

# 第一章 管理科学简介

- ◆ 特殊产品的盈亏平衡分析 **1.2 – 1.7**
- ◆ 笔记本电脑生产或购买案例 **1.8**
- ◆ 广告问题 **1.9 – 1.22**

# 特殊产品的盈亏平衡分析

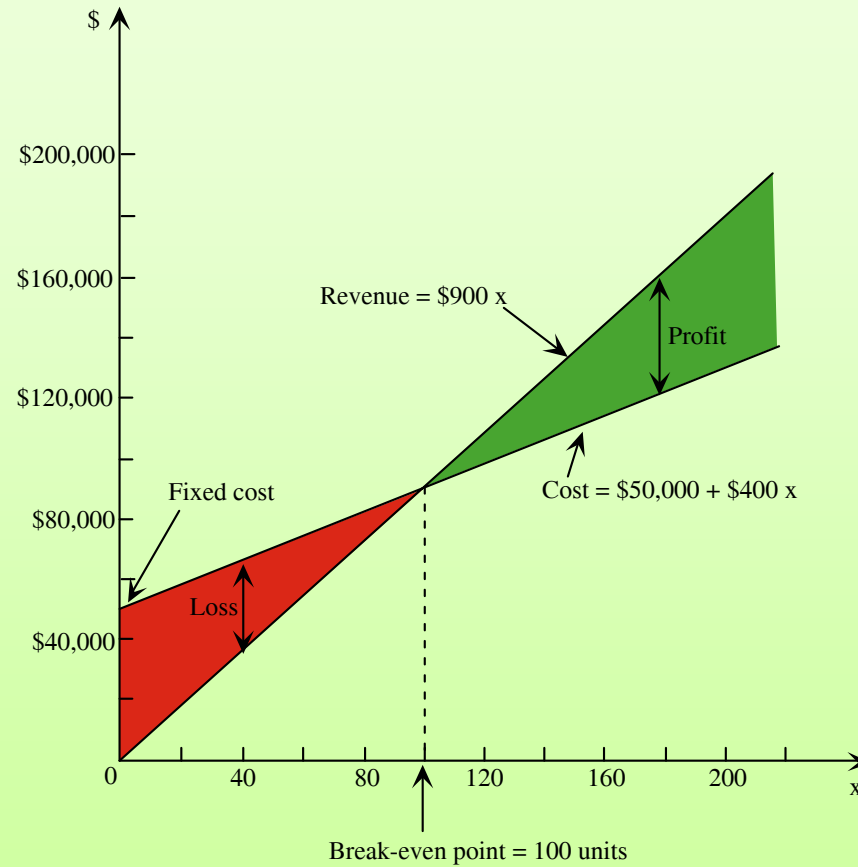
- ◆ 特殊产品公司生产在商店销售的昂贵而不常见的礼品
- ◆ 公司研发部最新的产品计划是限量版落地摆钟
- ◆ 数据：
  - 如果公司生产该产品，则固定费用为**\$50,000**
  - 每单位产品的变动成本为**\$400**
  - 每销售出**1**只落地摆钟的收入为**\$900**
  - 获得销售额的预测

