

Financial Models for Laboratory Decision Making

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March 19, 2015

Introduction

Laboratory personnel are periodically confronted with complex decisions such as buy versus lease, add a new test to the menu or bring a reference test in-house. Such decisions are often made with simple models that do not adequately capture risk, incorporate alternative courses of action, or allow for sequential decisions that evolve over time. As a result, decision makers often obtain suboptimal results.

In this webinar, cutting edge techniques that incorporate risk, facilitate the comparison of multiple alternatives, and provide insight into common laboratory decisions will be presented. Attendees will receive training in building financial models using Microsoft Excel and Palisade Decision Tools, a popular add-in.

Participants will learn to use decision trees and simulation models and then apply their knowledge to analyze whether to perform a test in house or send it to a reference laboratory.

Learning Objectives

- Determine when advanced modeling techniques are likely to be helpful
- Explain how simulation models are used to incorporate risk analysis in decisions
- Build simple models using Excel add-ins to analyze problems using decision trees and simulation

Session Faculty

Robert Schmidt, MD, PhD, MBA

- Medical Director, ARUP Laboratories
- Areas of Expertise
 - Quantitative Analysis/Modeling
 - Clinical Epidemiology
 - Operations Management
 - Diagnostic Testing
 - Cost Effectiveness Analysis
 - Meta-Analysis
 - Literature Evaluation
 - Laboratory Utilization
- Past Life
 - Assistant Professor, Operations Management, University of Minnesota
 - Associate Professor, Operations Management, University of Southern California

Session Faculty

Suzanne Carasso, MBA, MT (ASCP)

Director, Business Solutions Consulting, ARUP Laboratories

- Consulting Director, ARUP Laboratories
- Areas of Expertise:
 - Healthcare strategies for transitioning from volume to value based care
 - Laboratory legal structure and business models
 - Value analysis and development of lab value proposition
 - Strategy/business planning
 - Market, operations and financial analyses
- Education
 - B.S. Medical Technology, University of Tennessee
 - MBA, University of Colorado at Denver

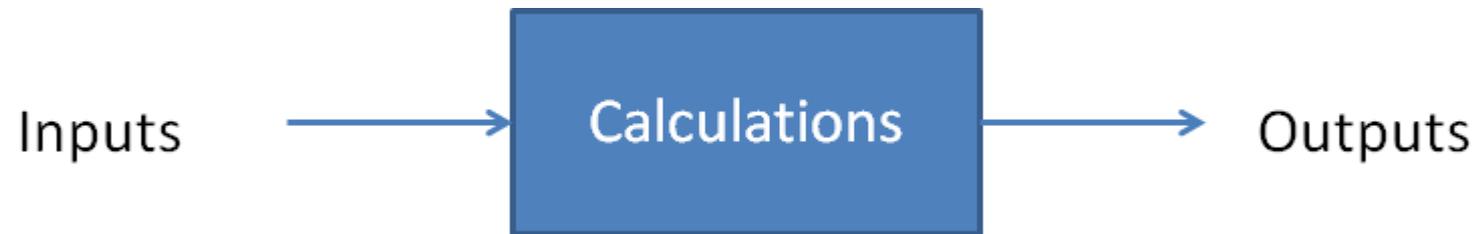
The purpose of this webinar is to educate participants to *make better decisions* in the clinical and anatomic pathology laboratory using financial models and risk-based analysis.

- Understand financial models
- Analyze risk
- Demonstrate tools for risk analysis

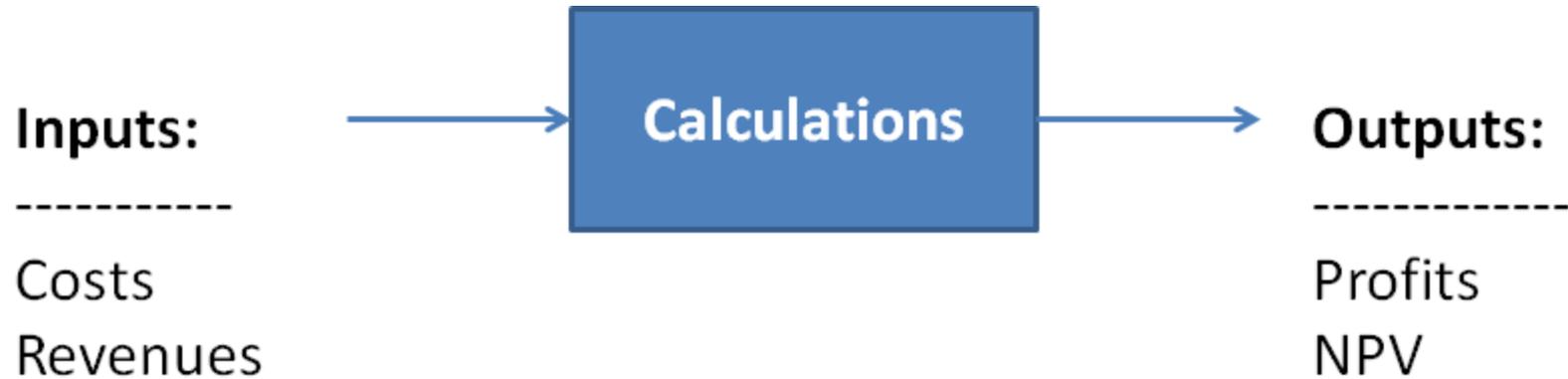
What is a financial model?

Total Revenue		\$750,000	\$2,700,000	\$5,100,000	\$7,500,000	\$9,900,000	\$25,950,000
Expenses	Pre-launch	Year 1	Year 2	Year 3	Year 4	Year 5	
Outreach Program Manager (Pre=1)	\$124,800	\$128,544	\$132,400	\$136,372	\$140,463	\$144,677	
Marketing/Sales Rep (Yr2=1, Yr3=2)			\$66,560	\$133,117	\$133,170	\$143,343	
Commissions			\$38,500	\$72,000	\$72,000	\$72,000	
IT Development/Customer Support (Pre=0.5, Yr2=2)	\$31,200	\$63,336	\$127,636	\$131,465	\$133,409	\$139,471	
PSC Phlebotomists (Yr1=2.4, Yr2=4.8, Yr3=7.2)		\$119,808	\$243,210	\$366,720	\$377,722	\$389,034	
Benefits @ 25%	\$39,000	\$77,922	\$157,077	\$210,419	\$216,191	\$222,137	
Total Salary Expense	\$195,000	\$389,610	\$785,383	\$1,052,093	\$1,080,956	\$1,110,685	
Cost/Test (supplies/disposables/reagents)		\$184,890	\$701,603	\$1,325,251	\$1,848,898	\$2,572,543	
Reference Testing		\$30,100	\$180,361	\$340,681	\$301,002	\$661,323	
Billing	Evaluate/Select	\$60,000	\$202,500	\$337,000	\$323,000	\$693,000	
Sales Entertainment/Expenses			\$12,000	\$24,000	\$24,000	\$24,000	
Sales - cell phones		\$1,200	\$2,400	\$2,400	\$2,400	\$2,400	
Mileage			\$8,230	\$16,300	\$16,300	\$16,300	
Courier	Evaluate/Select	\$43,000	\$162,000	\$306,000	\$430,000	\$394,000	
IT Solution	\$100,000	\$42,000	\$42,000	\$42,000	\$42,000	\$42,000	
Client EMR Interface Estimates		\$60,000	\$73,000	\$73,000	\$73,000	\$73,000	
Client IT Hardware		\$4,800	\$6,000	\$6,000	\$6,000	\$6,000	
Marketing Expenses		\$3,000	\$3,000	\$3,000	\$3,000	\$3,000	
Office Supplies		\$10,000	\$10,000	\$10,000	\$10,000	\$10,000	
Patient Service Center Leases		\$140,000	\$280,000	\$420,000	\$420,000	\$420,000	
Total Operating Expenses	\$100,000	\$612,990	\$1,687,114	\$2,929,832	\$4,025,800	\$5,121,768	
Total Expenses	\$295,000	\$1,002,600	\$2,472,497	\$3,981,925	\$5,106,756	\$6,232,452	\$19,091,231
Contribution	(\$295,000)	(\$252,600)	\$227,503	\$1,118,075	\$2,393,244	\$3,667,548	\$6,858,769

Financial Model



Financial Model



Financial Models

- Always wrong
- Sometimes useful

Examples of “Wrong” Models

- Ideal gas laws
- Newtonian fluids
- Laws of motion (ignore friction, point masses)
- Perfect competition

How are models useful?

- Eliminate bad ideas
- Provide insight
 - Relationships between variables
 - Uncertainty
- Provide predictions
 - Don't need to be perfect
 - “fit for use”

Simple Example

$$\text{Cost} = \text{Labor} + \text{Reagents} + \text{Overhead}$$

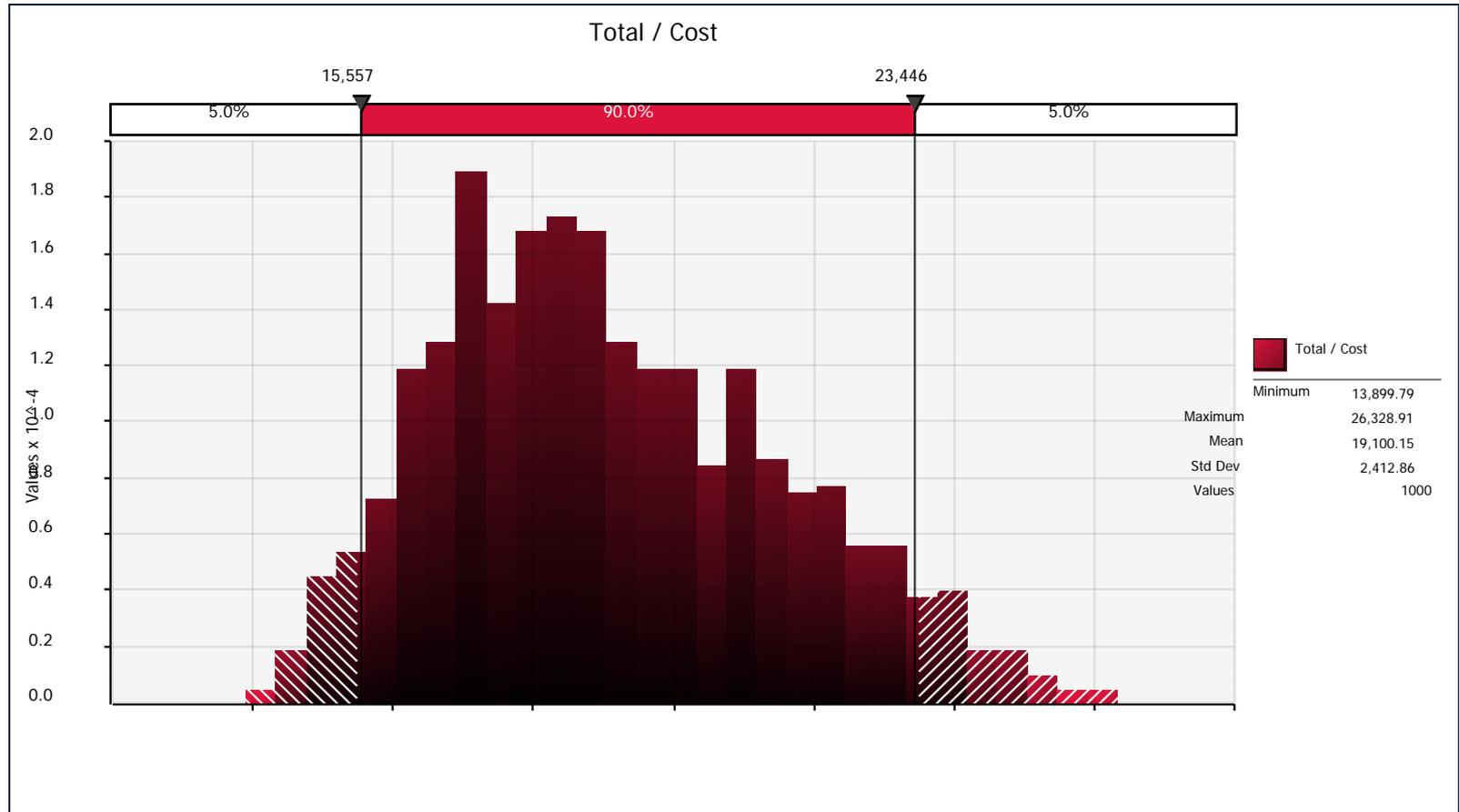
Item	Cost
Labor	10,000
Reagents	5,000
Supplies	2,000
Total	17,000

What about uncertainty?



