

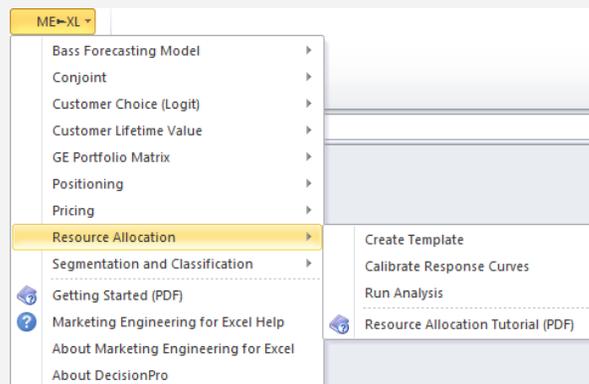
Tutorial

Resource Allocation



Marketing Engineering for Excel is a *Microsoft Excel* add-in. The software runs from within *Microsoft Excel* and only with data contained in an *Excel* spreadsheet.

After installing the software, simply open *Microsoft Excel*. A new Add-in menu appears, called "ME ▶XL." This tutorial refers to the "ME ▶XL/Resource Allocation" submenu.



Overview

Resource Allocation is a tool used for optimizing resource size (e.g., advertising budgets) and the allocation of resources across segments, products, channels, etc.

Hard data rarely are available to support such decisions, because resource allocation decisions influence future (unknowable) outcomes. Consequently, in the first phase, resource allocation analysis builds on managerial experience and insights to create an effort/impact response curve consensus; that is, users answer the question, "Given our experience and knowledge about the market, products, customers, and competition, what would happen if we increased [a resource such as advertising] by x%?" A response curve may then be **calibrated** on the basis of these "what-if" assessments to determine how the market might react to changes in the resources allocated.

Then, in the second phase, these calibrated response curves can be used to derive an optimal solution to the resource allocation problem at hand by taking into account both stated objectives and constraints (e.g., budget limitations).

Resource allocation analysis helps firms answer such questions as:

- ✓ How much should we spend in total during a given planning horizon?

- ✓ How should that spending get allocated to each marketing mix element? How much of our budget should be spent on advertising and other forms of impersonal marketing communications? On sales promotion? On the sales force?
- ✓ How should individual budgets be allocated? To customers? To geographies? To sub-elements of the marketing communications mix? Over time?

These types of questions are closely interrelated. It is nearly impossible to address the question of how much to spend (budget) without determining how to spend the budget properly (i.e., allocated across competing uses). Thus, these questions provide the perspective used to explore each question individually.

Getting Started

To apply resource allocation analysis, you can use your own data directly or use a preformatted template. However, because of the required calibration phase, we urge users to follow the steps described next.



The next section explains how to create an easy-to-use template to enter your own data.

If you want to run a resource allocation analysis immediately, open the example file "*OfficeStar Data (Resource Allocation, calibrated).xls*" and jump to "Step 4: Running analyses" (p. 10).

Running analyses require calibrating response curves based on managerial judgments. If you want to perform that intermediary step yourself, open the example file "*OfficeStar Data (Resource Allocation).xls*", which contains managerial judgments on which to calibrate the curves, and jump to "Step 3: Calibrating the response curves".

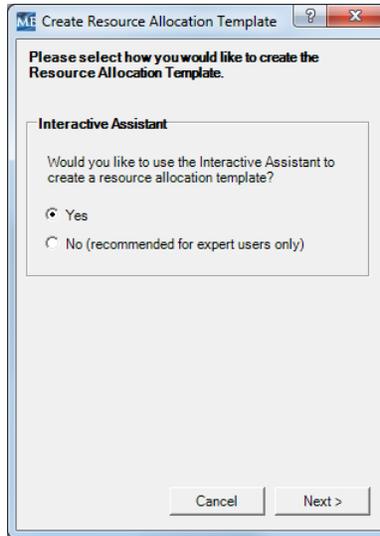
By default, the example files install in "*My Documents/My Marketing Engineering/*".

