NORTHEASTERN UNIVERSITY

Department of Mechanical and Industrial Engineering

Supply Chain Engineering **Prof. Gupta**

IE 7200 **Spring 2014 (Mondays)**

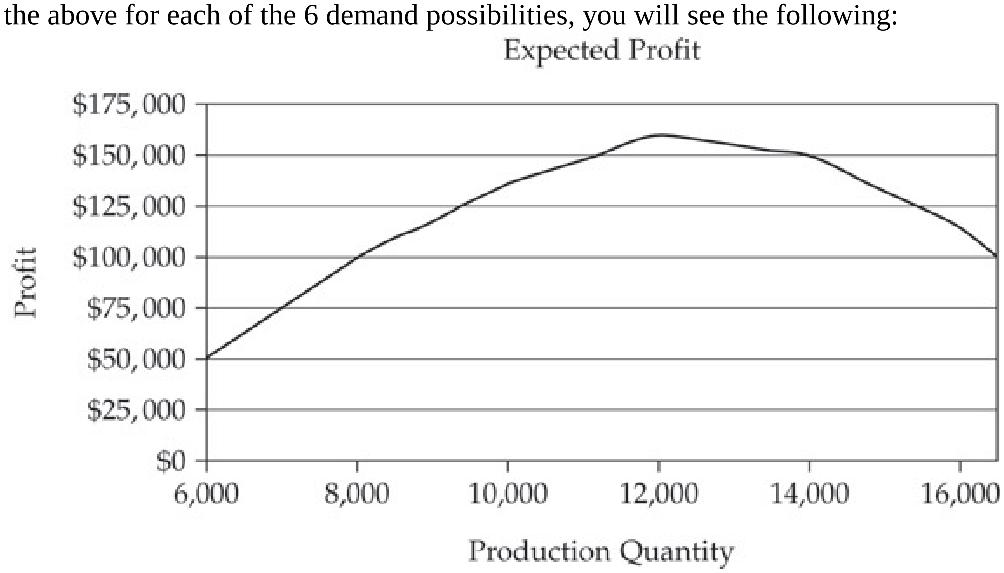
Homework No. 7

(Solution: Note that all tables are not shown: only relevant tables are shown)

Problem 1. If the manufacturer produces 12,000 units, the **manufacturer's** expected profit is calculated as follows:

Demand	Probability	Revenue	Cost	Profit
8,000	0.11	$720,000	$760,000	($40,000)
10,000	0.11	$840,000	$760,000	$80,000
12,000	0.28	$960,000	$760,000	$200,000
14,000	0.22	$960,000	$760,000	$200,000
16,000	0.18	$960,000	$760,000	$200,000
18,000	0.1	$960,000	$760,000	$200,000
				Expected Profit = $160,400

If you do the above for each of the 6 demand possibilities, you will see the following:



If the manufacturer produces 12,000 units, the **distributor's** expected profit is calculated as follows:

Demand	Probability	Revenue	Cost	Profit
8,000	0.11	$1,000,000	$640,000	$360,000
10,000	0.11	$1,250,000	$800,000	$450,000
12,000	0.28	$1,500,000	$960,000	$540,000
14,000	0.22	$1,500,000	$960,000	$540,000
16,000	0.18	$1,500,000	$960,000	$540,000
18,000	0.1	$1,500,000	$960,000	$540,000
				Expected Profit = $510,300

The manufacturer assumes all the risk (of having more inventory than sales). Hence, he limits his production quantity (however, here too, there is a risk of going out of stock).

The distributor has zero risk (hence, he would like the manufacturer to produce as much as possible).

If the distributor is willing to share some of the manufacturer's risk, it may be profitable for the manufacturer to produce more items, thereby reducing the probability of going out of stock, and increasing the profits of both the distributor and the manufacturer.

