

# Optimization: Discrete Project Selection

Short Examples Series  
using  
Risk Simulator



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## ***Optimization – Discrete Project Selection***

**File Name:** *Optimization – Discrete Project Selection*

**Location:** *Modeling Toolkit | Optimization | Discrete Project Selection*

**Brief Description:** *This sample model illustrates how to run an optimization on discrete integer decision variables in project selection in order to choose the best projects in a portfolio given a large variety of project options, subject to risk, return, budget and other constraints*

**Requirements:** *Modeling Toolkit, Risk Simulator*

This model shows 12 different projects with different risk and return characteristics. The idea here is to find the best portfolio allocation such that the portfolio's total strategic returns are maximized. That is, the model is used to find the best project mix in the portfolio that maximizes the total returns after considering the risks and returns of each project, subject to the constraints of number of projects and the budget constraint. Figure 1 illustrates the model.

### ***Objective:***

*Maximize Total Portfolio Returns (C17) or Sharpe Ratio returns to risk ratio (C19)*

### ***Decision Variables:***

*Allocation or Go/No-Go Decision (I4:I15)*

### ***Restrictions on Decision Variables:***

*Binary decision variables (0 or 1)*

### ***Constraints:***

*Total Cost (D17) is less than \$5000 and less than or equal to 6 projects selected (I17)*

	A	B	C	D	E	F	G	H	I
1									
2									
3		<b>Credit Line</b>	<b>ENPV</b>	<b>Cost</b>	<b>Risk</b>	<b>Return to Risk Ratio</b>	<b>Profitability Index</b>		<b>Selection</b>
4		Project 1	\$458.00	\$1,732.44	12.00%	3816.67	1.26		1.0000
5		Project 2	\$1,954.00	\$859.00	98.00%	1993.88	3.27		1.0000
6		Project 3	\$1,599.00	\$1,845.00	97.00%	1648.45	1.87		1.0000
7		Project 4	\$2,251.00	\$1,645.00	45.00%	5002.22	2.37		1.0000
8		Project 5	\$849.00	\$458.00	109.00%	778.90	2.85		1.0000
9		Project 6	\$758.00	\$52.00	74.00%	1024.32	15.58		1.0000
10		Project 7	\$2,845.00	\$758.00	198.00%	1436.87	4.75		1.0000
11		Project 8	\$1,235.00	\$115.00	75.00%	1646.67	11.74		1.0000
12		Project 9	\$1,945.00	\$125.00	108.00%	1800.93	16.56		1.0000
13		Project 10	\$2,250.00	\$458.00	85.00%	2647.06	5.91		1.0000
14		Project 11	\$549.00	\$45.00	48.00%	1143.75	13.20		1.0000
15		Project 12	\$525.00	\$105.00	59.00%	889.83	6.00		1.0000
16									
17		Total	\$17,218.00	\$8,197.44	329%				12
18		Goal:	MAX	<=\$5000					<=6
19		Sharpe Ratio	5238.25						
20									
21		ENPV is the expected NPV of each credit line or project, while Cost can be the total cost of							
22		administration as well as required capital holdings to cover the credit line, and Risk is the							
23		Coefficient of Variation of the credit line's ENPV.							

Figure 1: Discrete project selection model

## Running an Optimization

To run this preset model, simply run the optimization (**Risk Simulator | Optimization | Run Optimization**) or for practice, set up the model yourself:

1. Start a new profile (**Risk Simulator | New Profile**) and give it a name.
2. In this example, all the allocations are required to be binary (0 or 1) values, so first select cell **I4** and make this a decision variable in the Integer Optimization worksheet and select cell **I4** and define it as a decision variable (**Risk Simulator | Optimization | Decision Variables** or click on the *Define Decision icon*) and make it a **Binary Variable**. This setting automatically sets the minimum to 0 and maximum to 1 and can only take on a value of 0 or 1. Then use the **Risk Simulator Copy** on cell **I4**, select cells **I5 to I15**, and use **Risk Simulator's Paste** (**Risk Simulator | Copy Parameter** and **Risk Simulator | Paste Parameter** or use the *Risk Simulator copy* and *paste icons*, NOT the Excel copy/paste).
3. Next, set up the optimization's constraints by selecting **Risk Simulator | Optimization | Constraints**, and selecting **ADD**. Then link to cell **D17**, and make it  $\leq 5000$ , and select **ADD** one more time and click on the link icon and point to cell **I17** and set it to  $\leq 6$ .