Step 1 Creating a template

Using the interactive assistant

In Excel, if you click on ME ▶ XL → RESOURCE ALLOCATION → CREATE TEMPLATE, a dialog box appears. This box represents the first step in creating a template for running the resource allocation software (both calibration and optimization phases). The first dialog box prompts you to use an interactive assistant.

Unless you are already familiar with the methodology, you should select “yes.”



Specifying the measurement

The first step of the template generation process requires you to label the measurement units.

- **Effort unit** describes the “input” label of the model, usually the decision variables on which you can act, such as how many advertising dollars you want to invest to certain marketing channels, or how many sales representatives you plan to allocate to a specific product, market, or segment of customers.
- **Outcome unit** describes the “output” label of the model, including the consequences of the decisions you will make, such as sales, revenues, profits, unit sold, market shares, or generated leads.

The screenshot shows a dialog box titled "Resource Allocation" with a question mark icon and a close button. The main instruction is "Please select the options to design a Resource Allocation Template." Below this, there is a section titled "Measurement Units" containing two input fields: "Effort Unit:" with a text box and the example "(e.g., advertising dollars, sales reps)", and "Outcome Unit:" with a text box and the example "(e.g., revenues, units sold)". At the bottom, there are three buttons: "Cancel", "< Previous", and "Next >".

Listing segments

The second step of the template generation process in the interactive assistant requires you to input the segment names. A **segment** is the base unit of analysis in resource allocation; you might allocate resources across channels, customers, or products, such that each channel, customer, or product is defined by the generic term "segment" for the purposes of this analysis.

The screenshot shows a dialog box titled "Resource Allocation" with a question mark icon and a close button. The main instruction is "Enter the segments (at least 2) of your resource allocation analysis." Below this, there is a section titled "Segments" containing a "New Segment" text box with "Internet" entered and an "Add to list" button. Below that is a "List of Segments" list box containing "TV ads", "Print ads", "Radio ads", and "Direct marketing". At the bottom of the list box are "Up", "Down", and "Delete" buttons. At the very bottom of the dialog are three buttons: "Cancel", "< Previous", and "Next >".

Specifying current situation

The third and last step of the template generation process requires you to describe the current situation, in terms of current efforts, outcomes, and cost and gross margin figures.

Resource Allocation

Enter the base scenario (current efforts and outcomes) and cost and gross margin figures per segment. You can also edit these values directly in the spreadsheet after you close this dialog box.

Base Scenario

Segments	Current Advertising dollars (\$000)	Current Revenues (\$000)	Cost per Advertising dollars (\$000)	Gross Margin per Revenues (\$000)
	<input type="checkbox"/> Same for all	<input type="checkbox"/> Same for all	<input checked="" type="checkbox"/> Same for all	<input checked="" type="checkbox"/> Same for all
TV ads	1000.0	3500.0	1000.0	1000.0
Print ads	250.0	800.0	1000.0	1000.0
Radio ads	100.0	250.0	1000.0	1000.0
Direct marketing	1500.0	4000.0	1000.0	1000.0
Internet	300.0	400.0	1000.0	1000.0

Buttons: Cancel, < Previous, Next >

When you click "Next >," a new spreadsheet will be generated that contains a "Scenario" sheet and a "Calibration" sheet (see the next section for a snapshot of the latter).

