Optimization: Optimal Timing

Short Examples Series

using

Risk Simulator

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Optimization – Optimization of a Harvest Model

File Name: *Optimization – Optimization of a Harvest Model*
Location: *Modeling Toolkit | Optimization | Optimization of a Harvest Model*
Brief Description: *This sample model illustrates how to find the optimal harvest rate for a population that maximizes return*
Requirements: *Modeling Toolkit, Risk Simulator*

This is a population dynamics and harvest model, where given an initial population, the growth rate of the population, we can determine the optimal harvest rate that maximizes the return on investment, given a specific cost of capital and carrying capacity of the population. For instance, this can be a model on a herd of cattle or a forest of trees, where there is a carrying or maximum capacity of the population. The population dynamics can be summarized as:

$$Percentage\ Growth_t = Growth\ Rate\,(1 - Population_{t-1} \div Carrying\ Capacity)$$
$$Births_t = Percentage\ Growth_t\ Population_{t-1}$$
$$Continuing\ Population_t = Population_{t-1} - Harvest_t$$
$$Population_t = Births_t + Continuing\ Population_t$$

A sample set of inputs is provided, as are the model computations and the time-series chart shows the population dynamics and interactions. Typically, if there is no excess harvesting, the continuing graph should stabilize over time as shown in Figure 1 and 2.

Growth Rate	60.00%
Maximum Capacity	1000
Annual Harvest	100.00
Starting Value	300
Harvest Sales Price	$10
PV Salvage Price Each	$12
Cost of Capital	5.00%
Minimum Harvest	50
Maximum Harvest	200

Ending Population	689
Total Harvested	5,000
Total Harvested PV Sales	$17,726.14
Salvage Value	$8,086.05
Total Value of Property	$25,812.18

Figure 1: Harvest model

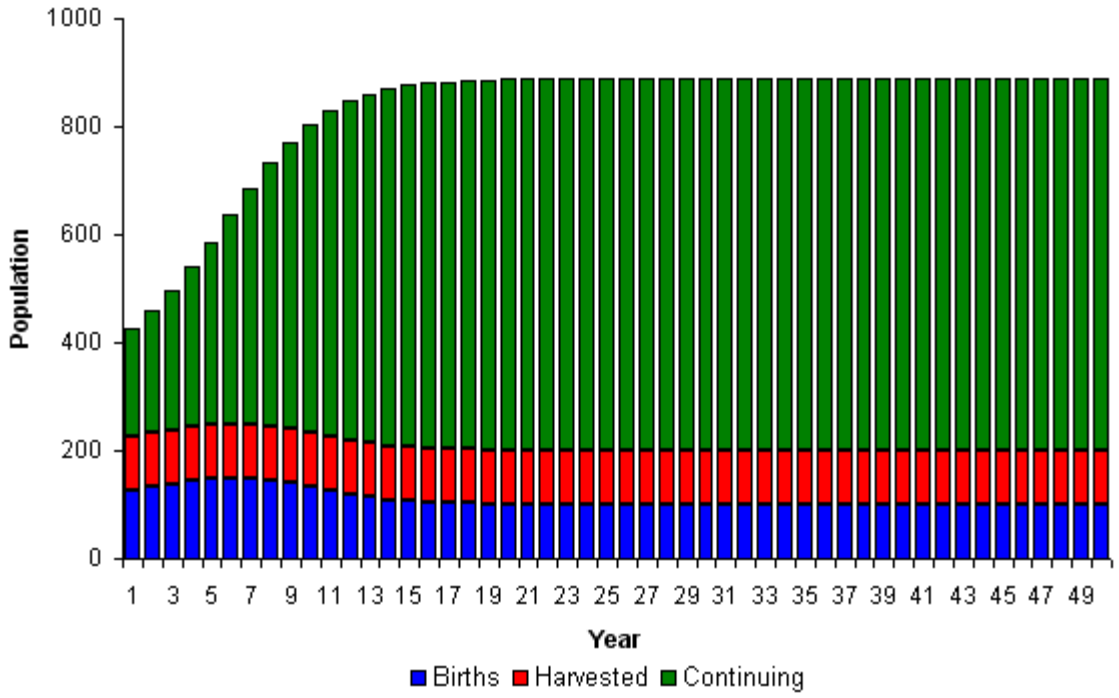

Figure 2: Harvest model chart

Procedure

The model has been preset with optimization parameters and simulation assumptions. To run this model, simply:

1. Go to the *Model* worksheet and click on **Risk Simulator | Change Profile** and select the *Population and Harvest Model* profile.
2. Click on the **Run Optimization** icon or **Risk Simulator | Optimization** | **Run Optimization**, and click **Replace** when the optimization routine is complete.

