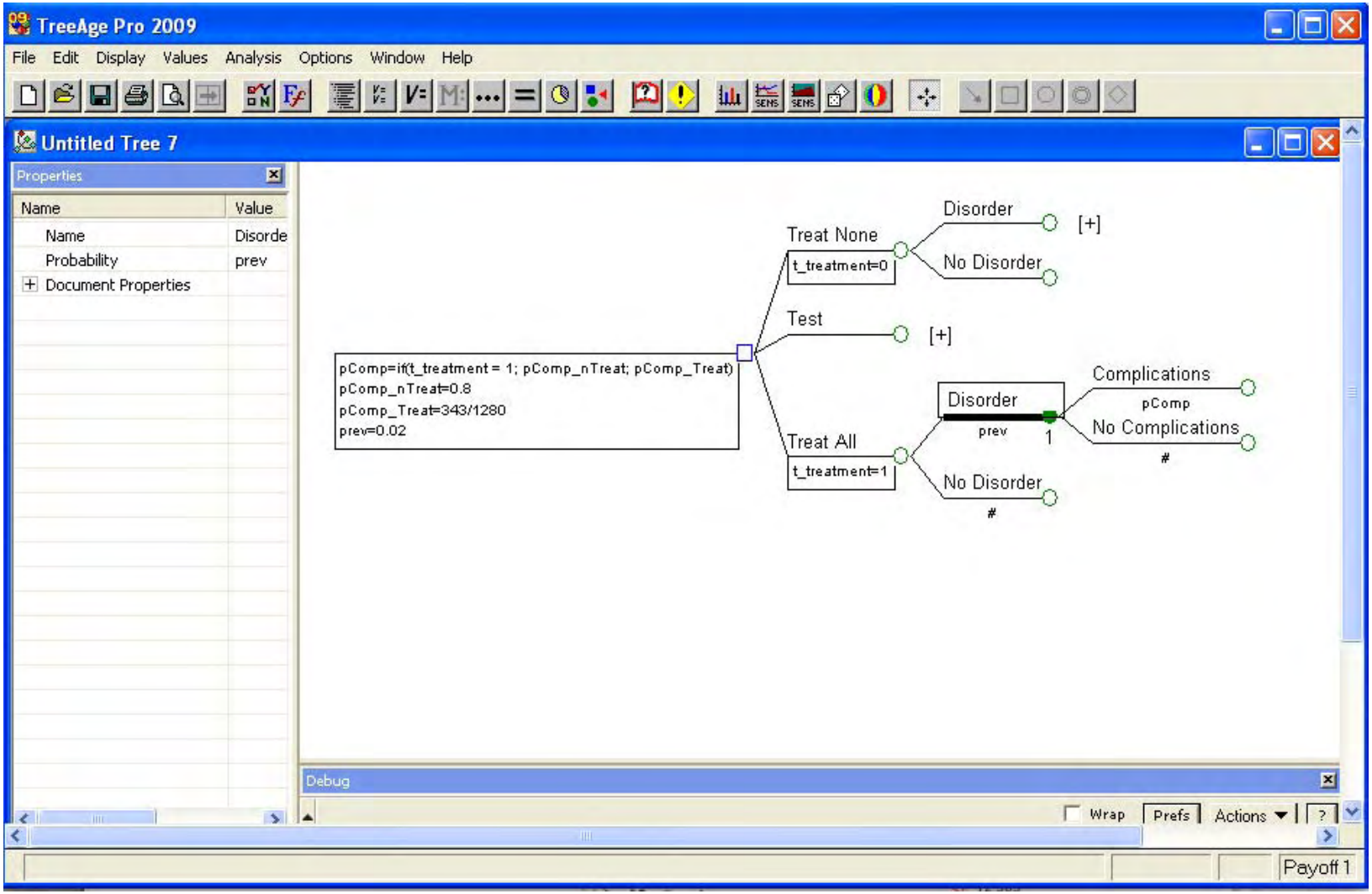

Properties: pComp_Treat
Basic Properties
Name: pComp_Treat
Description: Probability of complication if treatmen
Comment...
Categories...
Show in tree
Define numerically (at root)
Value: 0.22
OK
Cancel
Properties for Sensitivity Analysis
Low value: 0.
High value: 0.
Correlations...
Tracking Properties
Use as Monte Carlo tracker
Initial value: 0.
Close
Help
New Variable...
Edit Properties...
Define Variable...
Edit in Excel
Delete Variable(s)...
Report...
Import Variables...
Variable Categories...
Distributions...
Databases...
Hide Trackers
Hide Others
Description: Probability of complication if treatment
LE_normal - if(t_disorder =
chance node, child 2, 0 branches
Payoff 1

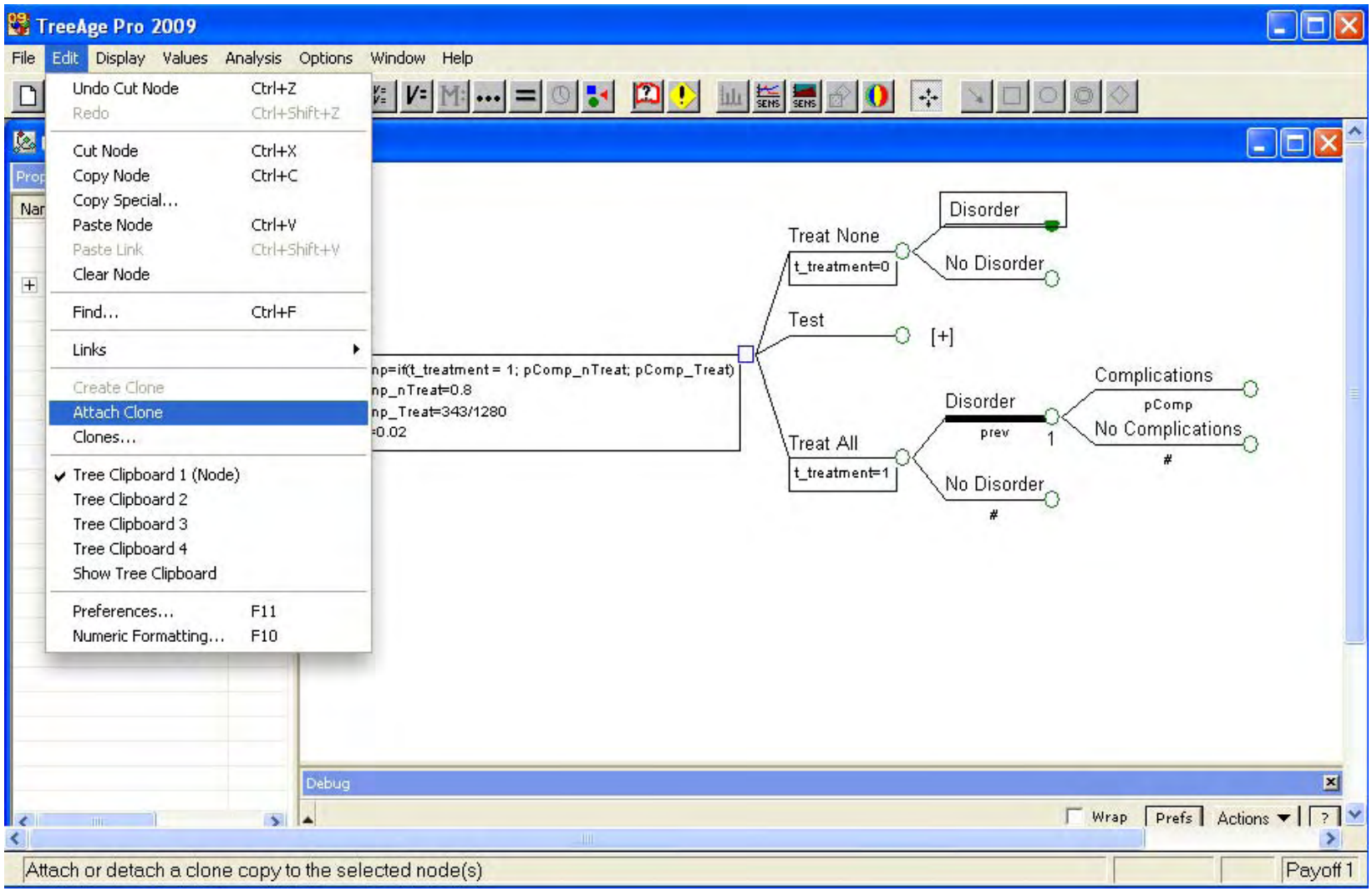

TreeAge Pro 2009
File Edit Display Values Analysis Options Window Help
Untitled Tree 10
Properties
Name
Value
Name
Table Files
Document Properties
Complications
Disorder
No Complications
Treat None
t_treatment=0
No Disorder
Test
[+]
pComp=0.1
prev=0.
Complications
pComp
Disorder
prev
No Complications
#
Treat All
t_treatment=1
No Disorder
#
Payoff 1

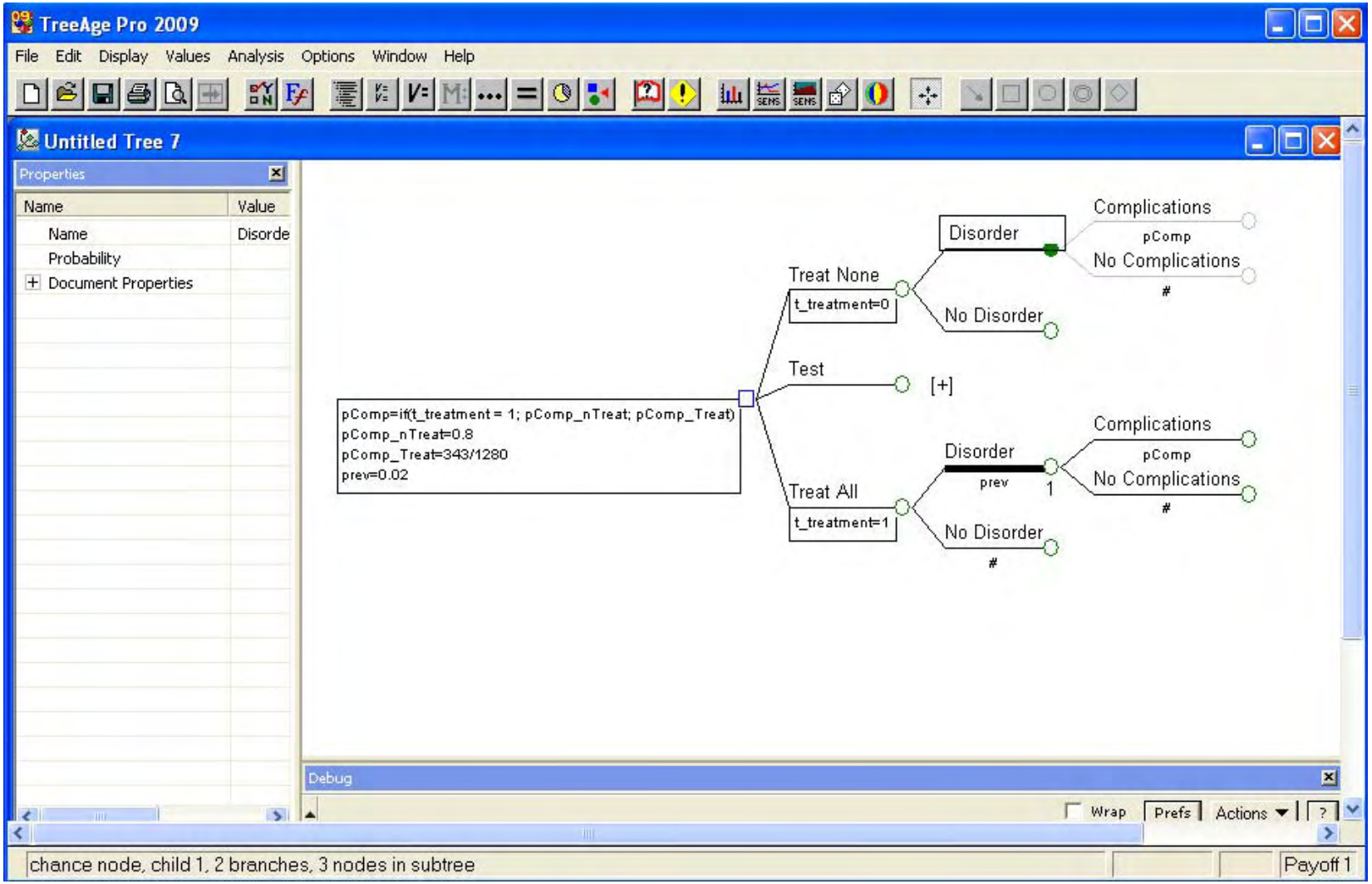

TreeAge Pro 2009
File Edit Display Values Analysis Options Window Help
Untitled Tree 7
Properties
Name Value
Name Disorde
Probability prev
Document Properties
pComp=if(t_treatment = 1; pComp_nTreat; pComp_Treat)
pComp_nTreat=0.8
pComp_Treat=343/1280
prev=0.02
Treat None
t_treatment=0
Disorder
[+]
No Disorder
Test
[+]
Treat All
t_treatment=1
Disorder
prev
Complications
pComp
No Disorder
#
Define Variable
Markov Bindings...
Cut
Copy
Paste Text
Paste Node(s)
Change Node Type
Node Comment...
Select Subtree
Create Note
Create Arrow
Branch(es)
Custom Node Action...
Hide Roll-Back Box
Sensitivity Analysis
Monte Carlo Simulation
Debug
ayoff 1

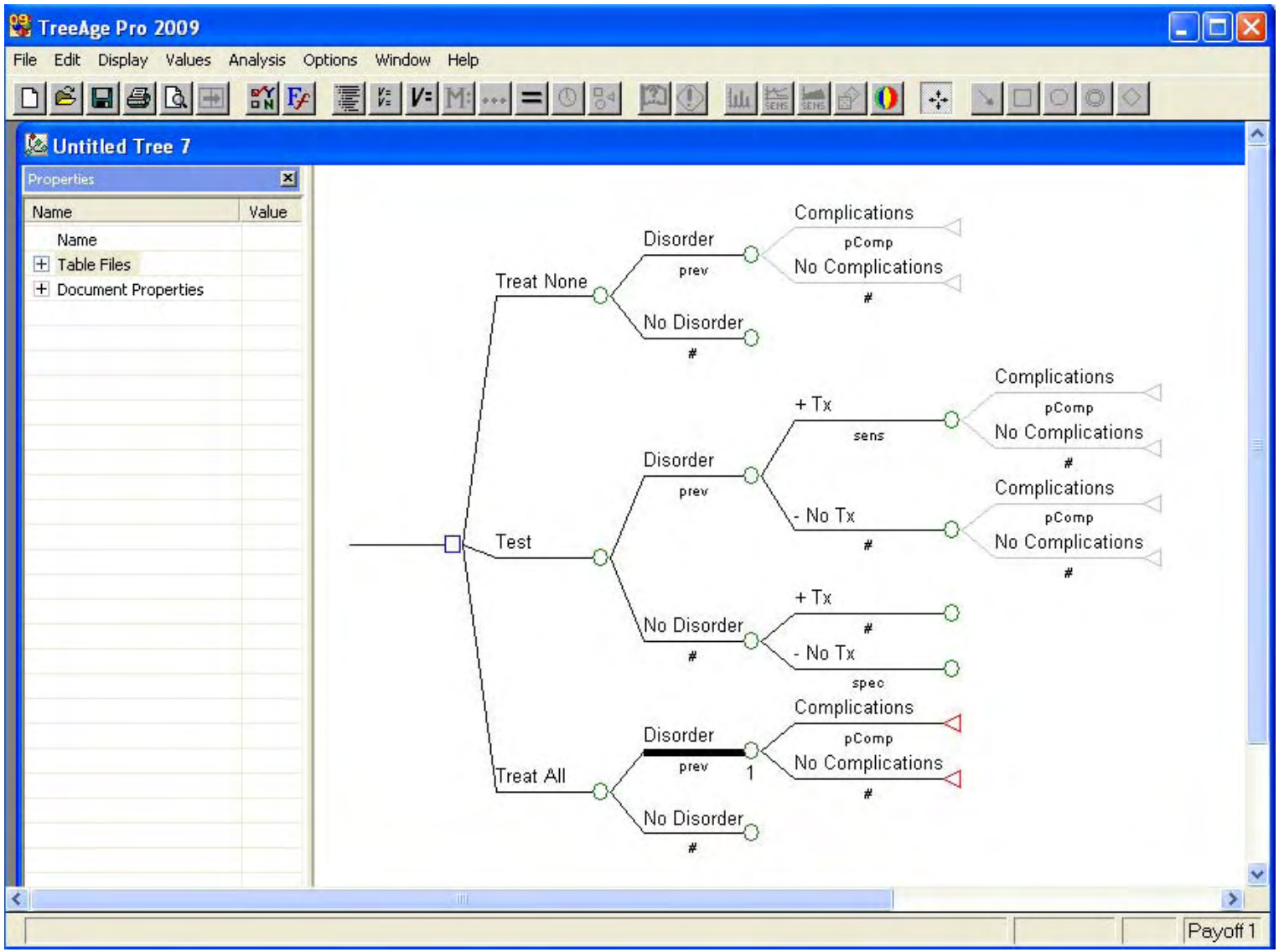

TreeAge Pro 2009
File
Edit
Display
Values
Analysis
Options
Window
Help
Undo Typing Ctrl+Z
Redo Ctrl+Shift+Z
Cut Subtree Ctrl+X
Copy Subtree Ctrl+C
Copy Special...
Paste Node Ctrl+V
Paste Link Ctrl+Shift+V
Clear Subtree
Find... Ctrl+F
Links
Create Clone
Attach Clone
Clones...
Tree Clipboard 1 (Node)
Tree Clipboard 2
Tree Clipboard 3
Tree Clipboard 4
Show Tree Clipboard
Preferences... F11
Numeric Formatting... F10
np=if(t_treatment = 1; pComp_nTreat; pComp_Treat)
np_nTreat=0.8
np_Treat=343/1280
=0.02
Treat None
t_treatment=0
Disorder
[+]
No Disorder
Test
[+]
Treat All
t_treatment=1
Disorder
prev
Complications
pComp
No Complications
#
No Disorder
#
Debug
Wrap
Prefs
Actions
Create or destroy a clone master at the selected node
Payoff 1


TreeAge Pro 2009
File Edit Display Values Analysis Options Window Help
Create Clone
Enter a name for your clone master at node "Disorder".
Complications
OK
Cancel
Help
pComp=if(t_treatment = 1; pComp_nTreat; pComp_Treat)
pComp_nTreat=0.8
pComp_Treat=343/1280
prev=0.02
Treat None
t_treatment=0
Disorder
[+]
No Disorder
Test
[+]
Treat All
t_treatment=1
Disorder
prev
Complications
pComp
No Complications
#
No Disorder
#
Debug
Wrap
Prefs
Actions
Payoff 1


TreeAge Pro 2009
File Edit Display Values Analysis Options Window Help
Untitled Tree 7
Properties
Name Value
Name Disorde
Probability prev
Document Properties
pComp=if(t_treatment = 1; pComp_nTreat; pComp_Treat)
pComp_nTreat=0.8
pComp_Treat=343/1280
prev=0.02
Treat None
t_treatment=0
Disorder
[+]
No Disorder
Test
[+]
Treat All
t_treatment=1
Disorder
prev
1
Complications
pComp
No Complications
#
No Disorder
#
Debug
Wrap
Prefs
Actions
?
Payoff 1


TreeAge Pro 2009
File
Edit
Display
Values
Analysis
Options
Window
Help
Undo Cut Node Ctrl+Z
Redo Ctrl+Shift+Z
Cut Node Ctrl+X
Copy Node Ctrl+C
Copy Special...
Paste Node Ctrl+V
Paste Link Ctrl+Shift+V
Clear Node
Find... Ctrl+F
Links
Create Clone
Attach Clone
Clones...
Tree Clipboard 1 (Node)
Tree Clipboard 2
Tree Clipboard 3
Tree Clipboard 4
Show Tree Clipboard
Preferences... F11
Numeric Formatting... F10
np=if(t_treatment = 1; pComp_nTreat; pComp_Treat)
np_nTreat=0.8
np_Treat=343/1280
=0.02
Treat None
t_treatment=0
Disorder
No Disorder
Test
[+]
Treat All
t_treatment=1
Disorder
prev
1
Complications
pComp
No Complications
#
No Disorder
#
Debug
Wrap
Prefs
Actions
Attach or detach a clone copy to the selected node(s)
Payoff 1