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Menu Commands

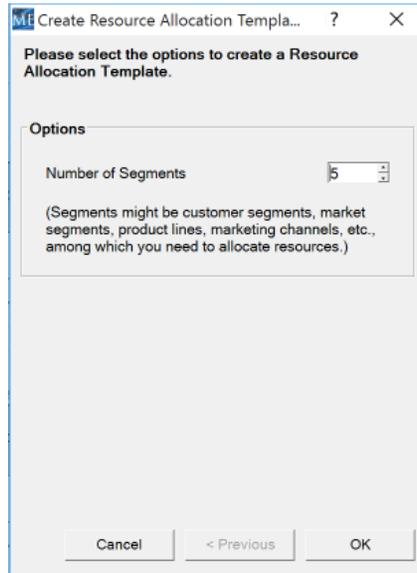
M24

	A	B	C	D	E	F	G	H	I
1									
2		Base Scenario							
3		Enter effort and outcome values for the base scenario, which will be used for calibration first, and as a benchmark later.							
4		Efforts and outcomes / Segments	TV ads	Print ads	Radio ads	Direct marketing	Internet	Total costs / Total gross margins	Total net margins
5		Advertising dollars (\$000)	1000	250	100	1500	300	\$3,150,000	
6		Revenues (\$000)	3500	800	250	4000	400	\$8,950,000	\$5,800,000
7									
8									
9		Recommended Scenario							
10		This area will contain recommended effort and predicted outcome values.							
11		Efforts and outcomes / Segments	TV ads	Print ads	Radio ads	Direct marketing	Internet	Total costs / Total gross margins	Total net margins
12		Advertising dollars (\$000)						\$0	
13		Revenues (\$000)						\$0	\$0
14									
15									
16		Costs and Gross Margins							
17		Enter observations id (e.g., respondent's name), choice and independent variables.							
18		Efforts and outcomes / Segments	TV ads	Print ads	Radio ads	Direct marketing	Internet		
19		Advertising dollars (\$000)	\$1,000	\$1,000	\$1,000	\$1,000	\$1,000		
20		Revenues (\$000)	1000	1000	1000	1000	1000		
21									

Ready

Not using the interactive assistant

If you choose not to use the interactive assistant, the following dialog box will appear, requesting you to specify the number of segments and the effort and outcome calibration bases. When you click "OK," you generate a new template. You must enter segment labels, current situation, cost and gross margin figures, and other inputs manually.



Step 2 Entering your calibration data



In this tutorial, we use the example file "OfficeStar Data (Resource Allocation).xls," which in the default condition appears in "My Documents/My Marketing Engineering/."

To view an example of the appropriate data format, open this spreadsheet in Excel. A snapshot is reproduced below.

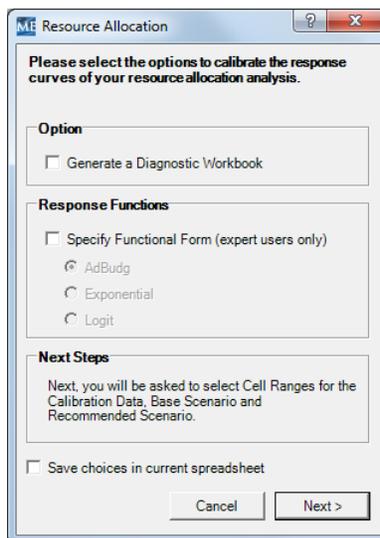
Effort levels / Segments	Budget for TV ads	Revenues from TV ads	Budget for Print ads	Revenues from Print ads	Budget for Radio ads	Revenues from Radio ads	Budget for Direct marketing	Revenues from Direct marketing	Budget for Internet	Revenues from Internet
Lowest effort	None	0.00	None	0.00	None	0.00	None	0.00	None	0.00
Low effort	0.50	0.60	0.50	0.40	0.50	0.20	0.50	0.50	0.50	0.20
Current effort	Current effort	1.00	Current effort	1.00	Current effort	1.00	Current effort	1.00	Current effort	1.00
Higher effort	1.50	1.20	1.50	1.60	1.50	1.25	1.50	2.10	1.50	1.80
Highest effort	Saturation	1.40	Saturation	2.00	Saturation	1.40	Saturation	2.80	Saturation	2.10

The calibration sheet contains the consensus estimates of how outcomes might be affected by changes in the input variables for each segment. For instance, how much additional sales would be generated by an increase of 50% in the sales force allocated to a specific customer segment or product?

