Recitation/Review of LP Models in Production Planning

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Sensitivity Analysis

- values of the decision variables and those of the slack and surplus variables remain unchanged even though some coefficients in the objective function are varied.
- varying the RHS value for a particular constraint alters the optimal value of the objective function in a way that allows us to impute a per-unit value, or shadow price, to that constraint.
- shadow prices and the shadow prices on the implicit nonnegativity constraints, called reduced costs, remain unchanged even though some of the righthand-side values are varied.
- uncertainty in the data (parameters) it is useful to know over what range and under what conditions the components of a particular solution remain unchanged.
- the sensitivity of a solution to changes in the data gives us insight into possible technological improvements in the process being modeled.
- available resources are not balanced properly and the primary issue is not to resolve the most effective allocation of these resources, but to investigate what additional resources should be acquired to eliminate possible bottlenecks. Sensitivity analysis provides an invaluable tool for addressing such issues.

3.36 a)

k = 12000/[(100)(26)] = 4.615385

Month	Prod Days	Units/ Worker	Cum Units/ Worker	Net Demand (00)	Cum Nt Dem (00)	Ratio	Cum Prod* (00)	Ending Inv. (00)
April	11	50.77	50.77	50	50	99	69.55	19.55
May	22	101.54	152.31	93	143	94	208.66	65.66
June	20	92.31	244.62	122	265	109	335.12	70.12
July	23	106.15	350.77	176	441	126	480.55	39.55
August	16	73.85	424.62	140	581	137	581.72	0.72
Sept	20	92.31	516.92	83	664	129	708.18	44.18
Total	239.80							

*This assumes a constant work force of 137.

Note that net demand is computed by:
(1) Deleting the initial inventory of 4500 from April demand.
(2) Adding min buffer inventory back into April`s demand only (giving 85 - 45 + 10 = 50).
(3) Adding additional 2000 in Sept. to satisfy final inventory constraint.

Hiring cost = (125)(137 - 86) = $6375.
Holding cost = (75)[239.8 + (5)(10) for buffer inventories + 30 for ending inventory] = $23,985

Total cost of this plan = $30,360

3.36 b)

The company would have had to add 51 workers in March in order for them to have been ready to start in April. If that is no longer possible, then current hiring decisions would not take effect until May. In April the 86 workers would produce (86)(50.77) = 4366 cases giving a starting inventory in May of 4500 + 4366 -8500 = 366. Hence the net demand in May is 9300 - 366 = 8934. We now add 1,000 to May`s demand to account for the minimum buffer requirement.

	(A)	(B)	(C)	(D)
Month	Units/Worker	Cum Net Dem	Predicted Demand	Cum Net Ratio(D/B rounded up)
May	101.54	9,934	9,934	98
June	193.85	12,200	22,134	115
July	300.00	17,600	39,734	133
Aug	373.85	14,000	53,734	144
Sept	466.15	8,300	62,034	134

Hence the firm should plan to increase the work force to 144 (i.e., hire 58 workers) in April so that they will be trained in sufficient time to begin work in May.

3.36 c)

Assuming that they hire exactly 10 workers per month, then

Month	Units/ Worker	#Workers	Monthly Prod(00)	Cum Prod(00)	Cum Dem	Ending Inv
April	50.77	96	48.74	48.74	45	3.74
May	152.31	106	107.63	156.37	138	18.37
June	244.62	116	107.08	263.45	261	3.45
July	350.77	126	133.75	397.20	436	-38.80
Aug	424.62	136	100.43	497.63	576	-78.37
Sept	516.92	146	134.77	632.40	639	- 6.60

With this restriction they will be unable to meet demand in July, August, and September.

3.36 e)

LP OPTIMUM FOUND AT STEP 27

OBJECTIVE FUNCTION VALUE 1) 30116.4100

VARIABLE	VALUE	REDUCED COST	VARIABLE	VALUE	REDUCED COST
H1	50.828220	.000000	W1	136.828200	.000000
H2	.000000	307.484200	W2	136.828200	.000000
H3	.000000	346.297700	W3	136.828200	.000000
H4	.000000	312.350400	W4	136.828200	.000000
H5	.000000	193.701000	W5	136.828200	.000000
H6	.000000	55.767500	W6	136.828200	.000000
P1	6946.769000	.000000	F1	.000000	425.000000
P2	13893.540000	.000000	F2	.000000	482.484200
P3	12630.610000	.000000	F3	.000000	521.297700
P4	14524.320000	.000000	F4	.000000	487.350400
P5	10104.760000	.000000	F5	.000000	368.701000
P6	12630.610000	.000000	F6	.000000	230.76750
I1	2946.769000	.000000			
I2	7540.307000	.000000			
I3	7970.919000	.000000			
I4	4895.235000	.000000			
I5	1000.000000	.000000			
I6	7330.613000	.000000			