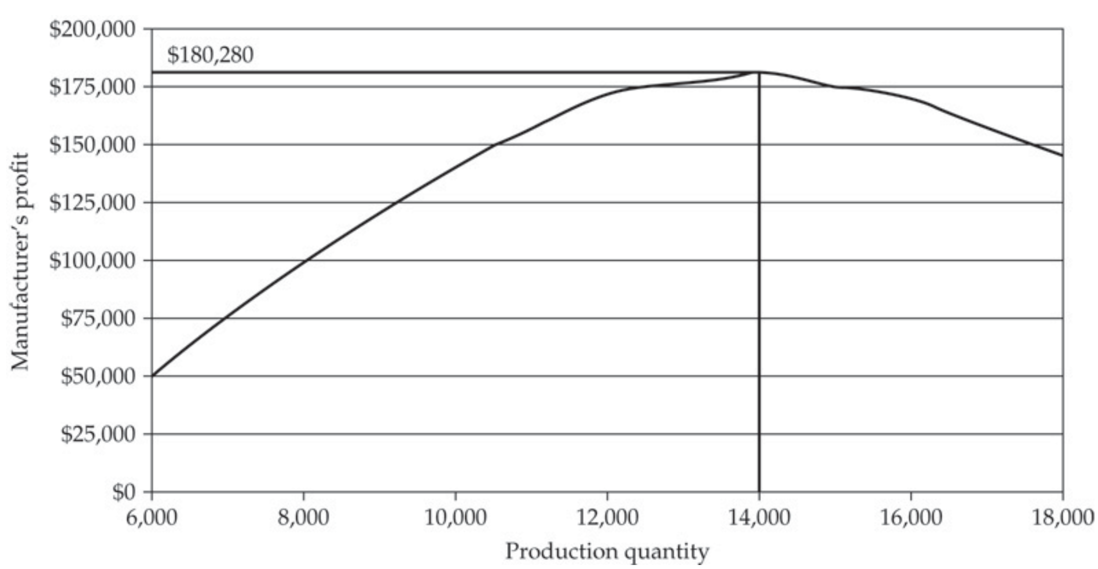
Problem 2

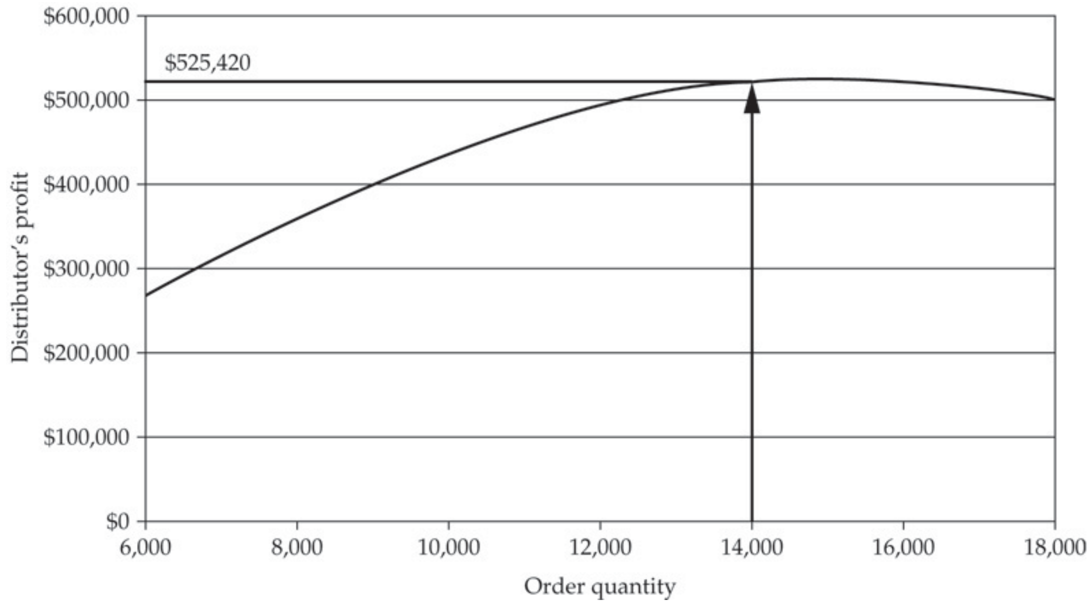
If the manufacturer produces 14,000 units, the **manufacturer's** expected profit is calculated as follows:

Demand	Probability	Revenue	Cost	Profit
8,000	0.11	$868,000	$870,000	($2,000)
10,000	0.11	$952,000	$870,000	$82,000
12,000	0.28	$1,036,000	$870,000	$166,000
14,000	0.22	$1,120,000	$870,000	$250,000
16,000	0.18	$1,120,000	$870,000	$250,000
18,000	0.1	$1,120,000	$870,000	$250,000
				Expected Profit = $180,280

If the manufacturer produces 14,000 units, the **distributor's** expected profit is calculated as follows:

Demand	Probability	Revenue	Cost	Profit
8,000	0.11	$1,000,000	$748,000	$252,000
10,000	0.11	$1,250,000	$872,000	$378,000
12,000	0.28	$1,500,000	$996,000	$504,000
14,000	0.22	$1,750,000	$1,120,000	$630,000
16,000	0.18	$1,750,000	$1,120,000	$630,000
18,000	0.1	$1,750,000	$1,120,000	$630,000
				Expected Profit = $525,420





Total supply chain profit is higher than the no contract situation! Also, each entity has a higher profit.

Problem 3

If the manufacturer produces 14,000 units, the **manufacturer's** expected profit is calculated as follows:

Demand	Probability	Revenue	Cost	Profit
8,000	0.11	$616,000	$609,000	$7,000
10,000	0.11	$700,000	$609,000	$91,000
12,000	0.28	$784,000	$609,000	$175,000
14,000	0.22	$868,000	$609,000	$259,000
16,000	0.18	$868,000	$609,000	$259,000
18,000	0.1	$868,000	$609,000	$259,000
				Expected Profit = $189,280

If the manufacturer produces 14,000 units, the **distributor's** expected profit is calculated as follows:

Demand	Probability	Revenue	Cost	Profit
8,000	0.11	$1,000,000	$757,000	$243,000
10,000	0.11	$1,250,000	$881,000	$369,000
12,000	0.28	$1,500,000	$1,005,000	$495,000
14,000	0.22	$1,750,000	$1,129,000	$621,000
16,000	0.18	$1,750,000	$1,129,000	$621,000
18,000	0.1	$1,750,000	$1,129,000	$621,000
				Expected Profit = $516,420

Total supply chain profit is higher than before (no contract situation)! Also, each entity has a higher profit.

Problem 4.
Average demand/week = 100
SD demand/week = 50
Holding cost = 0.25
Cycle Service Level = 0.95

Supplier 1: Reliable

Cost/unit = $5000
Min batch size = 100
Lead time (wks) = 1
SD Lead time (wks) = 0.1

Material Cost = (52)(100)(5000) = $26,000,000
Cycle inventory = 100/2 = 50
Cycle inventory cost = (50)(5000)(0.25) = $62,500
Standard deviation of demand during lead time is:

$$\sigma_L = \sqrt{L\sigma_D^2 + D^2 s_L^2} = \sqrt{1 \times 50^2 + 100^2 \times (0.1)^2} = 50.99$$

$ss = F_S^{-1}(CSL) \times \sigma_L = F_S^{-1}(0.95) \times 50.99 = 83.87$ (where, $F_S^{-1}(0.95) = 1.645$)

Safety inventory cost = (83.87)(5000)(0.25) = $104,839

Total cost = $26,000,000 + $62,500+ $104,839 = **$26,167,339**

Supplier 2: Value

Cost/unit = $4800
Min batch size = 1000
Lead time (wks) = 5
SD Lead time (wks) = 4

Material Cost = (52)(100)(4800) = $24,960,000
Cycle inventory = 1000/2 = 500
Cycle inventory cost = (500)(4800)(0.25) = $600,000
Standard deviation of demand during lead time is:

$$\sigma_L = \sqrt{L\sigma_D^2 + D^2 s_L^2} = \sqrt{5 \times 50^2 + 100^2 \times 4^2} = 415.33$$

$ss = F_S^{-1}(CSL) \times \sigma_L = F_S^{-1}(0.95) \times 415.33 = 683.16$ (where, $F_S^{-1}(0.95) = 1.645$)

Safety inventory cost = (683.16)(4800)(0.25) = $819,791

Total cost = $24,960,000 + $600,000+ $819,791 = $26,379,790

It is evident that ***supplier 1*** is the preferred supplier due to lower costs