Obtaining accurate and consistent consensus estimates from a group of managers and experts is as much an art as it is a science. It requires free information exchange, constructive feedback, and a constructive discussion of the “what-if?” scenarios.¹

Step 3 Calibrating the response curves

After you enter consensus estimates for different “what-if” scenarios for each segment, click on ME ► XL → RESOURCE ALLOCATION → CALIBRATE RESPONSE CURVES. The following dialog box appears:



Options

The first option refers to generating a **diagnostic workbook**, which gives you details about the estimated parameters and goodness of fit, as well as a graphical representation of the fitted curves.

You can also specify the functional form of the **response curves** you want and thereby fit your data:

- **AdBudg** and **Logit** response functions are S-shaped functions that allow outcomes to increase very slowly as you increase effort from low levels, and then accelerate rapidly, before eventually reaching a plateau, or saturation level.
- An **Exponential** response function increases rapidly at the very beginning, and each additional effort unit has a marginally lower impact than the previous effort unit.

¹ For a discussion and process description, please refer to the discussion of the Delphi method in Chapter 5 and Exhibit 7.8 in *Principles of Marketing Engineering, 2nd Edition*.

The **AdBudg** function is the default selection, because it is the most versatile and recommended response curve functional form.



If you want functional forms to differ among segments, or you prefer to calibrate one response function at a time, you can do so. Just proceed through the described procedure and then later select only those data cells relevant to the segment(s) you have chosen. You can select one, some, or all segments (the latter is the default option). Note, however, segment data should be in contiguous cells.

Selecting calibration data, base scenario, and target cells

The next step asks you to select calibration data, base scenario data, and the target cells (recommended scenario data) to calibrate the response curves. If you used the “Create Template” option of *Marketing Engineering for Excel*, these cells will be selected by default.

Input

Please select Calibration Data.

The first column should contain different levels, followed by a column with estimated outcome levels, one pair per segment. The first row should include headings.

Calibration!\$C\$5:\$L\$10

OK Cancel

Input

Please select Base Scenario Data.

The first row should contain segment names, and the next two rows should contain current efforts and current outcomes.

Scenario!\$C\$4:\$G\$6

OK Cancel

Input

Please select Recommended Scenario Data.

The first row should contain segment names, and the next two rows should contain placeholders for recommended efforts and predicted outcomes.