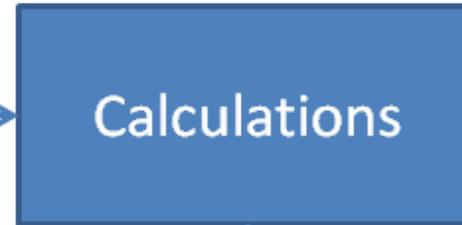
Item	Cost	min	most likely	max
Labor	10,000	7,000	10,000	18,000
Reagents	5,000	4,000	5,000	6,500
Supplies	2,000	1,800	2,000	3,000
Total	17,000			

Distribution of Total Cost

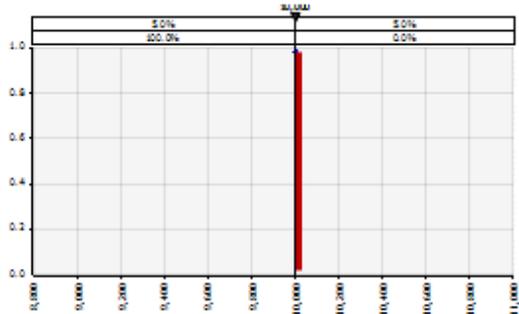


Old Way (point estimate)

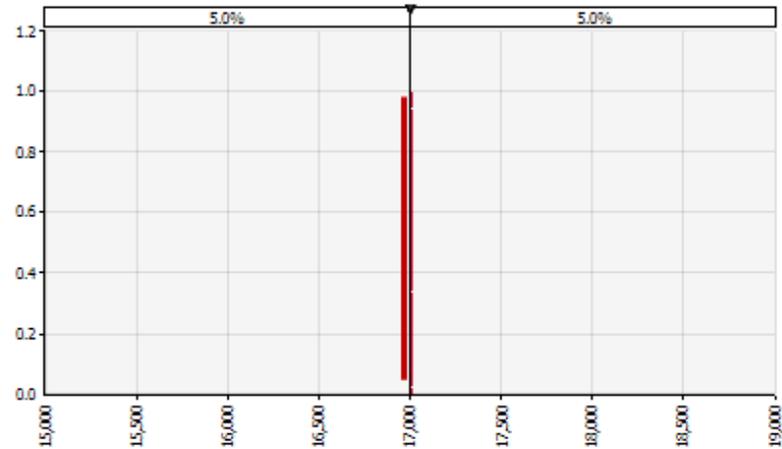
Item	Cost
Labor	10,000
Reagents	5,000
Supplies	2,000
Total	17,000



Labor cost

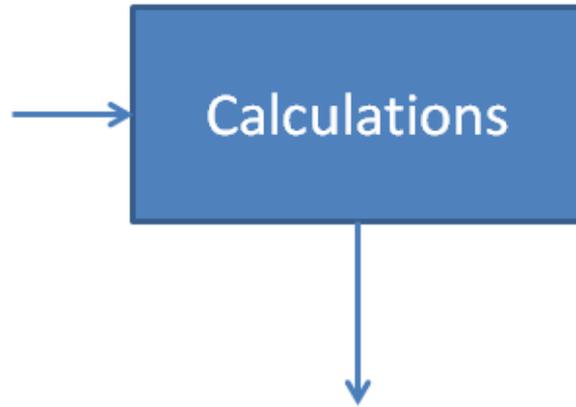


Total cost

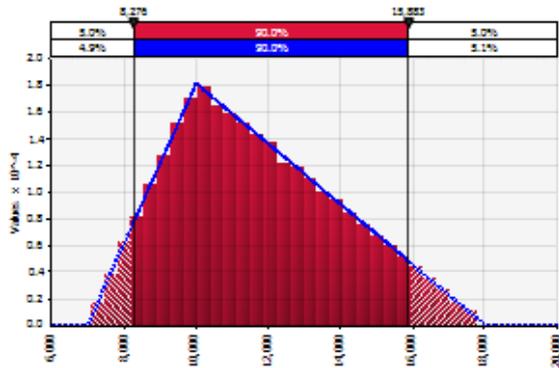


New Way (probabilistic estimate)

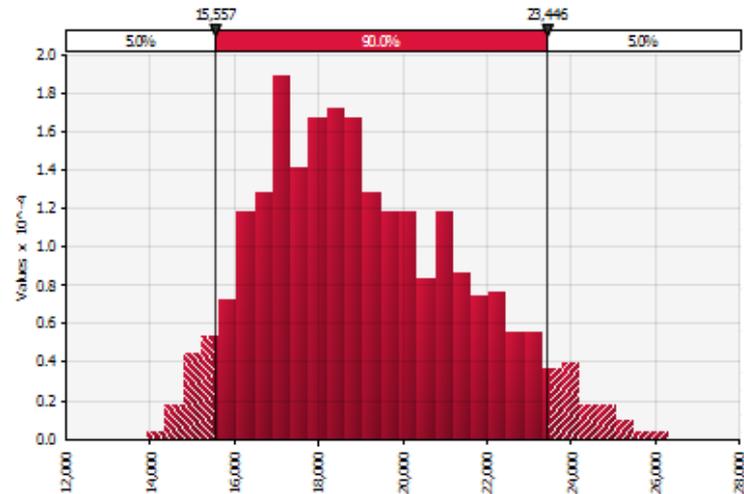
Item	Cost	min	most likely	max
Labor	10,000	7,000	10,000	18,000
Reagents	5,000	4,000	5,000	6,500
Supplies	2,000	1,800	2,000	3,000
Total	17,000			



Labor cost



Total cost



How to do it (continued)

- Open Excel
- Click the @Risk Toolbar



Example 1 Simple - Microsoft Excel

File Home Insert Page Layout Formulas Data Review View Developer Add-Ins Acrobat PrecisionTree @RISK

Define Add Insert Define Distribution Fitting Model Window

Iterations: 1000
Simulations: 1
Settings

Start Simulation

Excel Reports Browse Results

Summary Define Filters

Tools Help

	A	B	C	D	E	F	G	H	I	J	K
1	Item	Cost	min	most likely	max						
2	Labor	10,000	7,000	10,000	18,000						
3	Reagents	5,000	4,000	5,000	6,500						
4	Supplies	2,000	1,800	2,000	3,000						
5	Total	17,000									

How to do it (continued)

- Click on Cell B2
- Click on Define Distributions

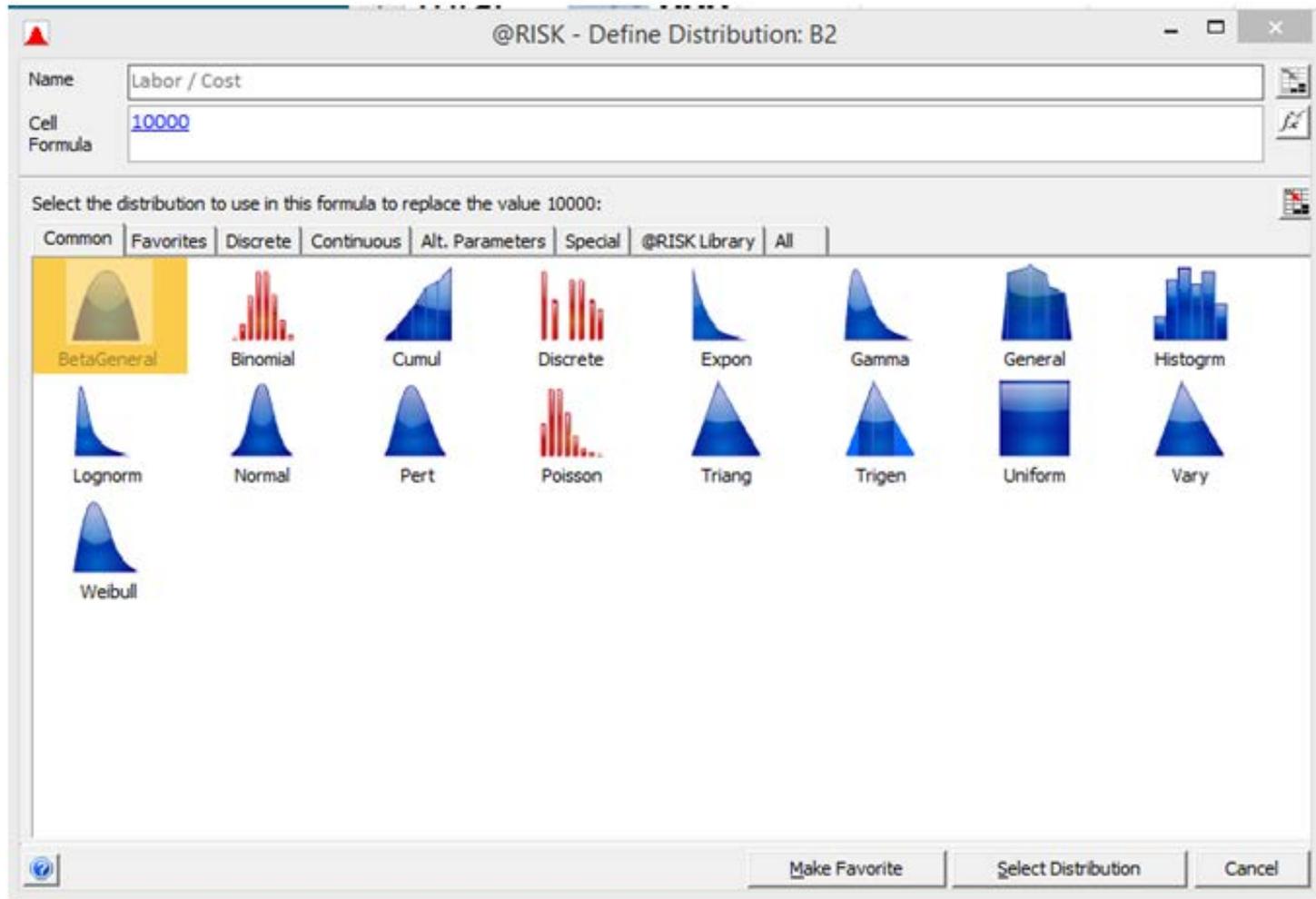


The screenshot shows the Microsoft Excel interface with the @RISK ribbon active. The ribbon includes sections for Model (Define Distributions, Add Output Function, Define Correlations, Distribution Fitting, Model Window), Simulation (Iterations, Simulations, Settings, Start Simulation), and Results (Excel Reports, Browse Results, Define Filters, Summary, Tools, Help). The formula bar displays the function `=RiskTriang(7000,10000,18000,RiskStatic(10000))` for cell B2. The data table below is as follows:

	A	B	C	D	E	F	G	H	I	J	K
1	Item	Cost	min	most likely	max						
2	Labor	10,000	7,000	10,000	18,000						
3	Reagents	5,000	4,000	5,000	6,500						
4	Supplies	2,000	1,800	2,000	3,000						
5	Total	17,000									
6											

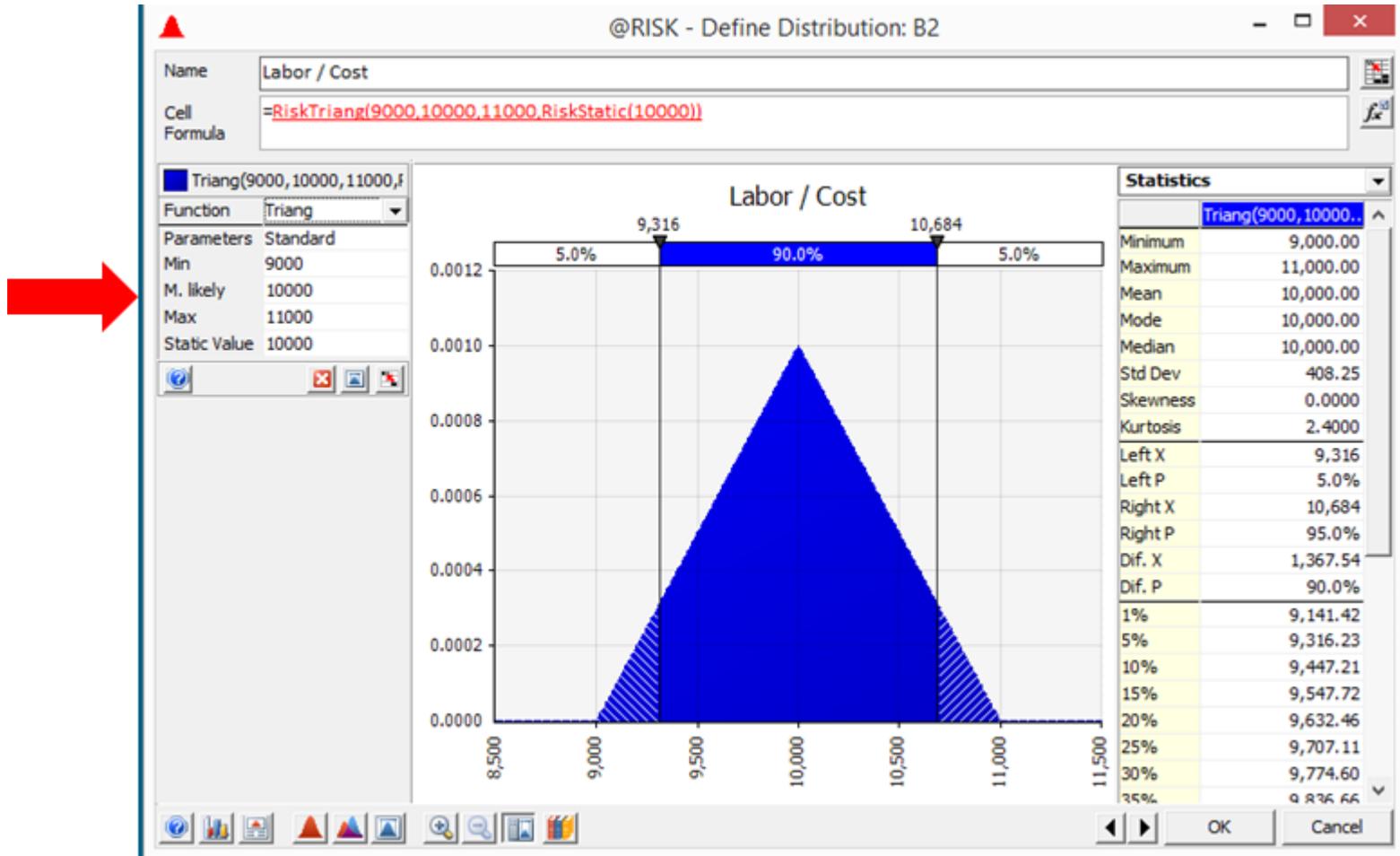
How to do it (continued)