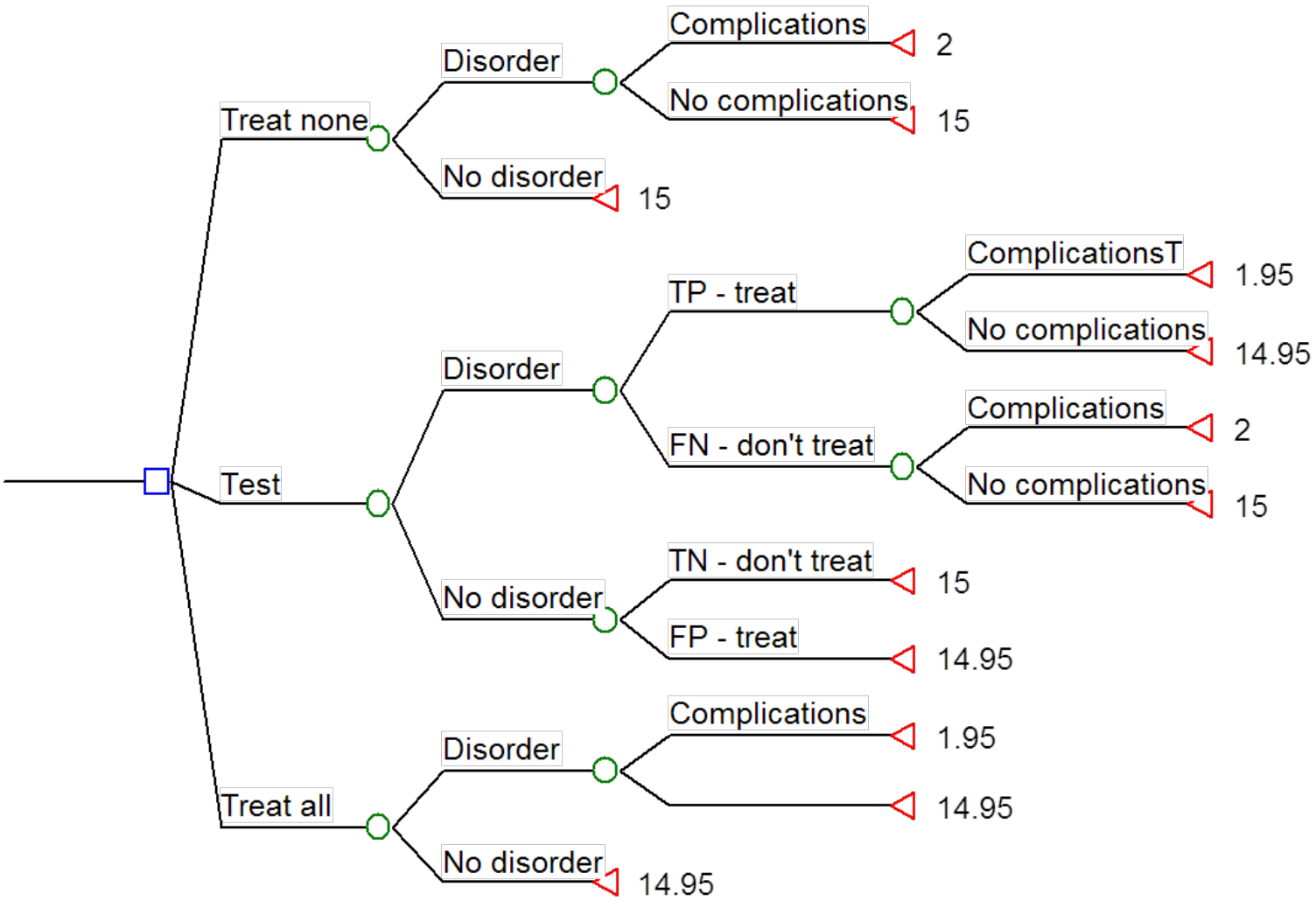

TreeAge Pro 2009
File Edit Display Values Analysis Options Window Help
Untitled Tree 7
Properties
Name Value
Name Disorde
Probability
Document Properties
pComp=if(t_treatment = 1; pComp_nTreat; pComp_Treat)
pComp_nTreat=0.8
pComp_Treat=343/1280
prev=0.02
Test
[+]
Treat None
t_treatment=0
Disorder
Complications
pComp
No Complications
#
No Disorder
Treat All
t_treatment=1
Disorder
prev
1
Complications
pComp
No Complications
#
No Disorder
#
Debug
Wrap
Prefs
Actions
?
chance node, child 1, 2 branches, 3 nodes in subtree
Payoff 1


TreeAge Pro 2009
File Edit Display Values Analysis Options Window Help
Untitled Tree 7
Properties
Name
Value
Name
Table Files
Document Properties
Treat None
Disorder
prev
Complications
pComp
No Complications
#
No Disorder
#
Test
Disorder
prev
+ Tx
sens
Complications
pComp
No Complications
#
- No Tx
#
Complications
pComp
No Complications
#
No Disorder
#
+ Tx
#
- No Tx
spec
Treat All
Disorder
prev
1
Complications
pComp
No Complications
#
No Disorder
#
Payoff 1

Recap

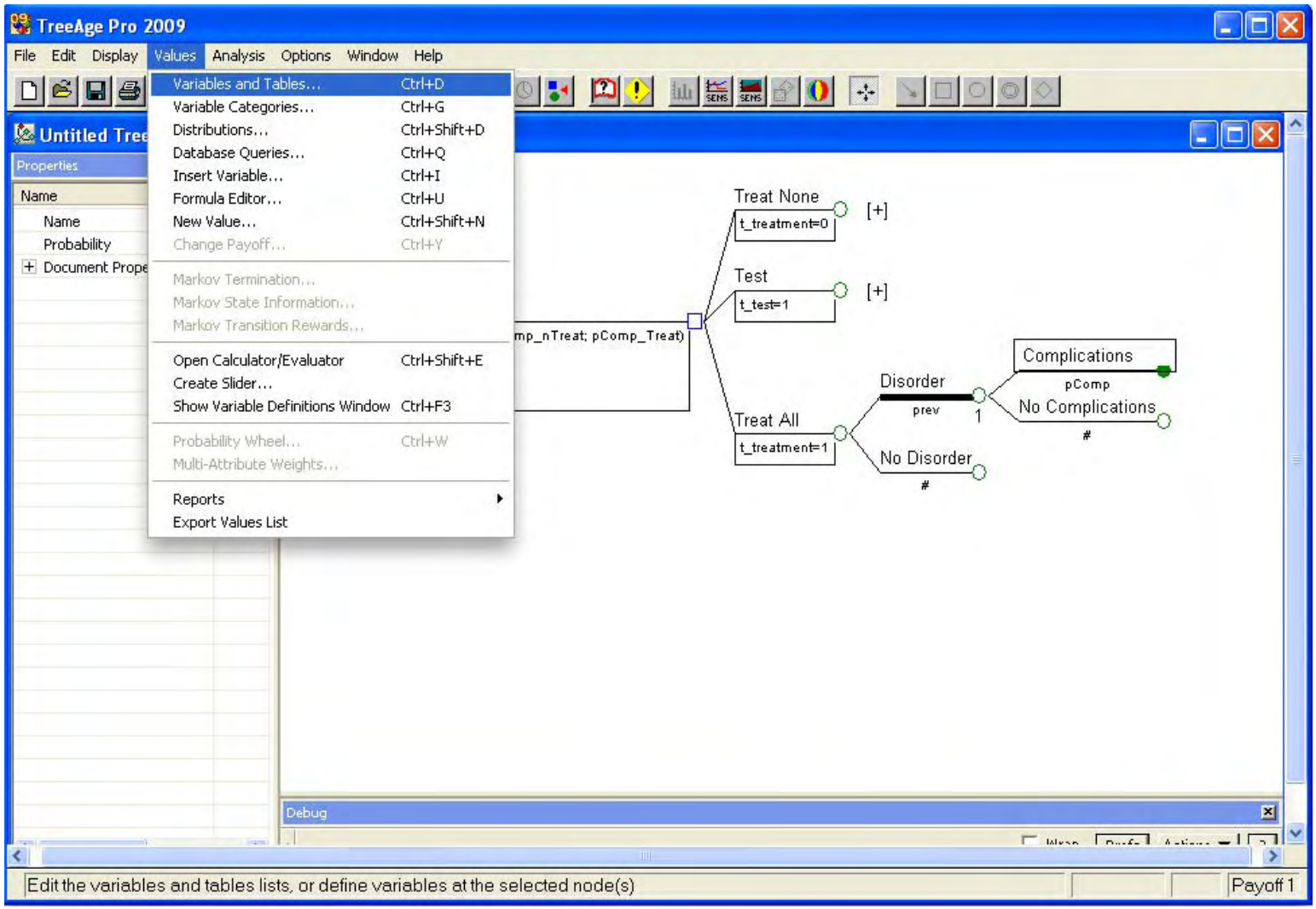
- Thus far…
  - Created decision tree
  - Used descriptive variable names
  - Used clones to take advantage of parallel structure
    - Tracking variables

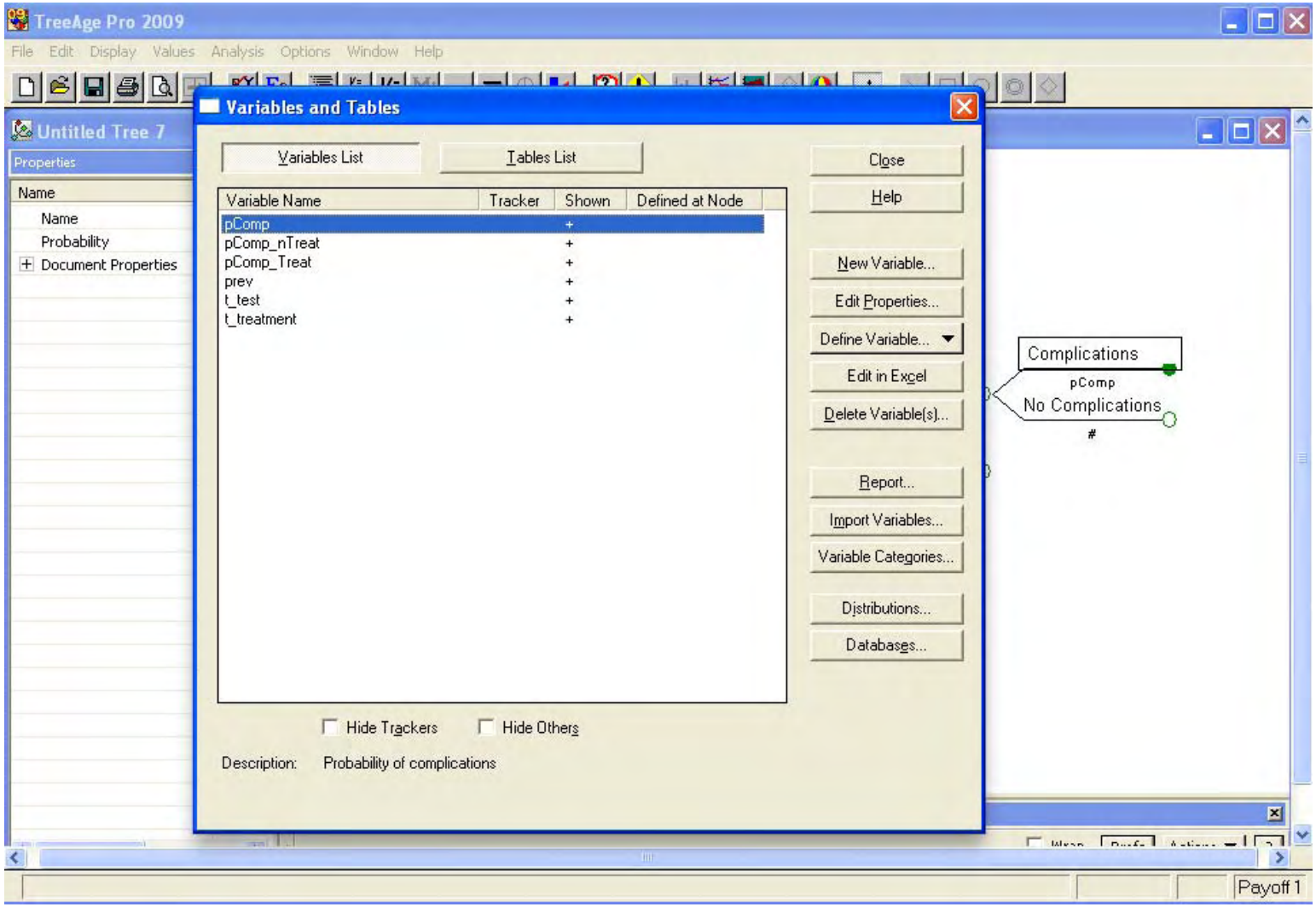
- Now What?
  - Outcomes
  - Assume we know from clinical trial
    - Costs
    - Life years

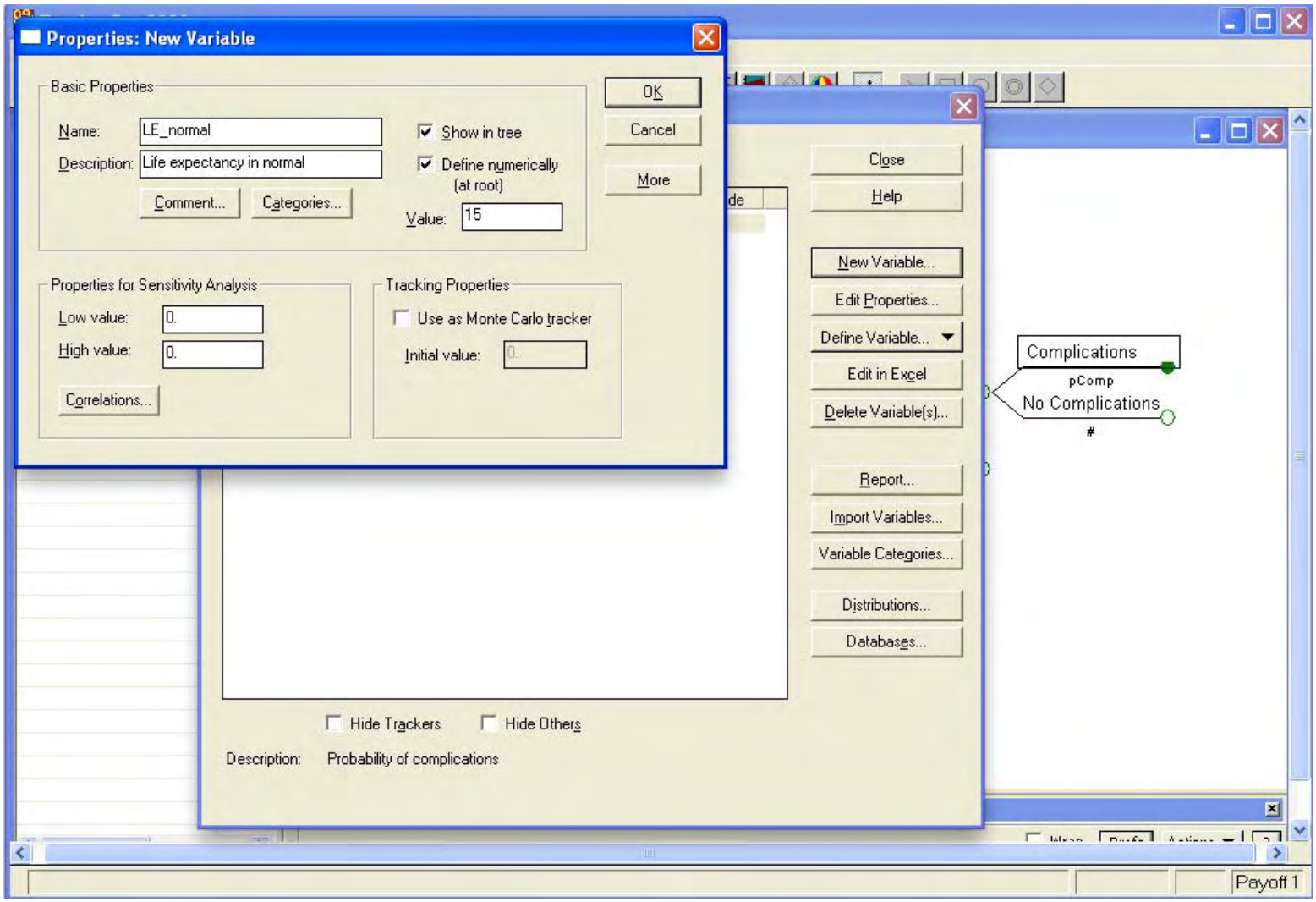

Treat none
Disorder
Complications
2
No complications
15
No disorder
15
Test
Disorder
TP - treat
ComplicationsT
1.95
No complications
14.95
FN - don't treat
Complications
2
No complications
15
No disorder
TN - don't treat
15
FP - treat
14.95
Treat all
Disorder
Complications
1.95
14.95
No disorder
14.95

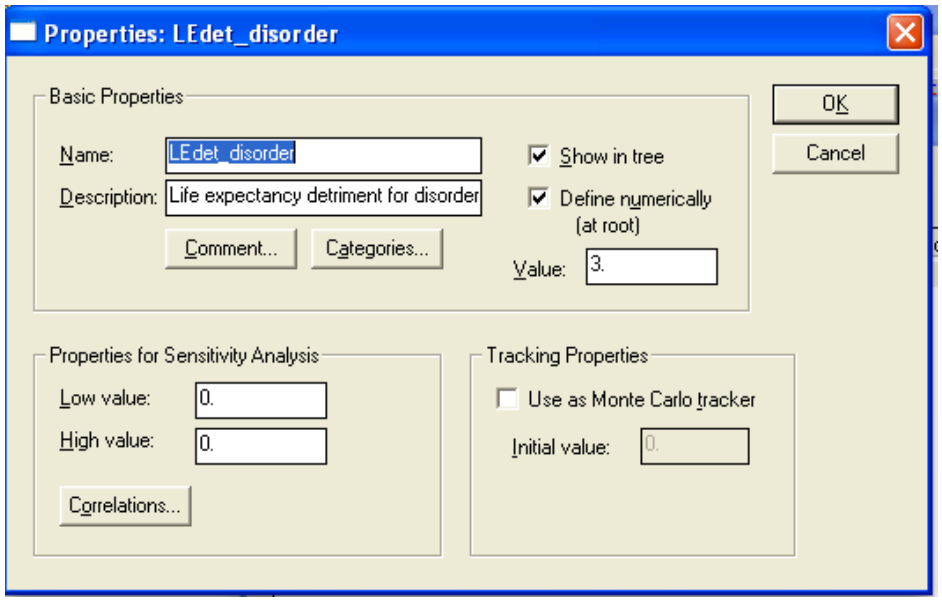
Effectiveness Outcomes

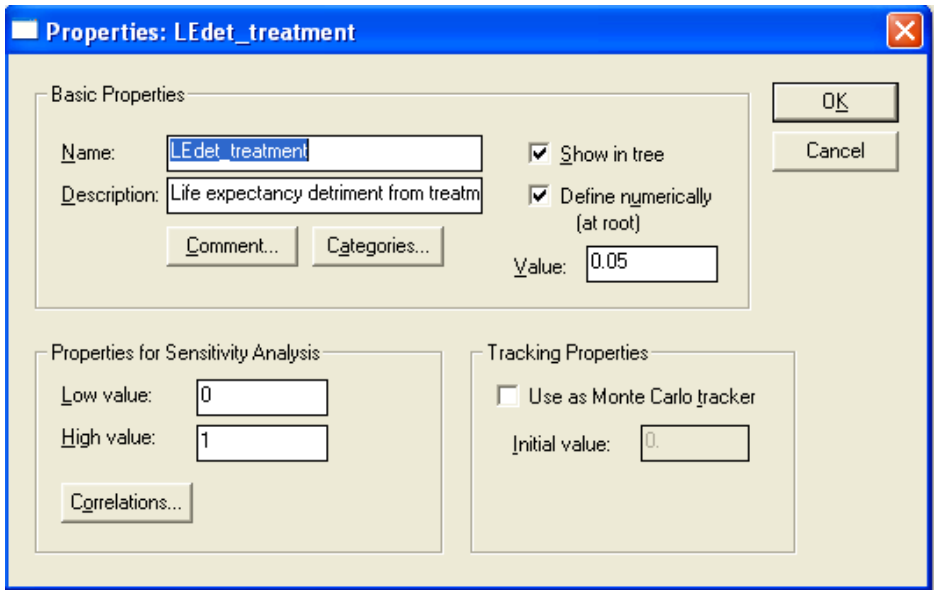
- Normal – 15 life expectancy
- Disorder – 3 year detriment
- Complications – 10 year detriment
- Treatment – 0.05 year detriment

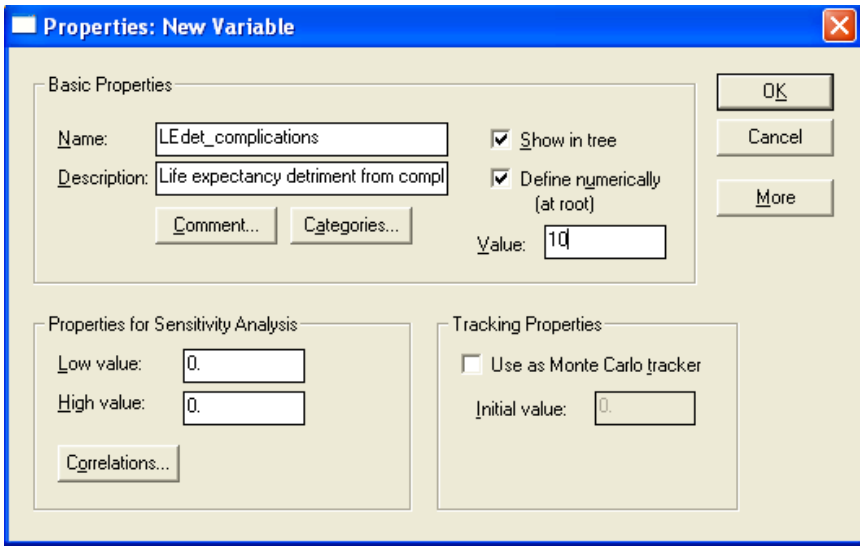

TreeAge Pro 2009
File Edit Display Values Analysis Options Window Help
Variables and Tables... Ctrl+D
Variable Categories... Ctrl+G
Distributions... Ctrl+Shift+D
Database Queries... Ctrl+Q
Insert Variable... Ctrl+I
Formula Editor... Ctrl+U
New Value... Ctrl+Shift+N
Change Payoff... Ctrl+Y
Markov Termination...
Markov State Information...
Markov Transition Rewards...
Open Calculator/Evaluator Ctrl+Shift+E
Create Slider...
Show Variable Definitions Window Ctrl+F3
Probability Wheel... Ctrl+W
Multi-Attribute Weights...
Reports
Export Values List
Untitled Tree
Properties
Name
Name
Probability
Document Prope
Treat None
t_treatment=0
[+]
Test
t_test=1
[+]
Treat All
t_treatment=1
Disorder
prev
1
No Disorder
#
Complications
pComp
No Complications
#
Debug
Edit the variables and tables lists, or define variables at the selected node(s)
Payoff 1