决策：公司应该生产此种落地摆钟吗？如果生产，应该生产多少？

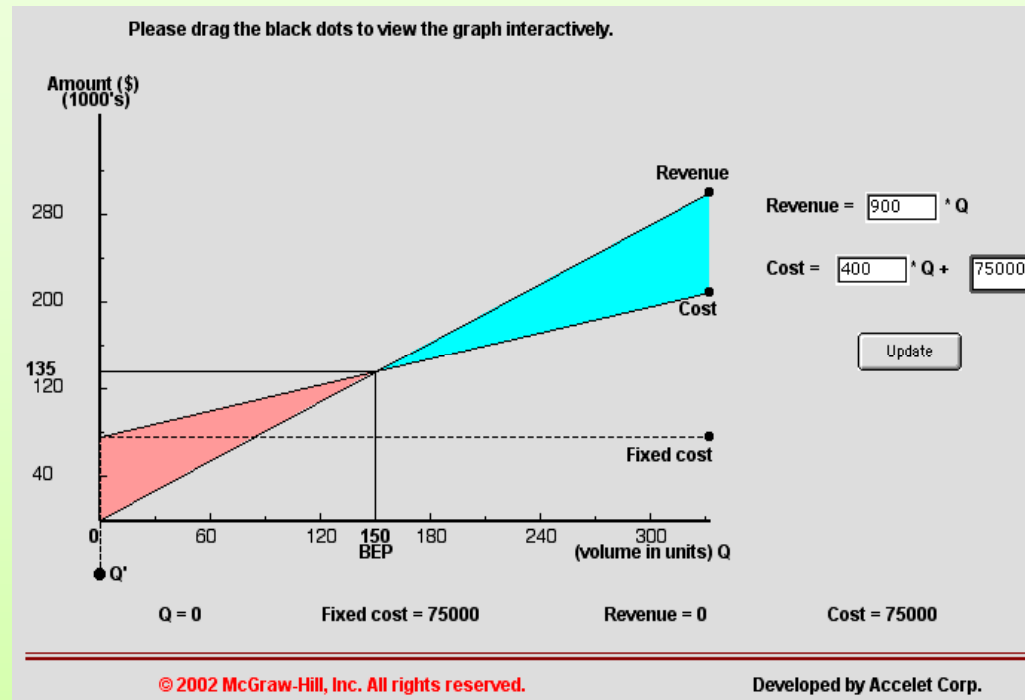
# 用数学方式描述问题

- ◆ 决策变量：
  - $Q =$  落地摆钟的生产数量
- ◆ 成本：
  - 固定成本 = \$50,000 ( 如果  $Q > 0$  )
  - 变动成本 =  $\$400 Q$
  - 总成本 =
    - $0$  , 如果  $Q = 0$
    - $\$50,000 + \$400 Q$  , 如果  $Q > 0$
- ◆ 利润：
  - 利润 = 总收入 - 总成本
    - 利润 =  $0$  , 如果  $Q = 0$
    - 利润 =  $\$900Q - (\$50,000 + \$400Q) = -\$50,000 + \$500Q$  , 如果  $Q > 0$

# 分析问题



# 交互式管理科学模型



- ◆ 在交互式管理科学模型中敏感性分析可以用来构建盈亏平衡分析模型（可以应用到管理科学课件中）。
  - 在图表中可以看到固定成本变为\$75,000后的情况。

# 特殊产品问题的电子表格模型

	B	C	D	E	F
3		<b>Data</b>			<b>Results</b>
4	Unit Revenue	\$900		Total Revenue	\$270,000
5	Fixed Cost	\$50,000		Total Fixed Cost	\$50,000
6	Marginal Cost	\$400		Total Variable Cost	\$120,000
7	Sales Forecast	300		Profit (Loss)	\$100,000
8					
9	Production Quantity	300			

	E	F
3		<b>Results</b>
4	Total Revenue	=UnitRevenue*MIN(SalesForecast,ProductionQuantity)
5	Total Fixed Cost	=IF(ProductionQuantity>0,FixedCost,0)
6	Total Variable Cost	=MarginalCost*ProductionQuantity
7	Profit (Loss)	=TotalRevenue-(TotalFixedCost+TotalVariableCost)

Range Name	Cell
FixedCost	C5
MarginalCost	C6
ProductionQuantity	C9
Profit	F7
SalesForecast	C7
TotalFixedCost	F5
TotalRevenue	F4
TotalVariableCost	F6
UnitRevenue	C4

# 特殊产品问题的电子表格模型

	B	C	D	E	F
3		<b>Data</b>			<b>Results</b>
4	Unit Revenue	\$900		Total Revenue	\$270,000
5	Fixed Cost	\$50,000		Total Fixed Cost	\$50,000
6	Marginal Cost	\$400		Total Variable Cost	\$120,000
7	Sales Forecast	300		Profit (Loss)	\$100,000
8					
9	Production Quantity	300		Break-Even Point	100