Click on Triang



How to do it (continued)

Enter minimum, most likely, maximum



How to do it (continued)

- Repeat for Reagent Costs
- Repeat for Supplies
 - Enter min, most likely, max

The screenshot shows the Microsoft Excel interface with the @RISK add-in. The ribbon includes tabs for File, Home, Insert, Page Layout, Formulas, Data, Review, View, Developer, Add-Ins, Acrobat, PrecisionTree, and @RISK. The @RISK ribbon has sections for Model (Define Distributions, Add Output Function, Insert Correlations), Simulation (Iterations: 1000, Simulations: 1, Start Simulation), Results (Excel Reports, Browse Results), and Tools (Summary, Define Filters, Tools, Help). The formula bar shows the formula for cell B3: `=RiskTriang(5000,5000,5000,RiskStatic(5000))`. The spreadsheet data is as follows:

	A	B	C	D	E	F	G	H	I	J	K
1	Item	Cost	min	most likely	max						
2	Labor	10,000	7,000	10,000	18,000						
3	Reagents	5,000	4,000	5,000	6,500						
4	Supplies	2,000	1,800	2,000	3,000						
5	Total	17,000									

How to do it (continued)

- **Designate Output Cell**
 - Click on B5 (Total)
 - Click on Add Output



The screenshot shows the Microsoft Excel interface with the @RISK ribbon active. The ribbon includes buttons for 'Define Distributions', 'Add Output', 'Insert Function', 'Define Correlations', 'Distribution Fitting', and 'Model Window'. The 'Add Output' button is highlighted with a yellow border. The formula bar shows the formula `=RiskOutput()+SUM(B2:B4)` for cell B5. The spreadsheet data is as follows:

	A	B	C	D	E	F	G	H	I	J	K
1	Item	Cost	min	most likely	max						
2	Labor	10,000	7,000	10,000	18,000						
3	Reagents	5,000	4,000	5,000	6,500						
4	Supplies	2,000	1,800	2,000	3,000						
5	Total	17,000									
6											
7											

How to do it (continued)

Click OK on dialog box

The screenshot shows a Microsoft Excel window titled "Example 1 Simple - Microsoft Excel". The ribbon includes "File", "Home", "Insert", "Page Layout", "Formulas", "Data", "Review", "View", "Developer", "Add-Ins", "Acrobat", "PrecisionTree", and "@RISK". The "@RISK" tab is active, showing options like "Define Distributions", "Add Output", "Insert Function", "Define Correlations", "Distribution Fitting", "Model Window", "Iterations" (set to 1000), "Simulations" (set to 1), "Start Simulation", "Excel Reports", "Browse Results", "Summary", "Define Filters", "Tools", and "Help".

The active cell is B5, containing the formula `=RiskOutput()+SUM(B2:B4)`. The spreadsheet data is as follows:

	A	B	C	D	E	F	G	H	I	J	K
1	Item	Cost	min	most likely	max						
2	Labor	10,000	7,000	10,000	18,000						
3	Reagents	5,000	4,000	5,000	6,500						
4	Supplies	2,000	1,800	2,000	3,000						
5	Total	17,000									

A dialog box titled "@RISK - Add/Edit Output: Cell B5" is open over cell B5. It has a "Name:" field containing "Total / Cost" and buttons for "Remove", "OK", and "Cancel".

How to do it (continued)

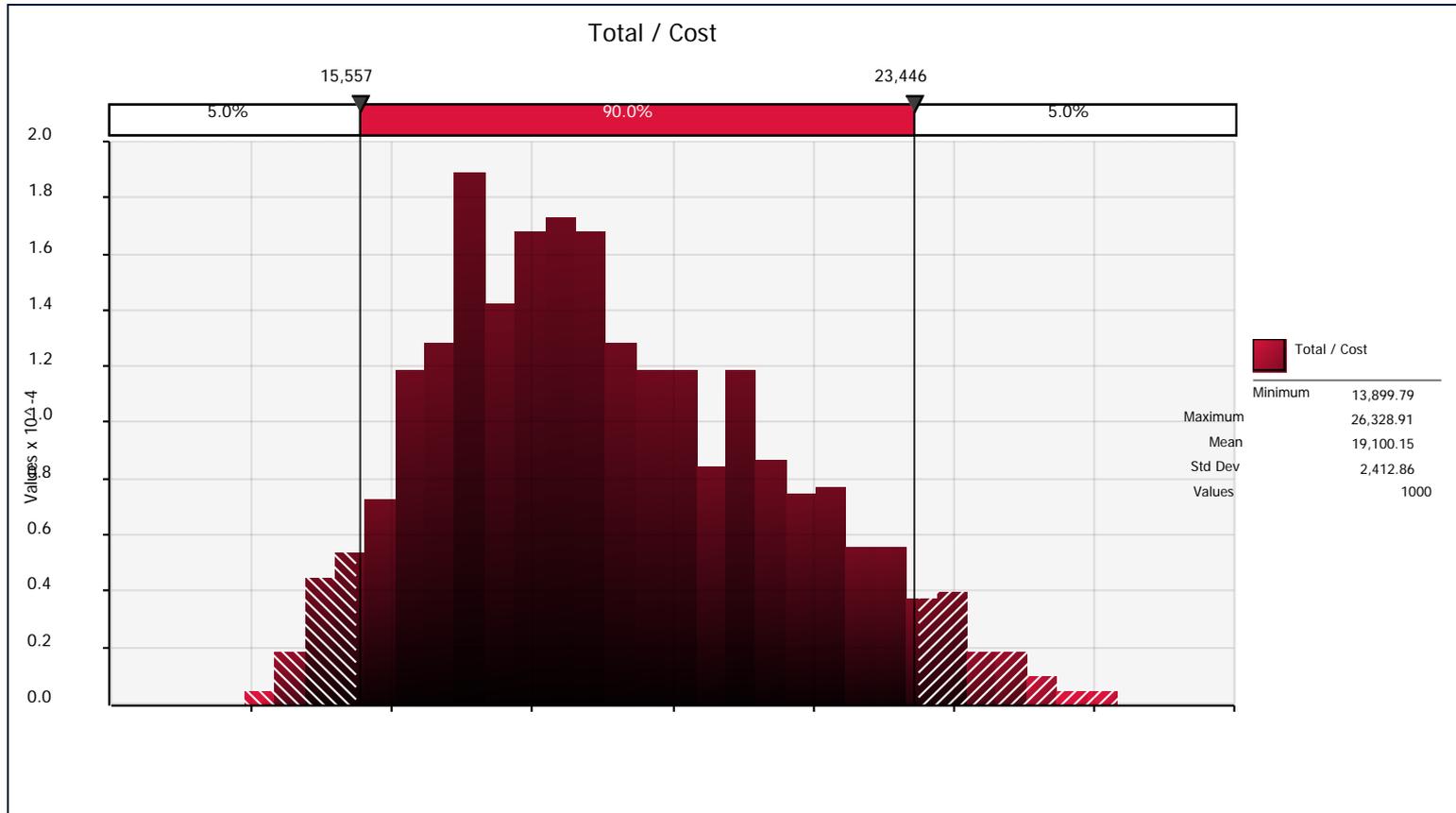
Set the iterations to 1000

Click “Start Simulation”

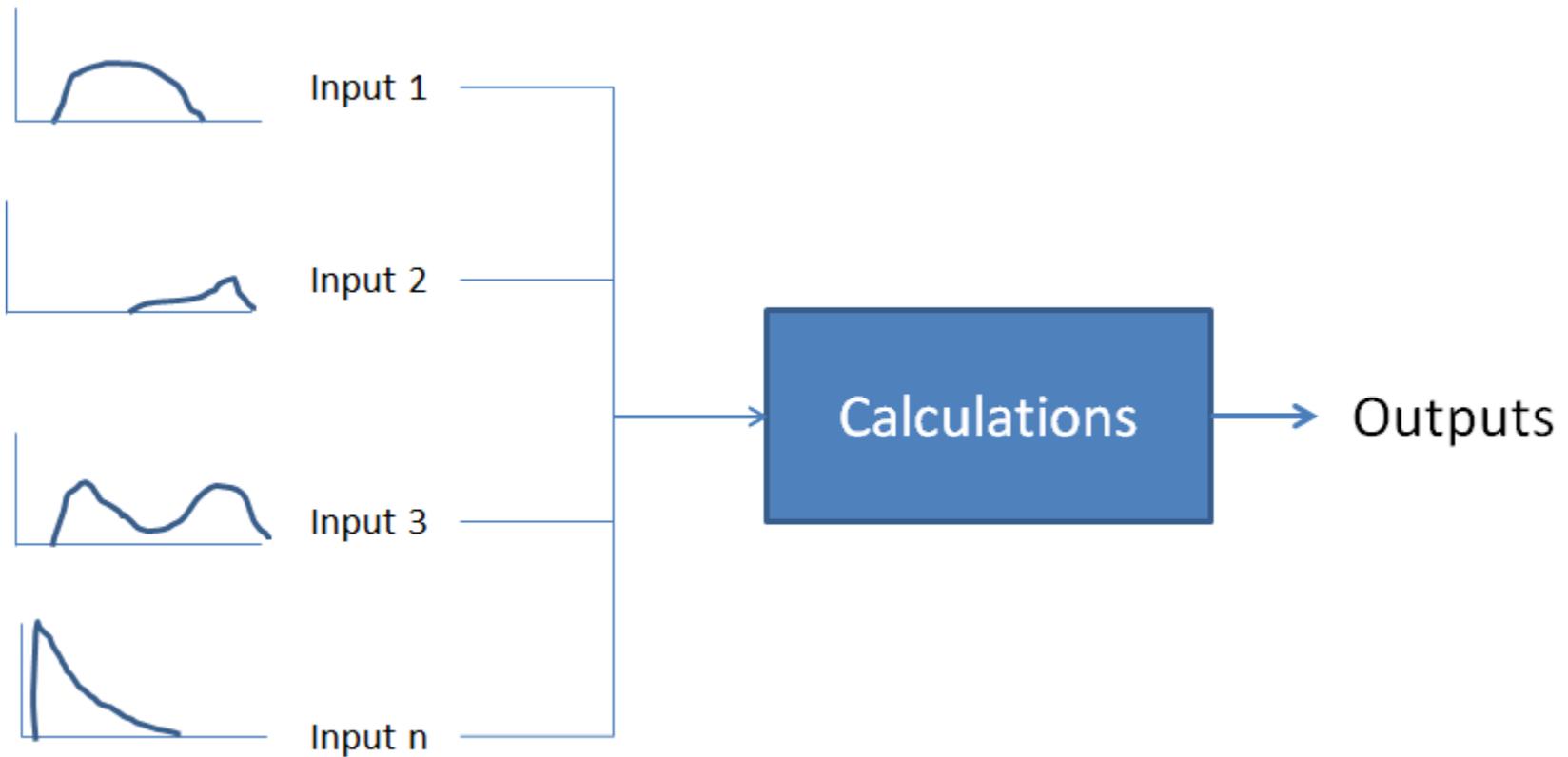
The screenshot displays the Microsoft Excel interface with the @RISK ribbon active. The ribbon includes sections for Model, Simulation, and Results. In the Simulation section, the 'Iterations' dropdown is set to 1000, and the 'Start Simulation' button is highlighted. Two blue arrows point to these elements. The spreadsheet below shows a table with the following data:

	A	B	C	D	E	F	G	H	I	J	K
1	Item	Cost	min	most likely	max						
2	Labor	10,000	7,000	10,000	18,000						
3	Reagents	5,000	4,000	5,000	6,500						
4	Supplies	2,000	1,800	2,000	3,000						
5	Total	17,000									

Voila!



