

Inventory Management Optimized Decision Modelling

Christina Lu Jin

1) Define the data, uncontrollable inputs, and decision variables that influence total inventory cost.

This inventory management dataset includes the following components

Annual Demand	14900
Unit Cost	\$75
Holding Rate	18%
Order Cost	\$225

Uncontrollable Inputs: also include the components above: Annual demand, Unit cost, Holding rate and Order cost
Decision Variable: the quantity of units purchased in one order

2) Develop mathematical functions that compute the annual ordering cost and annual holding cost based on average inventory held throughout the year in order to arrive at a model for total cost.

INPUTS:

Annual Demand **D**
Unit Cost **C**
Holding Rate **H**
Order Cost **O**
Quantity of units per order **x**

FORMULAS:

Annual ordering cost = **O * (D / x)**
Average inventory = **x/2**
Annual holding cost = **C * H * x/2**
Total inventory cost (T) = annual ordering cost + annual holding cost = **O*(D/x) + C*H*x/2**

We would like to find out how the change of one variable (quantity of units per order, x), affects the total annual inventory cost (T)
therefore we would have to differentiate the total inventory cost with respect to x
differentiate d(T)/d(x) = **C*H/2 - D*O/x^2 = 0**
So, **x = (2*D*O/(C*H))^0.5**

3) Implement model

INPUTS & CONSTRAINTS:	
Annual Demand (D)	14900
Unit Cost (C)	\$75
Holding Rate (H)	18%
Order Cost (O)	\$225

DERIVED INPUTS & OUTPUTS:	
Quantity per Order (x)	704.00
Average Inventory	352.00
Annual Holding Cost	\$4,752.00
Annual Ordering Cost	\$4,762.07
Total Inventory Cost (T)	\$9,514.07

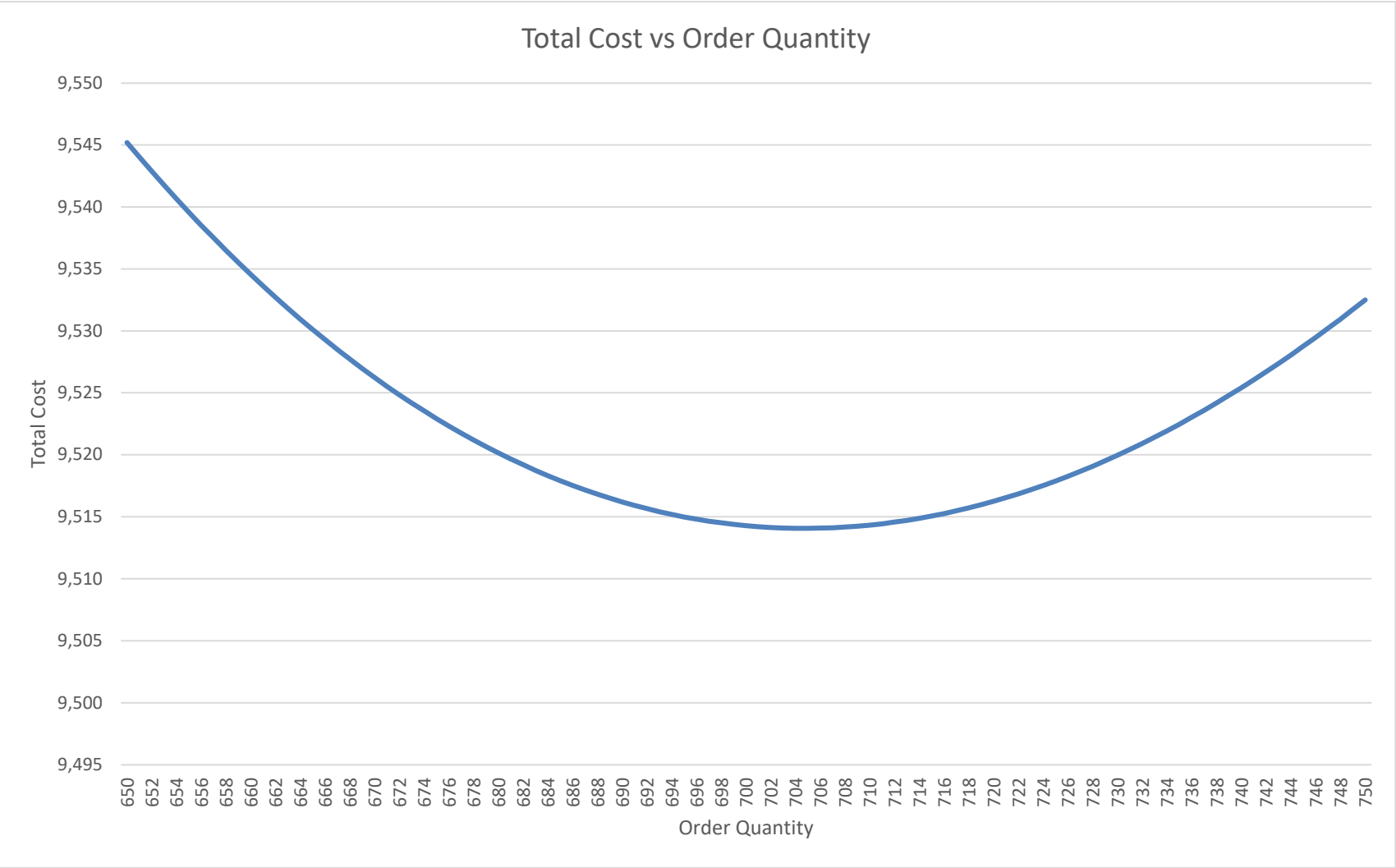
4) Use data tables to find an approximate order quantity that results in the smallest total cost.