	E	F
3		<b>Results</b>
4	Total Revenue	=UnitRevenue*MIN(SalesForecast,ProductionQuantity)
5	Total Fixed Cost	=IF(ProductionQuantity>0,FixedCost,0)
6	Total Variable Cost	=MarginalCost*ProductionQuantity
7	Profit (Loss)	=TotalRevenue-(TotalFixedCost+TotalVariableCost)
8		
9	Break-Even Point	=FixedCost/(UnitRevenue-MarginalCost)

Range Name	Cell
BreakEvenPoint	F9
FixedCost	C5
MarginalCost	C6
ProductionQuantity	C9
Profit	F7
SalesForecast	C7
TotalFixedCost	F5
TotalRevenue	F4
TotalVariableCost	F6
UnitRevenue	C4

# 生产还是购买？

- ◆ Power Notebooks, Inc.是一个笔记本电脑制造商，他们想决定是为他们的电脑从外界供应商那购买液晶显示屏还是内部制造。
- ◆ 从外界购买一个液晶显示屏的成本是\$100。
- ◆ 装配液晶显示屏内部生产线的成本是\$10,000.，生产一个液晶显示屏的成本是\$75。

问题：两种决策中液晶显示屏的数量是多少为最佳？



# 投资问题

- ◆ Parker Mothers是一个儿童玩具的制造商，他们最畅销的产品是叫做Harry Potter的电子互动玩具。
- ◆ 数据：
  - 单位变动成本：\$48
  - 单位销售价格：\$65
  - 售货人员薪水：\$9,000
  - 固定间接费用：\$23,000
- ◆ Parker Mothers已经分析了过去Harry Potter玩具的数据（以及其他类似玩具的数据），并且确认了影响销售量的一些因素：
  - 季节（举例如：圣诞节、新的Harry Potter玩具手册或电影版本发行时销售额会增加），
  - 销售人员专心于产品销售的规模大小，
  - 广告的水平。

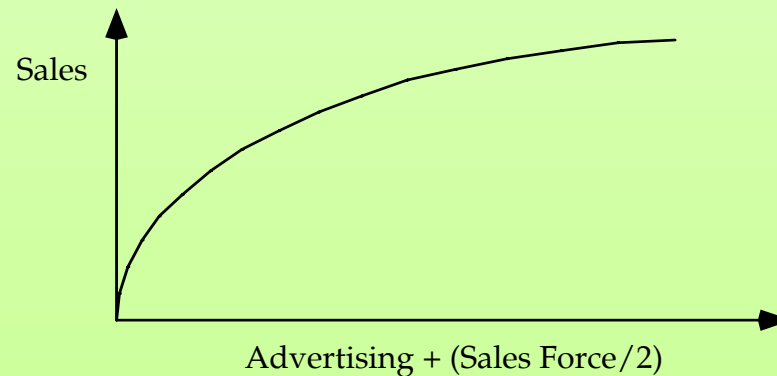
问题： Harry Potter玩具的广告预算是多少？（建议：\$10,000）

# 预测销售水平

- ◆ 在履行统计衰退分析后，他们估计季度销售额将涉及到季节、销售人员薪水以及广告预算等因素，如下所示：

$$\text{Sales} \approx (35) \times (\text{Seasonality Factor}) \times \sqrt{\text{Advertising} + \frac{\text{Sales Force}}{2}}$$

- ◆ 季节因素：
  - Q1: 1.2 （发行新的Harry Potter玩具手册）
  - Q2: 0.7
  - Q3: 0.8
  - Q4: 1.3 （圣诞节以及预期的新Harry Potter玩具电影）
- ◆ 广告以及售货力量：



# 季度销售量电子表格数据1

	B	C
3	<b>Parameters:</b>	
4	Unit Variable Cost	\$48
5	Unit Price	\$65
6	Salesforce Salary	\$9,000
7	Fixed Overhead	\$23,000
8	Seasonality	1.2
9		
10	<b>Decision Variable:</b>	
11	Advertising	\$10,000
12		
13	<b>Quarter</b>	<b>Q1</b>
14	Units Sold	5057
15		
16	Sales Revenue	\$328,736
17	Cost of Sales	\$242,759
18	Gross Margin	\$85,977
19		
20	Advertising Cost	\$10,000
21	Total Fixed Costs	\$32,000
22		
23	<b>Profit</b>	<b>\$43,977</b>