Each input has a distribution



Repeat calculations 1,000 times

obtain inputs from distributions

Trial	Total Cost	Labor	Reagents	Supplies
1	15,125	8,578	4,165	2,381
2	20,386	12,685	5,344	2,358
3	18,825	12,745	4,061	2,019
4	17,812	10,168	5,594	2,050
5	22,887	15,754	4,769	2,363
6	18,497	11,668	4,256	2,573
7	17,962	10,822	4,484	2,655
8	17,584	11,084	4,592	1,908
9	19,706	12,833	4,694	2,179

The Question:

How can we apply this theory to a realistic laboratory scenario?

The Answer:

Create a realistic scenario.

The Scenario:

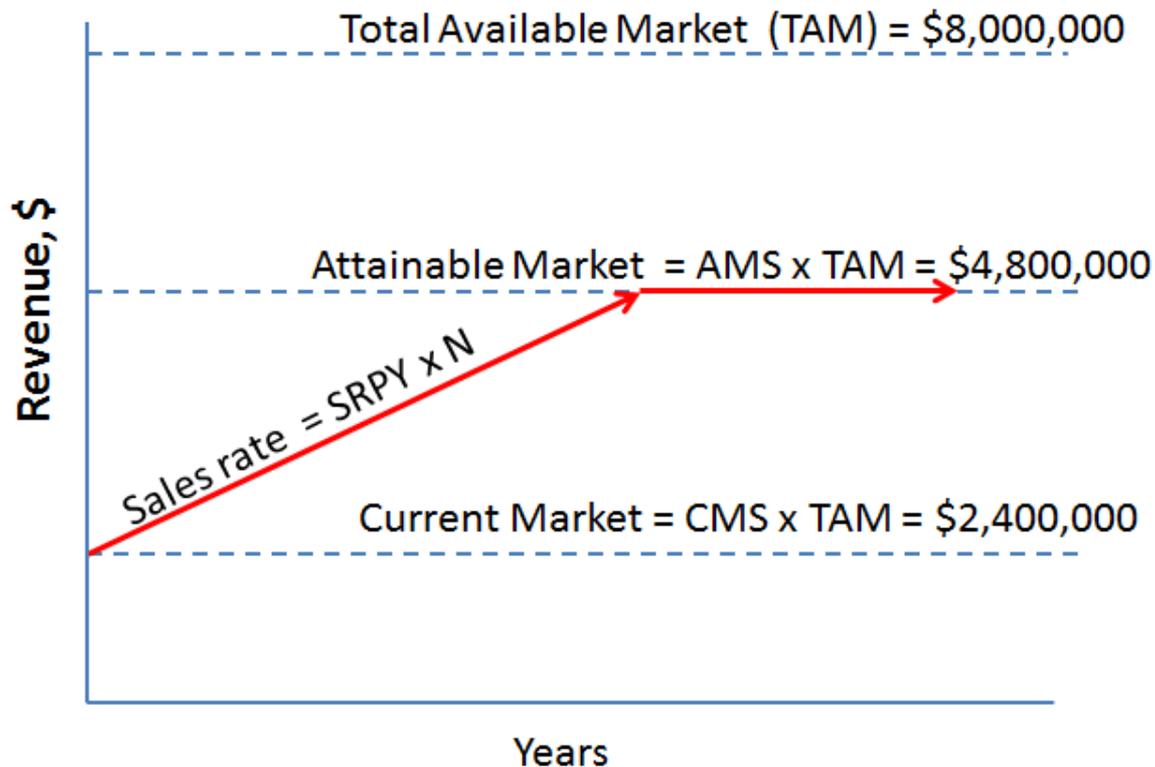
Build a financial model using a sales forecast and five-year proforma to determine the rate at which the laboratory sales team will capture the attainable market

The Process:

- Define inputs for sales forecast
- Identify sources of uncertainty in sales forecast
- Develop 5-year forecast and financial projections
- Evaluate net present value
- Analyze one-way sensitivity analysis: Tornado Diagram
- Analyze two-way sensitivity analysis: Strategy Map

Sales Forecast requires five inputs

- Total Available Market (TAM)
- Attainable Market Share (AMS)
- Current Market Share (CMS)
- Sales Rate per person year (SRPY)
- Number of sales persons (N)



Sales Forecast – Sources of Uncertainty

Sales Forecast Inputs	Input Value	Minimum	Most Likely	Maximum
Total Available Market (TAM)	\$8,000,000	\$7,000,000	\$8,000,000	\$9,000,000
Attainable Market Share (AMS)	60%	50%	60%	70%
Current Market Share (CMS)	30%	25%	30%	35%
Sales Rate per person year (SRPY)	\$73,333	\$50,000	\$70,000	\$100,000
Number of sales people (N)	6			
YEAR 1: Sales per year (SRPY x N)	\$440,000			

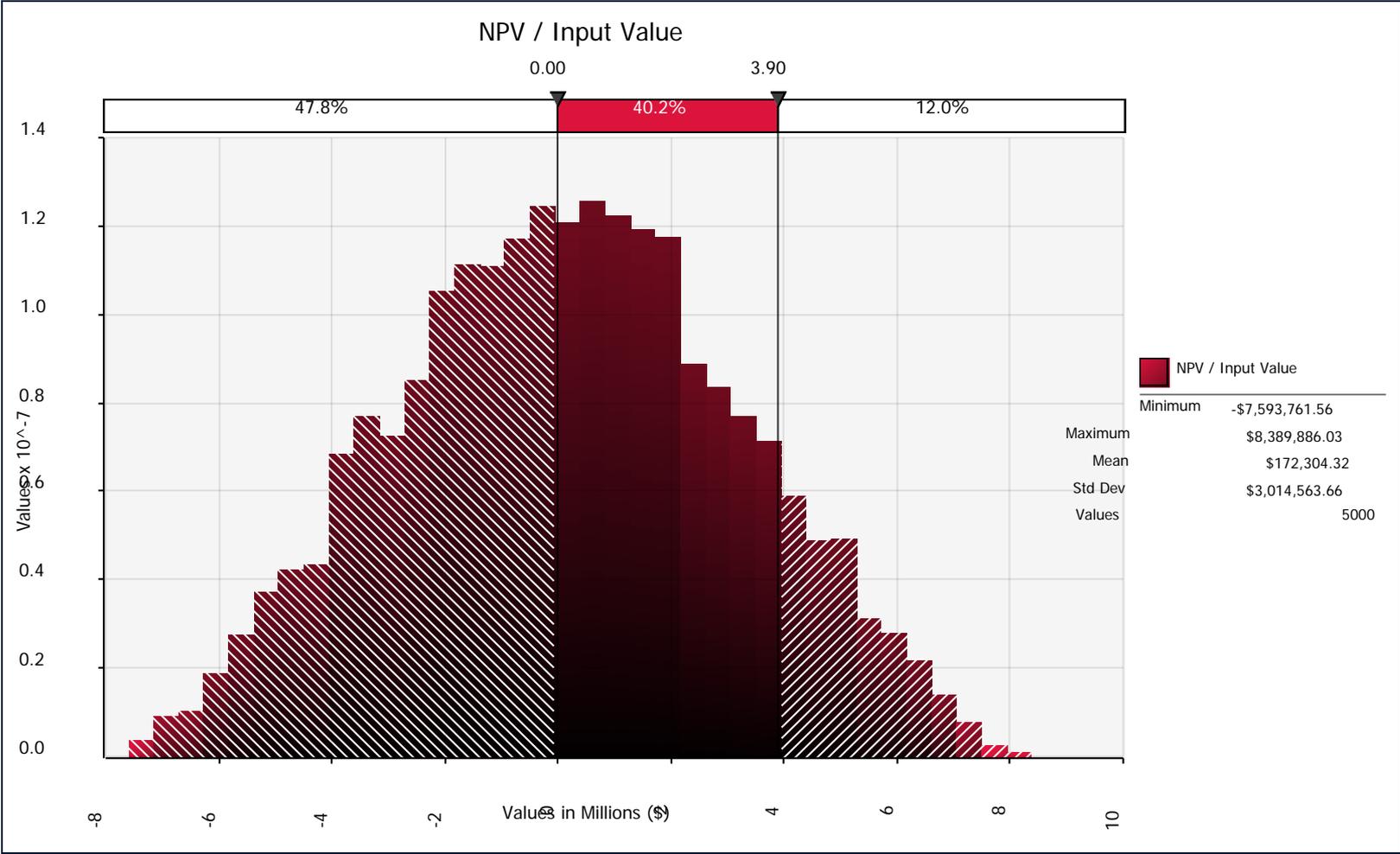
Salary and Operation Inputs	Input Value	Minimum	Most Likely	Maximum
Investment Cost	\$ 60,000	\$ 40,000	\$ 60,000	\$ 80,000
Total Salary Expense/yr	\$ 366,000	\$ 50,000	\$ 60,000	\$ 73,000
Total Operating Expense/yr	\$ 3,000,000	\$ 1,000,000	\$ 3,000,000	\$ 5,000,000
Revenue Growth Rate:	5%	3%	5%	7%
Inflation Rate	3%	2%	3%	5%
Discount Rate	15%			

Pro-Forma Financial Statement

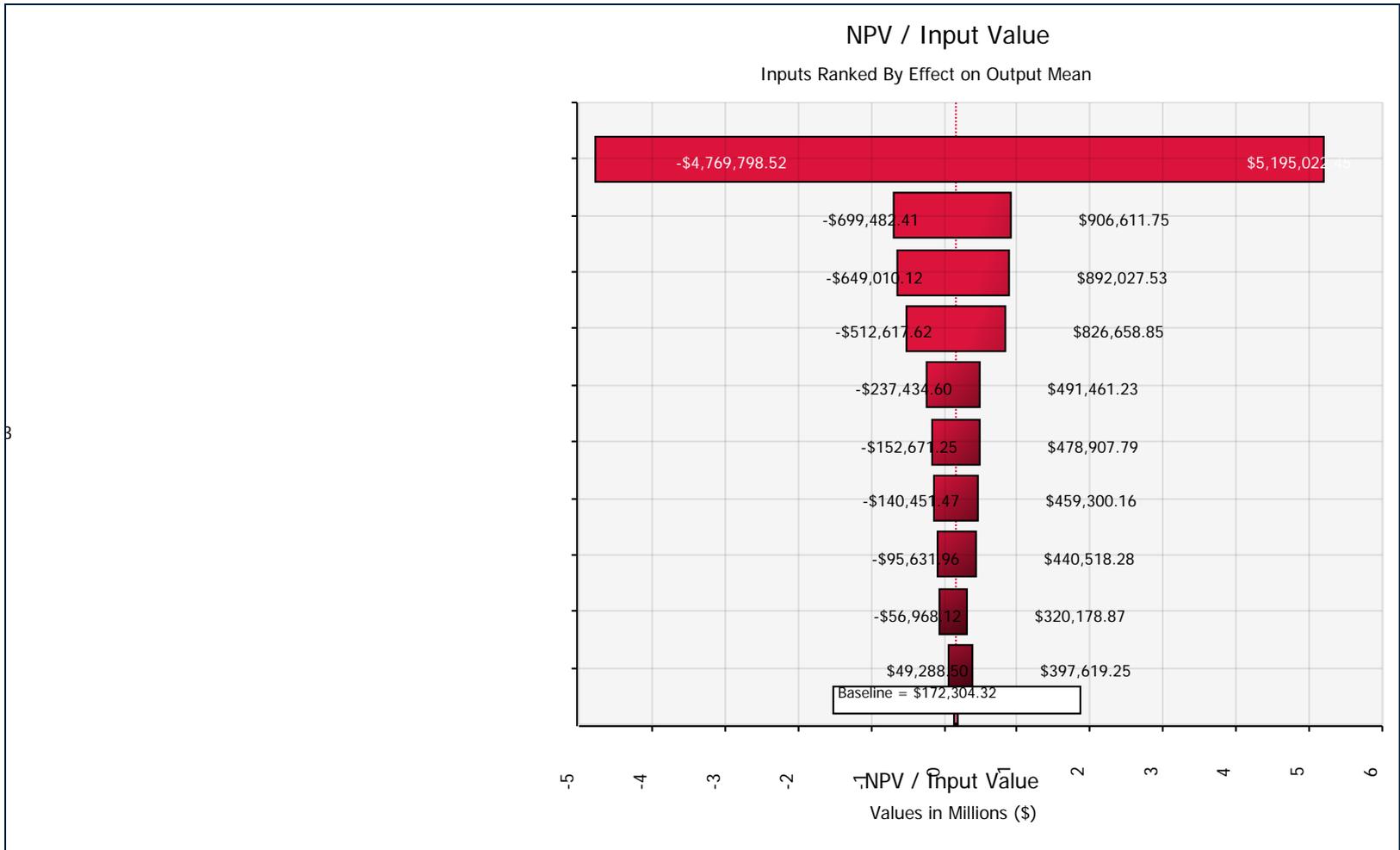
Estimated Financial Pro-forma							
Revenue		Year 1	Year 2	Year 3	Year 4	Year 5	
Current Revenue		\$ 2,400,000	\$ 2,400,000	\$ 2,400,000	\$ 2,400,000	\$ 2,400,000	
Incremental New Sales Revenue		\$ 440,000	\$ 902,000	\$ 1,387,100	\$ 1,896,455	\$ 2,400,000	
Total Sales Revenue (Current + New Sales Revenue)		\$ 2,840,000	\$ 3,302,000	\$ 3,787,100	\$ 4,296,455	\$ 4,800,000	\$19,025,555
Expenses		Year 1	Year 2	Year 3	Year 4	Year 5	
Initial Investment	\$ (60,000)	-	-	-	-	-	(\$60,000)
Total Salary Expense		\$ 366,000	\$378,200	\$390,807	\$403,834	\$417,295	\$1,956,135
Total Operating Expense		\$ 3,000,000	\$3,100,000	\$3,203,333	\$3,310,111	\$3,420,448	\$16,033,893
Total Expenses	\$ (60,000)	\$3,366,000	\$3,478,200	\$3,594,140	\$3,713,945	\$3,837,743	\$17,930,027
Cash Flow	\$ (60,000)	(\$526,000)	(\$176,200)	\$192,960	\$582,510	\$962,257	\$975,528
Return Analysis							
Discount Rate		15%					
NPV		\$287,715					