TreeAge Pro 2009
File Edit Display Values Analysis Options Window Help
Untitled Tree 7
Properties
Name
Name
Probability
Document Properties
Variables and Tables
Variables List
Tables List
Variable Name
Tracker
Shown
Defined at Node
pComp +
pComp_nTreat +
pComp_Treat +
prev +
t_test +
t_treatment +
Close
Help
New Variable...
Edit Properties...
Define Variable...
Edit in Excel
Delete Variable(s)...
Report...
Import Variables...
Variable Categories...
Distributions...
Databases...
Hide Trackers
Hide Others
Description: Probability of complications
Complications
pComp
No Complications
#
Payoff 1

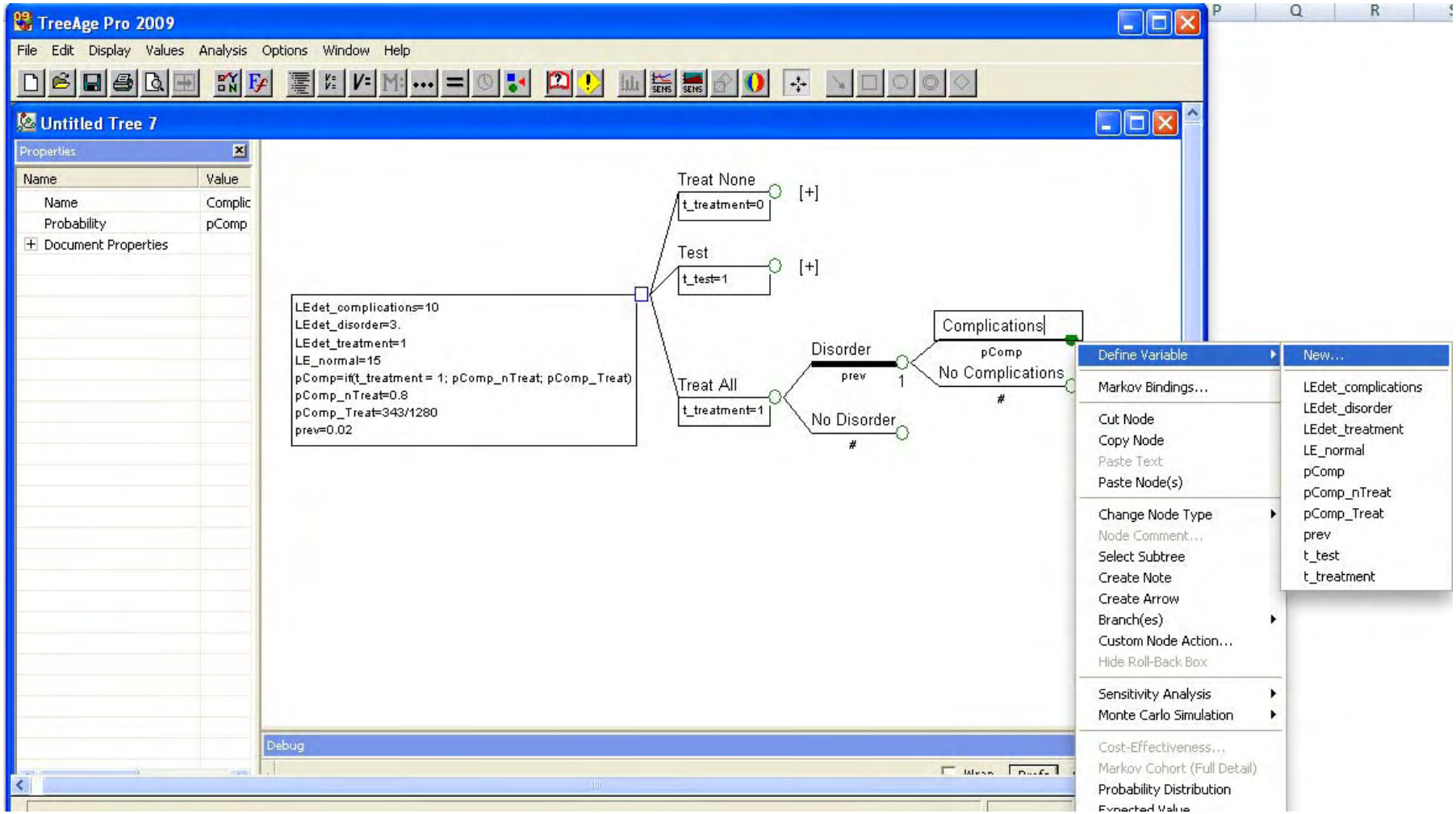

Properties: New Variable
Basic Properties
Name: LE_normal
Description: Life expectancy in normal
Comment...
Categories...
Show in tree
Define numerically (at root)
Value: 15
OK
Cancel
More
Properties for Sensitivity Analysis
Low value: 0.
High value: 0.
Correlations...
Tracking Properties
Use as Monte Carlo tracker
Initial value: 0.
Close
Help
New Variable...
Edit Properties...
Define Variable...
Edit in Excel
Delete Variable(s)...
Report...
Import Variables...
Variable Categories...
Distributions...
Databases...
Hide Trackers
Hide Others
Description: Probability of complications
Complications
pComp
No Complications
#
Payoff 1


Properties: LEdet_disorder
Basic Properties
Name: LEdet_disorder
Description: Life expectancy detriment for disorder
Comment...
Categories...
Show in tree
Define numerically (at root)
Value: 3.
OK
Cancel
Properties for Sensitivity Analysis
Low value: 0.
High value: 0.
Correlations...
Tracking Properties
Use as Monte Carlo tracker
Initial value: 0.

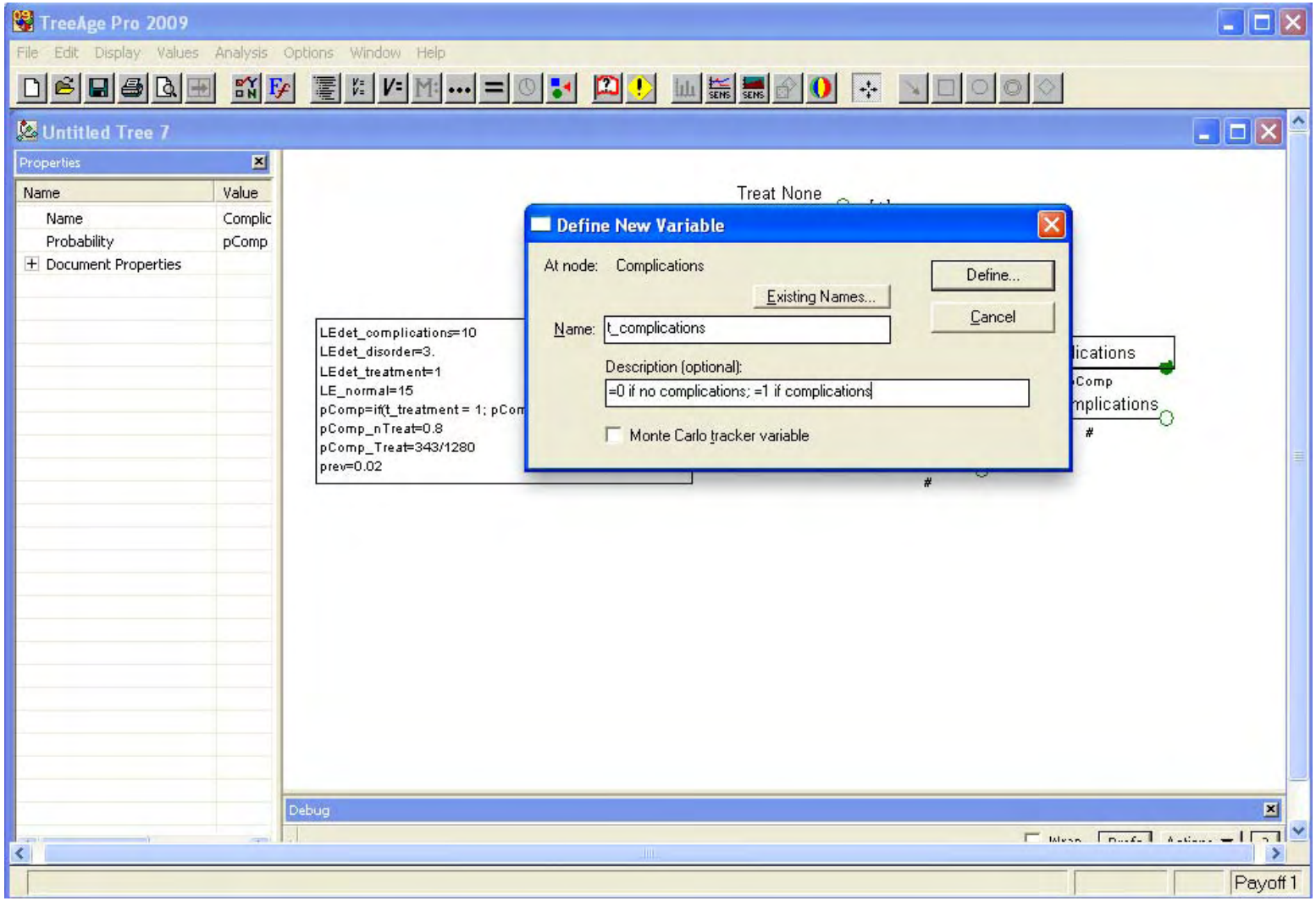

Properties: LEdet_treatment
Basic Properties
Name: LEdet_treatment
Description: Life expectancy detriment from treatm
Comment...
Categories...
Show in tree
Define numerically (at root)
Value: 0.05
OK
Cancel
Properties for Sensitivity Analysis
Low value: 0
High value: 1
Correlations...
Tracking Properties
Use as Monte Carlo tracker
Initial value: 0.


Properties: New Variable
Basic Properties
Name: LEdet_complications
Description: Life expectancy detriment from compl
Comment...
Categories...
Show in tree
Define numerically (at root)
Value: 10
OK
Cancel
More
Properties for Sensitivity Analysis
Low value: 0.
High value: 0.
Correlations...
Tracking Properties
Use as Monte Carlo tracker
Initial value: 0.