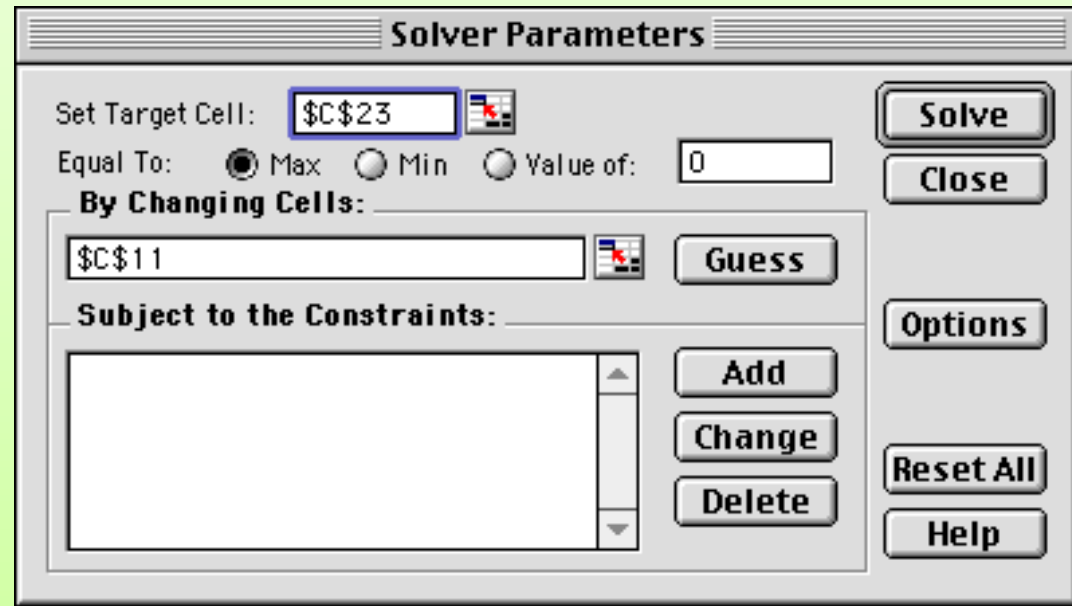
	B	C
13	<b>Quarter</b>	<b>Q1</b>
14	Units Sold	=35*C8*SQRT(C11+(\$C\$6/2))
15		
16	Sales Revenue	=C14*\$C\$5
17	Cost of Sales	=C14*\$C\$4
18	Gross Margin	=C16-C17
19		
20	Advertising Cost	=C11
21	Total Fixed Costs	=\$C\$6+\$C\$7
22		
23	<b>Profit</b>	<b>=C18-C20-C21</b>

# 尝试解法

	B	C	D	E	F	G	H
3	<b>Parameters:</b>						
4	Unit Variable Cost	\$48					
5	Unit Price	\$65					
6	Salesforce Salary	\$9,000					
7	Fixed Overhead	\$23,000					
8	Seasonality	1.2					
9							
10	<b>Decision Variable:</b>						
11	Advertising	\$10,000	\$40,000	\$70,000	\$100,000	\$130,000	\$160,000
12							
13	<b>Quarter</b>	<b>Q1</b>	<b>Q1</b>	<b>Q1</b>	<b>Q1</b>	<b>Q1</b>	<b>Q1</b>
14	Units Sold	5057	8860	11464	13577	15403	17035
15							
16	Sales Revenue	\$328,736	\$575,894	\$745,145	\$882,512	\$1,001,207	\$1,107,250
17	Cost of Sales	\$242,759	\$425,276	\$550,261	\$651,701	\$739,353	\$817,661
18	Gross Margin	\$85,977	\$150,618	\$194,884	\$230,811	\$261,854	\$289,588
19							
20	Advertising Cost	\$10,000	\$40,000	\$70,000	\$100,000	\$130,000	\$160,000
21	Total Fixed Costs	\$32,000	\$32,000	\$32,000	\$32,000	\$32,000	\$32,000
22							
23	<b>Profit</b>	<b>\$43,977</b>	<b>\$78,618</b>	<b>\$92,884</b>	<b>\$98,811</b>	<b>\$99,854</b>	<b>\$97,588</b>