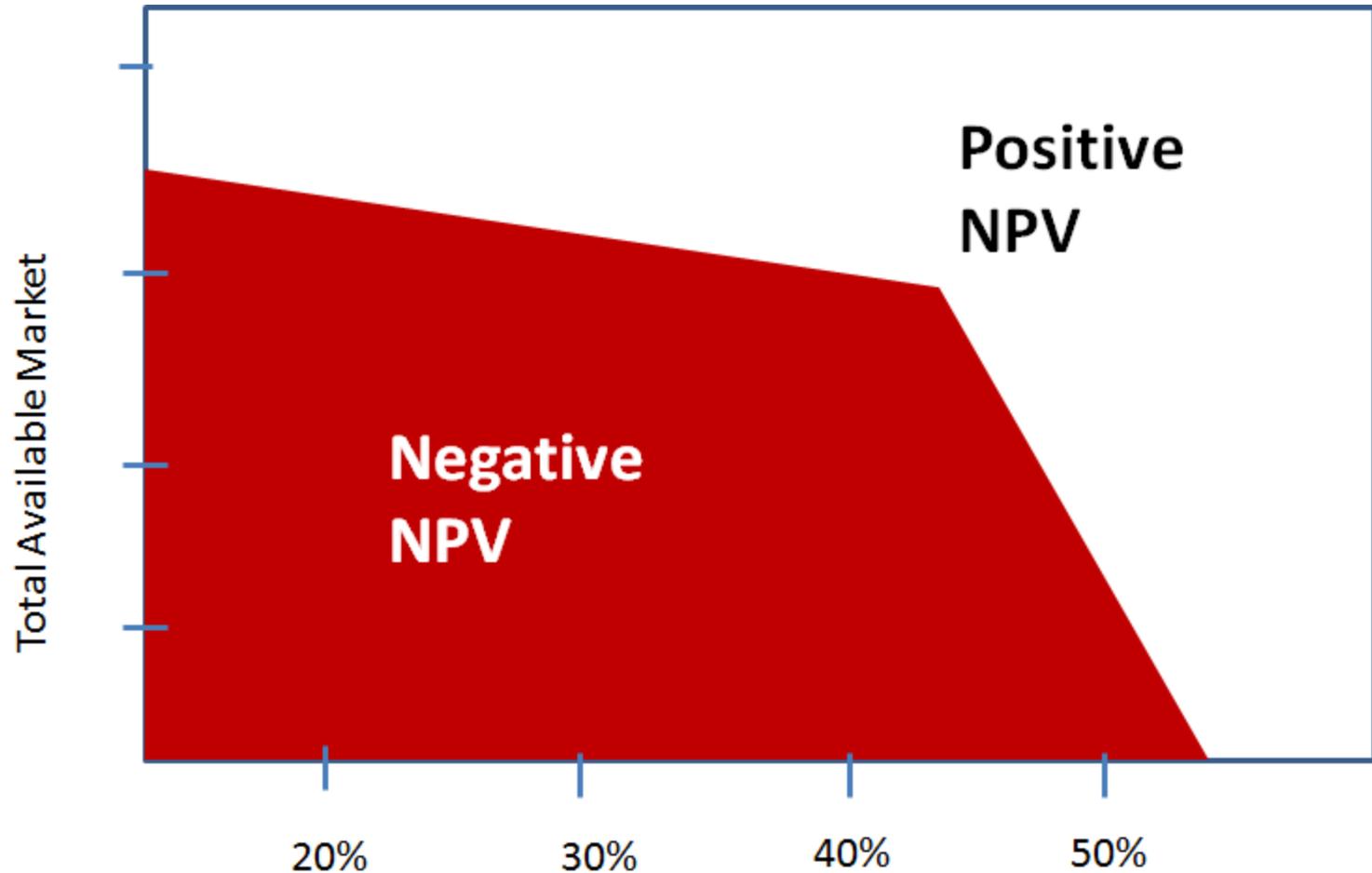
Estimated Net Present Value



Tornado Diagram (One-Way Sensitivity Analysis)

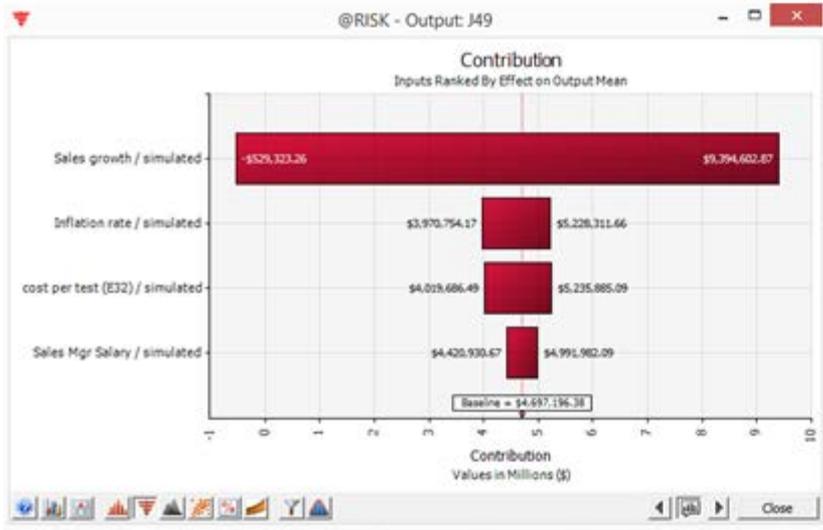


Strategy Map (Two Way Sensitivity Analysis)

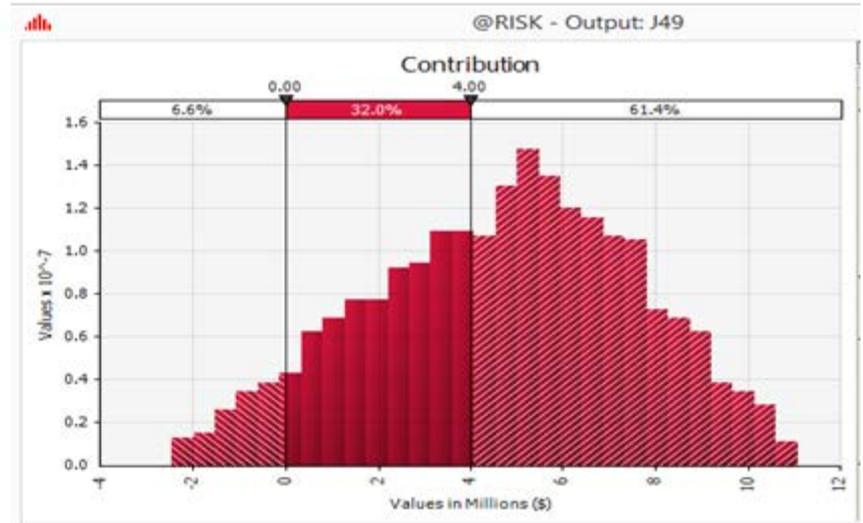


Value of Information

Tornado Diagram



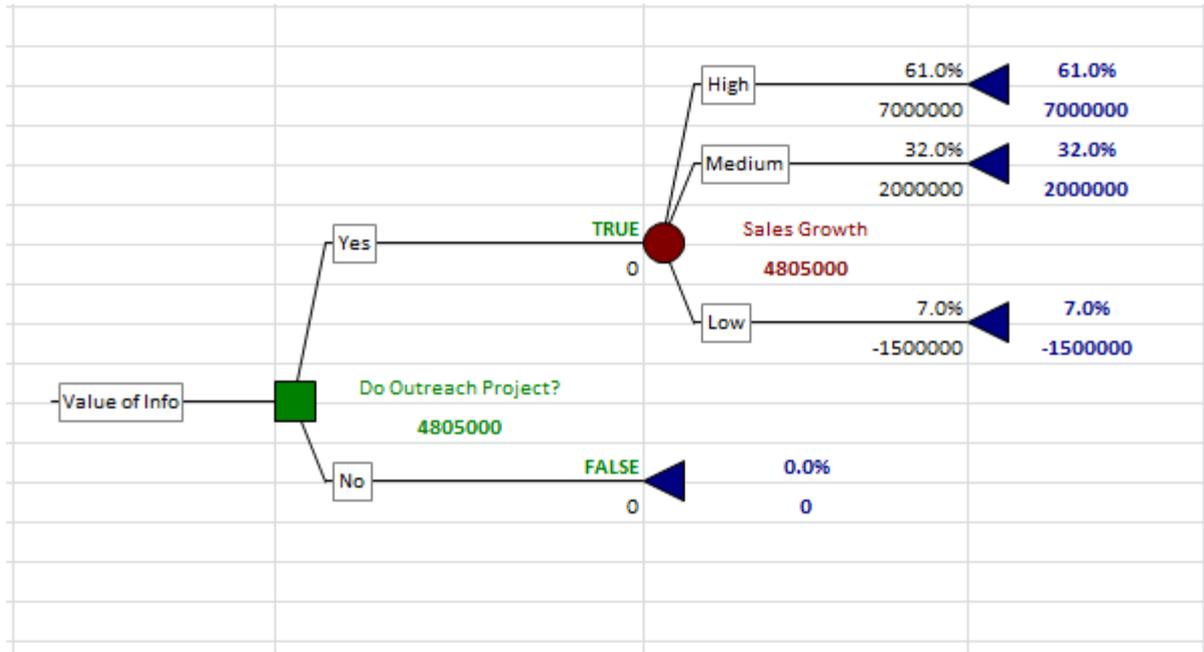
Profit Distribution



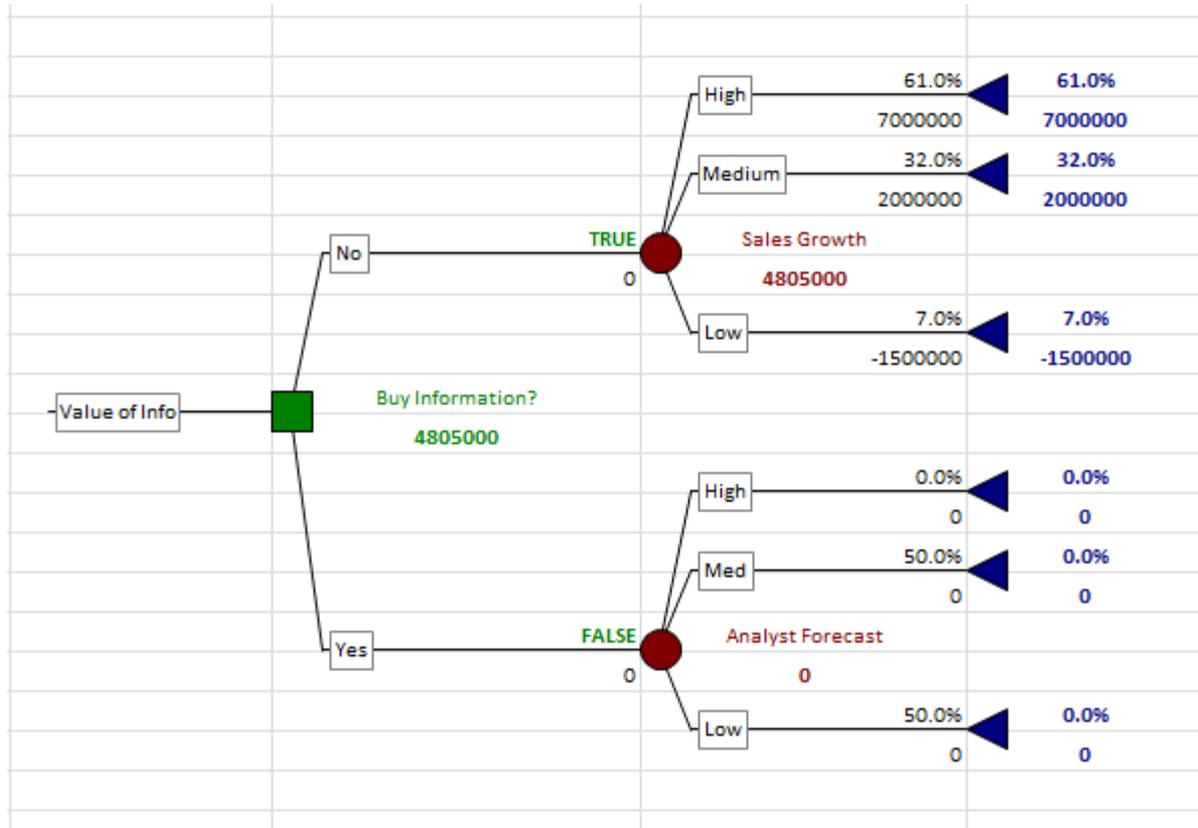
Uncertainty in Sales Forecast

- Driven by Uncertainty in sales
- Market Research reduces uncertainty
- How to evaluate?