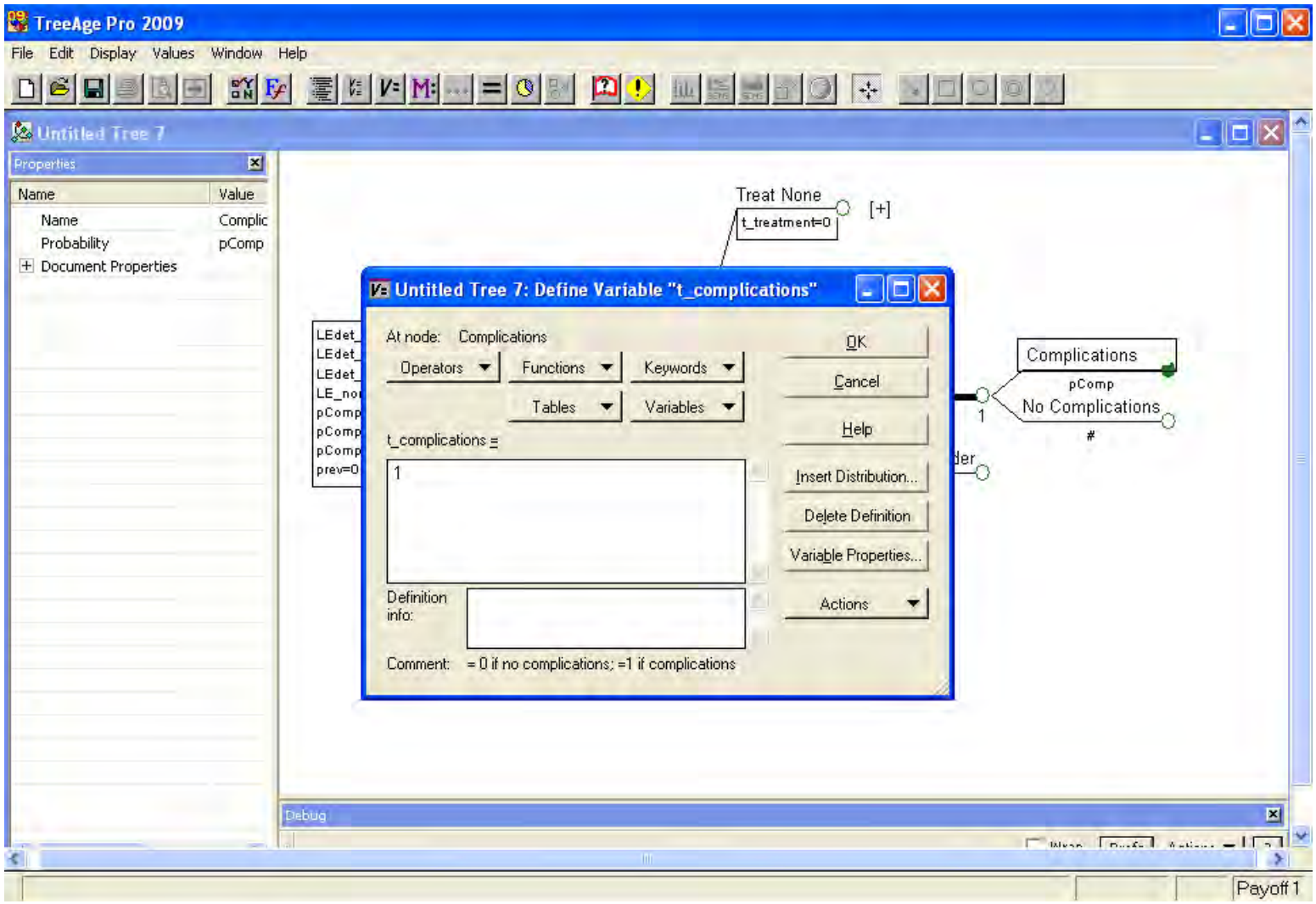
Add Complications Tracker



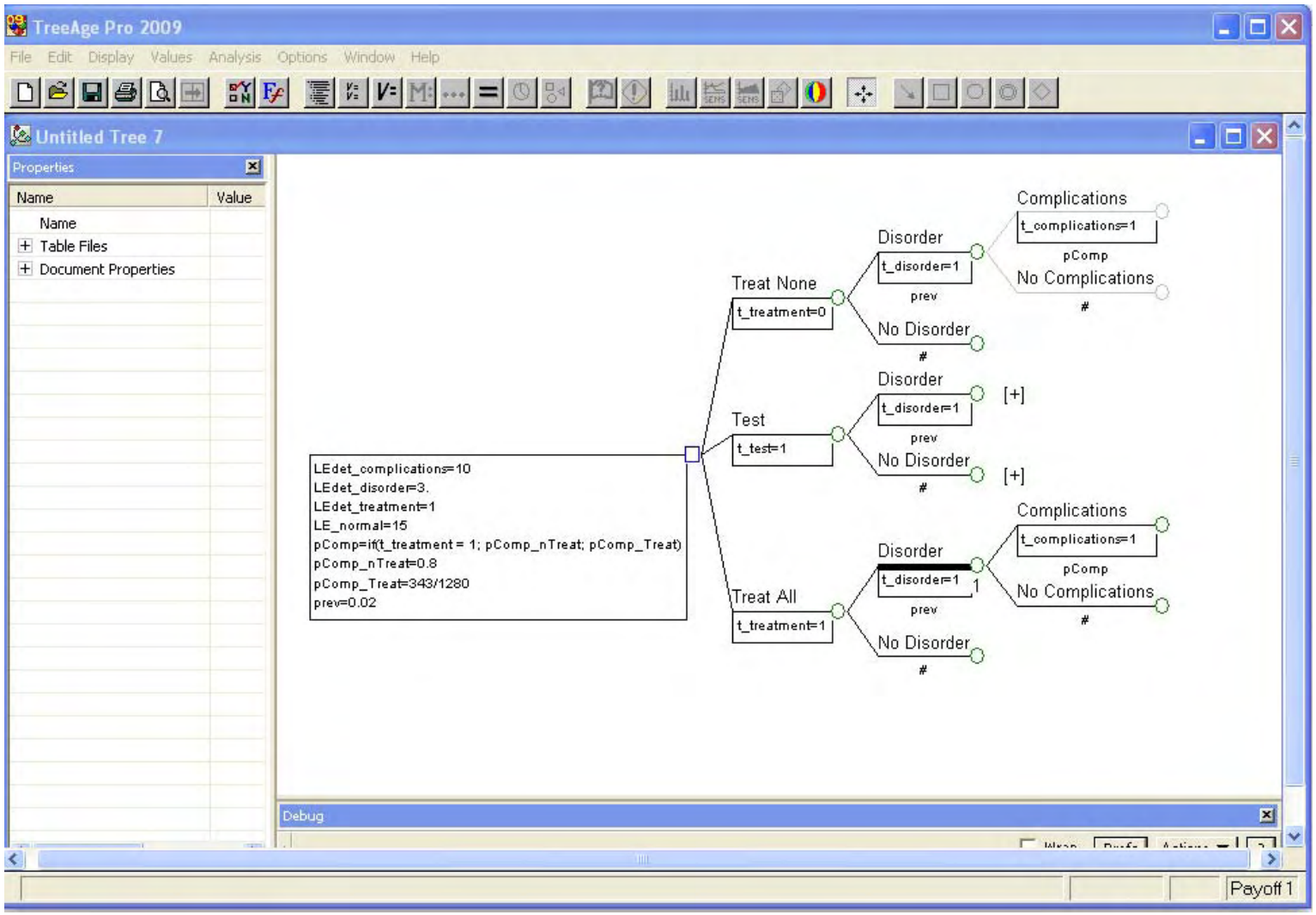
Add Complications Tracker

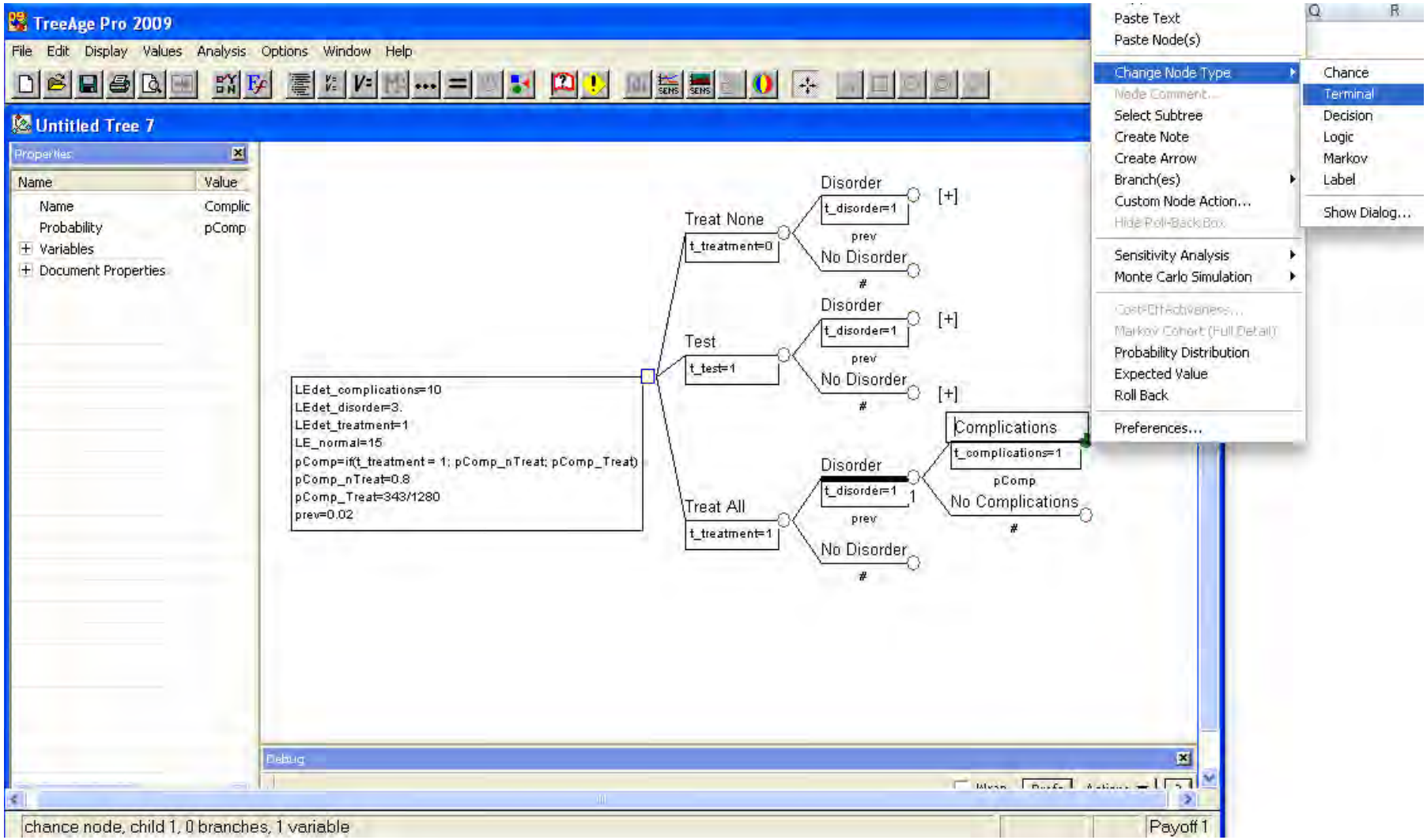


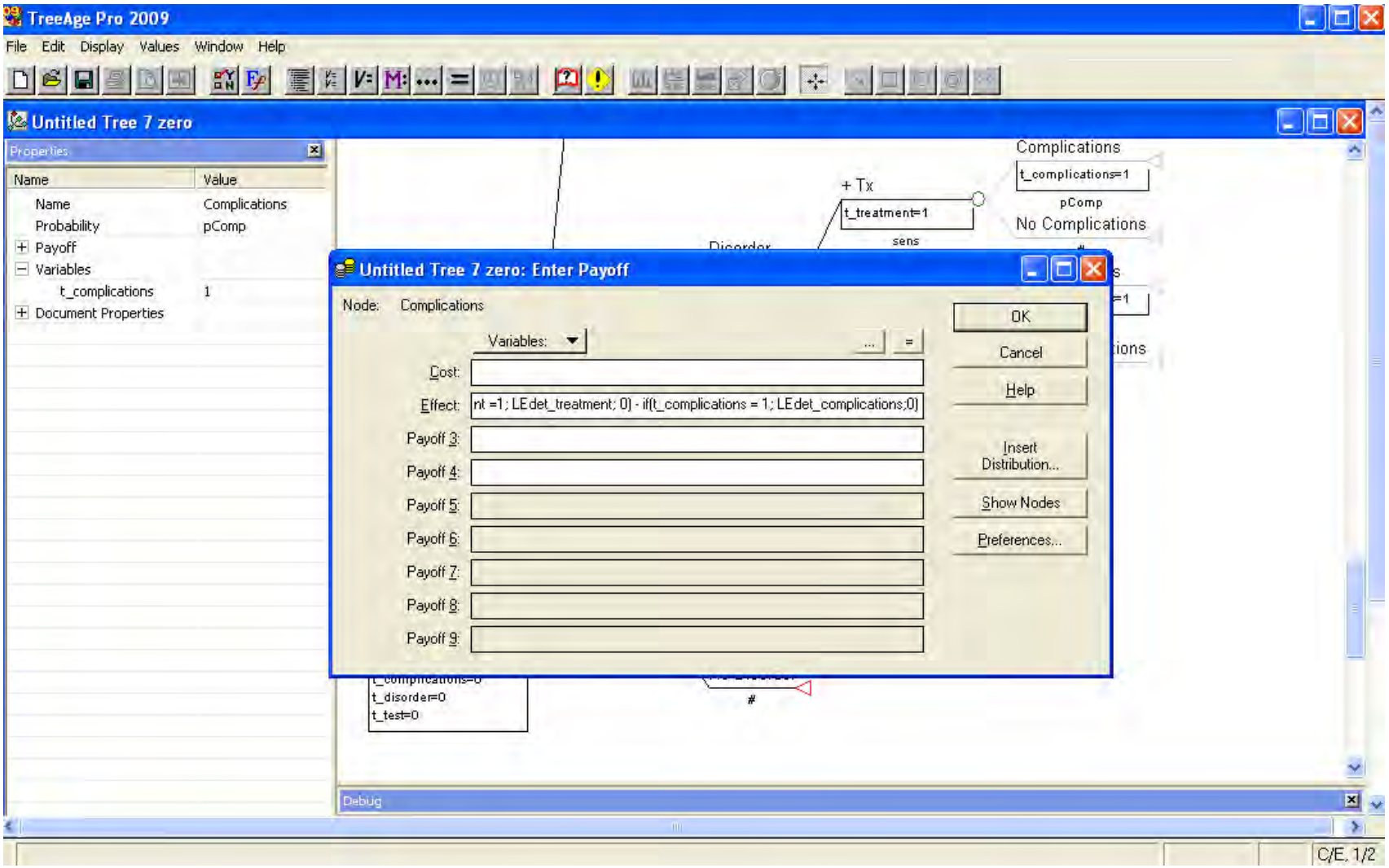
Add Complications Tracker



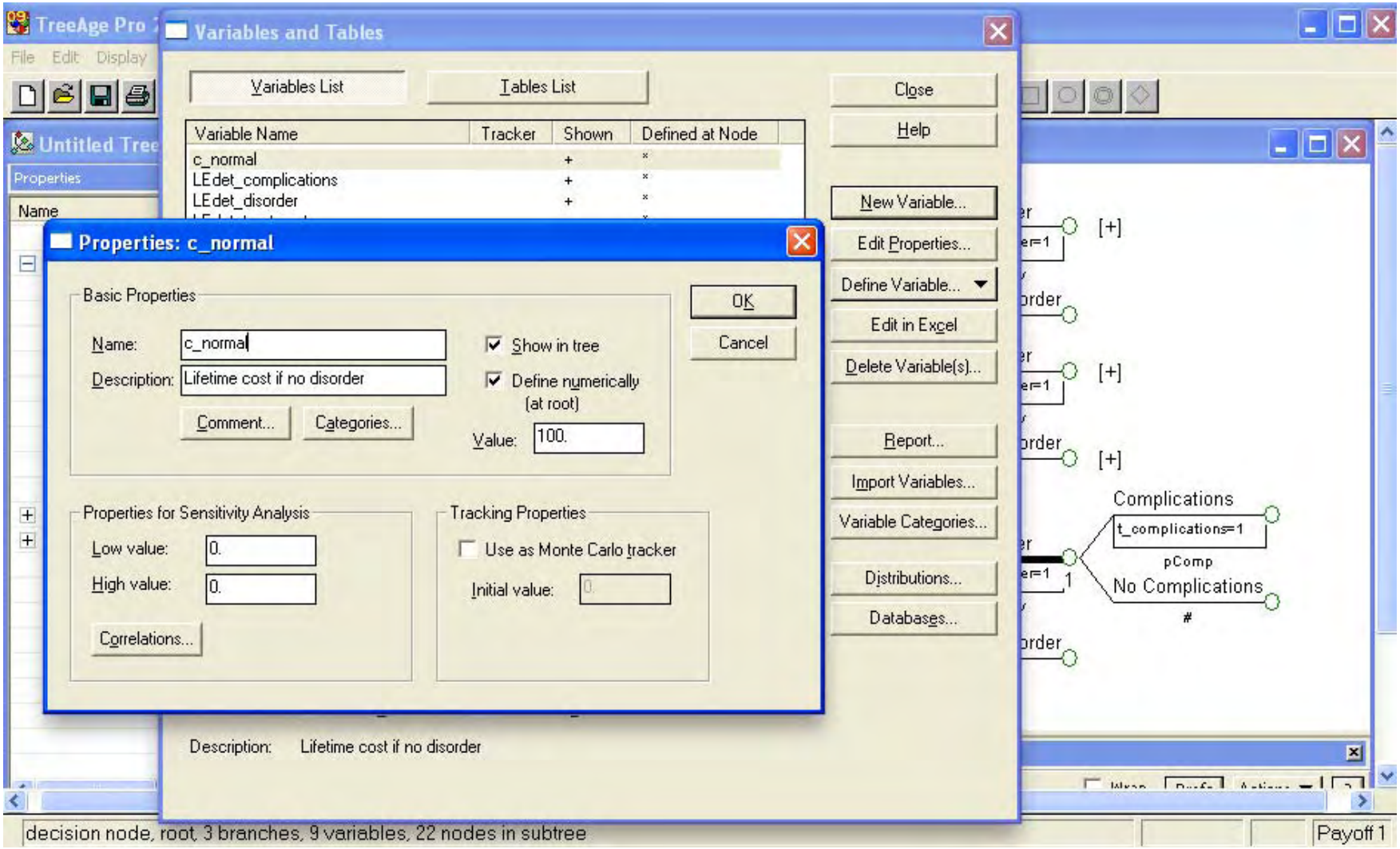
Add Disorder Tracker

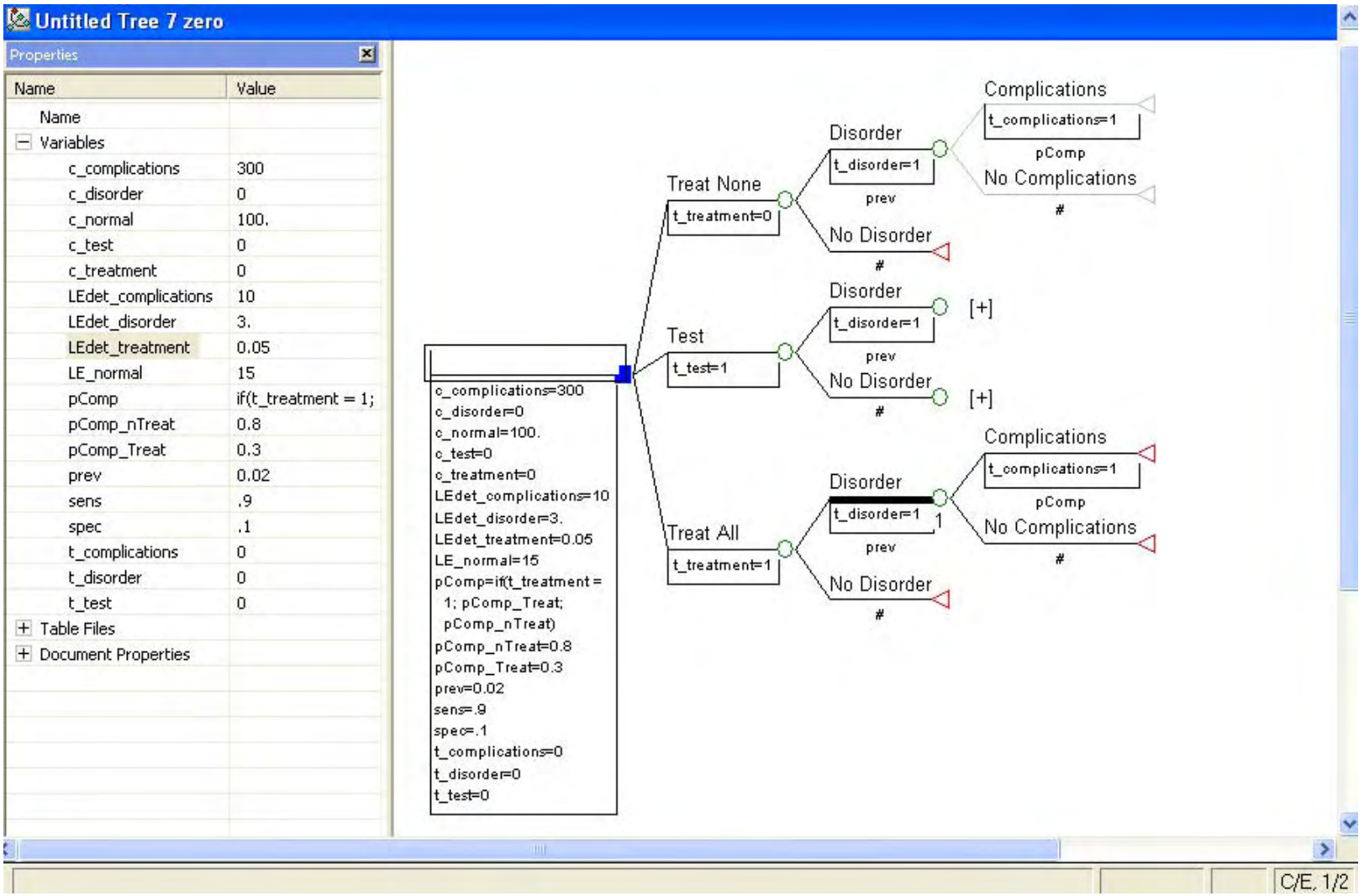


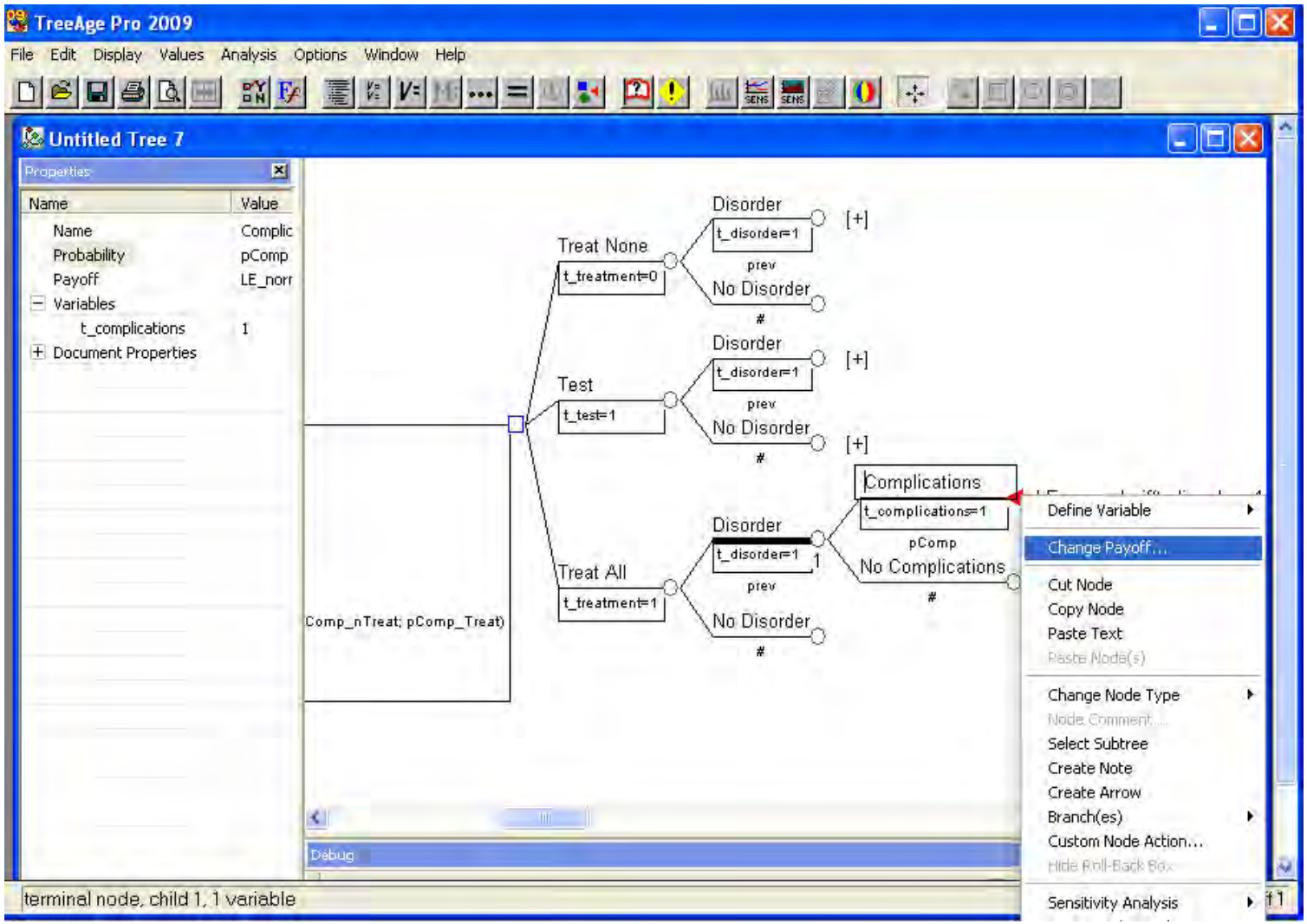

TreeAge Pro 2009
File Edit Display Values Analysis Options Window Help
Untitled Tree 7
Properties
Name Value
Name Complic
Probability pComp
Variables
Document Properties
LEdet_complications=10
LEdet_disorder=3.
LEdet_treatment=1
LE_normal=15
pComp=if(t_treatment = 1; pComp_nTreat; pComp_Treat)
pComp_nTreat=0.8
pComp_Treat=343/1280
prev=0.02
Treat None
t_treatment=0
Test
t_test=1
Treat All
t_treatment=1
Disorder
t_disorder=1
prev
No Disorder
#
[+]
Complications
t_complications=1
pComp
No Complications
1
Debug
chance node, child 1, 0 branches, 1 variable
Payoff 1
Paste Text
Paste Node(s)
Change Node Type
Node Comment...
Select Subtree
Create Note
Create Arrow
Branch(es)
Custom Node Action...
Hide Roll-Back Box
Sensitivity Analysis
Monte Carlo Simulation
Cost-Effectiveness...
Markov Cohort (Full Detail)
Probability Distribution
Expected Value
Roll Back
Preferences...
Chance
Terminal
Decision
Logic
Markov
Label
Show Dialog...

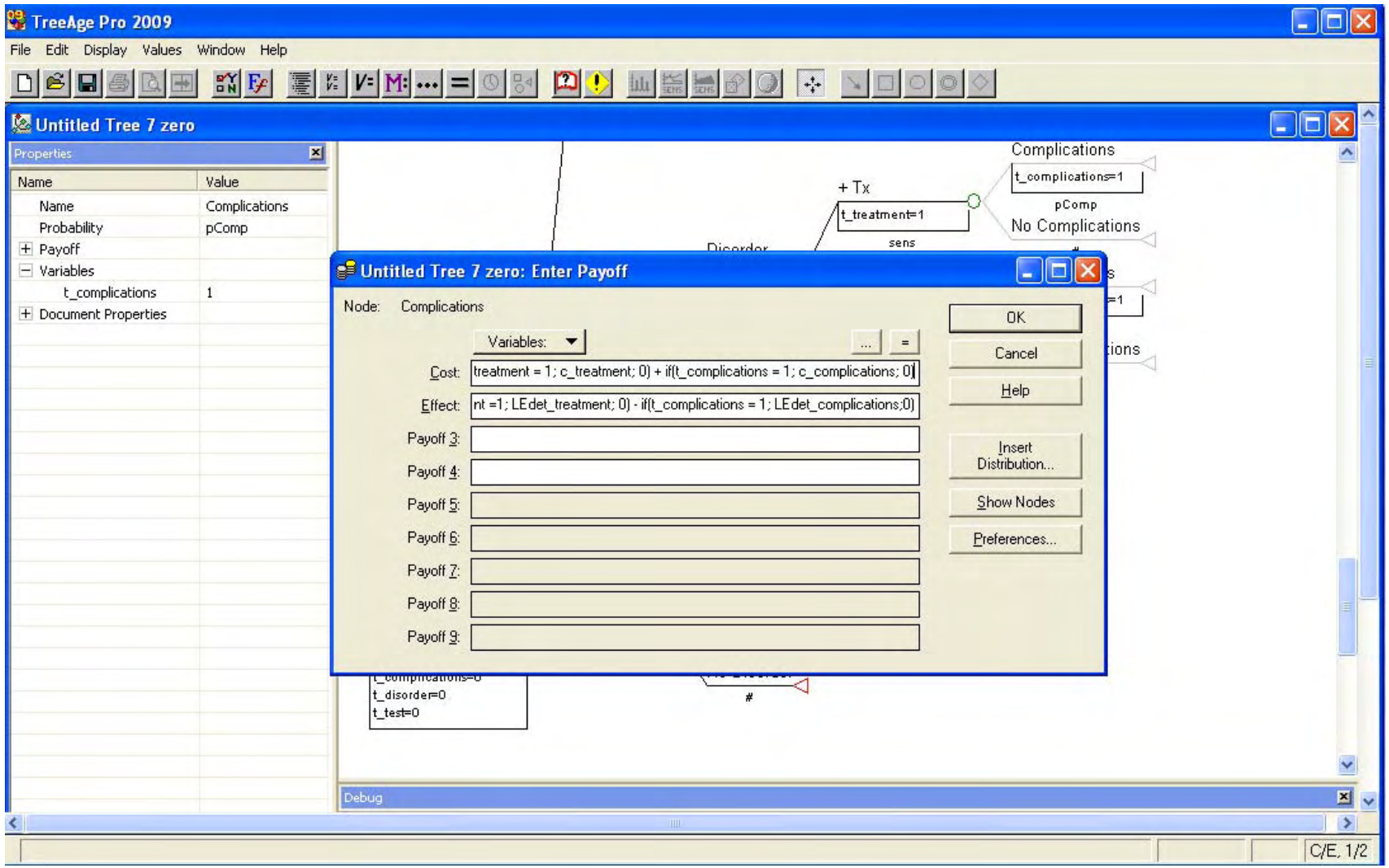


Payoff 1: LE_normal - if(t_disorder = 1; LEdet_disorder; 0) +
- if(t_treatment= 1; LEdet_treatment; 0) - if(t_complications = 1; LEdet_complications; 0)