You will see the optimal annual harvest is 125.80 thousand, providing the highest total value of the property (Figure 3). In fact, after the optimization is run, run a simulation on the optimized annual harvest. You can see that there is a 53% certainty that this optimized harvest level will result in values greater than that expected without optimization (Figure 4).

Growth Rate	60.00%
Maximum Capacity	1000
Annual Harvest	125.80
Starting Value	300
Harvest Sales Price	$10
PV Salvage Price Each	$12
Cost of Capital	5.00%
Minimum Harvest	50
Maximum Harvest	200

Ending Population	574
Total Harvested	6,290
Total Harvested PV Sales	$22,299.63
Salvage Value	$6,733.98
Total Value of Property	$29,033.61

Figure 3: Optimized results

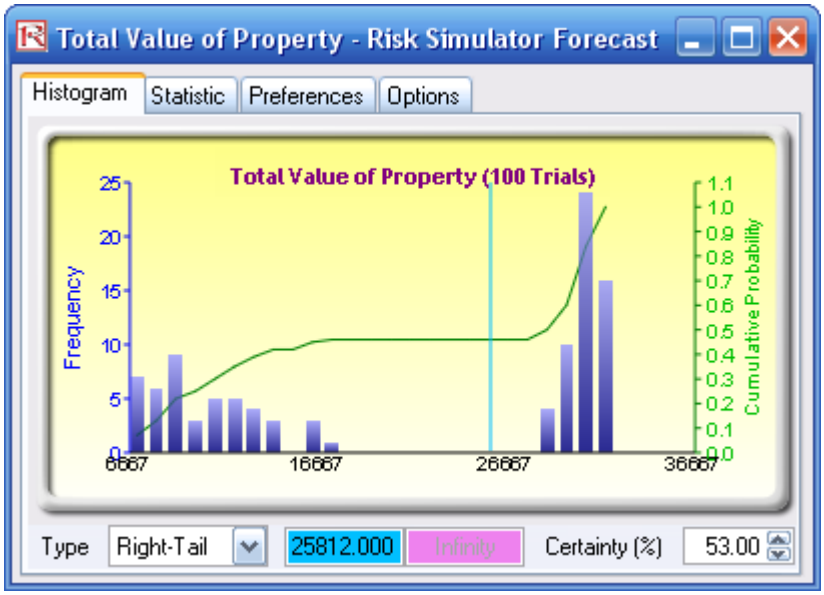

Figure 4: Total property value forecast chart

To replicate the model and create it from scratch, follow the instructions:

1. Go to the *Model* worksheet and click on **Risk Simulator | New Profile** and give the profile a name.
2. Set the objective. Select cell **H10** (Total Value of Property) and click on the **O** icon or **Risk Simulator | Optimization | Set Objective** (Figure 5).
3. Set the decision variable. Select cell **D7** (Annual Harvest) and click on the **D** icon or **Risk Simulator | Optimization | Set Decision**. Select **Continuous** and click on the link icon and link the lower bounds and upper bounds to **D12** and **D13** (Figure 6). Continuous decision variables can be chosen as the number of trees modeled is in thousands of units.
4. Reset the decision variable. Change the value in cell **D7** to some starting value, e.g., **100**.

5. Prepare to run the optimization. Click on the **Run Optimization** icon or **Risk Simulator | Optimization | Run Optimization** (Figure 7).
6. Run the optimization. Click on the *Method* tab and select **Discrete Optimization** and click **RUN**. Click **Replace** when the optimization routine is complete. You will see the optimal annual harvest is 125.80, providing the highest total value of the property.