Please refer to the next sheet (Q4 - Solve with Table) for solution of this question

From the table in the next sheet, we could find that a order quantitiy of both 704 and 705 units would provide us with the minimum inventory cost of \$9514.07

Quantity per Order (650-700)	Annual Holding Cost	Annual Ordering Cost	Total Inventory Cost (T)
650	4,387.50	5,157.69	9,545.19
651	4,394.25	5,149.77	9,544.02
...
703	4,745.25	4,768.85	9,514.10
704	4,752.00	4,762.07	9,514.07
705	4,758.75	4,755.32	9,514.07
706	4,765.50	4,748.58	9,514.08
...
750	5,062.50	4,470.00	9,532.50

5) Plot the Toal Cost vs Order Quantity



6) Use Solver to verify results

SOLVER OUTPUT SOLUTION		
INPUTS & CONSTRAINTS:		
Annual Demand (D)		14900
Unit Cost (C)		\$75
Holding Rate (H)		18%
Order Cost (O)		\$225
DERIVED INPUTS & OUTPUTS:		
Quantity per Order (x)		704.75
Total Inventory Cost (T)	$= (D117 * D118 * D122 / 2) + D119 * (D116 / D122)$	\$9,514.07

SOLVER ANSWER REPORT				
Microsoft Excel 16.0 Answer Report				
Worksheet: [EOQ.xls]Sheet1				
Report Created: 4/12/2021 3:08:44 PM				
Result: Solver has converged to the current solution. All Constraints are satisfied.				
Solver Engine				
Solver Options				
Objective Cell (Min)				
Cell	Name	Original Value	Final Value	
\$G\$7	#DIV/0!	\$3,352,506.75	\$9,514.07	
Variable Cells				
Cell	Name	Original Value	Final Value	Integer
\$G\$8	Quantity per Order (x)	1.00	704.75	Contin
Constraints				
NONE				

7) Conduct what-if analyses by using two-way tables to study the sensitivity of total cost to changes in the model parameters.