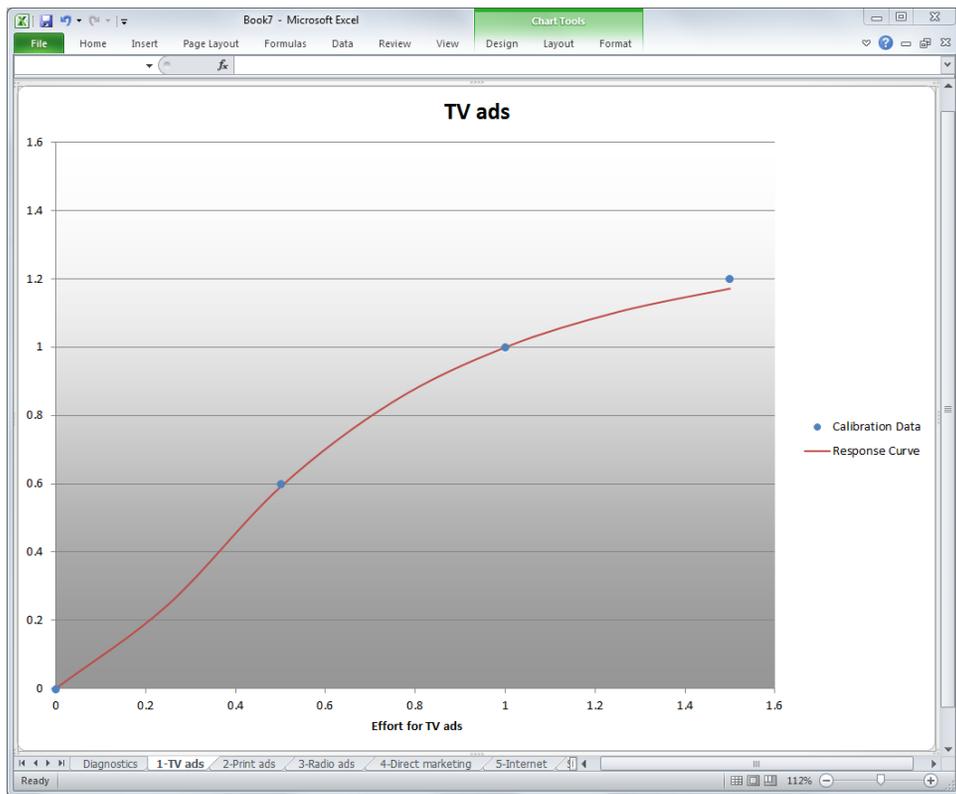
Scenario!\$C\$11:\$G\$13

OK Cancel

Diagnostic workbook

If you have selected “Generate a Diagnostic Workbook,” a new spreadsheet will be generated, showing how the calibrated curve fits the calibration data provided by the managerial team. It also displays example points and response function–estimated parameters.

Note that, by design, the parameters will be estimated such that the response curve replicates the lower and higher bounds, as well as the current situation, as closely as possible, even if that means fitting the other points poorly.



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Response Curve Estimation for TV ads

Calibration data and estimated response curve for TV ads

Revenues for TV ads / Sales reps.	Calibration Data	Response Curve
0	0	0
0.25		0.246034465
0.5	0.6	0.590789736
0.75		0.839986691
1	1	1
1.25		1.103115041
1.5	1.2	1.171846022
	1.4	1.362298483

Parameter Estimates for TV ads

Parameter estimates (adbudget function) for TV ads.

Min	0
Max	1.4
Shape	1.77579795
Shift	0.4

Response curve estimations

After calibrating the curves (regardless of whether you have generated a Diagnostic Workbook), the calibrated response curves get copied into the initial spreadsheet, in the selected **Recommended Scenario** section.

Although at first you will see no difference between the base and recommended scenarios, the key difference is that the outcome in the recommended scenario section is not a given anymore; rather, it is a function of the current efforts. If you alter the current efforts in the recommended scenario section, the estimated outcomes will change according to the calibrated response curves.

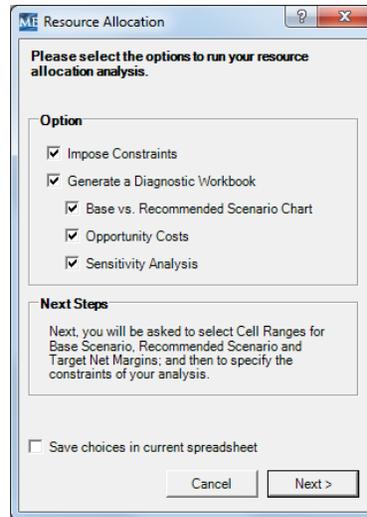
For instance, in the OfficeStar example, suppose the user cuts the advertising budget for television ads by half and doubles the budget for print ads. On the basis of the calibrated response curves, the model estimates that total net margins will diminish by more than half a million dollars (from \$5.8M to \$5.2M).

Base Scenario							
Enter effort and outcome values for the base scenario, which will be used for calibration first, and as a benchmark later.							
Efforts and outcomes Segments	TV ads	Print ads	Radio ads	Direct marketing	Internet	Total costs / Total gross margins	Total net margins
Advertising dollars (\$000)	1000	250	100	1500	300	\$3,150,000	\$5,800,000
Revenues (\$000)	3500	800	250	4000	400	\$8,950,000	\$5,800,000
Recommended Scenario							
This area will contain recommended effort and predicted outcome values.							
Efforts and outcomes Segments	TV ads	Print ads	Radio ads	Direct marketing	Internet	Total costs / Total gross margins	Total net margins
Advertising dollars (\$000)	500	500	100	1500	300	\$2,900,000	
Revenues (\$000)	2068	1368	250	4000	400	\$8,086,828	\$5,186,828
Costs and Gross Margins							
Enter observations id (e.g., respondent's name), choice and independent variables.							
Efforts and outcomes Segments	TV ads	Print ads	Radio ads	Direct marketing	Internet		
Advertising dollars (\$000)	\$1,000	\$1,000	\$1,000	\$1,000	\$1,000		
Revenues (\$000)	\$1,000	\$1,000	\$1,000	\$1,000	\$1,000		

After you have generated this spreadsheet, you can “play around” and see how an increase or decrease of effort in one segment affects the overall results. Marketing Engineering for Excel, however, offers you a better and more straightforward way to find the optimal budget and budget allocation, given specific objectives and constraints. The next section describes this method.

