

Tutorial for Preparation of Assignment 2 and for Building a Decision Tree in Microsoft Excel Add-In 'TreePlan'

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BU MET AD 715 Quantitative & Qualitative Decision-Making

Example of Decision Tree Analysis

Problem Description:

A business owner is considering whether to open a new shop in City A.

There are three **decision alternatives**:

- (1) Open a small shop
- (2) Open a medium-sized shop
- (3) Do not open a shop

The amount of payoffs (profit) depends on the following **market conditions**:

- (1) Good Market
- (2) Average Market
- (3) Bad Market

The probabilities for Good Market, Average Market, and Bad Market are predefined.

For the purpose of the sensitivity analysis, the probability of Bad Market condition is given.

Payoff Table: Template

Task 2-1 Payoff Table Preparation & Simplified Decision Tree

The estimated payoffs and probabilities are shown as follows:

Alternatives	States of Nature		
	Good Market	Average Market	Bad Market
Small Shop	\$40,000	\$20,000	-\$15,000
Medium-sized shop	\$70,000	\$30,000	-\$50,000
No shop	\$0	\$0	\$0
Probability	0.3	0.4	0.3
Probability for Sensitivity Analysis	P	$0.6 - P$	$i = 0.4$
	0.6		

Payoff Table: Template

Task 2-1 Payoff Table Preparation & Simplified Decision Tree

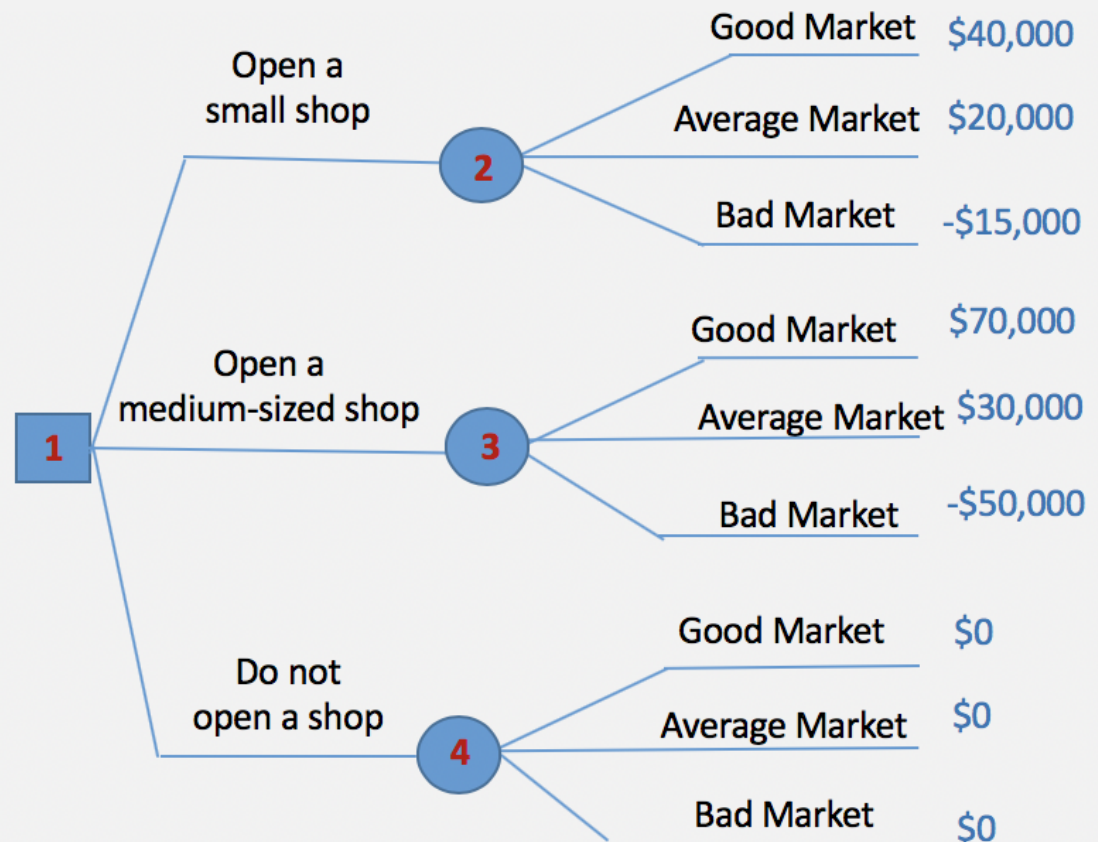
The estimated payoffs and probabilities are shown as follows:

Alternatives	States of Nature		
	Good Market	Average Market	Bad Market
Small Shop	\$40,000	\$20,000	-\$15,000
Medium-sized shop	\$70,000	\$30,000	-\$50,000
No shop	\$0	\$0	\$0
Probability	0.3	0.4	0.3

Task 2-1: Payoff Table Solution

Task 2-1 Payoff Table Preparation & Simplified Decision Tree (continued)

Based on the payoff table, we can draw the simplified decision tree (without probabilities and EMVs), where 1 is a decision node, and 2, 3, and 4 are chance nodes:



Task 2-2: EMV Calculation

Task 2-2: EMV Calculation

Based on the payoff table, the EMV for each decision alternative could be calculated as below:

(1) EMV (Small Shop) =

$$(\$40,000)*0.3 + (\$20,000)*0.4 + (-\$15,000)*0.3 = \$15,500$$

(2) EMV (Medium-Sized Shop) =

$$(\$70,000)*0.3 + (\$30,000)*0.4 + (-\$50,000)*0.3 = \$18,000$$

(3) EMV (No Shop) =

$$\$0*0.3 + \$0*0.4 + \$0*0.3 = \$0$$

Task 2-2: Solution – EMV Calculation

Task 2-2: EMV Calculation (continued)

Payoff Table Results:

Alternatives	States of Nature			EMV
	Good Market	Average Market	Bad Market	
Small Shop	\$40,000	\$20,000	-\$15,000	\$15,500
Medium-sized shop	\$70,000	\$30,000	-\$50,000	\$18,000
No shop	\$0	\$0	\$0	\$0
Probability	0.3	0.4	0.3	

Task 2-2: Solution

Task 2-2 Solution: The best EMV is EMV (Medium-sized shop)

Alternatives	States of Nature			EMV	Node
	Good Market	Average Market	Bad Market		
Small Shop	\$40,000	\$20,000	-\$15,000	\$15,500	2
Medium-sized shop	\$70,000	\$30,000	-\$50,000	\$18,000	3
No shop	\$0	\$0	\$0	\$0	4
Probability	0.3	0.4	0.3		

Final Decision	EMV	Node
Medium-sized Shop	\$18,000	1

Task 2-3: Sensitivity Analysis

Task 2-3: Sensitivity Analysis:

Let's assume that the probability of Bad Market condition is $i = 0.4$

Use sensitivity analysis to determine the probability range for Good Market which would change the business owner's decision. Draw a sensitivity chart and find the probability for the cross points.

Task 2-3: Sensitivity Analysis

The given information is that the probability of Bad Market is 0.4. Therefore, the total probability of Good Market and Average Market is 0.6. If we set **P** as the probability of Good Market, the probability of Average Market would be **(0.6-P)**.

Alternatives	States of Nature		
	Good Market	Average Market	Bad Market
Small Shop	\$40,000	\$20,000	-\$15,000
Medium-sized shop	\$70,000	\$30,000	-\$50,000
No shop	\$0	\$0	\$0
Probability	P	0.6 - P	0.4

Task 2-3: Sensitivity Analysis

Alternatives	States of Nature			EMV
	Good Market	Average Market	Bad Market	
Small Shop	\$40,000	\$20,000	-\$15,000	$\$20,000 * P + \$6,000$
Medium-sized shop	\$70,000	\$30,000	-\$50,000	$\$40,000 * P - \$2,000$
No shop	\$0	\$0	\$0	\$0
Probability	P	0.6-P	0.4	

$$\text{EMV (No shop)} = \$0 * P + \$0 * (0.6 - P) + \$0 * 0.4$$

$$= \$0$$

$$\text{EMV (Medium-sized shop)} = (\$70,000) * P + (\$30,000) * (0.6 - P) + (-\$50,000) * 0.4$$

$$= \$40,000 * P - \$2,000$$

$$\text{EMV (Small Shop)} = (\$40,000) * P + (\$20,000) * (0.6 - P) + (-\$15,000) * 0.4$$

$$= \$20,000 * P + \$6,000$$

Task 2-3: Sensitivity Analysis

In summary, we have the equations for the three EMVs (in dollars), where P is the probability of Good Market:

$$\text{EMV (Small Shop)} = \$20,000 * P + \$6,000$$

$$\text{EMV (Medium-sized shop)} = \$40,000 * P - \$2,000$$

$$\text{EMV (No shop)} = 0$$

When $P = 0$: $\text{EMV (Small Shop)} = \$6,000$

$$\text{EMV (Medium-sized Shop)} = -\$2,000$$

$$\text{EMV (No shop)} = \$0$$

When $P = 0.6$: $\text{EMV (Small Shop)} = \$18,000$

$$\text{EMV (Medium-sized Shop)} = \$22,000$$

$$\text{EMV (No shop)} = \$0$$

Now, we can use these points to draw the lines for EMVs to do sensitivity analysis.

Task 2-3: Sensitivity Analysis

Based on the previous equations, here are the three lines representing the EMVs for each decision alternatives respectively:

$$\begin{aligned} \$40,000 * P - \$2,000 &= \\ &= \$20,000 * P + \$6,000 \end{aligned}$$