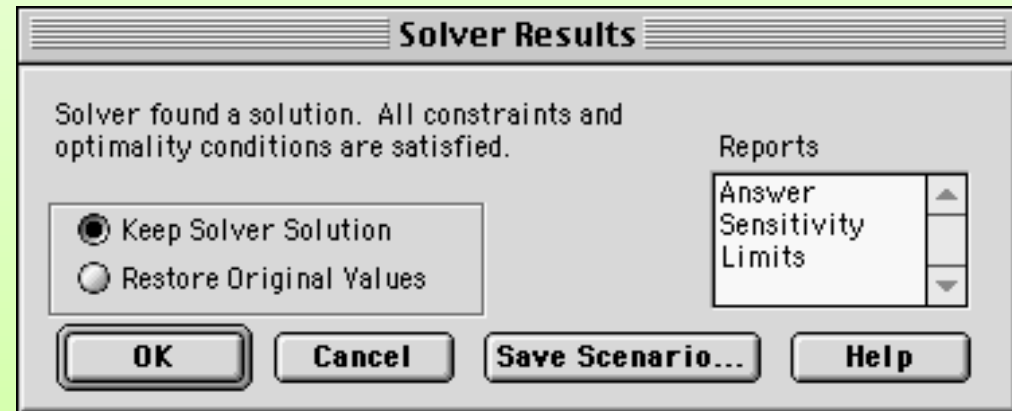
# Excel 解法

	B	C
3	<b>Parameters:</b>	
4	Unit Variable Cost	\$48
5	Unit Price	\$65
6	Salesforce Salary	\$9,000
7	Fixed Overhead	\$23,000
8	Seasonality	1.2
9		
10	<b>Decision Variable:</b>	
11	Advertising	\$10,000
12		
13	<b>Quarter</b>	<b>Q1</b>
14	Units Sold	5057
15		
16	Sales Revenue	\$328,736
17	Cost of Sales	\$242,759
18	Gross Margin	\$85,977
19		
20	Advertising Cost	\$10,000
21	Total Fixed Costs	\$32,000
22		
23	<b>Profit</b>	<b>\$43,977</b>



# 最优解决方案

	B	C
3	<b>Parameters:</b>	
4	Unit Variable Cost	\$48
5	Unit Price	\$65
6	Salesforce Salary	\$9,000
7	Fixed Overhead	\$23,000
8	Seasonality	1.2
9		
10	<b>Decision Variable:</b>	
11	Advertising	\$122,949
12		
13	<b>Quarter</b>	<b>Q1</b>
14	Units Sold	14994
15		
16	Sales Revenue	\$974,610
17	Cost of Sales	\$719,712
18	Gross Margin	\$254,898
19		
20	Advertising Cost	\$122,949
21	Total Fixed Costs	\$32,000
22		
23	<b>Profit</b>	<b>\$99,949</b>



# 四个季度销售量的电子数据表

	B	C	D	E	F	G
3	<b>Parameters:</b>					
4	Unit Variable Cost	\$48				
5	Unit Price	\$65				
6	Salesforce Salary	\$9,000				
7	Fixed Overhead	\$23,000				
8	Seasonality	1.2	0.7	0.8	1.3	
9						
10						<b>Total</b>
11	<b>Decision Variables:</b>					<b>Advertising</b>
12	Advertising	\$10,000	\$10,000	\$10,000	\$10,000	\$40,000
13						
14	<b>Quarter</b>	<b>Q1</b>	<b>Q2</b>	<b>Q3</b>	<b>Q4</b>	<b>Total</b>
15	Units Sold	5057	2950	3372	5479	16858
16						
17	Sales Revenue	\$328,736	\$191,762	\$219,157	\$356,130	\$1,095,785
18	Cost of Sales	\$242,759	\$141,609	\$161,839	\$262,988	\$809,195
19	Gross Margin	\$85,977	\$50,153	\$57,318	\$93,142	\$286,590
20						
21	Advertising Cost	\$10,000	\$10,000	\$10,000	\$10,000	\$40,000
22	Total Fixed Costs	\$32,000	\$32,000	\$32,000	\$32,000	\$128,000
23						
24	<b>Profit</b>	\$43,977	\$8,153	\$15,318	\$51,142	<b>\$118,590</b>