Step 4 Running analyses

When the spreadsheet is ready for optimization, click on ME ▶ XL → RESOURCE ALLOCATION → RUN ANALYSIS. The following dialog box appears:



This option enables you to find the optimal effort levels (e.g., the total budget as well as the allocation of that budget across market segments) to maximize outcomes (e.g., net revenues), conditional on specified constraints.

Options

The dialog box offers you several options from which to choose.

The first option enables you to specify **constraints** on your optimization, that is, lower and upper bounds within which a solution is determined. If you click on this option, another dialog box will appear later (see below).

The second option, if checked, generates a Diagnostic Workbook that details the recommended solution. This workbook typically contains the following information:

- **Base vs. Recommended Scenario Chart:** A simple, graphical comparison of the recommended solution versus the current allocation.
- **Opportunity Costs:** The extent to which the imposed constraints limit the final results, formally defined by the additional net margin achieved by relaxing a given constraint by 1 unit per segment, or in total. For example, if you impose a constraint stating that there can be no more than 50 sales representatives allocated to a given product line, or that the total advertising budget cannot be more than \$1.5M, this function indicates how much the profit (or other outcome measure) would improve if the constraints were relaxed by one unit (i.e., 51 sales reps, \$1.6M).



The literature sometimes refers to the term **shadow price**, formally defined as the additional net margin achieved by **increasing** a given constraint by 1 unit. **Shadow prices and opportunity costs are closely related as described below:**

When the user imposes an upper-bound constraint (say a segment cannot have *more* than 50 sales reps, i.e., $X \leq 50$), shadow prices and opportunity costs are equivalent.

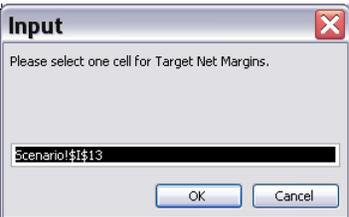
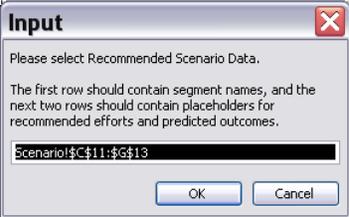
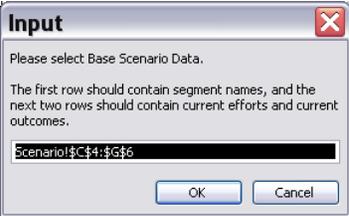
When the user imposes a lower-bound constraint (say a segment cannot have *less* than 20 sales reps, i.e., $X \geq 20$), on the one hand, shadow prices will compute differences in net margins with a new constraint of $X \geq 21$, and that figure might actually be negative; you may lose additional money by **increasing** an already costly constraint. On the other hand, opportunity costs will compute differences in net margins with a new constraint of $X \geq 19$, a figure that by definition cannot be negative; you cannot waste additional money by **relaxing** a constraint. At best, it doesn't affect anything in

your strategy.

- **Sensitivity Analysis:** Allows for an assessment of the maximum potential. It shows the maximum profit that could be achieved by imposing various levels of constraints on the total efforts (e.g., advertising budget, size of the sales force), given optimized resource allocation.

Selecting base scenario, recommended scenario, and target net margin cells

You next will be asked to select different range cells to feed the optimization algorithm. If you have used the “Create Template” option of *Marketing Engineering for Excel*, these cells are selected by default.



Imposing constraints

If you checked the “Impose Constraints” checkbox, a new dialog box appears, with which you can impose lower and/or upper constraints at the global level (e.g., a maximum allowed advertising budget) or the level of each segment (e.g., a minimum level of spending for a given channel).