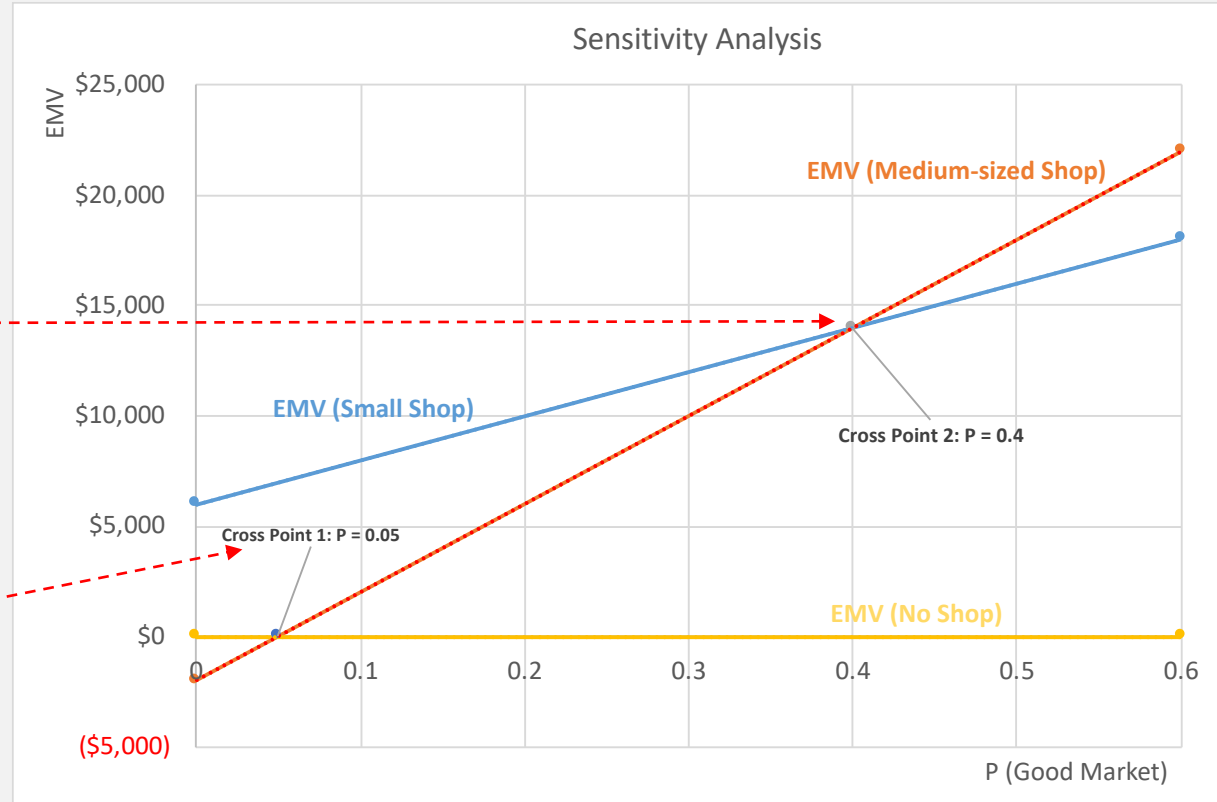
$$\begin{aligned} \$40,000 * P - \$20,000 * P &= \\ &= \$6,000 + \$2,000 \end{aligned}$$

$$\$20,000 * P = \$8,000$$

$$P = \$8,000 / \$20,000 = 0.4$$

$$\$40,000 * P - 2000 = 0$$

$$P = 2,000 / \$40,000 = 0.05$$



Task 2-3: Solution

From the sensitivity chart, it's obvious to see the **cross points**:

When **P = 0.05** $EMV(\text{Medium-sized Shop}) = EMV(\text{No Shop}) = \0 ;

When **P = 0.4** $EMV(\text{Small Shop}) = EMV(\text{Medium-sized Shop}) = \$14,000$

Probability ranges for Good Market:

When $0 < P(\text{Good Market}) < 0.4$ $EMV(\text{Small Shop})$ is the highest EMV , opening a small shop is the best choice.

When $0.4 < P(\text{Good Market}) < 0.6$ $EMV(\text{Medium-sized Shop})$ is the highest EMV , therefore opening a medium-sized shop is the best choice.

Task 2-4: Decision Tree in Excel Add-In 'TreePlan'

Use the following **Tutorial for Building a Decision Tree in Excel Add-in 'TreePlan':
A Step-By-Step Approach**

Step 1: Getting Started

Step 2: Adding Branch

Step 3: Naming Alternatives

Step 4: Adding chance node

Step 5: Naming Alternatives

Step 6: Copy Subtree

Step 7: Paste Subtree

Step 8: Inserting Values

Tutorial for Building a Decision Tree in Microsoft Excel Add-In 'TreePlan'

What is 'TreePlan'?

TreePlan = The Decision Tree Microsoft Excel Add-In

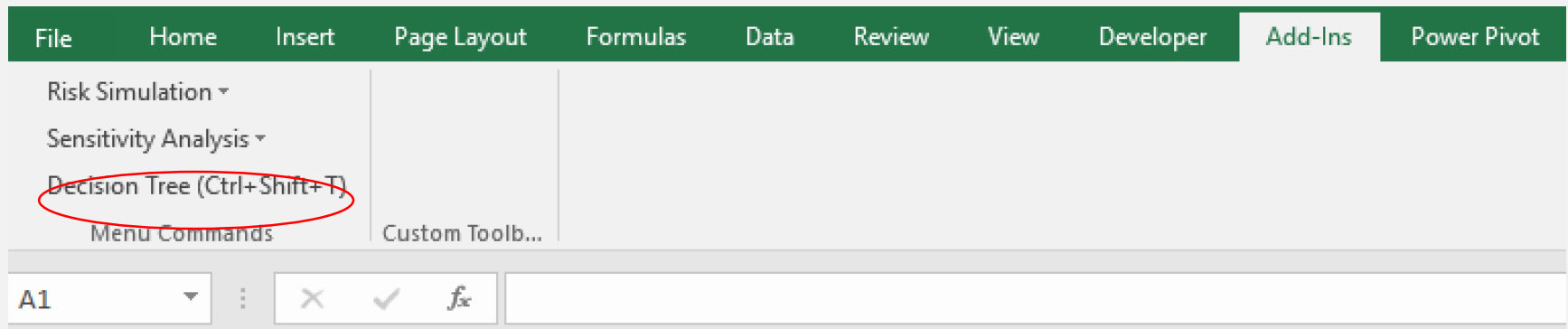
'TreePlan' helps you build a decision tree diagram in an Excel worksheet.