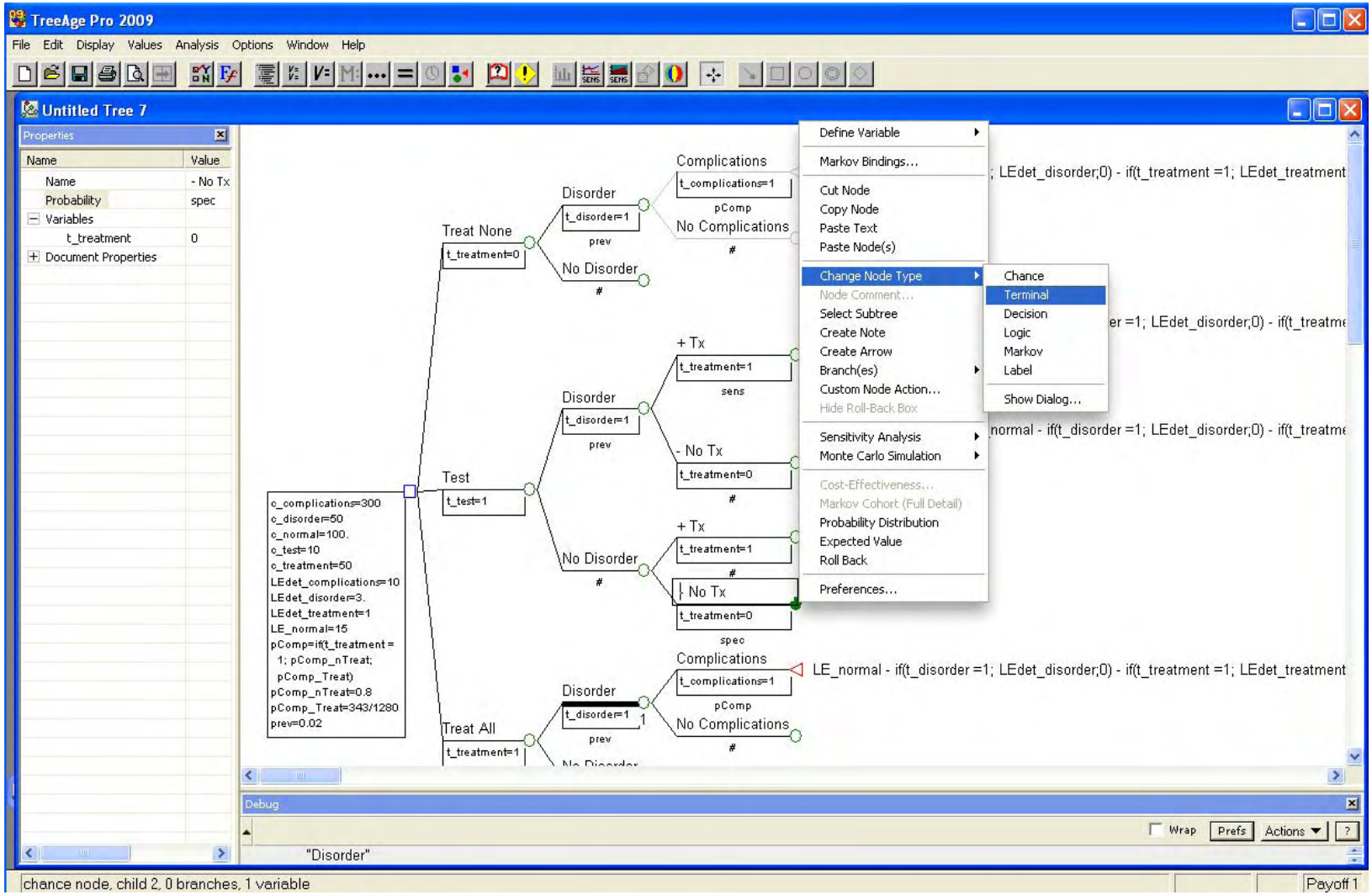

TreeAge Pro
File Edit Display
Variables and Tables
Variables List
Tables List
Close
Help
Variable Name
Tracker
Shown
Defined at Node
c_normal
LEdet_complications
LEdet_disorder
New Variable...
Edit Properties...
Define Variable...
Edit in Excel
Delete Variable(s)...
Report...
Import Variables...
Variable Categories...
Distributions...
Databases...
Properties: c_normal
Basic Properties
Name: c_normal
Description: Lifetime cost if no disorder
Comment...
Categories...
Show in tree
Define numerically (at root)
Value: 100.
OK
Cancel
Properties for Sensitivity Analysis
Low value: 0.
High value: 0.
Correlations...
Tracking Properties
Use as Monte Carlo tracker
Initial value:
Description: Lifetime cost if no disorder
Complications
t_complications=1
pComp
No Complications
#
decision node, root, 3 branches, 9 variables, 22 nodes in subtree
Payoff 1

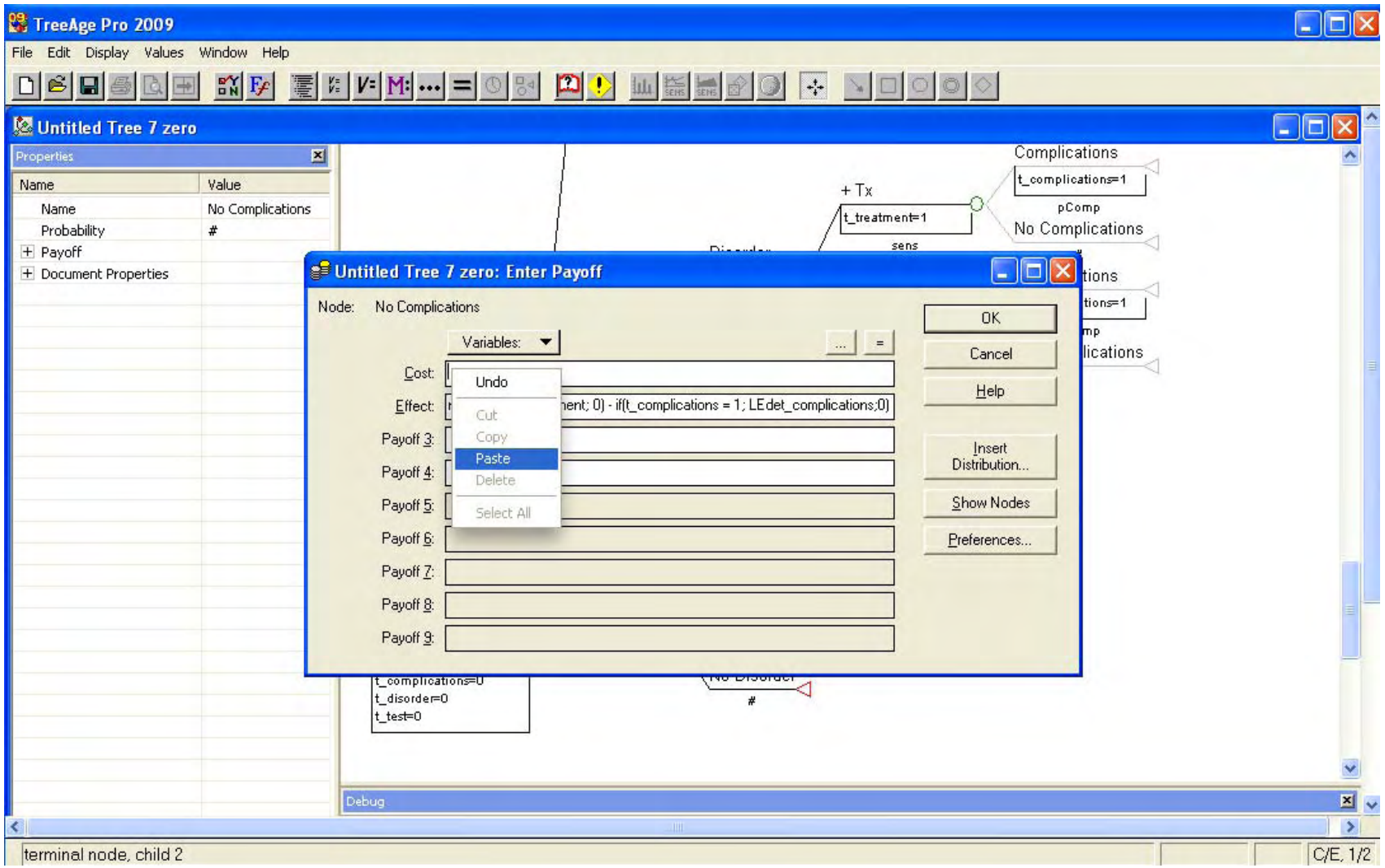

Untitled Tree 7 zero
Properties
Name
Value
Name
Variables
c_complications 300
c_disorder 0
c_normal 100.
c_test 0
c_treatment 0
LEdet_complications 10
LEdet_disorder 3.
LEdet_treatment 0.05
LE_normal 15
pComp if(t_treatment = 1;
pComp_nTreat 0.8
pComp_Treat 0.3
prev 0.02
sens .9
spec .1
t_complications 0
t_disorder 0
t_test 0
Table Files
Document Properties
c_complications=300
c_disorder=0
c_normal=100.
c_test=0
c_treatment=0
LEdet_complications=10
LEdet_disorder=3.
LEdet_treatment=0.05
LE_normal=15
pComp=if(t_treatment = 1; pComp_Treat; pComp_nTreat)
pComp_nTreat=0.8
pComp_Treat=0.3
prev=0.02
sens=.9
spec=.1
t_complications=0
t_disorder=0
t_test=0
Treat None
t_treatment=0
Test
t_test=1
Treat All
t_treatment=1
Disorder
t_disorder=1
prev
No Disorder
#
Complications
t_complications=1
pComp
No Complications
#
[+]
1
C/E, 1/2

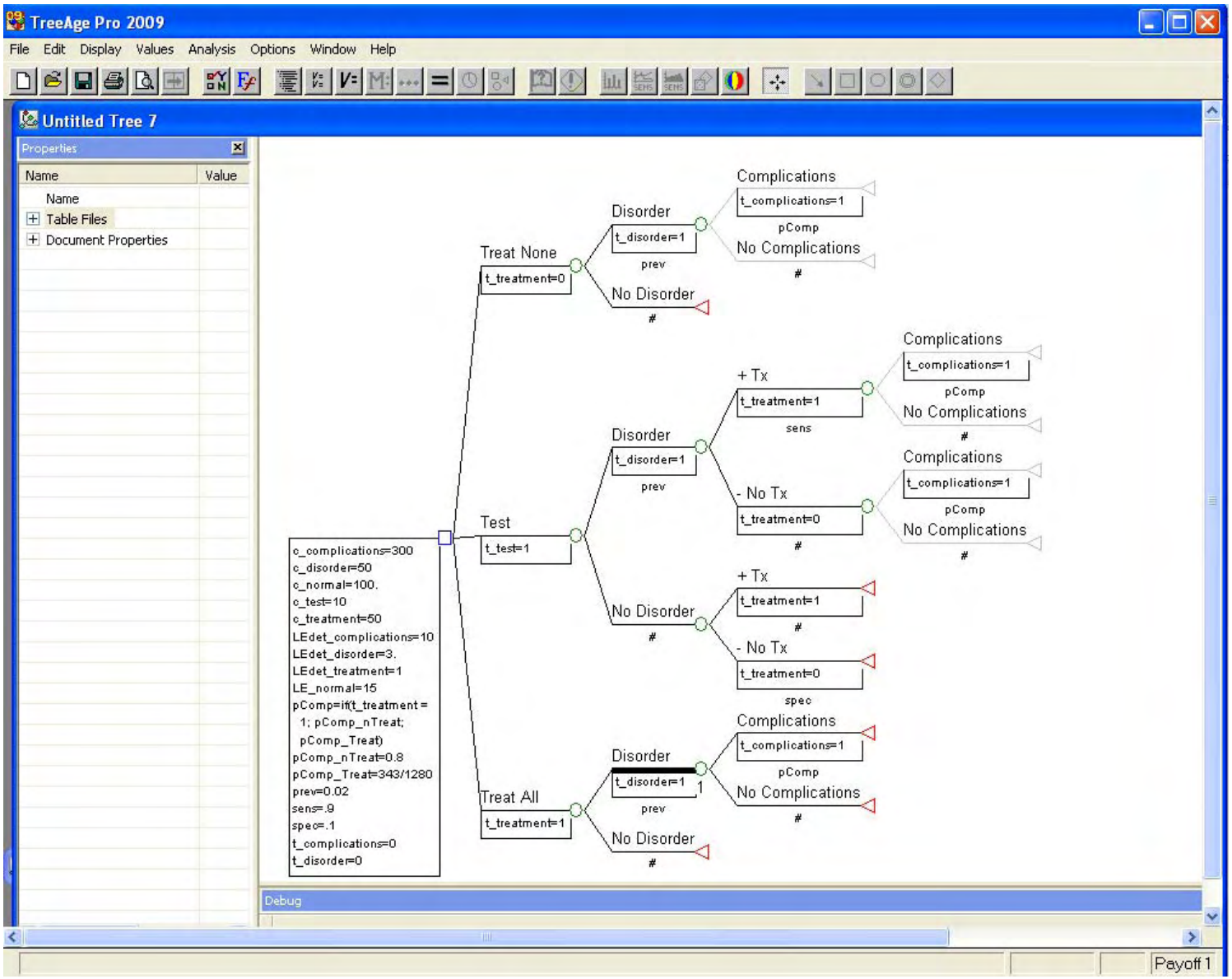

TreeAge Pro 2009
File Edit Display Values Analysis Options Window Help
Untitled Tree 7
Properties
Name Value
Name Complic
Probability pComp
Payoff LE_norr
Variables
t_complications 1
Document Properties
Treat None
t_treatment=0
Disorder
t_disorder=1
prev
No Disorder
#
[+]
Test
t_test=1
Disorder
t_disorder=1
prev
No Disorder
#
[+]
Treat All
t_treatment=1
Disorder
t_disorder=1
prev
No Disorder
#
Complications
t_complications=1
pComp
No Complications
#
Comp_nTreat; pComp_Treat)
Define Variable
Change Payoff...
Cut Node
Copy Node
Paste Text
Paste Node(s)
Change Node Type
Node Comment...
Select Subtree
Create Node
Create Arrow
Branch(es)
Custom Node Action...
Hide Roll-Back Box
Sensitivity Analysis
Debug
terminal node, child 1, 1 variable

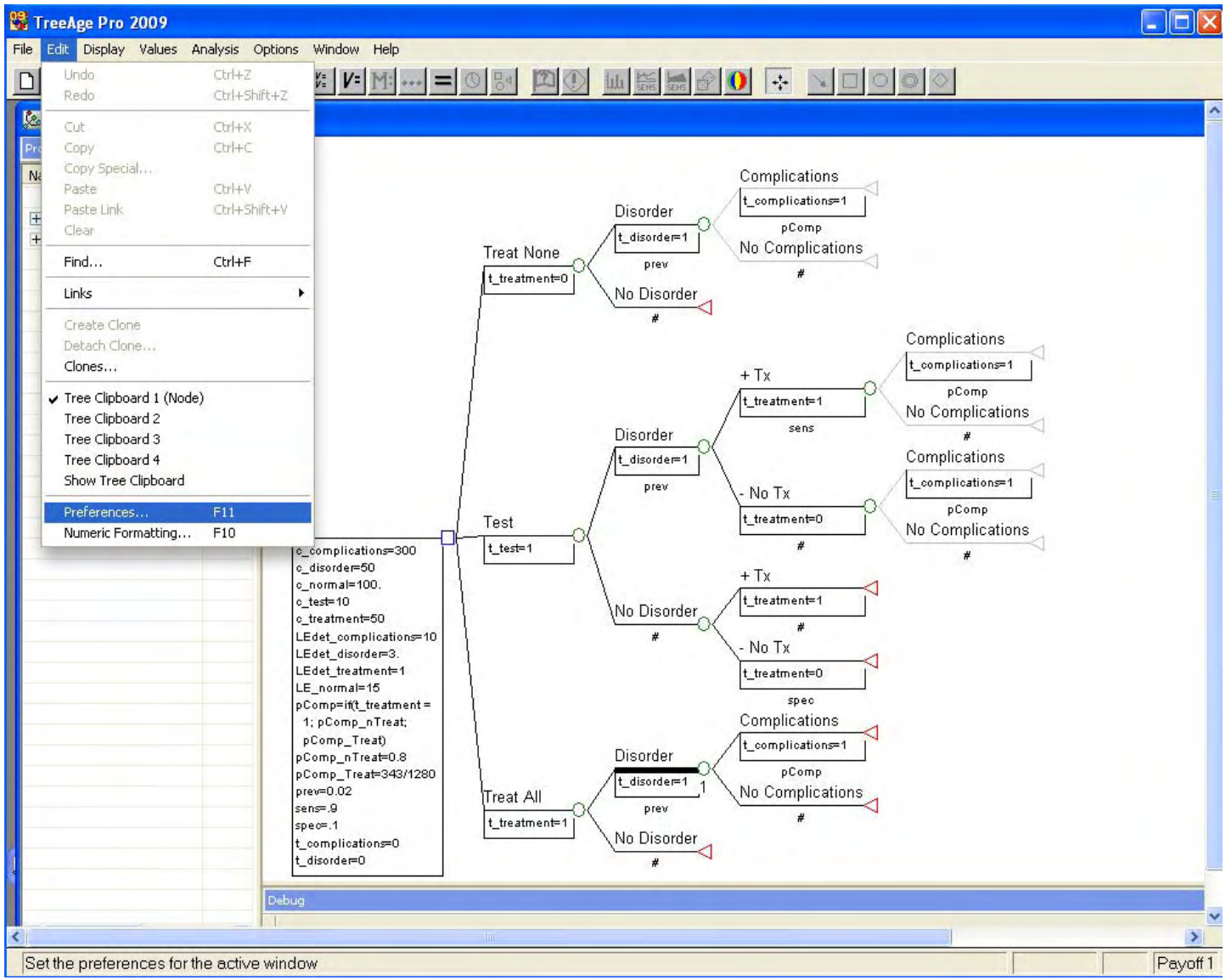


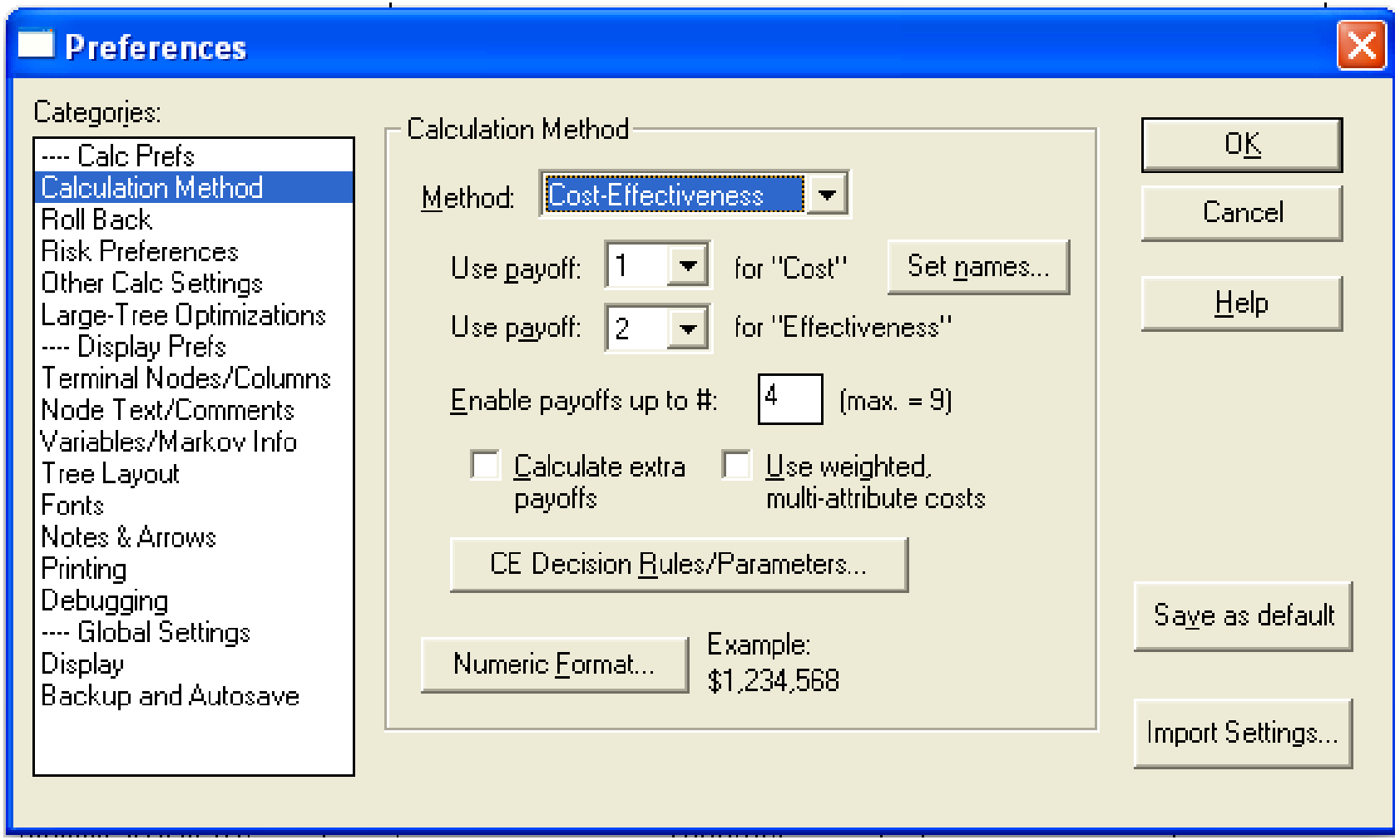
Payoff 2: c_normal + if(t_disorder = 1; c_disorder; 0) + if(t_test = 1; c_test; 0) +
+ if(t_treatment = 1; c_treatment; 0) + if(t_complications = 1; c_complications; 0)

