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 $_{t-1}$ ÷ Carrying Capacity) Births $_{t}$ = Percentage Growth $_{t}$ Population $_{t-1}$ Continuing Population $_{t}$ = Population $_{t-1}$ – Harvest $_{t}$ Population $_{t}$ = Births $_{t}$ + Continuing Population $_{t}$

> 60.00% 1000 100.00 300 \$10 \$12 5.00% 500 200

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	
Maximum Capacity	
Annual Harvest	
Starting Value	
Harvest Sales Price	
PV Salvage Price Each	
Cost of Capital	
Minimum Harvest	
Maximum Harvest	

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

574
6,290
\$22,299.63
\$6,733.98
\$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.
- 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).
- 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.

尾 Optimizati	on Objective 🛛 🔀			
Objective Cell	\$H\$10 🔄			
C Optimization O	bjective			
 Maximize the value in objective cell 				
 Minimize the value in objective cell 				
	OK Cancel			

Figure 5: Setting optimization objective

🖪 Decision Variable P	ropertie	s	X
Decision Name Annual H	Harvest		5
Decision Type			
 Continuous (e.g., 1.15 Lower Bound 50 	5, 2.35, 10. 🕞	55) Upper Bound	200 🖪
		opper bound	
Lower Bound	Ē	Upper Bound	ß
O Binary (0 or 1)			
		OK	Cancel

Figure 6: Continuous decision variables

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Figure 7: Optimization run