How to Get Access to Decision Tree using Excel Add-in 'TreePlan'?

Open V-Lab: <http://www.bu.edu/metit/hw-and-sw/virtual-labs/> and log in to your BU account

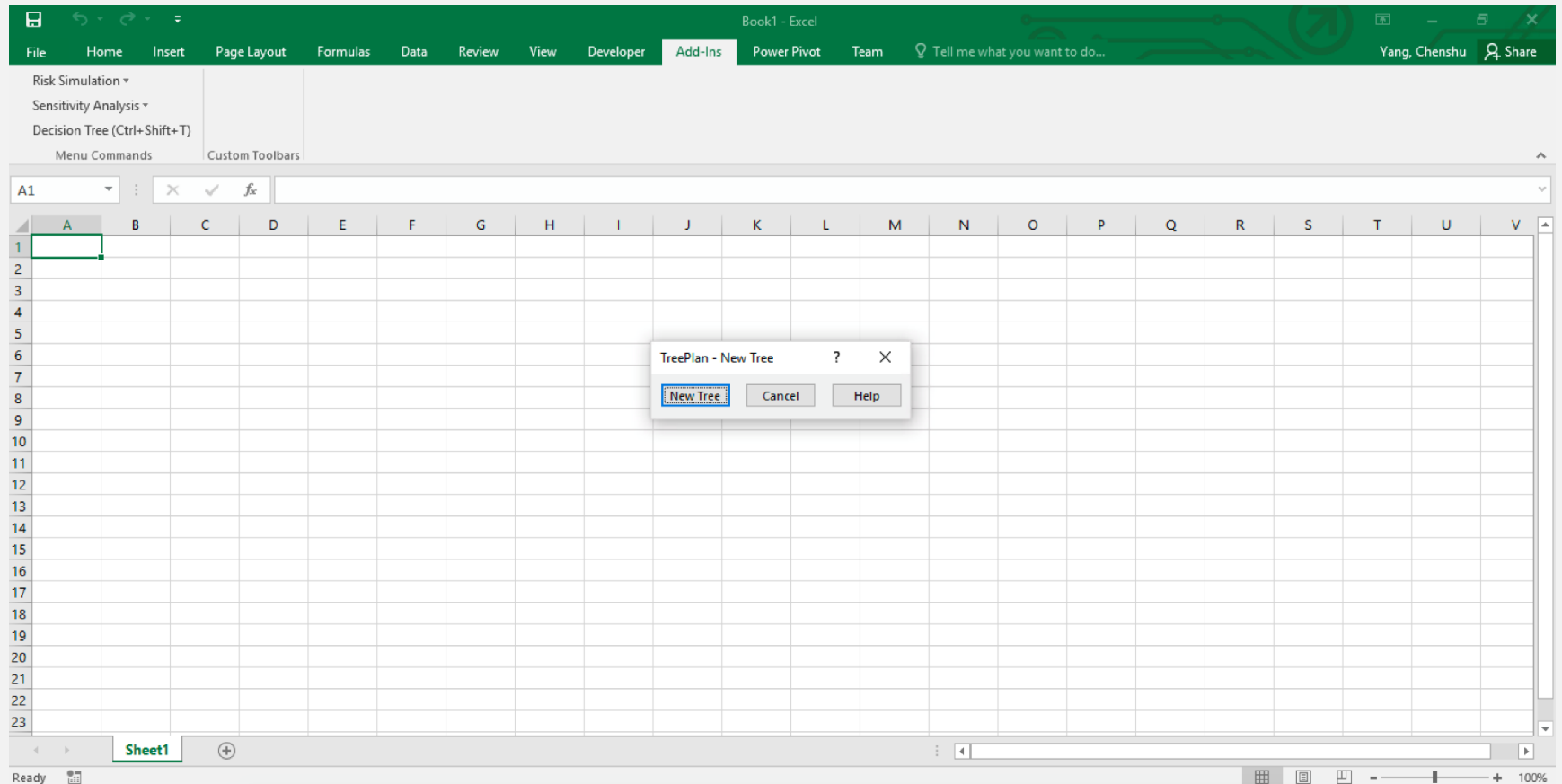
Click excel 2016 and open an new excel worksheet.

Choose Add-Ins → Decision Tree.