Global Constraint		Minimum	Maximum
Global effort	<input checked="" type="checkbox"/>	0.0	3000.0

Constraints per Segment		Minimum	Maximum
TV ads	<input checked="" type="checkbox"/>	500.0	<input type="checkbox"/> 0.0
Print ads	<input checked="" type="checkbox"/>	0.0	<input type="checkbox"/> 0.0
Radio ads	<input checked="" type="checkbox"/>	0.0	<input type="checkbox"/> 0.0
Direct marketing	<input checked="" type="checkbox"/>	0.0	<input checked="" type="checkbox"/> 1600.0
Internet	<input checked="" type="checkbox"/>	0.0	<input type="checkbox"/> 0.0

Save choices in current spreadsheet

Cancel < Previous Next >

By default, the lower-bound constraints are imposed, with a minimum level of 0.

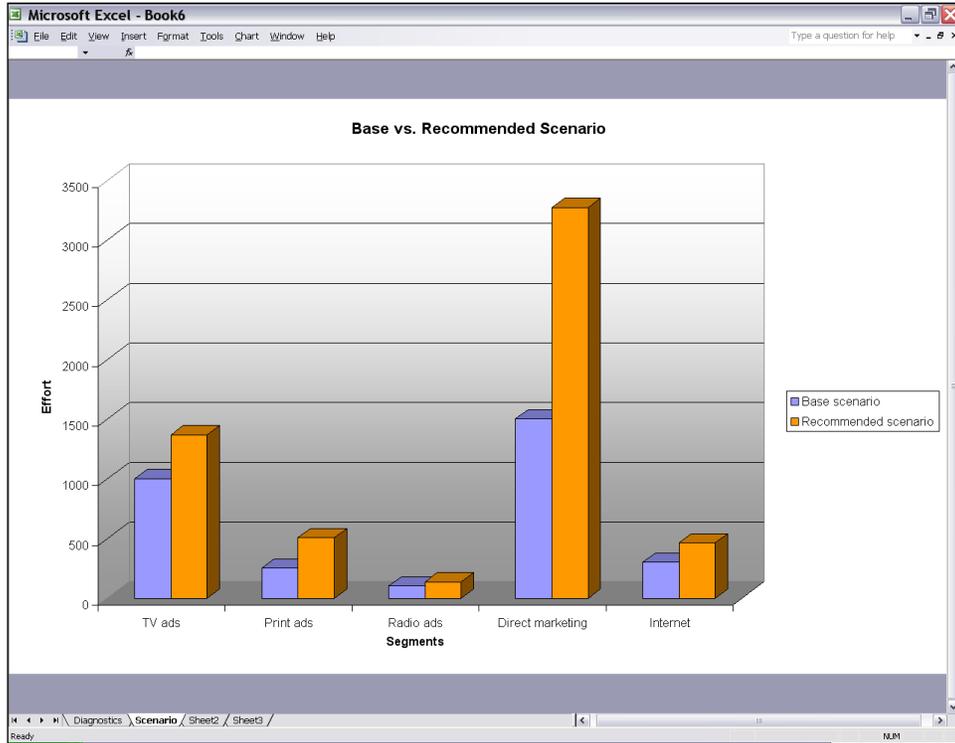


Most problems have lower-bound constraints. For instance, you cannot spend *less* than zero in a given segment. Therefore, you must impose lower-bound constraints of 0 (the default constraint); otherwise, the software might recommend a nonsensical solution.

Step 5 Interpreting the results

Base vs. recommended scenario

The recommended scenario (efforts) is copied into the initial spreadsheet. The copy generated in a Diagnostic Workbook (if you have checked this option) creates the following chart:



In the OfficeStar example, the Direct Marketing budget should be almost doubled, because this channel offers the most promising upstream potential. The budget for radio ads, in contrast, seems to have reached the appropriate (low) level given its low response to additional effort.