Model Parameters:	
Annual Demand (D)	14900
Unit Cost (C)	\$75
Holding Rate (H)	18%
Order Cost (O)	\$225
DERIVED INPUTS & OUTPUTS:	
Quantity per Order (x)	704.75
Total Inventory Cost (T)	\$9,514.07

What-if Two-way Table Results	What-if Two-way table results (Annual Demand vs Unit Cost)							
	\$9,514.07	\$14,600.00	\$14,700.00	\$14,800.00	\$14,900.00	\$15,000.00	\$15,100.00	\$15,200.00
	\$72	\$9,228.01	\$9,259.93	\$9,291.86	\$9,323.79	\$9,355.71	\$9,387.64	\$9,419.57
	\$73	\$9,291.44	\$9,323.36	\$9,355.29	\$9,387.21	\$9,419.14	\$9,451.07	\$9,482.99
	\$74	\$9,354.86	\$9,386.79	\$9,418.72	\$9,450.64	\$9,482.57	\$9,514.49	\$9,546.42
	\$75	\$9,418.29	\$9,450.22	\$9,482.14	\$9,514.07	\$9,545.99	\$9,577.92	\$9,609.85
	\$76	\$9,481.72	\$9,513.64	\$9,545.57	\$9,577.50	\$9,609.42	\$9,641.35	\$9,673.27
	\$77	\$9,545.14	\$9,577.07	\$9,609.00	\$9,640.92	\$9,672.85	\$9,704.78	\$9,736.70
	\$78	\$9,608.57	\$9,640.50	\$9,672.42	\$9,704.35	\$9,736.28	\$9,768.20	\$9,800.13
	What-if Two-way table results (Order Cost vs Holding Rate)							
	\$9,514.07	\$222.00	\$223.00	\$224.00	\$225.00	\$226.00	\$227.00	\$228.00
	15%	\$8,657.80	\$8,678.94	\$8,700.09	\$8,721.23	\$8,742.37	\$8,763.51	\$8,784.66
	16%	\$8,922.08	\$8,943.22	\$8,964.37	\$8,985.51	\$9,006.65	\$9,027.79	\$9,048.94
	17%	\$9,186.36	\$9,207.50	\$9,228.65	\$9,249.79	\$9,270.93	\$9,292.07	\$9,313.22
	18%	\$9,450.64	\$9,471.78	\$9,492.93	\$9,514.07	\$9,535.21	\$9,556.35	\$9,577.50
19%	\$9,714.92	\$9,736.06	\$9,757.21	\$9,778.35	\$9,799.49	\$9,820.63	\$9,841.78	
20%	\$9,979.20	\$10,000.34	\$10,021.49	\$10,042.63	\$10,063.77	\$10,084.91	\$10,106.06	
21%	\$0.15	\$0.15	\$0.15	\$0.15	\$0.15	\$0.15	\$0.15	

Scenario Manager

?

×

Scenarios:

Demand = 14500

Demand = 15300

Unit Cost = 70

Unit Cost = 80

Holding Rate = 17%

Holding Rate = 19%

Order Cost = 220

Order Cost = 230

Add...

Delete

Edit...

Merge...

Summary...

Changing cells:

\$D\$141

Comment:

Created by Lu Jin on 4/12/2021
Modified by Lu Jin on 4/13/2021

Show

Close

Scenario Summary										
		Current Values: Demand = 14500 emand = 15300 Unit Cost = 70 Unit Cost = 80 lding Rate = 17% lding Rate = 19% Order Cost = 220 Order Cost = 230								
Changing Cells:										
	\$D\$141	14900	14500	15300	14900	14900	14900	14900	14900	14900
	\$D\$142	\$75	\$75	\$75	\$70	\$80	\$75	\$75	\$75	\$75
	\$D\$143	18%	18%	18%	18%	18%	17%	19%	18%	18%
	\$D\$144	\$225	\$225	\$225	\$225	\$225	\$225	\$225	\$220	\$230
Result Cells:										
	\$D\$147	\$9,514.07	\$9,386.36	\$9,641.77	\$9,196.93	\$9,831.20	\$9,249.79	\$9,778.35	\$9,408.36	\$9,619.78

Notes: Current Values column represents values of changing cells at time Scenario Summary Report was created. Changing cells for each scenario are highlighted in gray.

We can see from the chart that total inventory cost is most sensitive to holding rate, is second sensitive to to annual demand, and then unit cost and lastly order cost