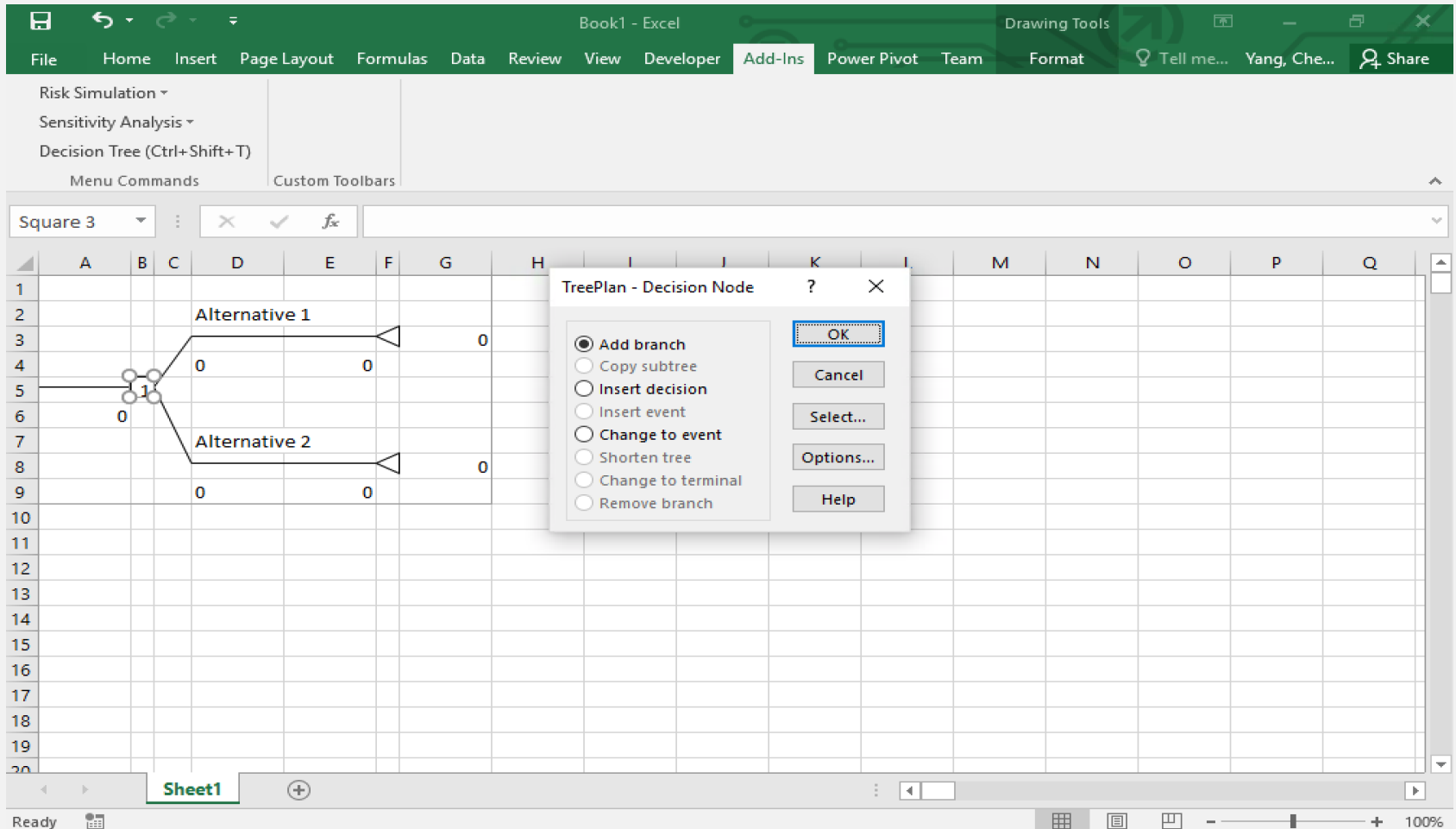
Tutorial for Building a Decision Tree in Microsoft Excel Add-In 'TreePlan'

Step 1: Getting Started. In a new worksheet, select cell A1. From **Add-Ins** tab choose **Decision Tree** from the **Menu Commands** group, then click **New Tree**