Decision Scenario



Value of Information



Value of Information



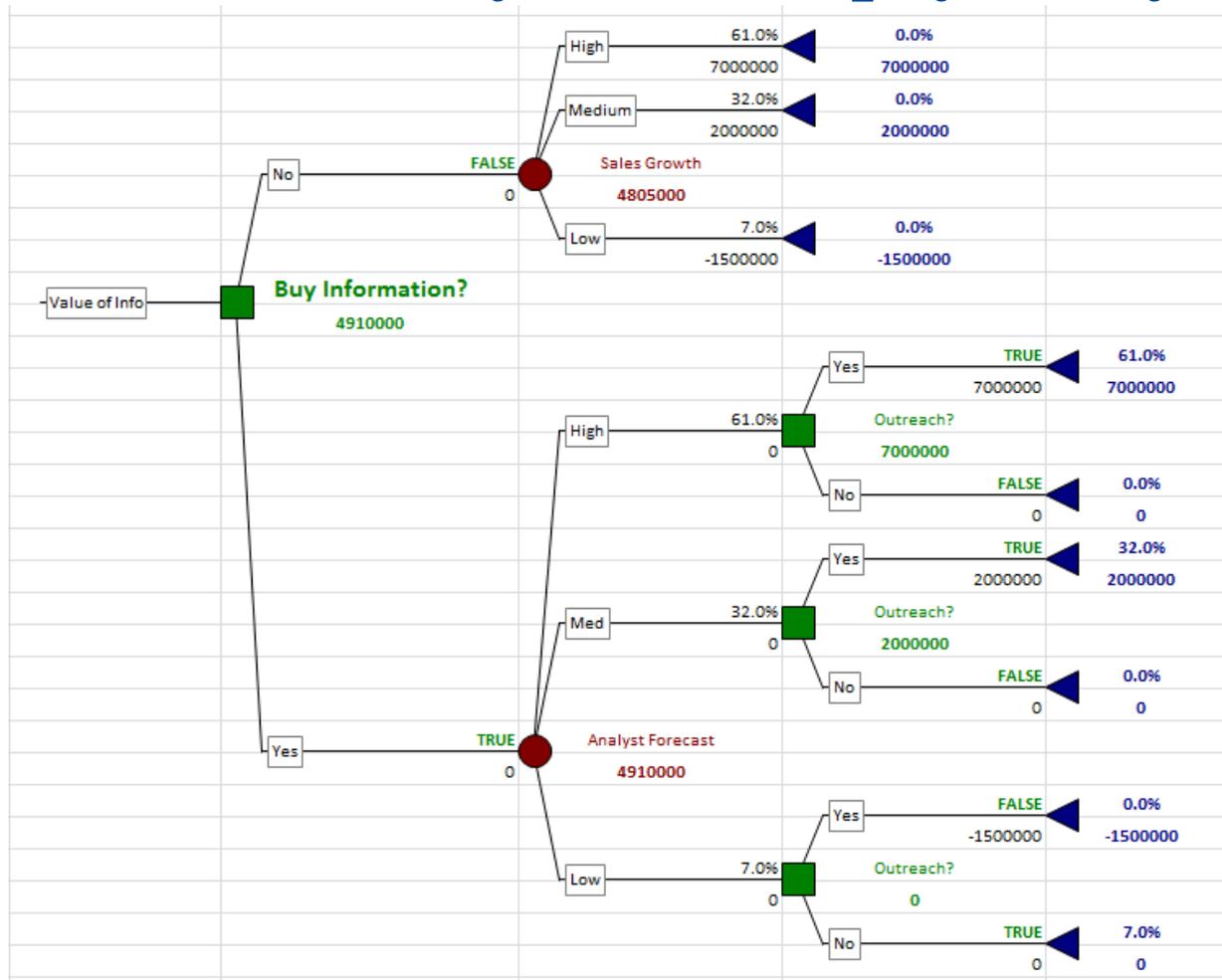
Analyst
1



Analyst 2 (well connected)

Value of Perfect Information

What is the most you would pay Analyst 2?



$$\text{Value of Perfect Info} = 4,910,000 - 4,805,000 = 105,000$$

How to build a decision tree

- Open Decision Tree Example
- Open Precision Tree
- Click on any cell
- Click on Decision Tree
- Click OK

The screenshot shows the Microsoft Excel interface with the PrecisionTree add-in ribbon. The ribbon includes the following groups and buttons:

- File** (highlighted)
- Home**
- Insert**
- Page Layout**
- Formulas**
- Data**
- Review**
- View**
- Developer**
- Add-Ins**
- Acrobat**
- PrecisionTree** (highlighted)
- @RISK**

The PrecisionTree ribbon contains the following buttons and groups:

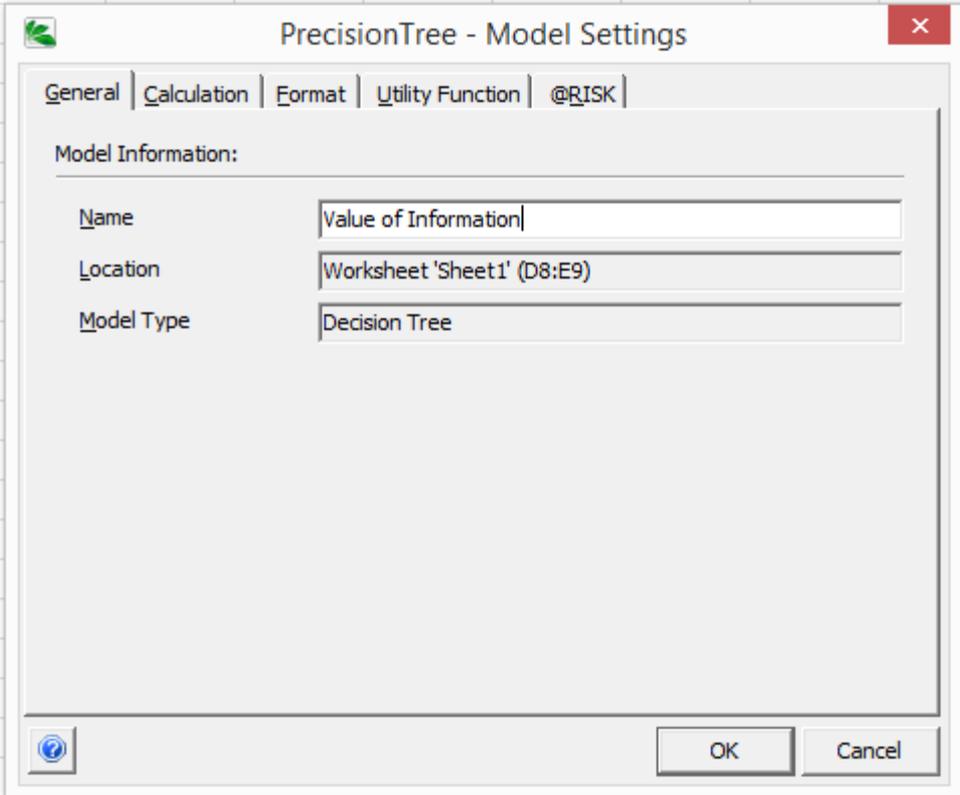
- Decision Tree** (with a blue arrow pointing to it)
- Influence Diagram / Node** (with a sub-button **Create New**)
- Influence Arc**
- Settings** (with a sub-button **Edit**)
- Decision Analysis** (with a sub-button **Analysis**)
- Sensitivity Analysis**
- Bayesian Revision**
- Append Tree**
- Tools** group containing:
 - Find**
 - Model Errors**
 - Update Links**
- Utilities** (with a dropdown arrow)
- Help** (with a dropdown arrow)

The spreadsheet area below the ribbon shows the following grid:

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
1														
2														
3														

Give the tree a name

Click OK



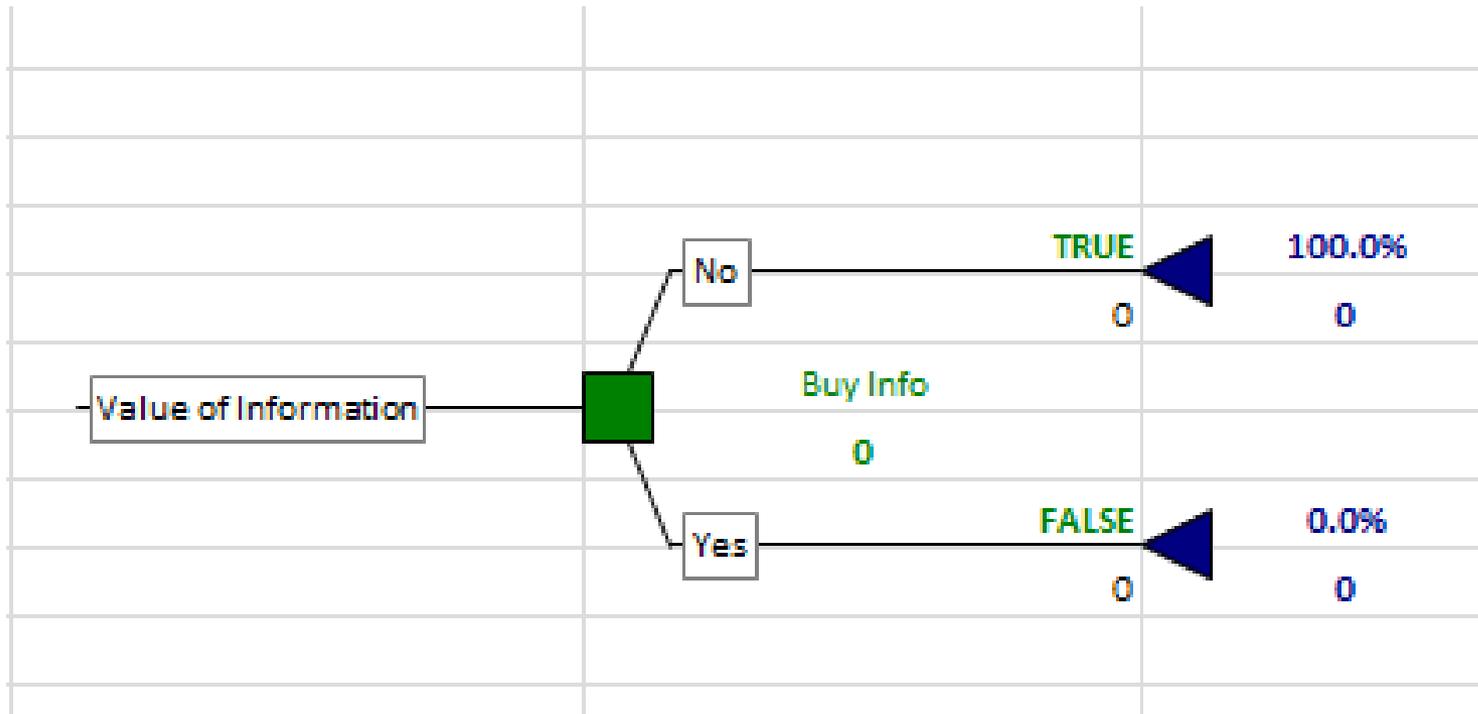
The image shows a dialog box titled "PrecisionTree - Model Settings" with a close button (X) in the top right corner. The dialog has several tabs: "General", "Calculation", "Format", "Utility Function", and "@RISK". The "General" tab is selected. Under the heading "Model Information:", there are three input fields:

Field	Value
Name	Value of Information
Location	Worksheet 'Sheet1' (D8:E9)
Model Type	Decision Tree

At the bottom of the dialog, there is a help icon (question mark in a circle) on the left, and "OK" and "Cancel" buttons on the right.