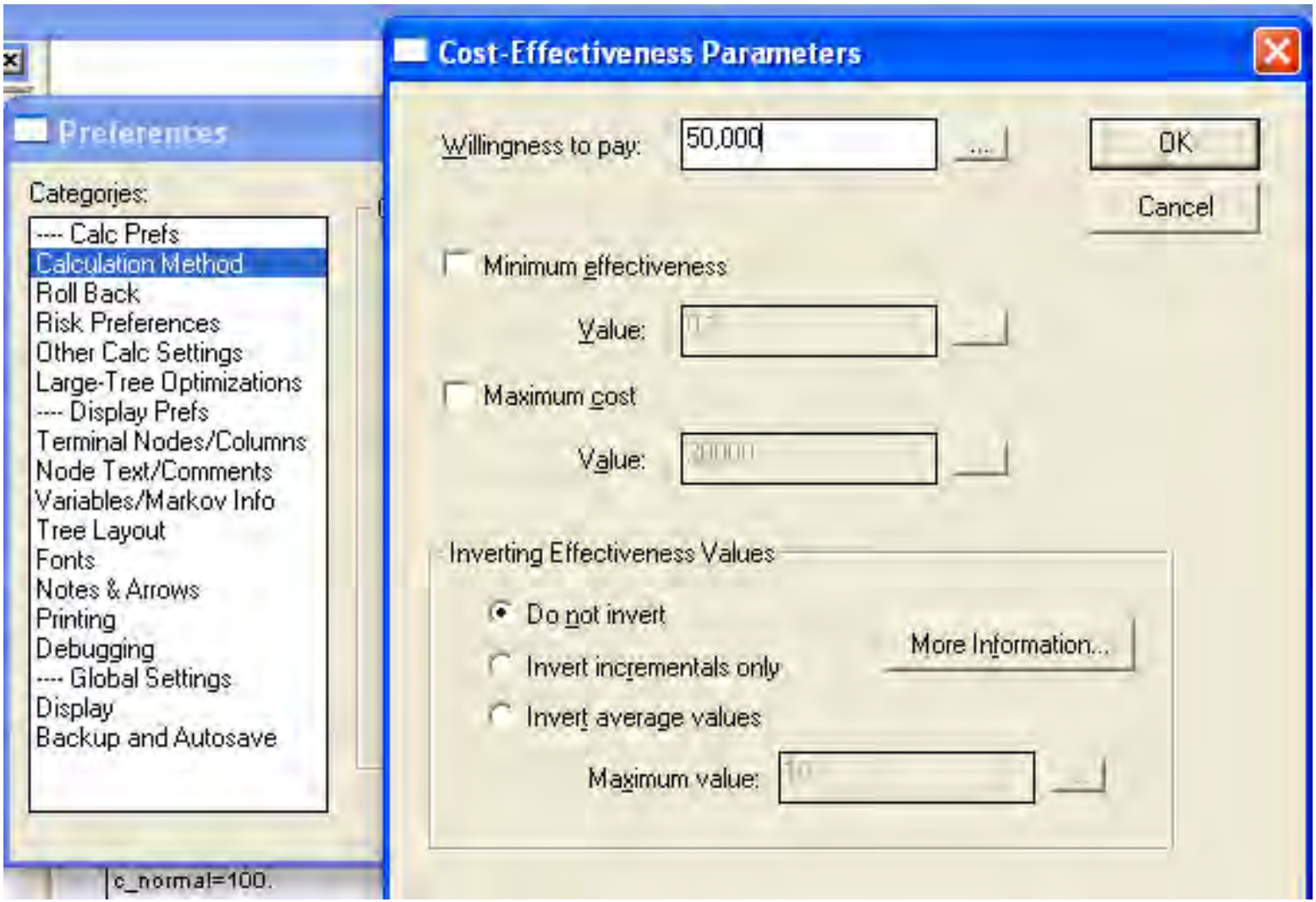

TreeAge Pro 2009
File Edit Display Values Analysis Options Window Help
Untitled Tree 7
Properties
Name Value
Name - No Tx
Probability spec
Variables
t_treatment 0
Document Properties
Treat None
t_treatment=0
Disorder
t_disorder=1
prev
Complications
t_complications=1
pComp
No Complications
#
No Disorder
#
Test
t_test=1
+ Tx
t_treatment=1
sens
Disorder
t_disorder=1
prev
- No Tx
t_treatment=0
#
No Disorder
#
+ Tx
t_treatment=1
#
No Tx
t_treatment=0
spec
Treat All
t_treatment=1
Disorder
t_disorder=1
prev
Complications
t_complications=1
pComp
No Complications
#
c_complications=300
c_disorder=50
c_normal=100.
c_test=10
c_treatment=50
LEdet_complications=10
LEdet_disorder=3.
LEdet_treatment=1
LE_normal=15
pComp=if(t_treatment = 1; pComp_nTreat; pComp_Treat)
pComp_nTreat=0.8
pComp_Treat=343/1280
prev=0.02
Define Variable
Markov Bindings...
Cut Node
Copy Node
Paste Text
Paste Node(s)
Change Node Type
Node Comment...
Select Subtree
Create Note
Create Arrow
Branch(es)
Custom Node Action...
Hide Roll-Back Box
Sensitivity Analysis
Monte Carlo Simulation
Cost-Effectiveness...
Markov Cohort (Full Detail)
Probability Distribution
Expected Value
Roll Back
Preferences...
Chance
Terminal
Decision
Logic
Markov
Label
Show Dialog...
; LEdet_disorder;0) - if(t_treatment =1; LEdet_treatment
er =1; LEdet_disorder;0) - if(t_treatme
normal - if(t_disorder =1; LEdet_disorder;0) - if(t_treatme
LE_normal - if(t_disorder =1; LEdet_disorder;0) - if(t_treatment =1; LEdet_treatment
Debug
Wrap Prefs Actions ?
"Disorder"
chance node, child 2, 0 branches, 1 variable
Payoff 1

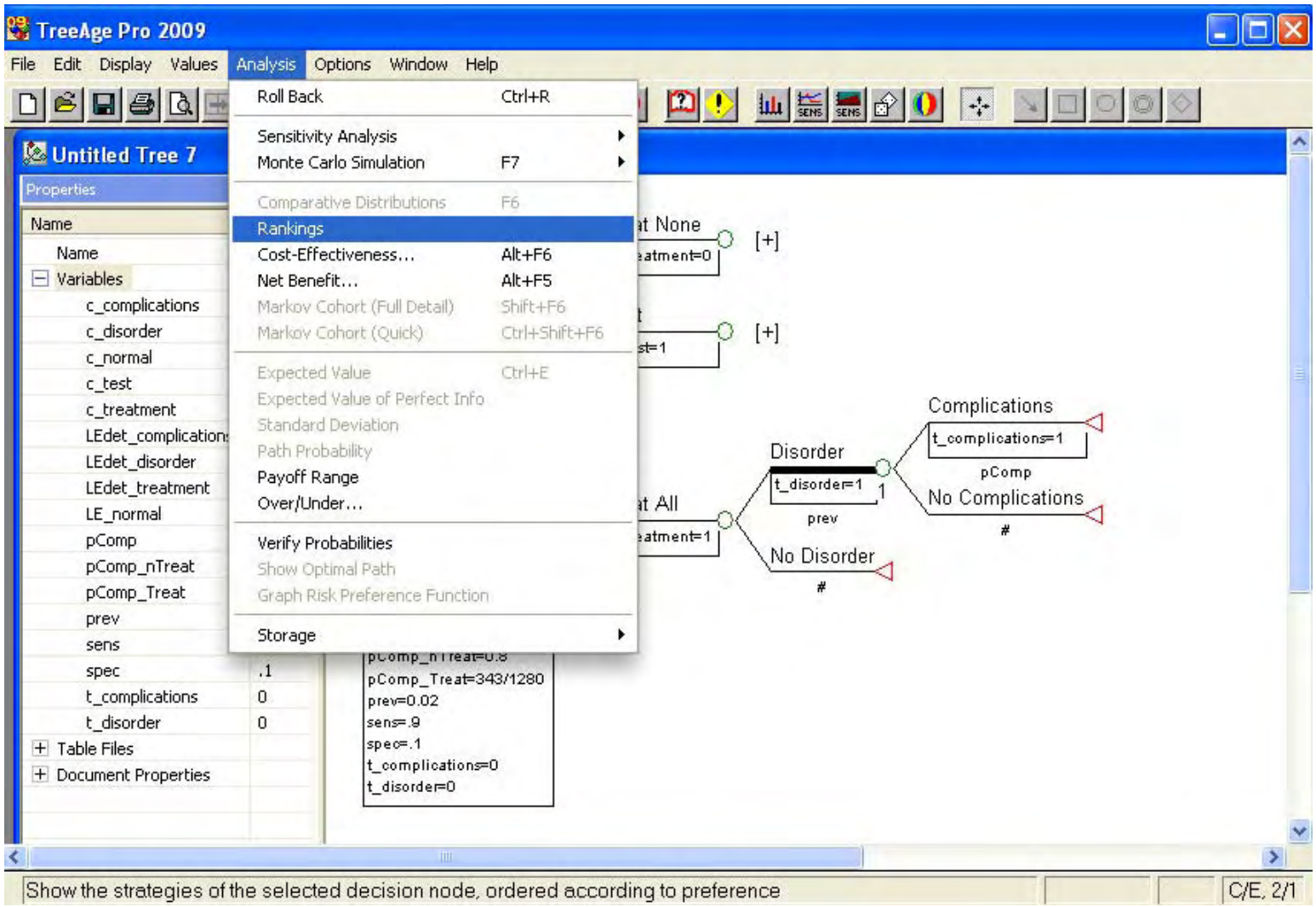

TreeAge Pro 2009
File Edit Display Values Window Help
Untitled Tree 7 zero
Properties
Name Value
Name No Complications
Probability #
Payoff
Document Properties
Complications
t_complications=1
pComp
No Complications
+ Tx
t_treatment=1
sens
Untitled Tree 7 zero: Enter Payoff
Node: No Complications
Variables:
Cost:
Effect:
Payoff 3:
Payoff 4:
Payoff 5:
Payoff 6:
Payoff 7:
Payoff 8:
Payoff 9:
Undo
Cut
Copy
Paste
Delete
Select All
OK
Cancel
Help
Insert Distribution...
Show Nodes
Preferences...
t_complications=0
t_disorder=0
t_test=0
Debug
terminal node, child 2
C/E, 1/2

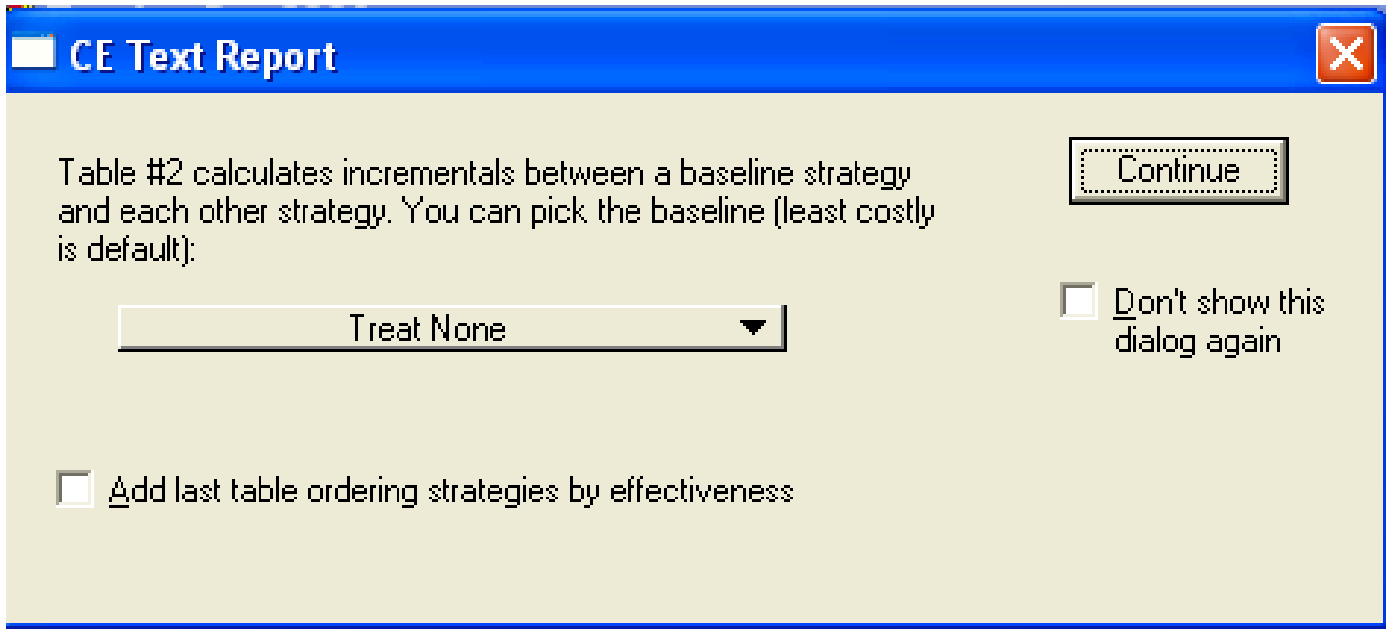

TreeAge Pro 2009
File Edit Display Values Analysis Options Window Help
Untitled Tree 7
Properties
Name
Value
Name
Table Files
Document Properties
c_complications=300
c_disorder=50
c_normal=100.
c_test=10
c_treatment=50
LEdet_complications=10
LEdet_disorder=3.
LEdet_treatment=1
LE_normal=15
pComp=if(t_treatment = 1; pComp_nTreat; pComp_Treat)
pComp_nTreat=0.8
pComp_Treat=343/1280
prev=0.02
sens=.9
spec=.1
t_complications=0
t_disorder=0
Treat None
t_treatment=0
Test
t_test=1
Treat All
t_treatment=1
Disorder
t_disorder=1
prev
No Disorder
#
Complications
t_complications=1
pComp
No Complications
#
+ Tx
t_treatment=1
sens
- No Tx
t_treatment=0
spec
Debug
Payoff 1


TreeAge Pro 2009
File
Edit
Display
Values
Analysis
Options
Window
Help
Undo Ctrl+Z
Redo Ctrl+Shift+Z
Cut Ctrl+X
Copy Ctrl+C
Copy Special...
Paste Ctrl+V
Paste Link Ctrl+Shift+V
Clear
Find... Ctrl+F
Links
Create Clone
Detach Clone...
Clones...
Tree Clipboard 1 (Node)
Tree Clipboard 2
Tree Clipboard 3
Tree Clipboard 4
Show Tree Clipboard
Preferences... F11
Numeric Formatting... F10
c_complications=300
c_disorder=50
c_normal=100.
c_test=10
c_treatment=50
LEdet_complications=10
LEdet_disorder=3.
LEdet_treatment=1
LE_normal=15
pComp=if(t_treatment = 1; pComp_nTreat; pComp_Treat)
pComp_nTreat=0.8
pComp_Treat=343/1280
prev=0.02
sens=.9
spec=.1
t_complications=0
t_disorder=0
Treat None
t_treatment=0
Test
t_test=1
Treat All
t_treatment=1
Disorder
t_disorder=1
prev
No Disorder
#
Complications
t_complications=1
pComp
No Complications
#
+ Tx
t_treatment=1
sens
- No Tx
t_treatment=0
spec
Debug
Set the preferences for the active window
Payoff 1

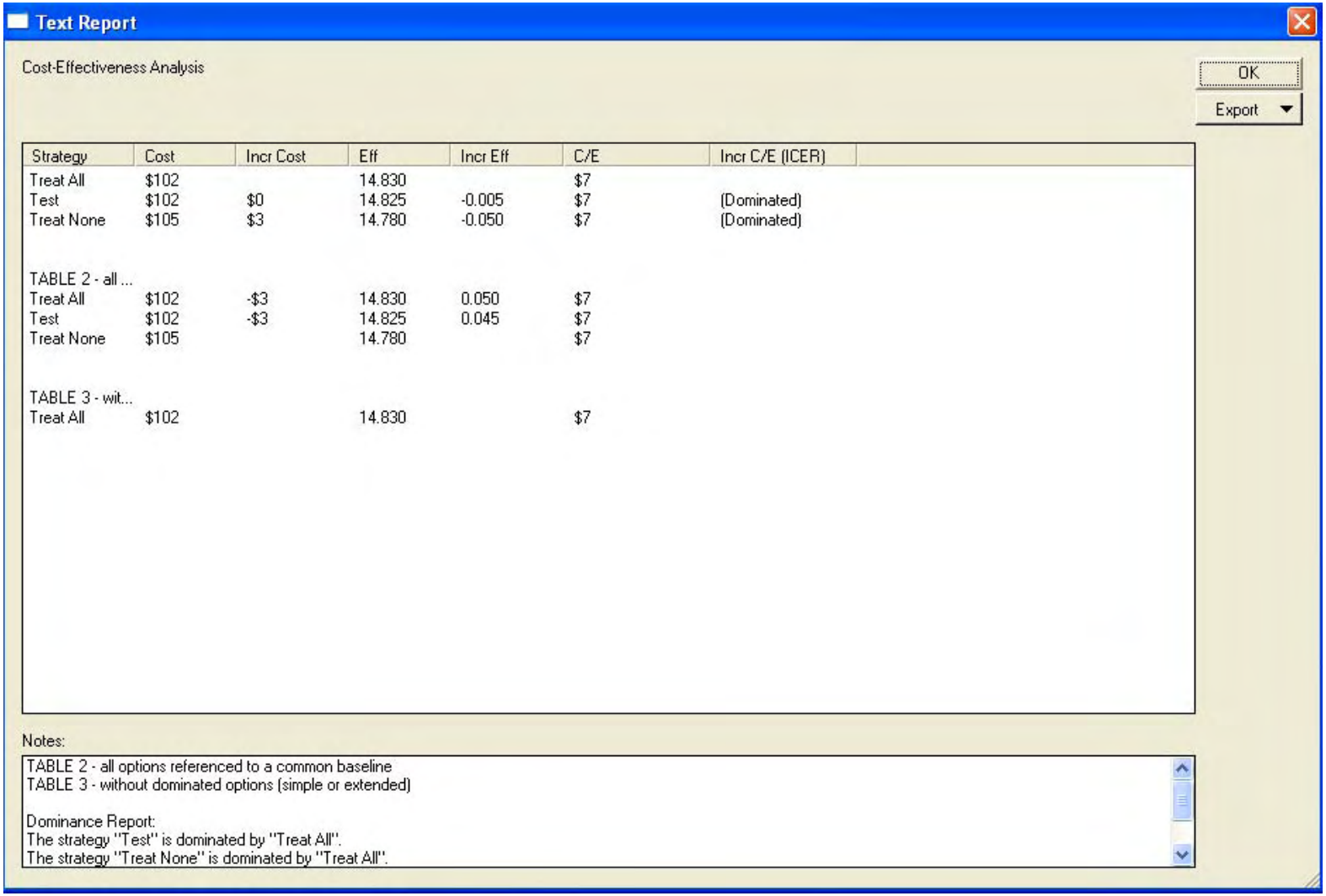

Preferences
Categories:
---- Calc Prefs
Calculation Method
Roll Back
Risk Preferences
Other Calc Settings
Large-Tree Optimizations
---- Display Prefs
Terminal Nodes/Columns
Node Text/Comments
Variables/Markov Info
Tree Layout
Fonts
Notes & Arrows
Printing
Debugging
---- Global Settings
Display
Backup and Autosave
Calculation Method
Method: Cost-Effectiveness
Use payoff: 1 for "Cost"
Set names...
Use payoff: 2 for "Effectiveness"
Enable payoffs up to #: 4 (max. = 9)
Calculate extra payoffs
Use weighted, multi-attribute costs
CE Decision Rules/Parameters...
Numeric Format...
Example: $1,234,568
OK
Cancel
Help
Save as default
Import Settings...