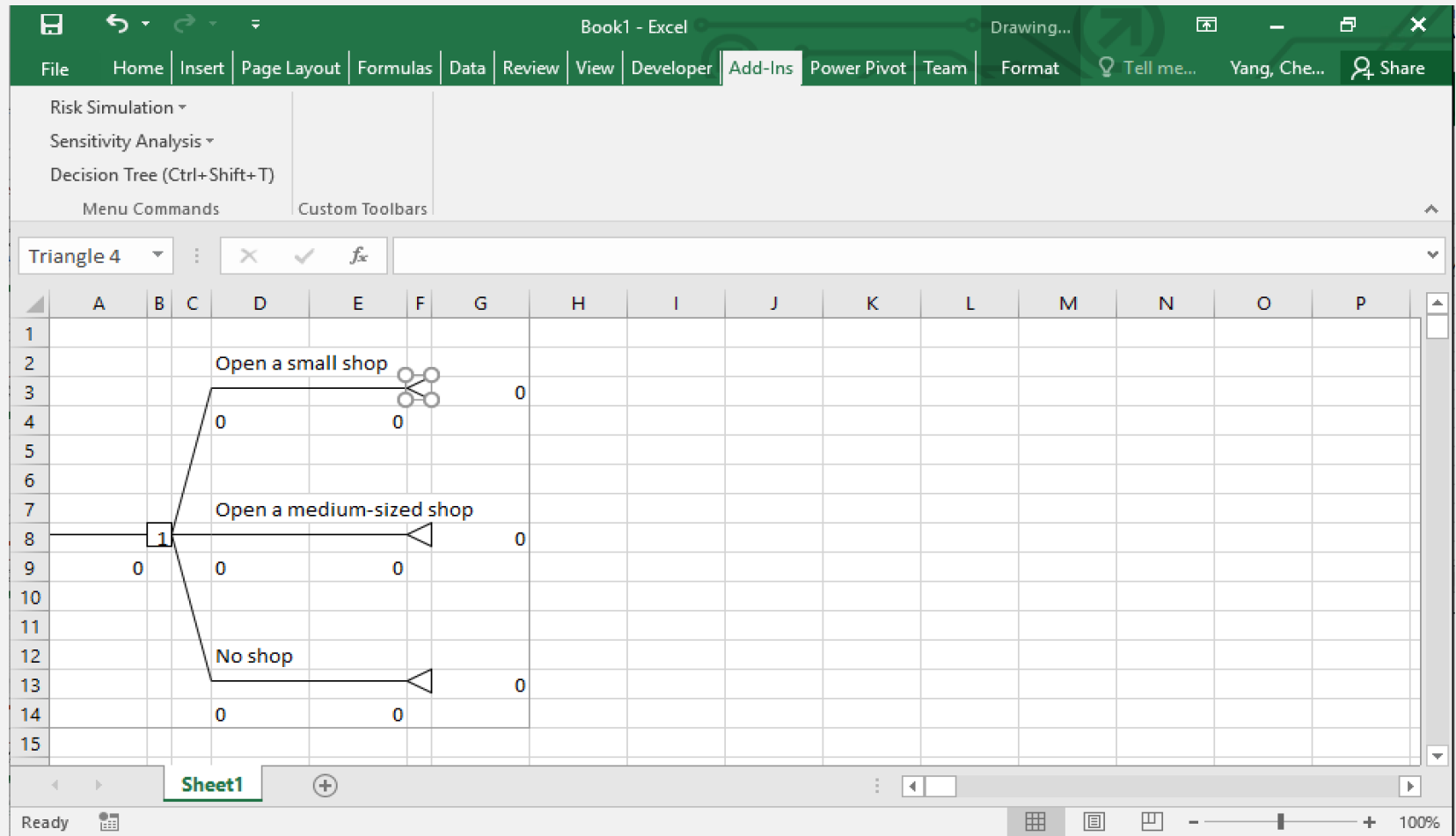
Tutorial for Building a Decision Tree in Microsoft Excel Add-In 'TreePlan'

Step 2: Adding Branch. Now the decision tree has two alternatives. Click cell B5, from **Add-Ins** tab choose Decision Tree from the **Menu Commands** group, click **Add Branch** and click **OK**.



Tutorial for Building a Decision Tree in Microsoft Excel Add-In 'TreePlan'

Step 3: Naming Alternatives. Entering “Open a small shop” in cell D2, “Open a medium-sized shop” in cell D7, and “No shop” in cell D12 instead of ‘Alternative 1’, ‘Alternative 2’ and ‘Alternative 3’.



Tutorial for Building a Decision Tree in Microsoft Excel Add-In 'TreePlan'

Step 4: Adding chance node. Click cell F3, choose Decision Tree from the Menu Commands group. Then select **Change to event node**. Select **Three** in the Branches section and Click **Ok**.

The screenshot shows the Microsoft Excel interface with the TreePlan add-in. The 'TreePlan - Terminal Node' dialog box is open, displaying the following options:

- ☐ Change to decision node
- ☒ Change to event node
- ☐ Paste subtree
- ☐ Remove previous branch

Buttons: OK, Cancel, Options..., Help, Select...