# 四个季度销售量的最优解

	B	C	D	E	F	G
3	<b>Parameters:</b>					
4	Unit Variable Cost	\$48				
5	Unit Price	\$65				
6	Salesforce Salary	\$9,000				
7	Fixed Overhead	\$23,000				
8	Seasonality	1.2	0.7	0.8	1.3	
9						
10						<b>Total</b>
11	<b>Decision Variables:</b>					<b>Advertising</b>
12	Advertising	\$122,949	\$38,868	\$52,144	\$145,076	\$359,036
13						
14	<b>Quarter</b>	<b>Q1</b>	<b>Q2</b>	<b>Q3</b>	<b>Q4</b>	<b>Total</b>
15	Units Sold	14994	5102	6664	17597	44357
16						
17	Sales Revenue	\$974,610	\$331,638	\$433,160	\$1,143,813	\$2,883,221
18	Cost of Sales	\$719,712	\$244,902	\$319,872	\$844,662	\$2,129,148
19	Gross Margin	\$254,898	\$86,736	\$113,288	\$299,151	\$754,073
20						
21	Advertising Cost	\$122,949	\$38,868	\$52,144	\$145,076	\$359,036
22	Total Fixed Costs	\$32,000	\$32,000	\$32,000	\$32,000	\$128,000
23						
24	<b>Profit</b>	\$99,949	\$15,868	\$29,144	\$122,076	<b>\$267,037</b>



# 剩余效应

	B	C	D	E	F	G
3	<b>Parameters:</b>					
4	Unit Variable Cost	\$48				
5	Unit Price	\$65				
6	Salesforce Salary	\$9,000				
7	Fixed Overhead	\$23,000				
8	Seasonality	1.2	0.7	0.8	1.3	
9						
10						<b>Total</b>
11	<b>Decision Variables:</b>					<b>Advertising</b>
12	Advertising	\$24,077	\$0	\$12,575	\$11,348	\$48,000
13						
14	<b>Quarter</b>	<b>Q1</b>	<b>Q2</b>	<b>Q3</b>	<b>Q4</b>	<b>Total</b>
15	Units Sold	7100	2742	3659	6441	19942
16						
17	Sales Revenue	\$461,503	\$178,231	\$237,821	\$418,664	\$1,296,219
18	Cost of Sales	\$340,802	\$131,617	\$175,622	\$309,167	\$957,208
19	Gross Margin	\$120,701	\$46,614	\$62,199	\$109,497	\$339,011
20						
21	Advertising Cost	\$24,077	\$0	\$12,575	\$11,348	\$48,000
22	Total Fixed Costs	\$32,000	\$32,000	\$32,000	\$32,000	\$128,000
23						
24	<b>Profit</b>	\$64,623	\$14,614	\$17,624	\$66,149	\$163,011

	B	C	D
14	<b>Quarter</b>	<b>Q1</b>	<b>Q2</b>
15	Units Sold	=35*C8*SQRT(C12+(\$C\$6/2))	=35*D8*SQRT(D12+(C12/3)+(\$C\$6/2))

	E	F	G
14	<b>Q3</b>	<b>Q4</b>	<b>Total</b>
15	=35*E8*SQRT(E12+(D12/3)+(\$C\$6/2))	=35*F8*SQRT(F12+(E12/3)+(\$C\$6/2))	=SUM(C15:F15)