On the basis of its calibration and analysis of the management team's input, the model suggests that the company is grossly underinvesting in advertising and promotion and that an increase and better allocation of its total advertising and promotional budget (from \$3.15M to \$5.77M) could almost double gross revenues and increase total net margins from \$5.8M to \$11.2M.

	A	B	C	D	E	F	G	H	I	J
1										
2		Base Scenario								
3		Enter effort and outcome values for the base scenario, which will be used for calibration first, and as a benchmark later.								
4		Efforts and outcomes / Segments	TV ads	Print ads	Radio ads	Direct marketing	Internet	Total costs / Total gross margins	Total net margins	
5		Advertising dollars (\$000)	1000	250	100	1500	300	\$3,150,000		
6		Revenues (\$000)	3500	800	250	4000	400	\$8,950,000	\$5,800,000	
7										
8										
9		Recommended Scenario								
10		This area will contain recommended effort and predicted outcome values.								
11		Efforts and outcomes / Segments	TV ads	Print ads	Radio ads	Direct marketing	Internet	Total costs / Total gross margins	Total net margins	
12		Advertising dollars (\$000)	1396.97163	519.498152	133.23012	3265.64043	456.812381	\$5,772,153		
13		Revenues (\$000)	14041.26147	1423.50938	306.884624	10462.9563	715.987087	\$16,950,599	\$11,178,446	
14										
15										
16		Costs and Gross Margins								
17		Enter observations id (e.g., respondent's name), choice and independent variables.								
18		Efforts and outcomes / Segments	TV ads	Print ads	Radio ads	Direct marketing	Internet			
19		Advertising dollars (\$000)	\$1,000	\$1,000	\$1,000	\$1,000	\$1,000			
20		Revenues (\$000)	\$1,000	\$1,000	\$1,000	\$1,000	\$1,000			
21										
22										

Opportunity costs

Opportunity costs represent the additional net margins a company could attain by releasing a given constraint by 1 unit (either decreasing a lower-bound constraint, or increasing an upper-bound constraint), per segment or in total. In the OfficeStar example, we do not impose any constraints; hence, no constraints could be released to improve total net margins.

If we rerun the analysis and constrain direct marketing spending to a maximum level of \$2M (2,000 units instead of the recommended 3,351), say because management does not want to invest too heavily in that channel, the projected total net margins will be much lower, because the full extent of revenues that could potentially be generated by direct marketing will not be realized.

	A	B	C	D	E	F	G	H	I
1									
2		Base vs. Recommended Scenario							
3		Base vs. recommended effort, per segment and total.							
4		Segments / Scenario	TV ads	Print ads	Radio ads	Direct marketing	Internet	Total	
5		Base scenario	1000	250	100	1500	300	3150	
6		Recommended scenari	1,396.9	519.5	133.2	2,000.0	456.8	4506.478874	
7									
8									
9		Opportunity Costs							
10		Opportunity costs represent the additional net margin you would achieve by relaxing effort constraint by 1 unit, per segment or in total.							
11		Segments / Efforts and opportunity costs	TV ads	Print ads	Radio ads	Direct marketing	Internet	Total	
12		Recommended effort	1,396.9	519.5	133.2	2,000.0	456.8	4506.478874	
13		Opportunity costs	n/a	n/a	n/a	\$ 4,308.40	n/a	n/a	
14									

In this case, the software reports an opportunity costs for direct marketing of \$4,308. At that level of spending, relaxing the constraint by one unit (i.e., increasing the maximum direct marketing budget by \$1,000) increases total net margins by \$4,308. Therefore, the return on investment of an additional dollar spent in direct marketing is +431%.

Sensitivity analysis

The sensitivity analysis feature graphs the evolution of net profit (in thousands of dollars) or another specified outcome, while the total effort varies. There are no constraints on segment-level marketing resources in the sensitivity analysis. Several specific data points are used to generate the graph:

- No effort
- The optimal effort
- The optimal effort +50% effort (over-investing)
- Various intermediate levels of effort

This chart gives a general overview of the sensitivity of the total net profit to major changes in the level of selling effort.