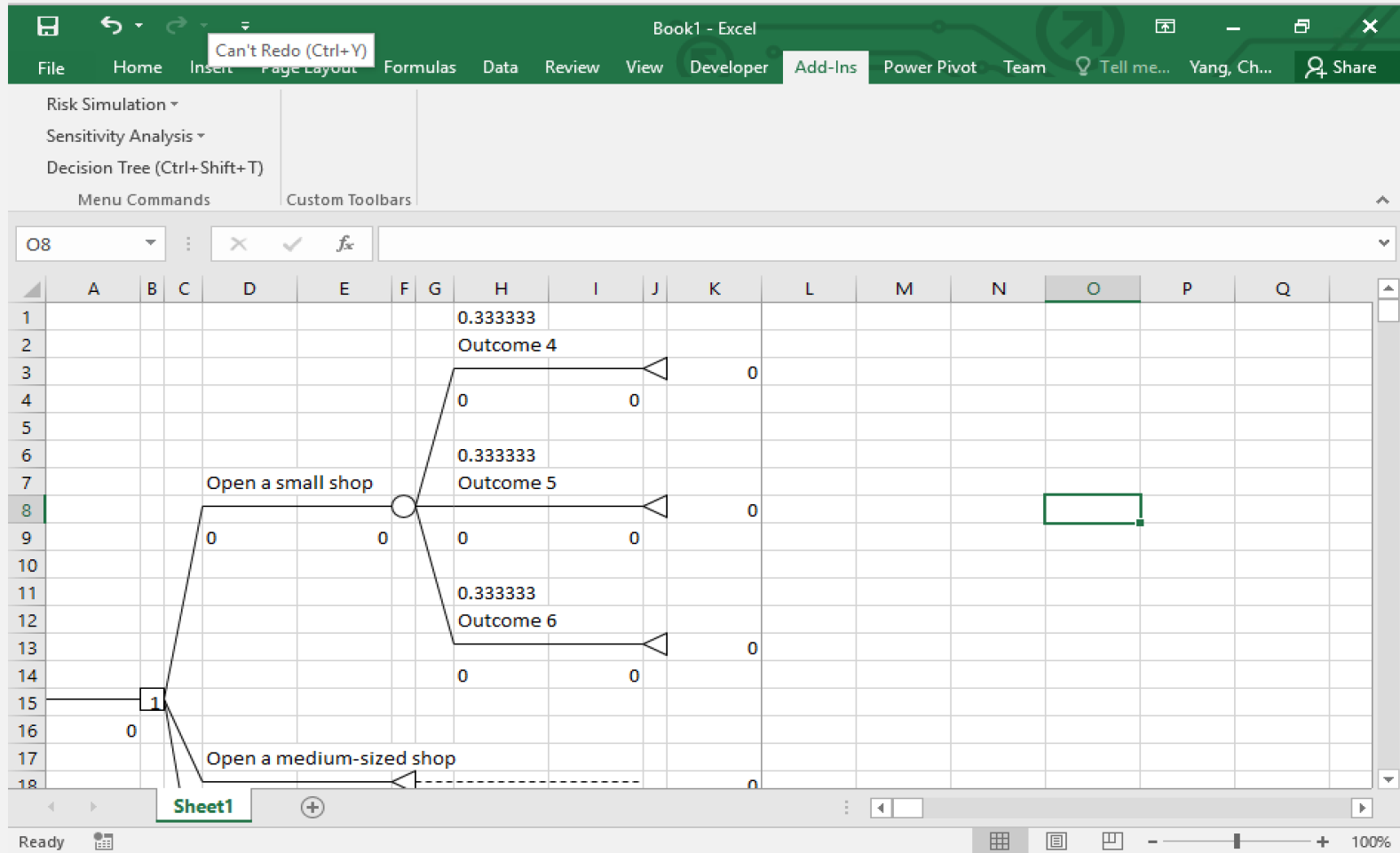
Branches section:

- ☐ One
- ☐ Two
- ☒ Three
- ☐ Four
- ☐ Five

The background shows a decision tree diagram with a decision node at cell F3 and three branches leading to chance nodes. The branches are labeled 'Open a small shop', 'Open a medium-sized shop', and 'No shop'. The values in the cells are 0.

Tutorial for Building a Decision Tree in Microsoft Excel Add-In 'TreePlan'

Step 5: Naming Alternatives. Entering “Good Market” in cell H2, “Average Market” in cell H6, and “Bad Market” in cell H11 instead of ‘Outcome 1’, ‘Outcome 2’ and ‘Outcome 3’.



Tutorial for Building a Decision Tree in Microsoft Excel Add-In 'TreePlan'

Step 6: Copy Subtree. Click on cell F8, choose Decision Tree from the **Menu Commands** group. Select **Copy Subtree**.

The screenshot shows the Microsoft Excel interface with the 'Add-Ins' tab selected. The 'TreePlan' add-in is visible in the ribbon, with the 'Menu Commands' group expanded. The 'Copy subtree' option is selected. A decision tree diagram is displayed on the worksheet, starting from a decision node in cell F8. The tree branches into three options: 'Open a small shop', 'Open a medium-sized shop', and 'Open a large shop'. Each option leads to a chance node, which then branches into three market scenarios: 'Good Market', 'Average Market', and 'Bad Market'. The probabilities for each market scenario are 0.333333. The expected monetary values (EMV) for each branch are calculated and displayed in the adjacent cells. The 'TreePlan - Event Node' dialog box is open, showing the 'Copy subtree' option selected.

TreePlan - Event Node

- ☐ Add branch
- ☒ Copy subtree
- ☐ Insert decision
- ☐ Insert event
- ☐ Change to decision
- ☐ Shorten tree
- ☐ Change to terminal
- ☐ Remove branch

Buttons: OK, Cancel, Select..., Options..., Help

Tutorial for Building a Decision Tree in Microsoft Excel Add-In 'TreePlan'

Step 7: Paste Subtree. Click on cell F18, choose Decision Tree from the **Menu Commands** group, then select **Paste subtree**.

The screenshot displays the Microsoft Excel interface with the 'TreePlan' add-in. The 'Menu Commands' group is expanded, showing 'Risk Simulation', 'Sensitivity Analysis', and 'Decision Tree (Ctrl+Shift+T)'. The 'Decision Tree' option is selected. The decision tree diagram is visible on the worksheet, showing a decision node (square) at cell F18 with three branches: 'Open a small shop', 'Open a medium-sized shop', and 'No shop'. The 'Open a small shop' branch leads to a chance node (circle) at cell G18, which has two branches: 'Average Market' and 'Bad Market'. The 'Open a medium-sized shop' branch leads to a chance node (circle) at cell G19, which has two branches: 'Average Market' and 'Bad Market'. The 'No shop' branch leads to a terminal node (triangle) at cell J18. The 'TreePlan - Terminal Node' dialog box is open, showing the 'Paste subtree' option selected under the 'Change to' section. The 'Branches' section shows 'Two' selected. The 'OK' button is highlighted.