Name the Decision “Buy Info”

Name the branches yes and no



Right click on upper terminal node

Click “node settings”

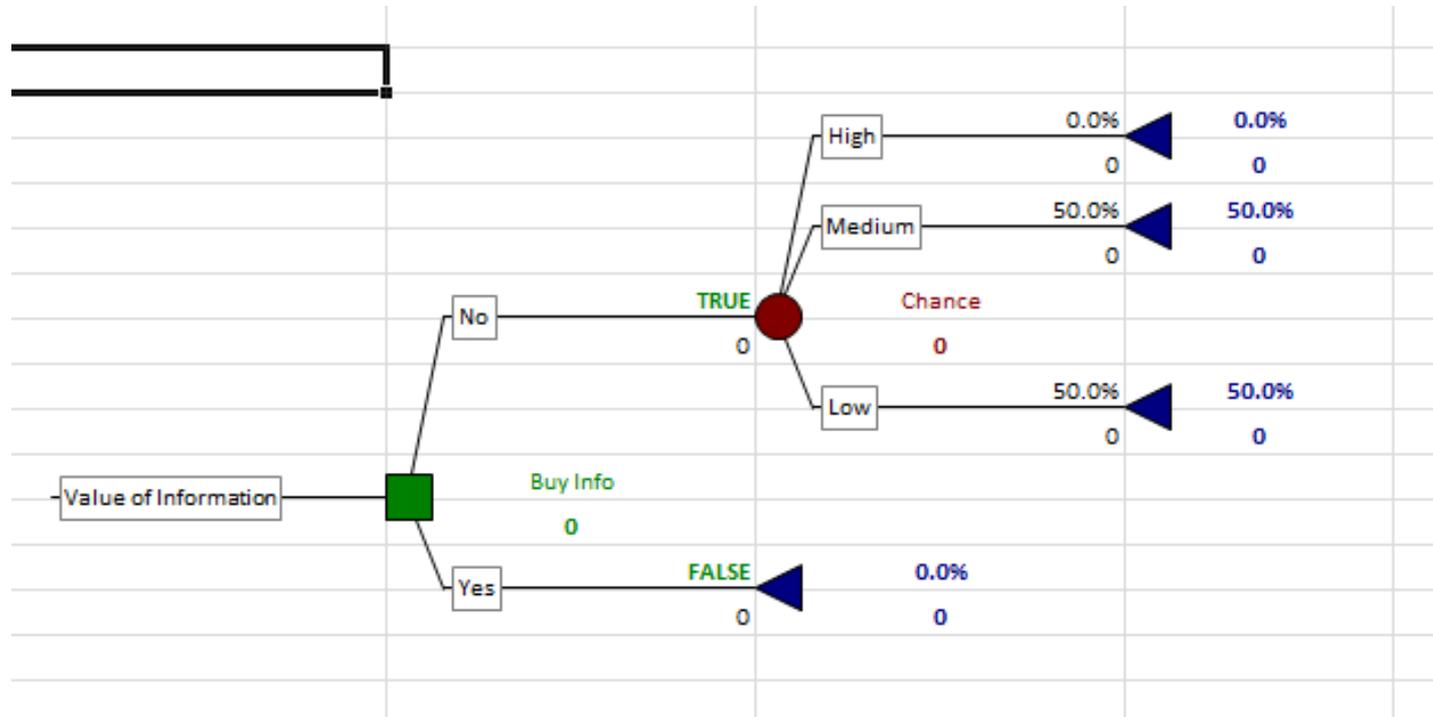
Change to chance

The screenshot displays the Microsoft Excel interface with the PrecisionTree add-in. The ribbon includes tabs for File, Home, Insert, Page Layout, Formulas, Data, Review, View, Developer, Add-Ins, and Acrobat. The PrecisionTree ribbon contains options like Decision Tree, Influence Diagram / Node, Influence Arc, Settings, Decision Analysis, Sensitivity Analysis, Bayesian Revision, Append Tree, Find, Model Errors, Update Links, Utilities, and Help. The active cell is F9, containing the formula `=PTreeNodeValue(treeCalc_1!F2,2)`. A decision tree is visible, with a green square node labeled 'Value of Information' branching into 'No' and 'Yes' options. The 'No' branch leads to a terminal node with a probability of 100.0% and a value of 0. The 'Yes' branch leads to a terminal node with a probability of 0.0% and a value of 0. A dialog box titled 'PrecisionTree - Decision Tree Node Settings' is open, showing the 'Node' tab. The 'Node Type' is set to 'Chance', and the 'Location' is F9. The 'Node Information' section is empty. The dialog box has 'OK' and 'Cancel' buttons.

Right Click chance node

Add branch

Rename branches high medium low

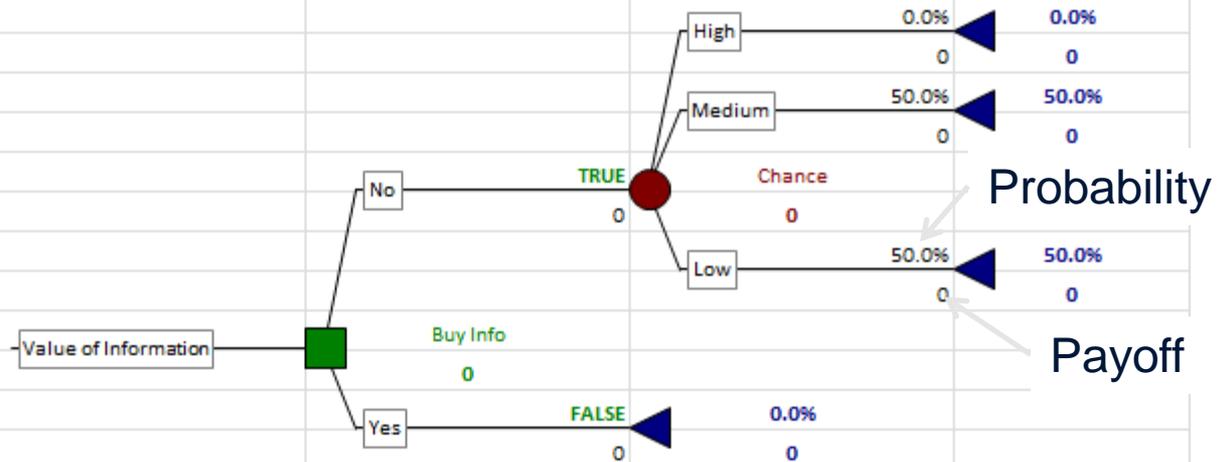


Link to the probabilities and payoffs

probabilities above the line
payoffs below

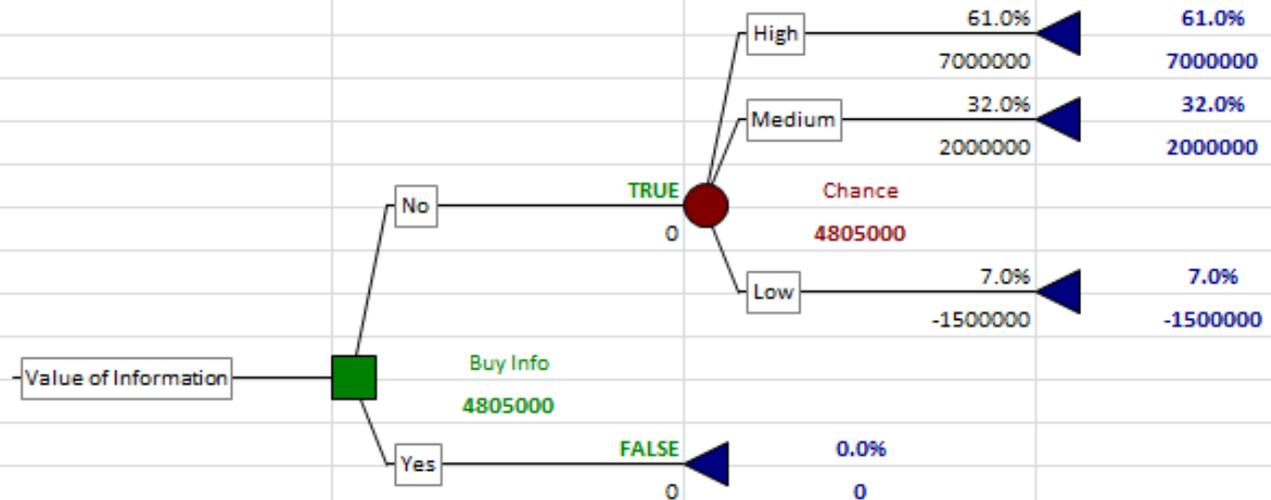
Use absolute references (click F4)

	Prob	Payoff
High	61	7000000
Medium	32	2000000
Low	7	-150000

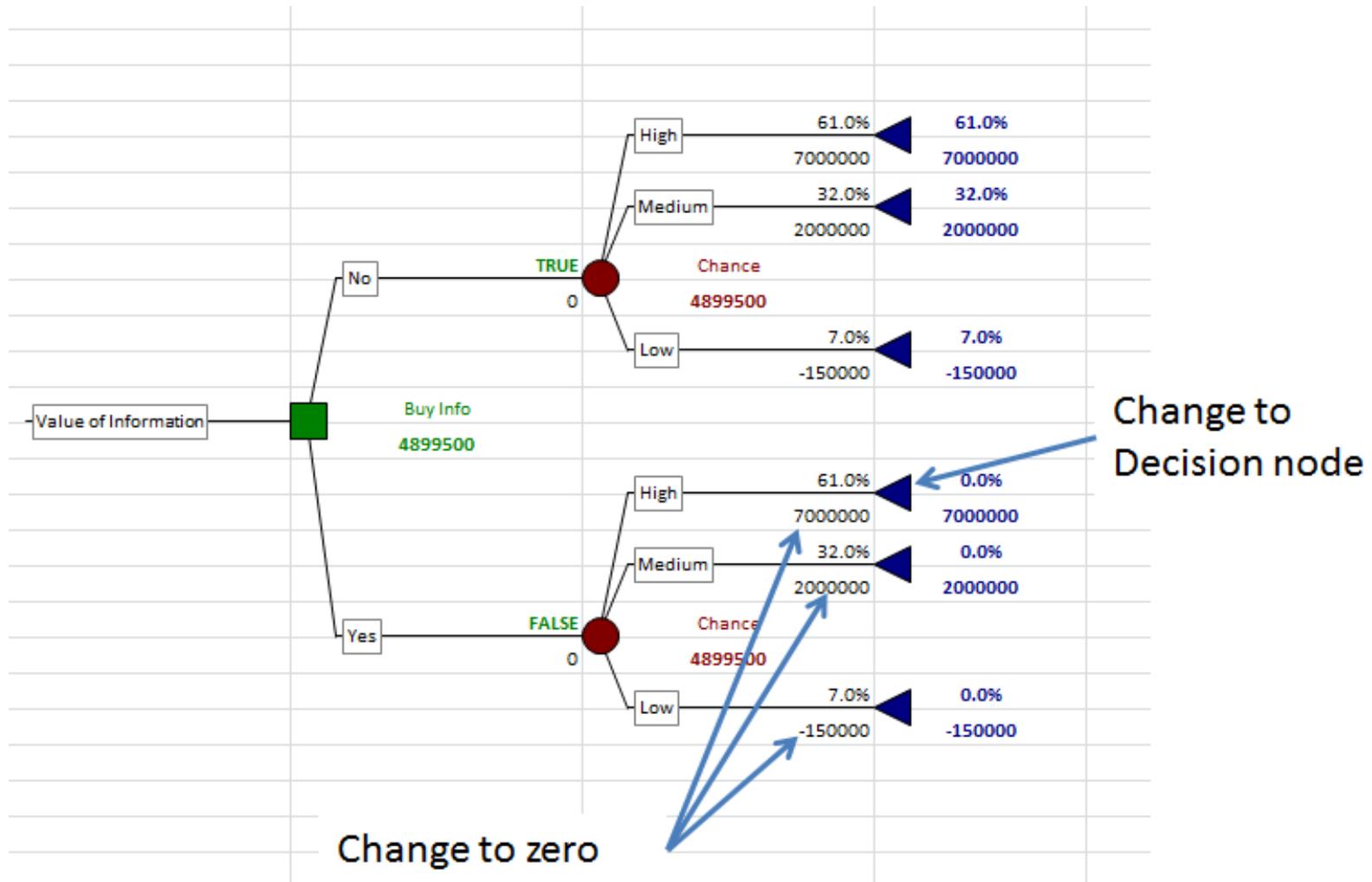


Right click on the chance node
Copy Subtree
Right click on end node of “Yes” Branch
Paste subtree