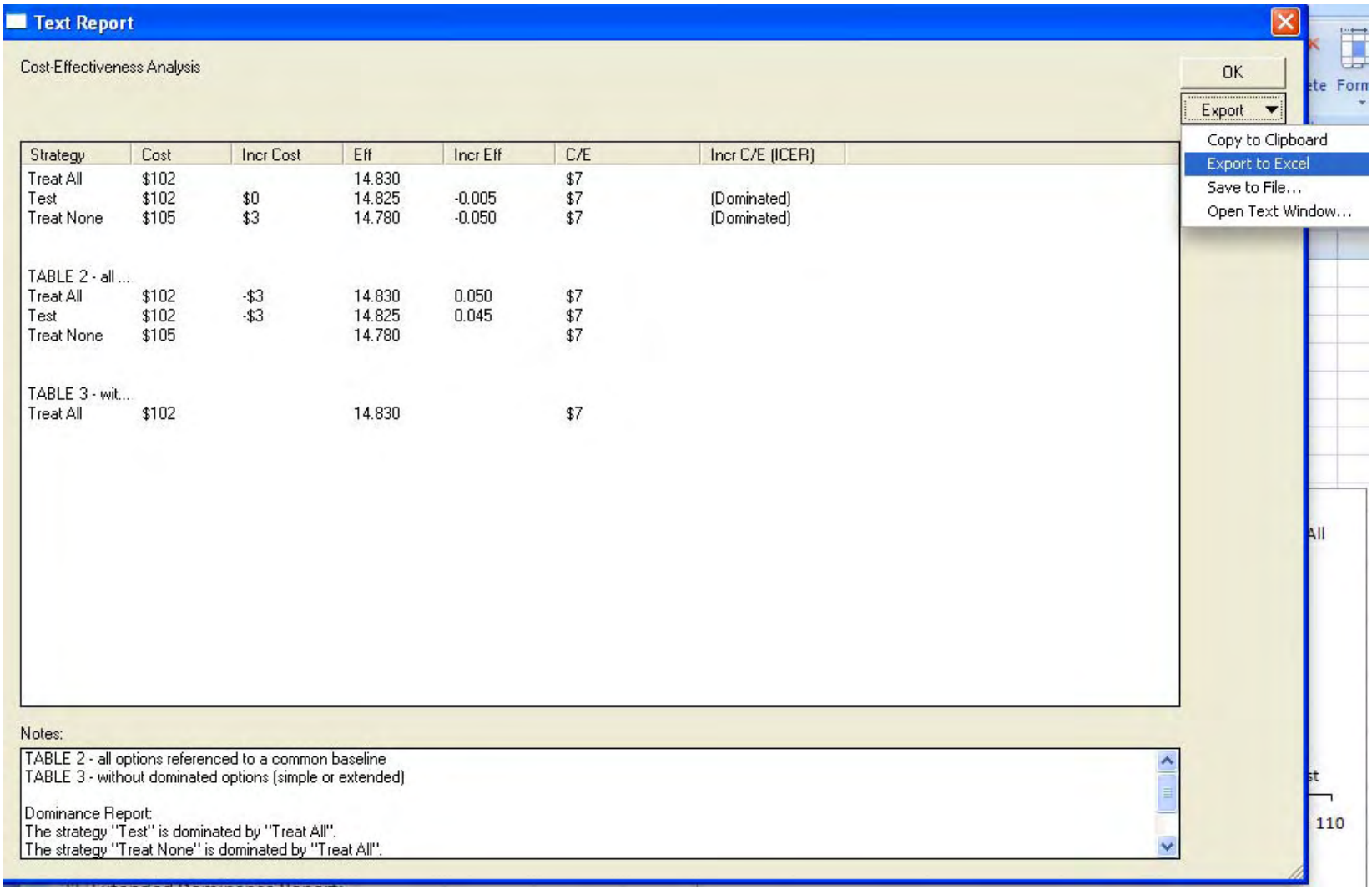

Preferences
Categories:
---- Calc Prefs
Calculation Method
Roll Back
Risk Preferences
Other Calc Settings
Large-Tree Optimizations
---- Display Prefs
Terminal Nodes/Columns
Node Text/Comments
Variables/Markov Info
Tree Layout
Fonts
Notes & Arrows
Printing
Debugging
---- Global Settings
Display
Backup and Autosave
c_normal=100.
Cost-Effectiveness Parameters
Willingness to pay:
50,000
OK
Cancel
Minimum effectiveness
Value:
Maximum cost
Value:
Inverting Effectiveness Values
Do not invert
Invert incrementals only
Invert average values
More Information...
Maximum value:

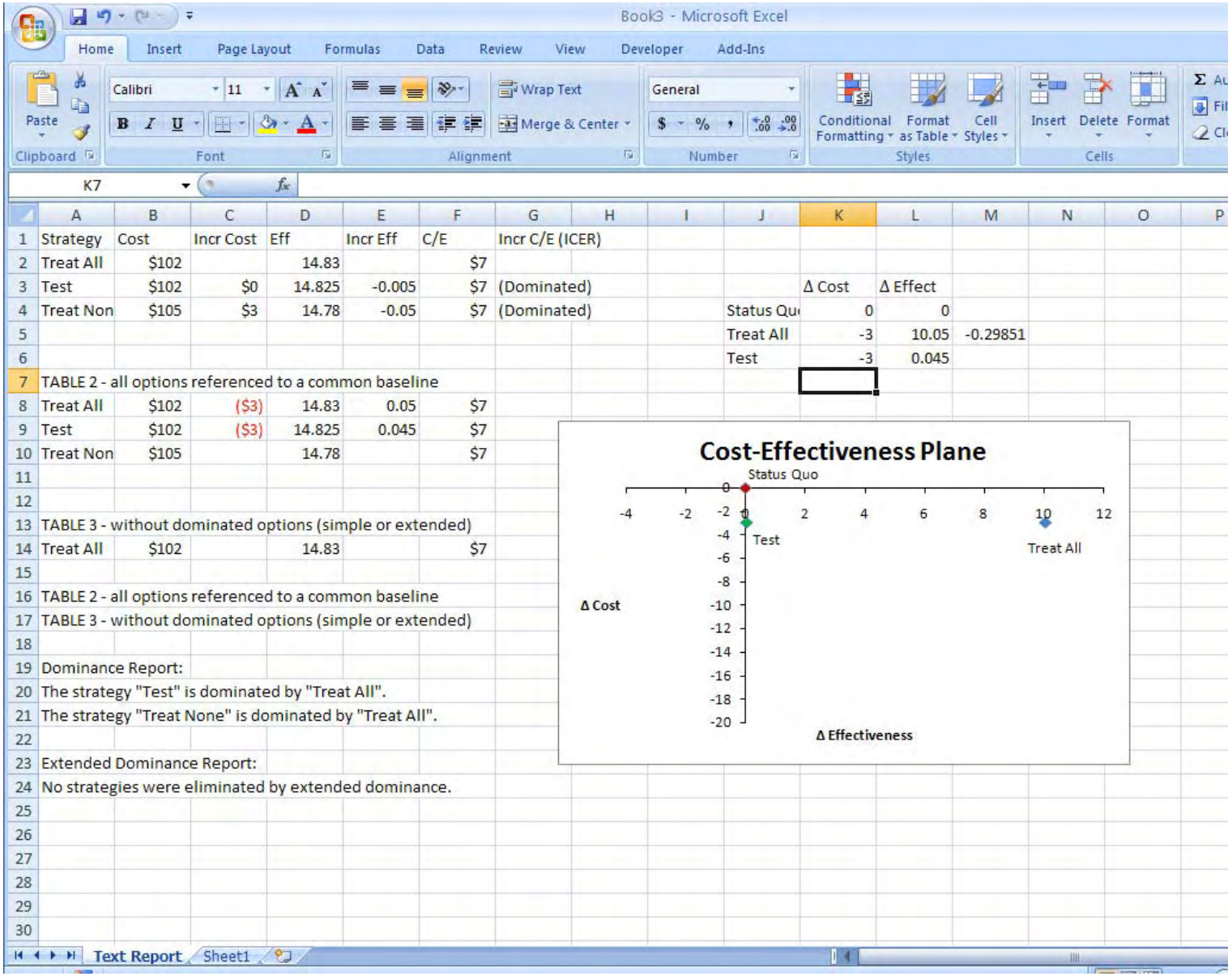

TreeAge Pro 2009
File Edit Display Values Analysis Options Window Help
Roll Back Ctrl+R
Sensitivity Analysis
Monte Carlo Simulation F7
Comparative Distributions F6
Rankings
Cost-Effectiveness... Alt+F6
Net Benefit... Alt+F5
Markov Cohort (Full Detail) Shift+F6
Markov Cohort (Quick) Ctrl+Shift+F6
Expected Value Ctrl+E
Expected Value of Perfect Info
Standard Deviation
Path Probability
Payoff Range
Over/Under...
Verify Probabilities
Show Optimal Path
Graph Risk Preference Function
Storage
Untitled Tree 7
Properties
Name
Variables
c_complications
c_disorder
c_normal
c_test
c_treatment
LEdet_disorder
LEdet_treatment
LE_normal
pComp
pComp_nTreat
pComp_Treat
prev
sens
spec .1
t_complications 0
t_disorder 0
Table Files
Document Properties
[+]
[+]
Disorder
t_disorder=1
prev
Complications
t_complications=1
pComp
No Complications
#
No Disorder
#
pComp_Treat=343/1280
prev=0.02
sens=.9
spec=.1
t_complications=0
t_disorder=0
Show the strategies of the selected decision node, ordered according to preference
C/E, 2/1



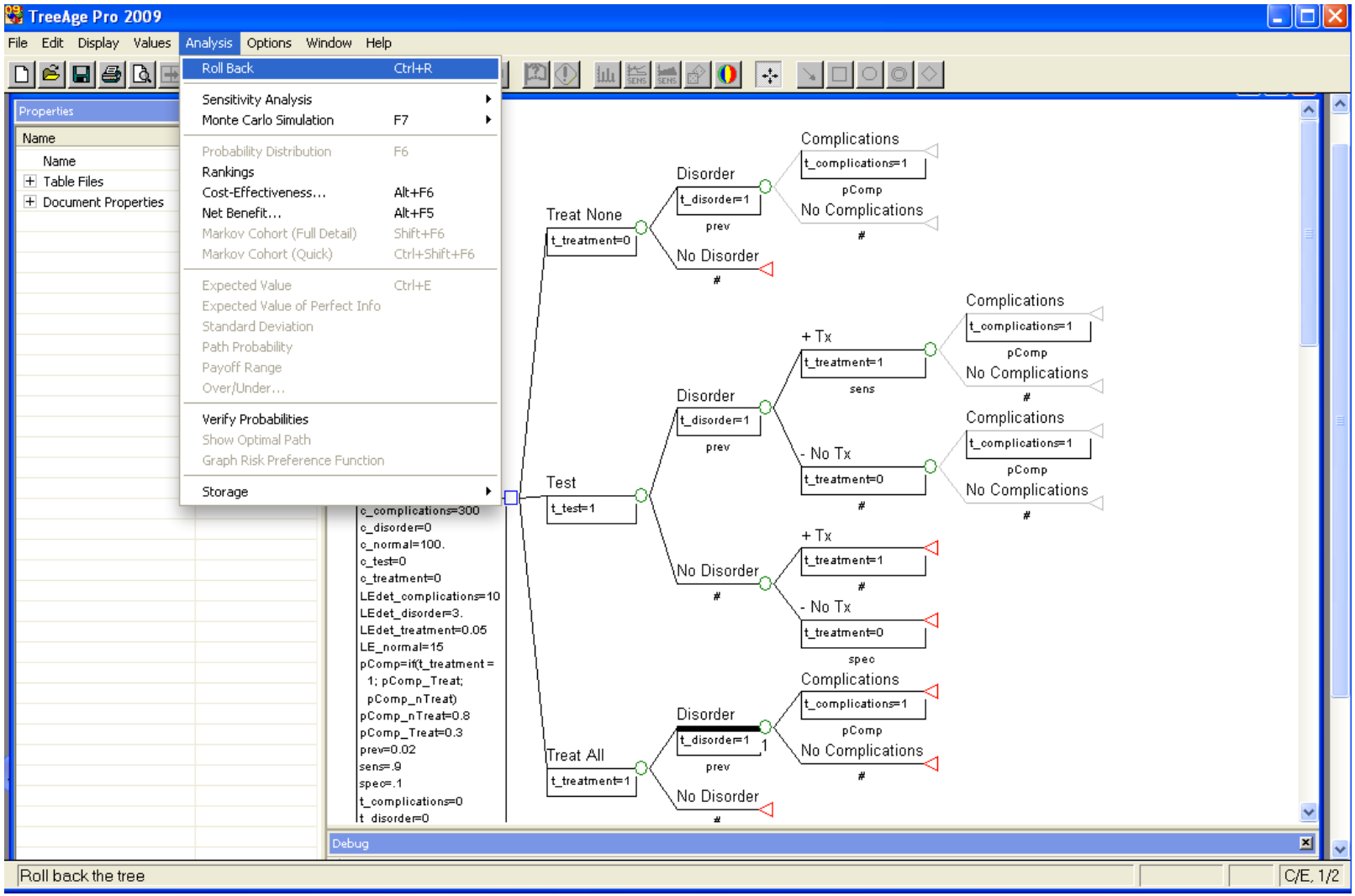
Baseline = Status Quo

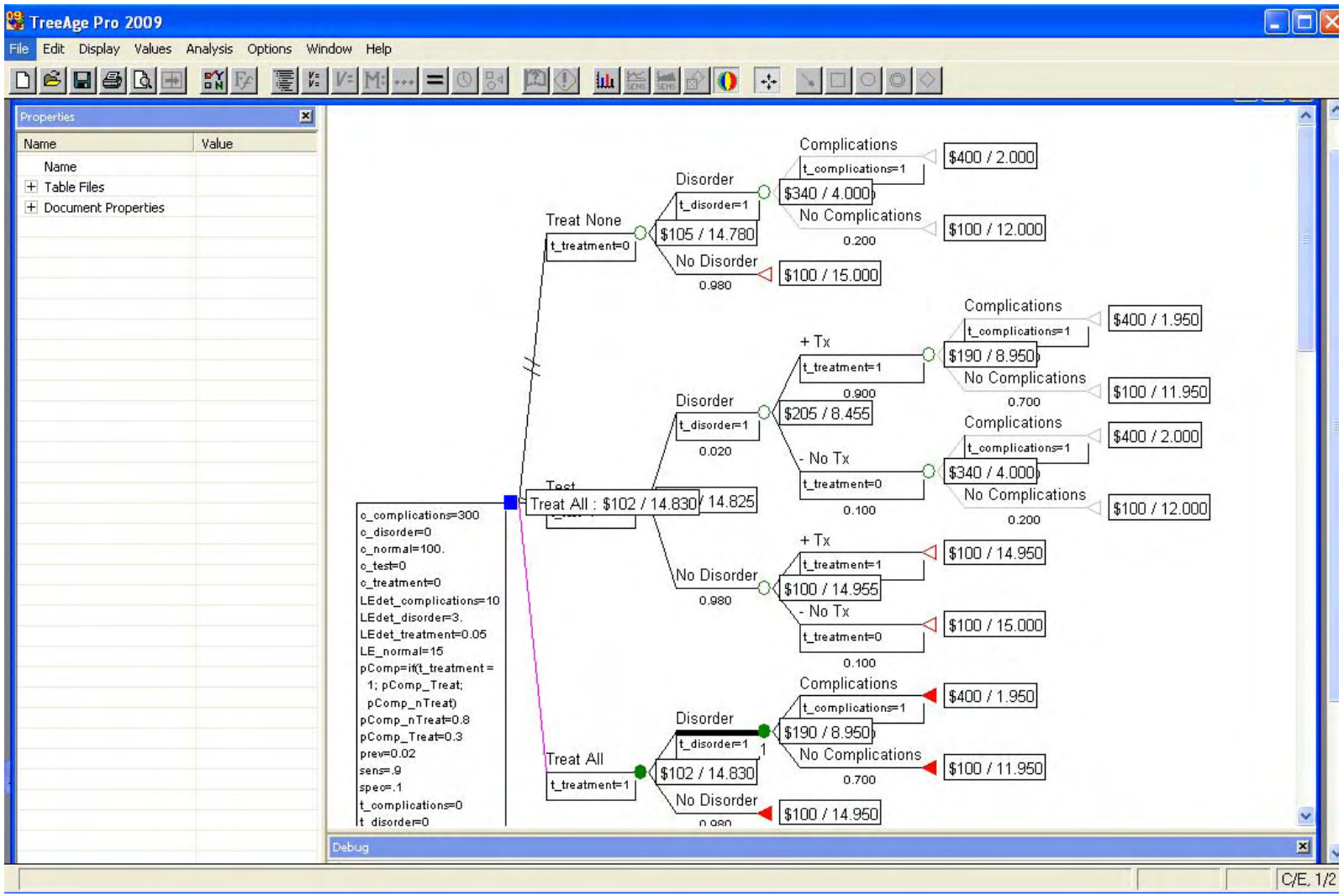

Text Report
Cost-Effectiveness Analysis
OK
Export
Strategy Cost Incr Cost Eff Incr Eff C/E Incr C/E (ICER)
Treat All $102 14.830 $7
Test $102 $0 14.825 -0.005 $7 (Dominated)
Treat None $105 $3 14.780 -0.050 $7 (Dominated)
TABLE 2 - all ...
Treat All $102 -$3 14.830 0.050 $7
Test $102 -$3 14.825 0.045 $7
Treat None $105 14.780 $7
TABLE 3 - wit...
Treat All $102 14.830 $7
Notes:
TABLE 2 - all options referenced to a common baseline
TABLE 3 - without dominated options (simple or extended)
Dominance Report:
The strategy "Test" is dominated by "Treat All".
The strategy "Treat None" is dominated by "Treat All".


Text Report
Cost-Effectiveness Analysis
OK
Export
Copy to Clipboard
Export to Excel
Save to File...
Open Text Window...
Strategy | Cost | Incr Cost | Eff | Incr Eff | C/E | Incr C/E (ICER)
Treat All | $102 | | 14.830 | | $7 |
Test | $102 | $0 | 14.825 | -0.005 | $7 | (Dominated)
Treat None | $105 | $3 | 14.780 | -0.050 | $7 | (Dominated)
TABLE 2 - all ...
Treat All | $102 | -$3 | 14.830 | 0.050 | $7
Test | $102 | -$3 | 14.825 | 0.045 | $7
Treat None | $105 | | 14.780 | | $7
TABLE 3 - wit...
Treat All | $102 | | 14.830 | | $7
Notes:
TABLE 2 - all options referenced to a common baseline
TABLE 3 - without dominated options (simple or extended)
Dominance Report:
The strategy "Test" is dominated by "Treat All".
The strategy "Treat None" is dominated by "Treat All".

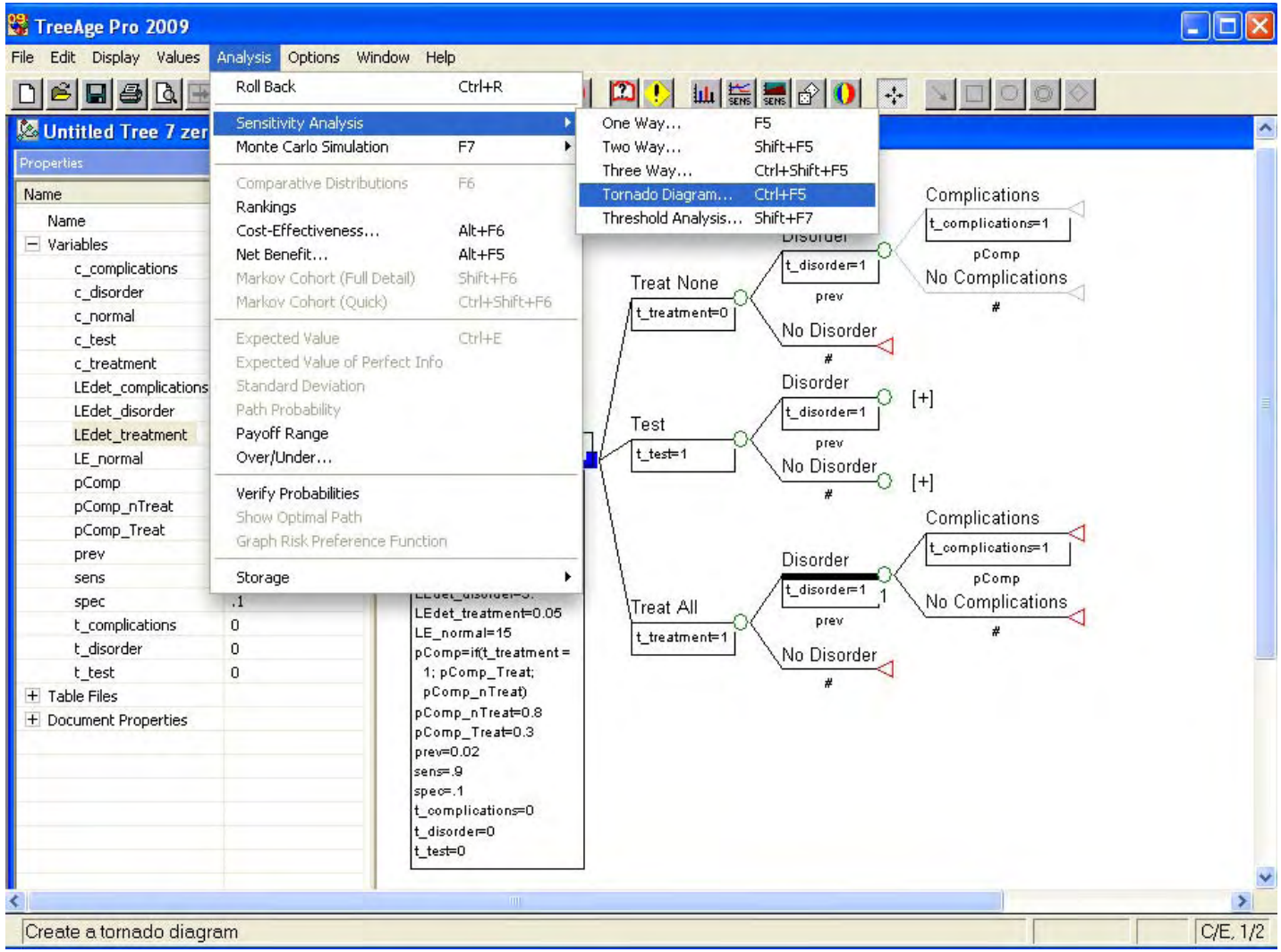


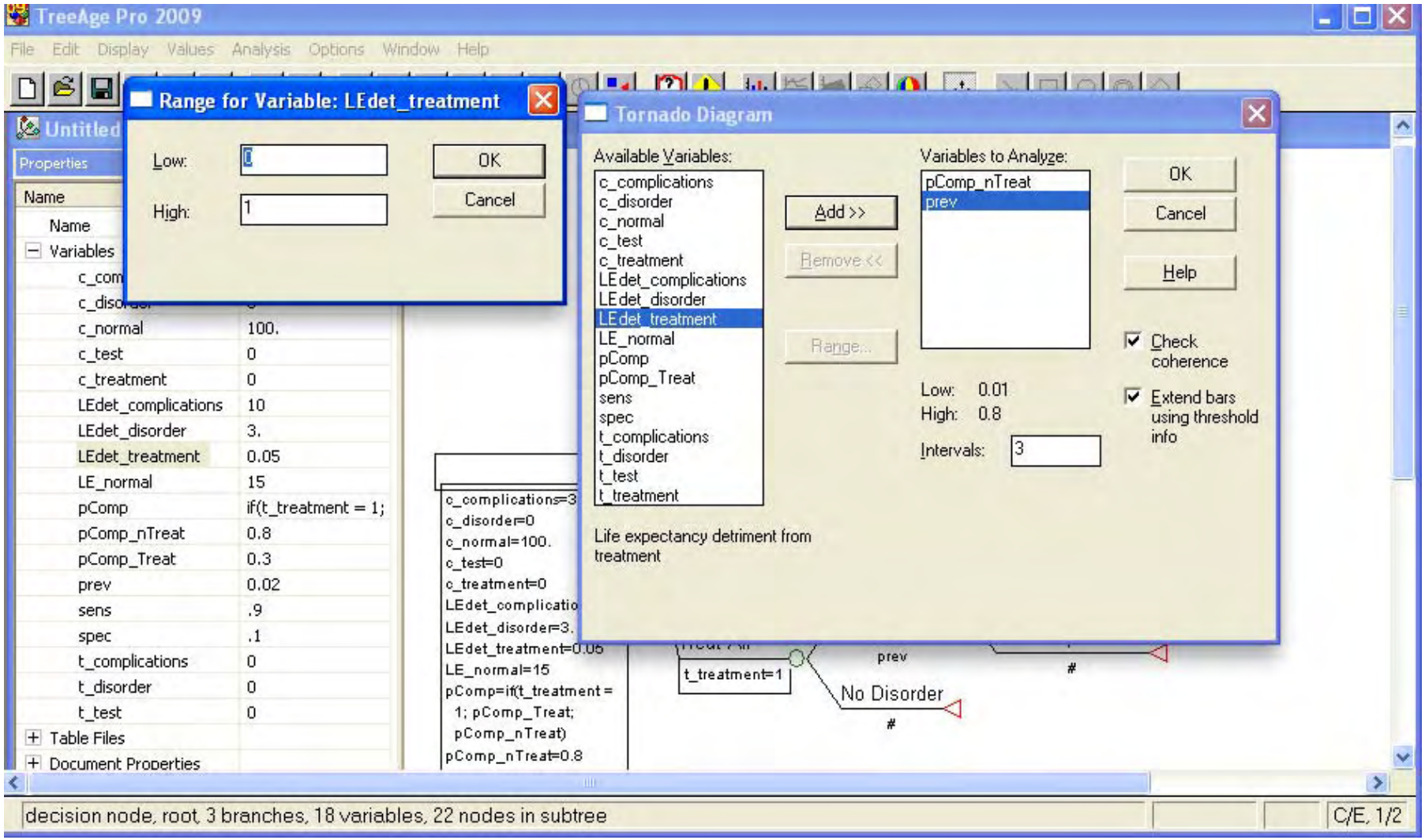
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
1	Strategy	Cost	Incr Cost	Eff	Incr Eff	C/E	Incr C/E (ICER)									
2	Treat All	$102		14.83		$7										
3	Test	$102	$0	14.825	-0.005	$7	(Dominated)				Δ Cost	Δ Effect				
4	Treat Non	$105	$3	14.78	-0.05	$7	(Dominated)			Status Qu	0	0				
5										Treat All	-3	10.05	-0.29851			
6										Test	-3	0.045				
7	TABLE 2 - all options referenced to a common baseline															
8	Treat All	$102	($3)	14.83	0.05	$7										
9	Test	$102	($3)	14.825	0.045	$7										
10	Treat Non	$105		14.78		$7										
11																
12																
13	TABLE 3 - without dominated options (simple or extended)															
14	Treat All	$102		14.83		$7										
15																
16	TABLE 2 - all options referenced to a common baseline															
17	TABLE 3 - without dominated options (simple or extended)															
18																
19	Dominance Report:															
20	The strategy "Test" is dominated by "Treat All".															
21	The strategy "Treat None" is dominated by "Treat All".															
22																
23	Extended Dominance Report:															
24	No strategies were eliminated by extended dominance.															
25																
26																
27																
28																
29																
30																