TreePlan - Terminal Node

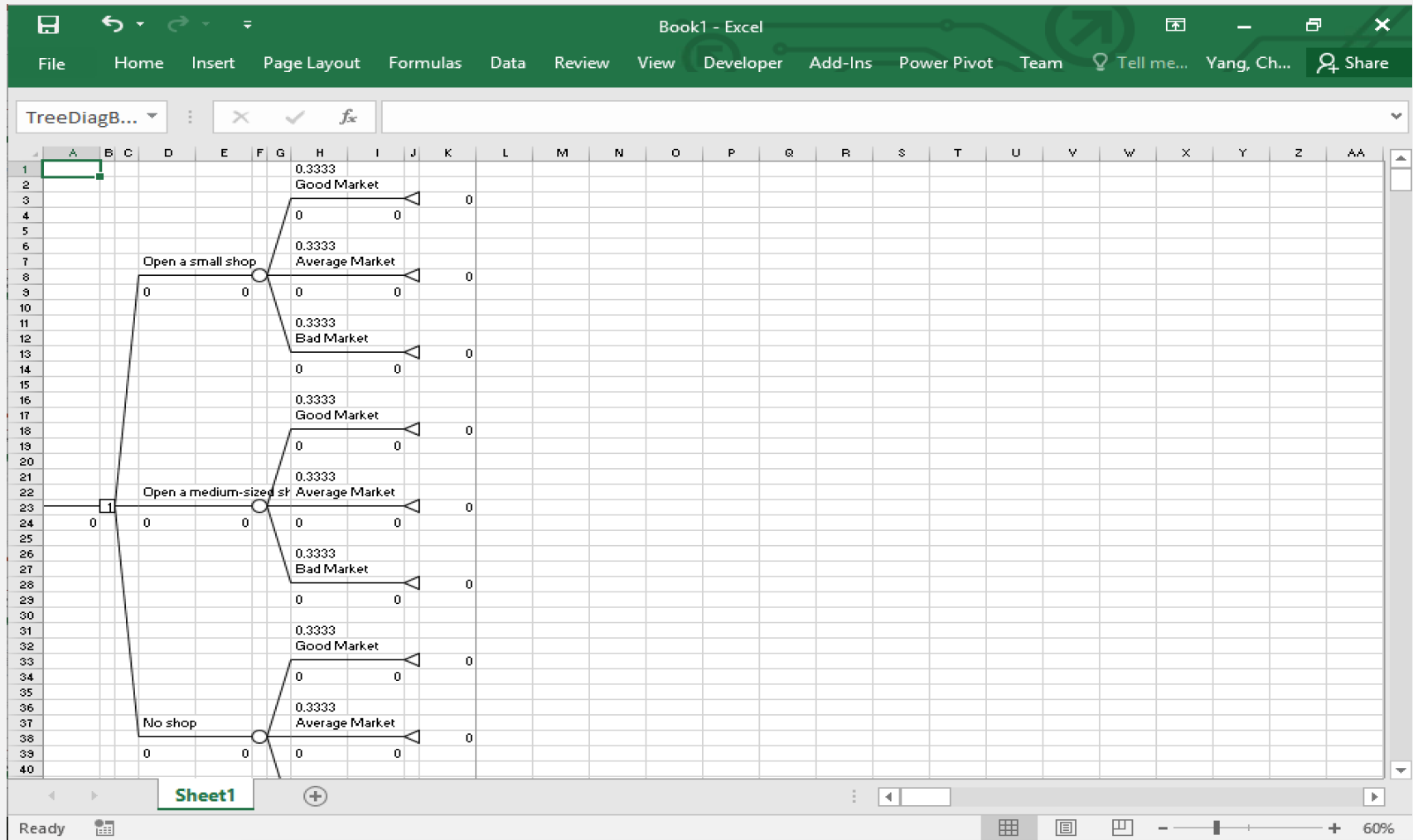
☐ Change to decision node
☐ Change to event node
☒ Paste subtree
☐ Remove previous branch

Branches
☐ One
☒ Two
☐ Three
☐ Four
☐ Five

OK Options... Cancel Help Select...

Tutorial for Building a Decision Tree in Microsoft Excel Add-In 'TreePlan'

Step 7 (Continued): Click on cell F8, **Copy Subtree**, and click cell F33 and **Paste the Subtree**, the decision tree will be shown as the following:



Tutorial for Building a Decision Tree in Microsoft Excel Add-In 'TreePlan'

Step 8: Inserting Values. List the values for each branch based on the given payoff tables.

- In cell H1, H11, H16, H26, H31 and cell H41, input 0.3;
- In cell H6, H21 and cell H36, input 0.4.
- In cell K3, K8 and cell K13, input value \$40,000, \$20,000, -\$15,000 respectively.
- In cell K18, cell K23, and cell K28, input value \$70,000, \$30,000, -\$50,000 respectively.

The EMV of the decision tree will be calculated automatically by Excel.

The best EMV is \$18,000, which is opening a medium-sized shop.

Tutorial for Building a Decision Tree in Microsoft Excel Add-In 'TreePlan'

Step 8 (Continued): EMV Calculation by Excel

- Excel Add-in 'TreePlan' will automatically calculate the EMV for each chance node and give the best EMV of the each decision node.
- The best EMV is \$18,000. Therefore, open a medium-sized shop is the best choice.