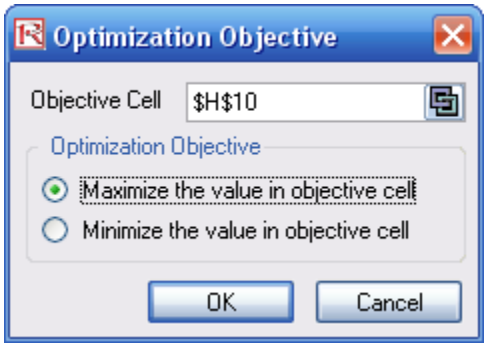

Figure 5: Setting optimization objective

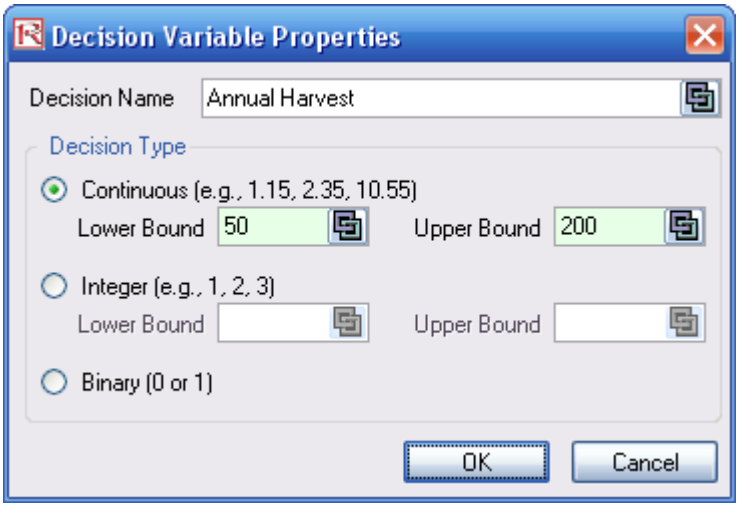

Figure 6: Continuous decision variables

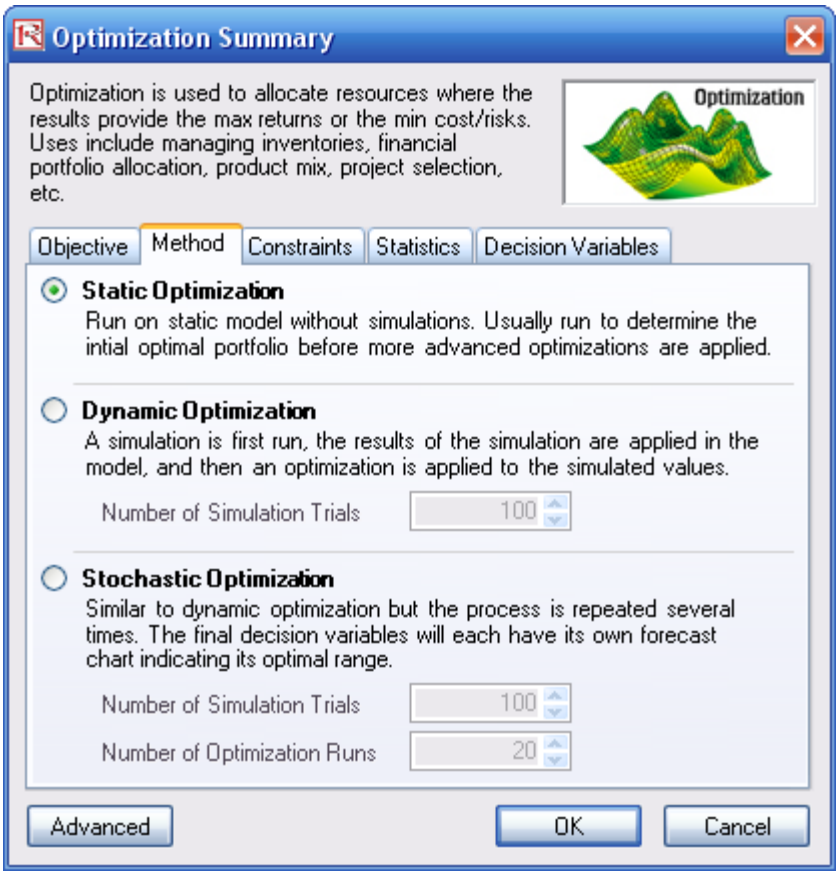

Figure 7: Optimization run