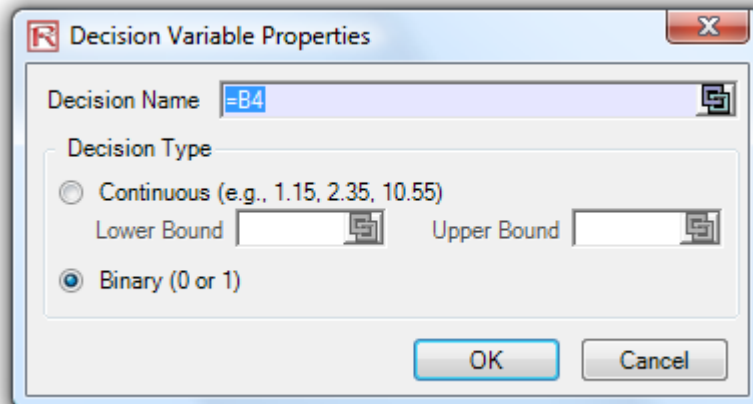
4. Select cell **C19**, the objective to be maximized, and select **Risk Simulator | Optimization | Run Optimization**. Review the different tabs to make sure that all the required inputs in steps 2 and 3 above are correct.
5. You may now select the optimization method of choice and click **OK** to run the optimization:

Note: Remember that if you are to run either a dynamic or stochastic optimization routine, make sure that you have assumptions first defined in the model. That is, make sure that some of the cells in C4:C15 are assumptions. The suggestion for this model is to run a Discrete Optimization.

### Viewing and Interpreting Forecast Results

Refer to Chapter 11 of Modeling Risk: Applying Monte Carlo Simulation, Real Options Analysis, Forecasting, and Optimization, 2nd Edition (Wiley Finance, 2006) by Dr. Johnathan Mun for more detailed explanations about this model, the different optimization techniques, as well as an interpretation of the results.

In addition, you can create a Markowitz Efficient Frontier by running the optimization, then resetting the budget to a higher level, and re-running the optimization. You can do this several times to obtain the Risk-Return efficient frontier. For a more detailed example, see the Efficient Frontier model.



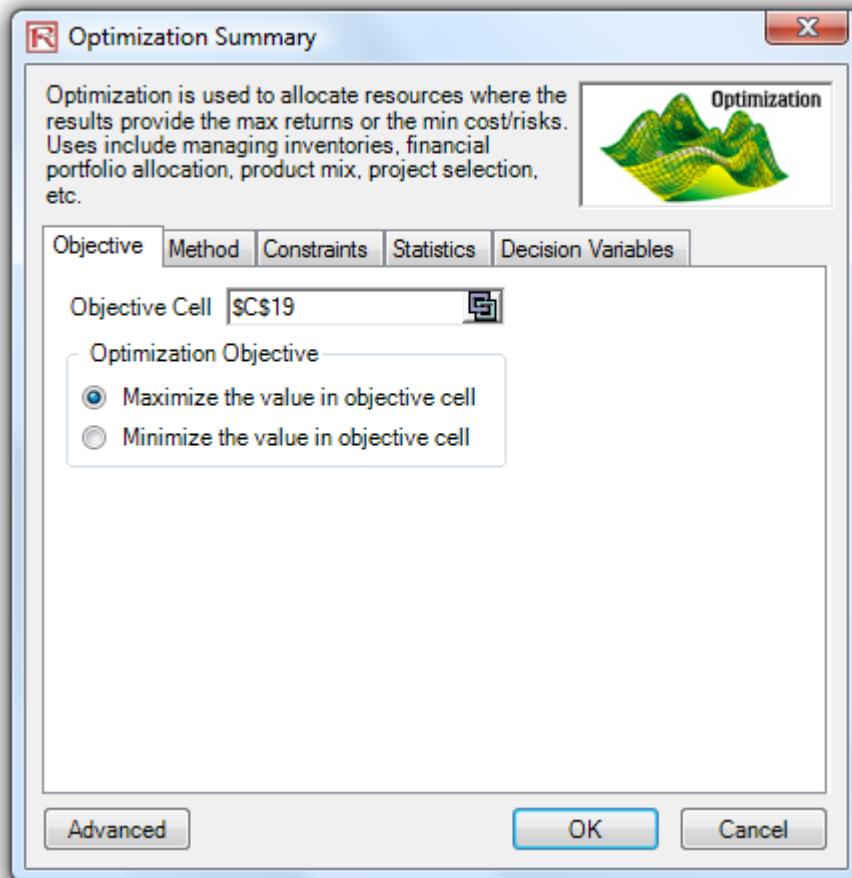
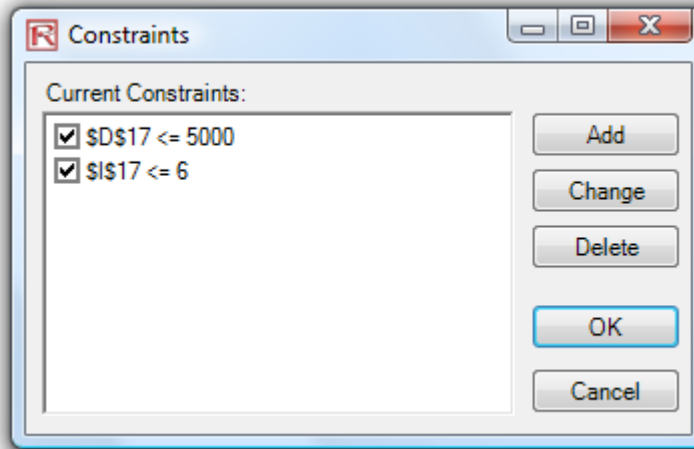


Figure 2 Setting up the optimization process