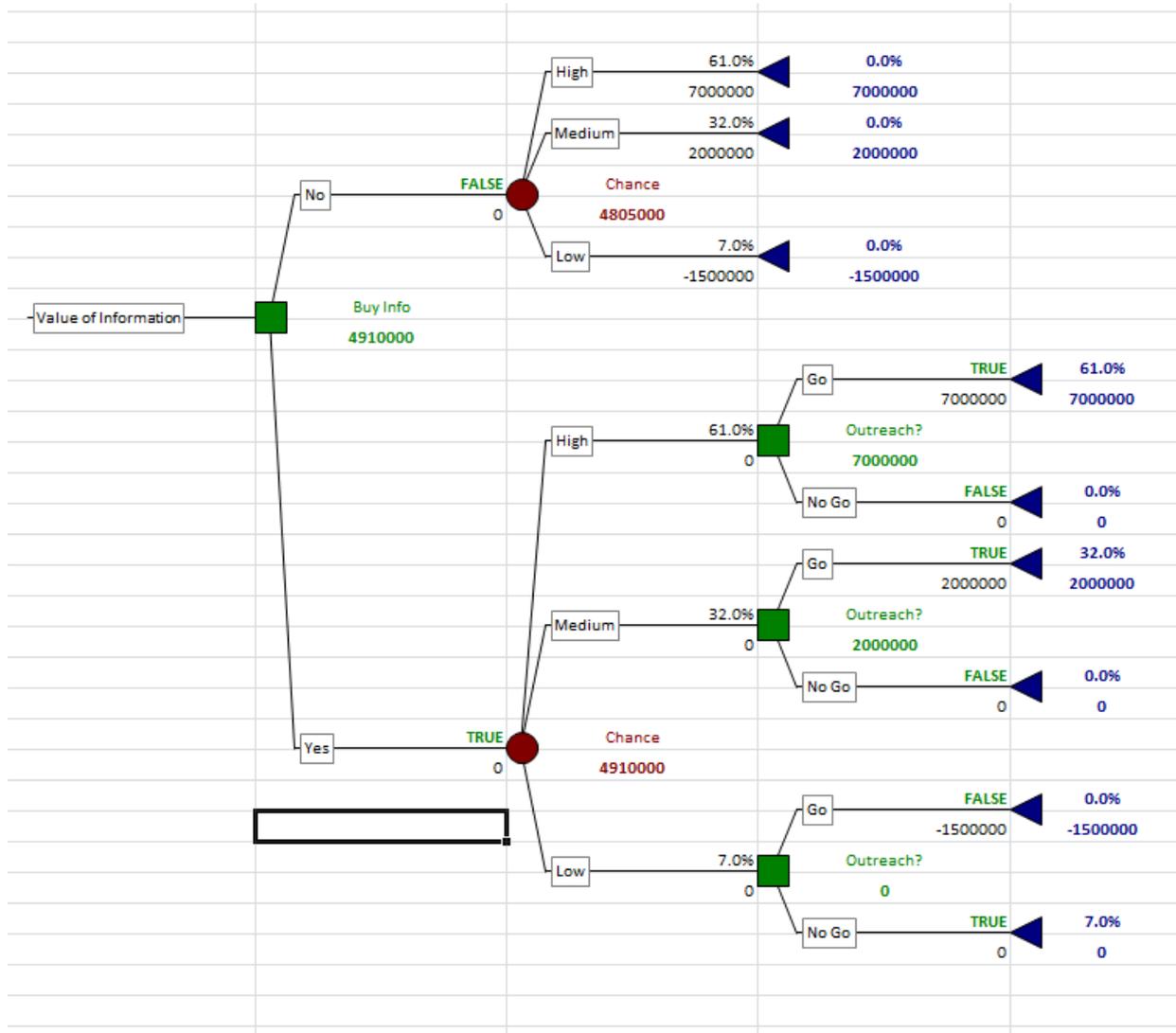
	Prob	Payoff
High	0.61	7000000
Medium	0.32	2000000
Low	0.07	-1500000



Change the payoffs on the lower subtree to zero change each end node on the lower subtree to a “go vs no go” decision



Voila!



Predicting the Impact of the FDA ruling on LDTs

Test Category	Risk	Approval	Approval Cost
1	Low	none	0
2	Medium	510k	50-250k
3	High	PAM	2.5-5.0M

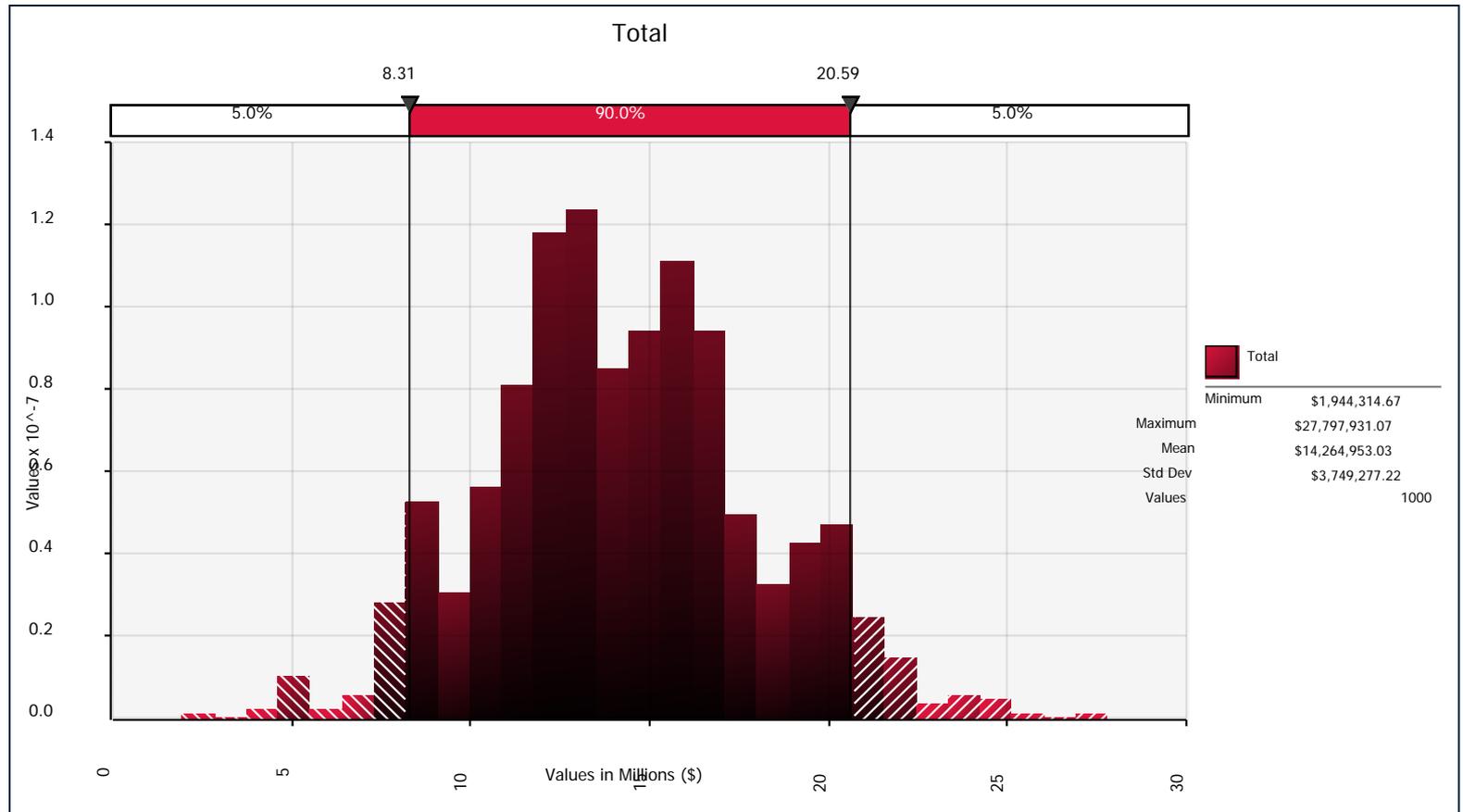
Classification Probability

Test	Class 1	Class 2	Class 3
1	90	10	
2		50	50
3		90	10
4	80	20	
.....			
100		10	90

Cost of Approval Process

	Minimum	Most Likely	Maximum
Class 1	0	0	0
Class 2	50,000	150,000	250,000
Class 3	2,000,000	3,500,000	5,000,000

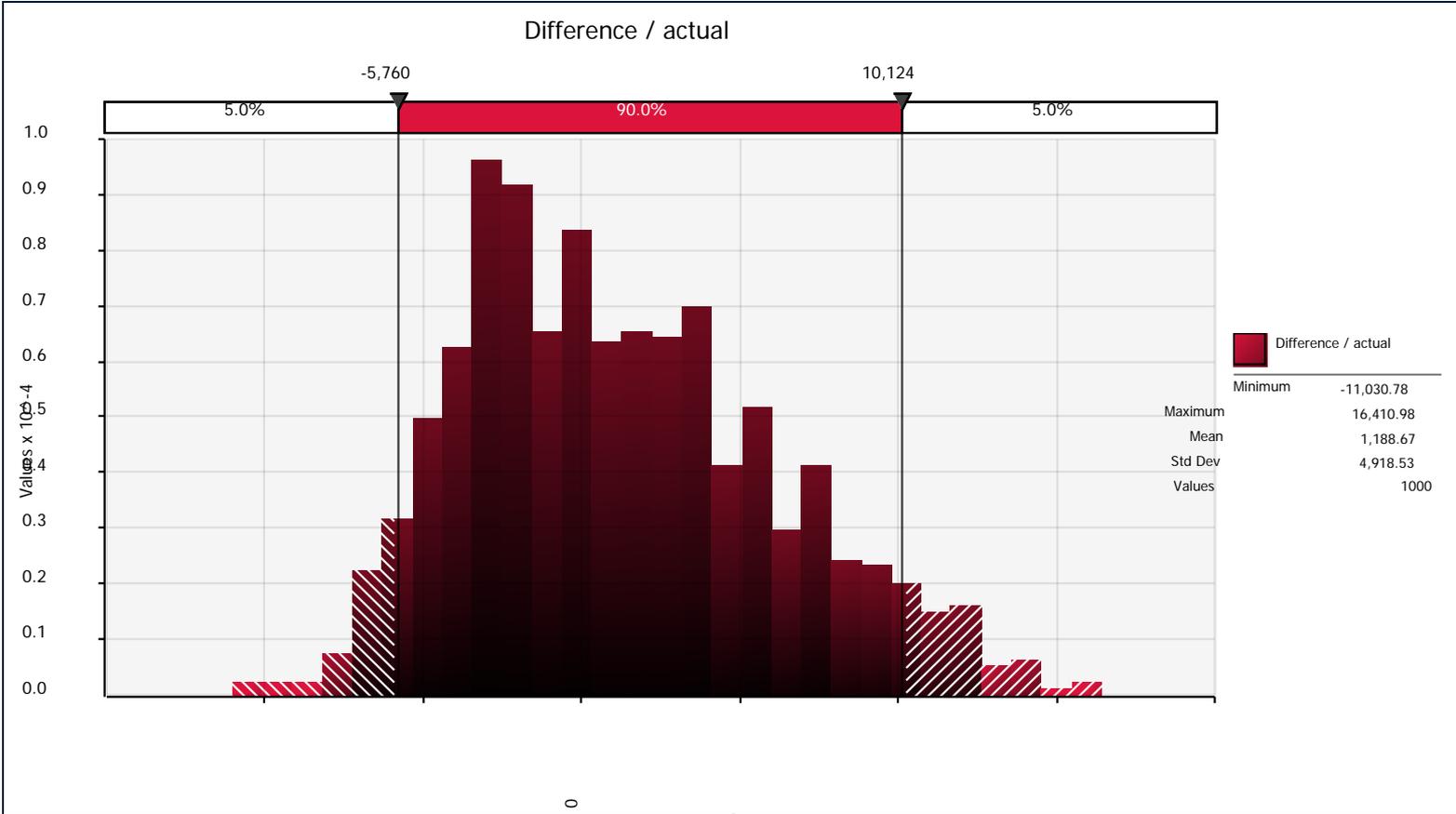
Distribution of Approval Cost



Should we perform this test in-house?

	actual	min	likely	max
demand	1833	1000	1500	3000
price	34	32	34	36
send out cost	30	29	30	32
reagent cost	20	19	20	22
QC volume	843	730	800	1000
Revenue	62,333			
In House Cost	54,426			
Send Out Cost	55,611			
In House Profit	7,908			
Send Out Profit	6,722			
Difference	1,186			

Difference (In-house vs send-out)



Quick Review

- Financial Modeling
 - Risk Analysis
 - Uncertainty in inputs
 - Uncertainty in outputs
 - Identify Risk Drivers
 - Value of Information

Is it worth the trouble?

- Easy to do
- Gain insight
 - Focus on the important stuff
 - Ignore the trivia
- Manage Risk
 - Identify weak spots
 - Develop options
- Increase Value

Sources for Simulation Software

- Crystal Ball (Oracle)
- @Risk (Palisade)
- Risk Solver Pro (Frontline Systems)
- Many others

Discussion:

Where can this be applied?

What problems would you like to see solved?

Summary

- Financial Modeling Adds Value
 - Can be applied to many problems
 - Simple tools are available
- We would like to know:
 - What risky decisions do you make?



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