# 剩余效应（最优解）

	B	C	D	E	F	G
3	<b>Parameters:</b>					
4	Unit Variable Cost	\$48				
5	Unit Price	\$65				
6	Salesforce Salary	\$9,000				
7	Fixed Overhead	\$23,000				
8	Seasonality	1.2	0.7	0.8	1.3	
9						
10						<b>Total</b>
11	<b>Decision Variables:</b>					<b>Advertising</b>
12	Advertising	\$227,776	-\$8,735	\$125,861	\$103,122	\$448,023
13						
14	<b>Quarter</b>	<b>Q1</b>	<b>Q2</b>	<b>Q3</b>	<b>Q4</b>	<b>Total</b>
15	Units Sold	20242	6560	9996	17597	54395
16						
17	Sales Revenue	\$1,315,723	\$426,392	\$649,740	\$1,143,813	\$3,535,668
18	Cost of Sales	\$971,611	\$314,874	\$479,808	\$844,662	\$2,610,955
19	Gross Margin	\$344,112	\$111,518	\$169,932	\$299,151	\$924,713
20						
21	Advertising	\$227,776	-\$8,735	\$125,861	\$103,122	\$448,023
22	Total Fixed Costs	\$32,000	\$32,000	\$32,000	\$32,000	\$128,000
23						
24	<b>Profit</b>	\$84,337	\$88,253	\$12,071	\$164,029	\$348,690

# 决策

**Solver Options**

Max Time:  seconds

Iterations:

Precision:

Tolerance:  %

Convergence:

Assume Linear Model     Use Automatic Scaling

Assume Non-Negative     Show Iteration Results

**Estimates**    **Derivatives**    **Search**

Tangent     Forward     Newton

Quadratic     Central     Conjugate

**OK**    **Cancel**    **Load Model...**    **Save Model...**    **Help**

# 剩余效应（重新最优决策）

	B	C	D	E	F	G
3	<b>Parameters:</b>					
4	Unit Variable Cost	\$48				
5	Unit Price	\$65				
6	Salesforce Salary	\$9,000				
7	Fixed Overhead	\$23,000				
8	Seasonality	1.2	0.7	0.8	1.3	
9						
10						<b>Total</b>
11	<b>Decision Variables:</b>					<b>Advertising</b>
12	Advertising	\$221,033	\$0	\$122,949	\$104,093	\$448,075
13						
14	<b>Quarter</b>	<b>Q1</b>	<b>Q2</b>	<b>Q3</b>	<b>Q4</b>	<b>Total</b>
15	Units Sold	19946	6850	9996	17597	54389
16						
17	Sales Revenue	\$1,296,487	\$445,268	\$649,740	\$1,143,813	\$3,535,307
18	Cost of Sales	\$957,406	\$328,813	\$479,808	\$844,662	\$2,610,688
19	Gross Margin	\$339,081	\$116,455	\$169,932	\$299,151	\$924,619
20						
21	Advertising Cost	\$221,033	\$0	\$122,949	\$104,093	\$448,075
22	Total Fixed Costs	\$32,000	\$32,000	\$32,000	\$32,000	\$128,000
23						
24	<b>Profit</b>	\$86,048	\$84,455	\$14,983	\$163,059	<b>\$348,544</b>

# 预算剩余效应（最优化）

	B	C	D	E	F	G	H	I
3	<b>Parameters:</b>							
4	Unit Variable Cost	\$48						
5	Unit Price	\$65						
6	Salesforce Salary	\$9,000						
7	Fixed Overhead	\$23,000						
8	Seasonality	1.2	0.7	0.8	1.3			
9								
10						<b>Total Advertising</b>		
11	<b>Decision Variables:</b>							Budget
12	Advertising	\$24,077	\$0	\$12,575	\$11,348	\$48,000	<=	\$48,000
13								
14	<b>Quarter</b>	<b>Q1</b>	<b>Q2</b>	<b>Q3</b>	<b>Q4</b>	<b>Total</b>		
15	Units Sold	7100	2742	3659	6441	19942		
16								
17	Sales Revenue	\$461,503	\$178,231	\$237,821	\$418,664	\$1,296,219		
18	Cost of Sales	\$340,802	\$131,617	\$175,622	\$309,167	\$957,208		
19	Gross Margin	\$120,701	\$46,614	\$62,199	\$109,497	\$339,011		
20								
21	Advertising Cost	\$24,077	\$0	\$12,575	\$11,348	\$48,000		
22	Total Fixed Costs	\$32,000	\$32,000	\$32,000	\$32,000	\$128,000		
23								
24	<b>Profit</b>	\$64,623	\$14,614	\$17,624	\$66,149	\$163,011		

# 在决策中增加一个约束