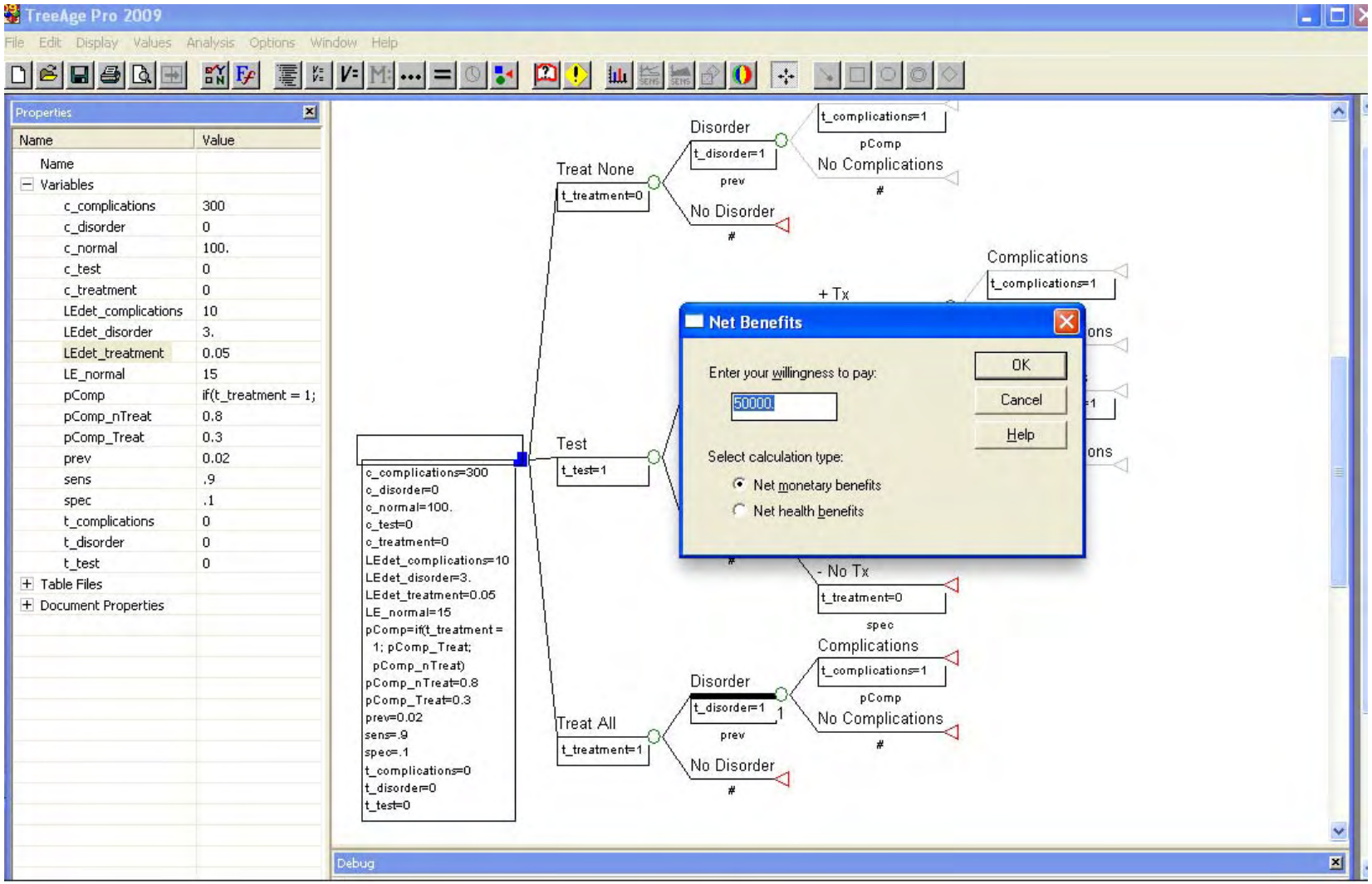

TreeAge Pro 2009
File Edit Display Values Analysis Options Window Help
Roll Back Ctrl+R
Sensitivity Analysis
Monte Carlo Simulation F7
Probability Distribution F6
Rankings
Cost-Effectiveness... Alt+F6
Net Benefit... Alt+F5
Markov Cohort (Full Detail) Shift+F6
Markov Cohort (Quick) Ctrl+Shift+F6
Expected Value Ctrl+E
Expected Value of Perfect Info
Standard Deviation
Path Probability
Payoff Range
Over/Under...
Verify Probabilities
Show Optimal Path
Graph Risk Preference Function
Storage
Properties
Name
Table Files
Document Properties
c_complications=300
c_disorder=0
c_normal=100.
c_test=0
c_treatment=0
LEdet_complications=10
LEdet_disorder=3.
LEdet_treatment=0.05
LE_normal=15
pComp=if(t_treatment = 1; pComp_Treat; pComp_nTreat)
pComp_nTreat=0.8
pComp_Treat=0.3
prev=0.02
sens=.9
spec=.1
t_complications=0
t_disorder=0
Treat None
t_treatment=0
Test
t_test=1
Treat All
t_treatment=1
Disorder
t_disorder=1
prev
No Disorder
#
Complications
t_complications=1
pComp
No Complications
#
+ Tx
t_treatment=1
sens
- No Tx
t_treatment=0
spec
Debug
Roll back the tree
C/E, 1/2

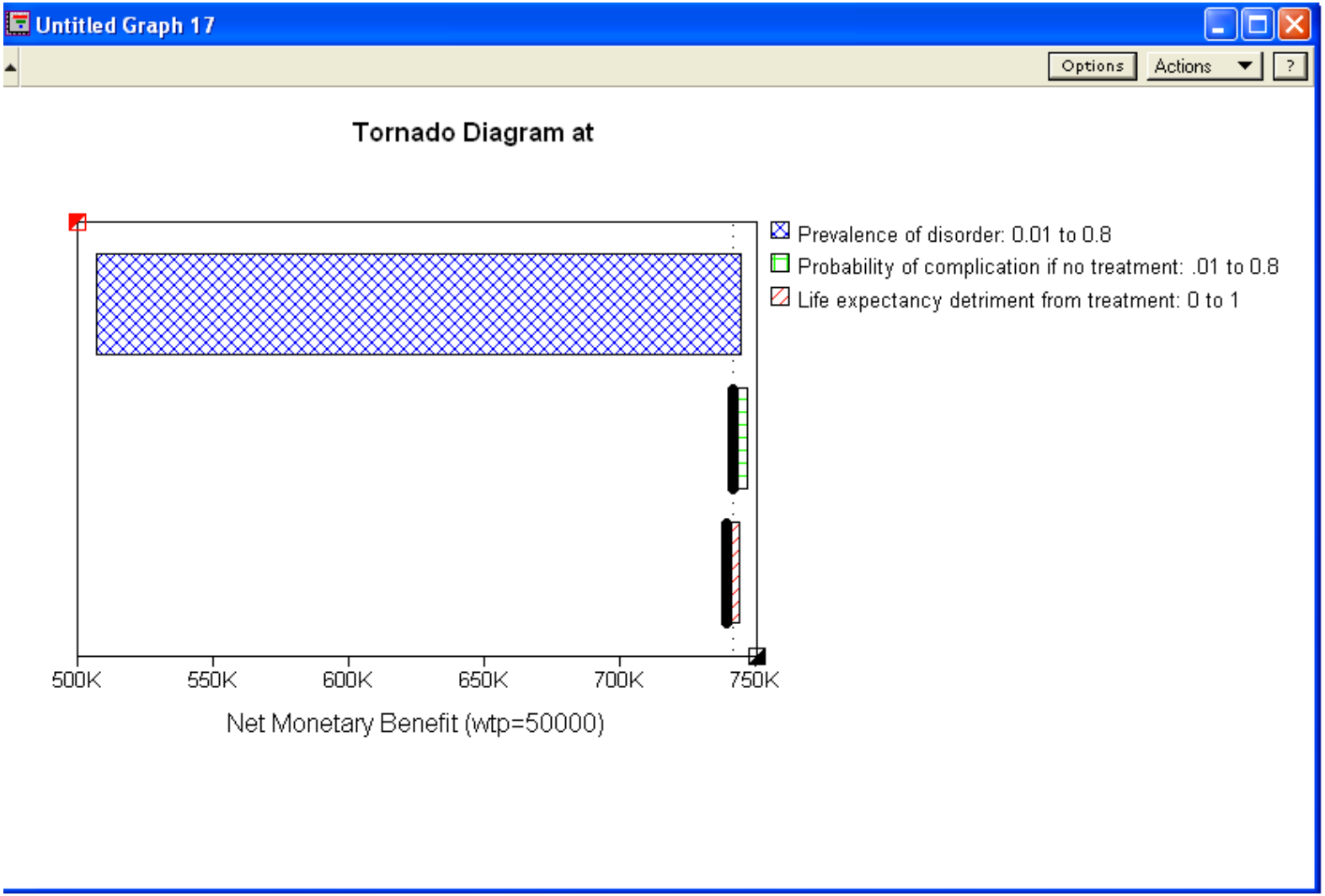

TreeAge Pro 2009
File Edit Display Values Analysis Options Window Help
Properties
Name Value
Name
Table Files
Document Properties
Treat None
t_treatment=0
Disorder
t_disorder=1
$105 / 14.780
Complications
t_complications=1
$340 / 4.000
$400 / 2.000
No Complications
0.200
$100 / 12.000
No Disorder
0.980
$100 / 15.000
Test
Treat All : $102 / 14.830
/ 14.825
Disorder
t_disorder=1
0.020
$205 / 8.455
+ Tx
t_treatment=1
0.900
Complications
t_complications=1
$190 / 8.950
$400 / 1.950
No Complications
0.700
$100 / 11.950
- No Tx
t_treatment=0
0.100
Complications
t_complications=1
$340 / 4.000
$400 / 2.000
No Complications
0.200
$100 / 12.000
No Disorder
0.980
+ Tx
t_treatment=1
$100 / 14.955
$100 / 14.950
- No Tx
t_treatment=0
0.100
$100 / 15.000
Treat All
t_treatment=1
Disorder
t_disorder=1
$102 / 14.830
Complications
t_complications=1
$190 / 8.950
$400 / 1.950
No Complications
0.700
$100 / 11.950
No Disorder
$100 / 14.950
c_complications=300
c_disorder=0
c_normal=100.
c_test=0
c_treatment=0
LEdet_complications=10
LEdet_disorder=3.
LEdet_treatment=0.05
LE_normal=15
pComp=if(t_treatment =
1; pComp_Treat;
pComp_nTreat)
pComp_nTreat=0.8
pComp_Treat=0.3
prev=0.02
sens=.9
spec=.1
t_complications=0
t_disorder=0
Debug
C/E, 1/2

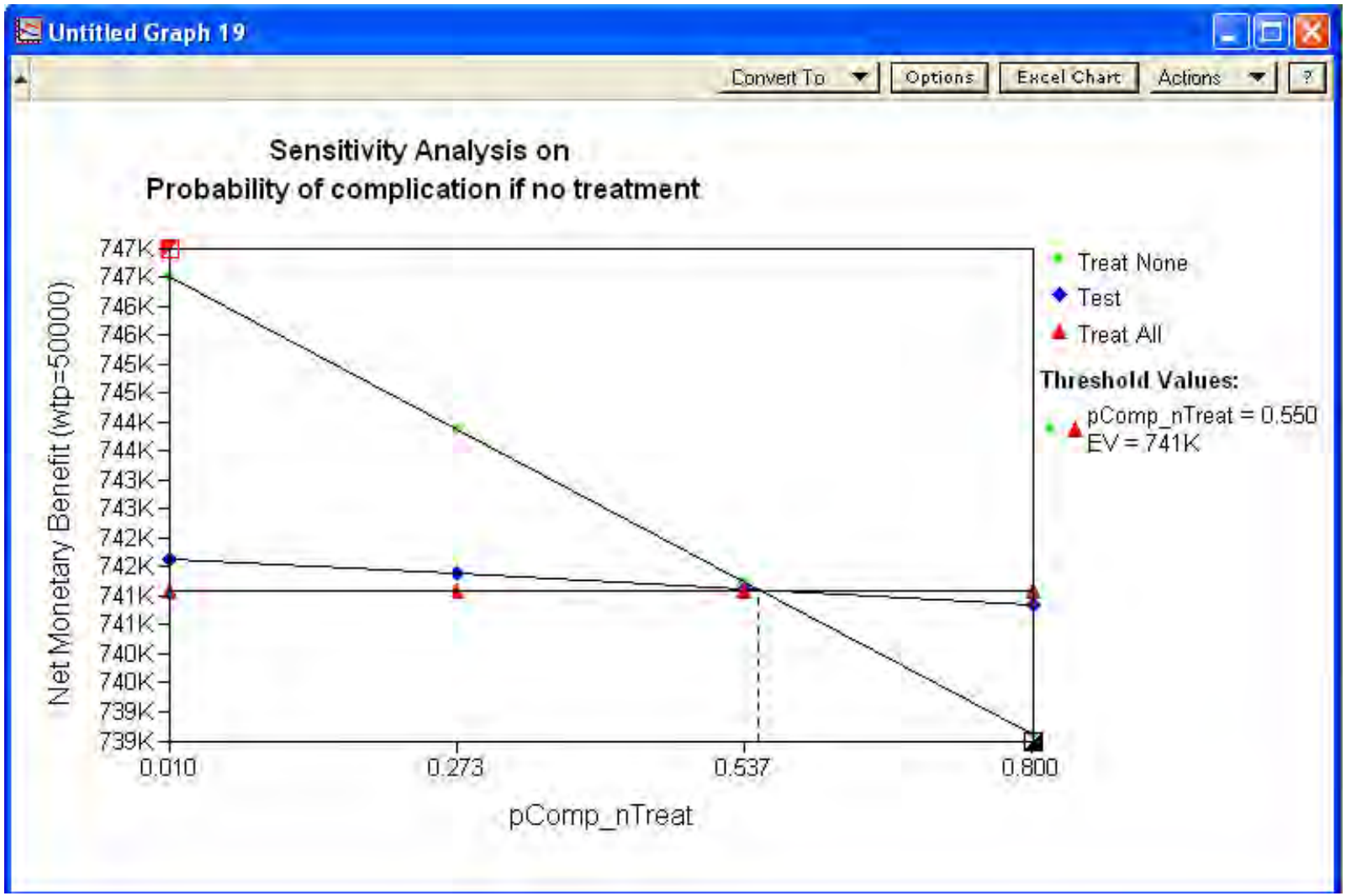
Sensitivity Analysis




TreeAge Pro 2009
File Edit Display Values Analysis Options Window Help
Range for Variable: LEdet_treatment
Low: 0
High: 1
OK
Cancel
Tornado Diagram
Available Variables:
c_complications
c_disorder
c_normal
c_test
c_treatment
LEdet_complications
LEdet_disorder
LEdet_treatment
LE_normal
pComp
pComp_Treat
sens
spec
t_complications
t_disorder
t_test
t_treatment
Add >>
Remove <<
Range...
Variables to Analyze:
pComp_nTreat
prev
OK
Cancel
Help
Check coherence
Extend bars using threshold info
Low: 0.01
High: 0.8
Intervals: 3
Life expectancy detriment from treatment
Untitled
Properties
Name
Variables
c_normal 100.
c_test 0
c_treatment 0
LEdet_complications 10
LEdet_disorder 3.
LEdet_treatment 0.05
LE_normal 15
pComp if(t_treatment = 1;
pComp_nTreat 0.8
pComp_Treat 0.3
prev 0.02
sens .9
spec .1
t_complications 0
t_disorder 0
t_test 0
Table Files
Document Properties
c_complications=3
c_disorder=0
c_normal=100.
c_test=0
c_treatment=0
LEdet_disorder=3.
LE_normal=15
pComp=if(t_treatment = 1; pComp_Treat; pComp_nTreat)
pComp_nTreat=0.8
t_treatment=1
prev
No Disorder
#
decision node, root, 3 branches, 18 variables, 22 nodes in subtree
C/E, 1/2


TreeAge Pro 2009
File Edit Display Values Analysis Options Window Help
Properties
Name
Value
Name
Variables
c_complications 300
c_disorder 0
c_normal 100.
c_test 0
c_treatment 0
LEdet_complications 10
LEdet_disorder 3.
LEdet_treatment 0.05
LE_normal 15
pComp if(t_treatment = 1;
pComp_nTreat 0.8
pComp_Treat 0.3
prev 0.02
sens .9
spec .1
t_complications 0
t_disorder 0
t_test 0
Table Files
Document Properties
Treat None
t_treatment=0
Disorder
t_disorder=1
prev
t_complications=1
pComp
No Complications
#
No Disorder
#
Test
t_test=1
+ Tx
Complications
t_complications=1
Net Benefits
Enter your willingness to pay:
50000
OK
Cancel
Help
Select calculation type:
Net monetary benefits
Net health benefits
#
- No Tx
t_treatment=0
spec
Treat All
t_treatment=1
Disorder
t_disorder=1
prev
Complications
t_complications=1
pComp
No Complications
#
No Disorder
#
c_complications=300
c_disorder=0
c_normal=100.
c_test=0
c_treatment=0
LEdet_complications=10
LEdet_disorder=3.
LEdet_treatment=0.05
LE_normal=15
pComp=if(t_treatment = 1; pComp_Treat; pComp_nTreat)
pComp_nTreat=0.8
pComp_Treat=0.3
prev=0.02
sens=.9
spec=.1
t_complications=0
t_disorder=0
t_test=0
Debug


Untitled Graph 17
Options
Actions
?
Tornado Diagram at
Prevalence of disorder: 0.01 to 0.8
Probability of complication if no treatment: .01 to 0.8
Life expectancy detriment from treatment: 0 to 1
500K
550K
600K
650K
700K
750K
Net Monetary Benefit (wtp=50000)


Untitled Graph 19
Convert To
Options
Excel Chart
Actions
?
Sensitivity Analysis on
Probability of complication if no treatment
Net Monetary Benefit (wtp=50000)
747K
747K
746K
746K
745K
745K
744K
744K
743K
743K
742K
742K
741K
741K
740K
740K
739K
739K
0.010
0.273
0.537
0.800
pComp_nTreat
Treat None
Test
Treat All
Threshold Values:
pComp_nTreat = 0.550
EV = 741K

Caveats

- Assumed full knowledge of
  - Future life expectancy
  - Future lifetime costs
- Inappropriate if payoffs without full lifetime info
  - Markov model

Thank you!