

IE5203 Decision Analysis
Solutions to Chapter 8 Case Study Exercise (Biotekno)

Decision Basis Development

Decision Variables

1. Partnership?
 - a) No partner
 - b) Joint venture Partnership
 - c) Royalty partnership
2. Build new plant?
 - a) Build new plant
 - b) Don't build new plant

Business Strategies

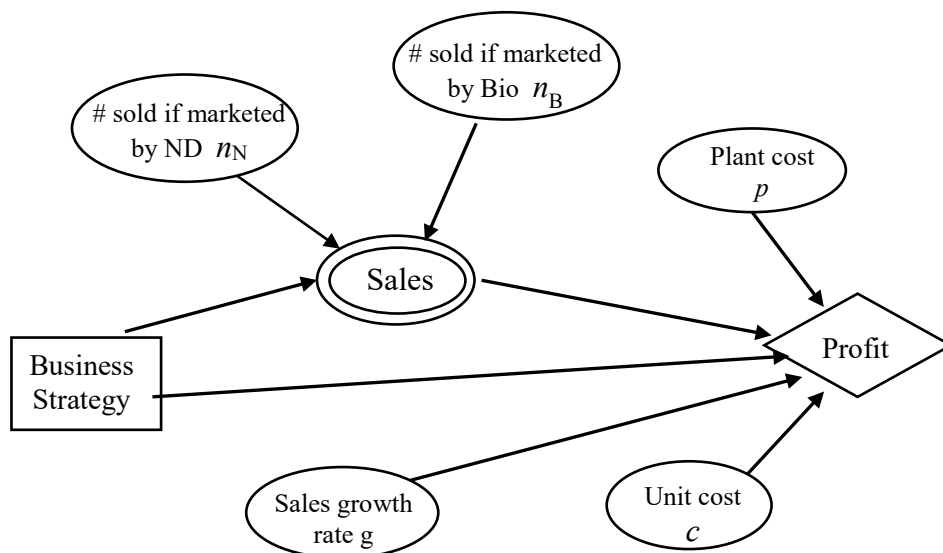
- I. No partner, build new plant
- II. No partner, don't build new plant
- III. Joint venture partner, build new plant
- IV. Royalty partnership, don't build new plant

Uncertain Variables

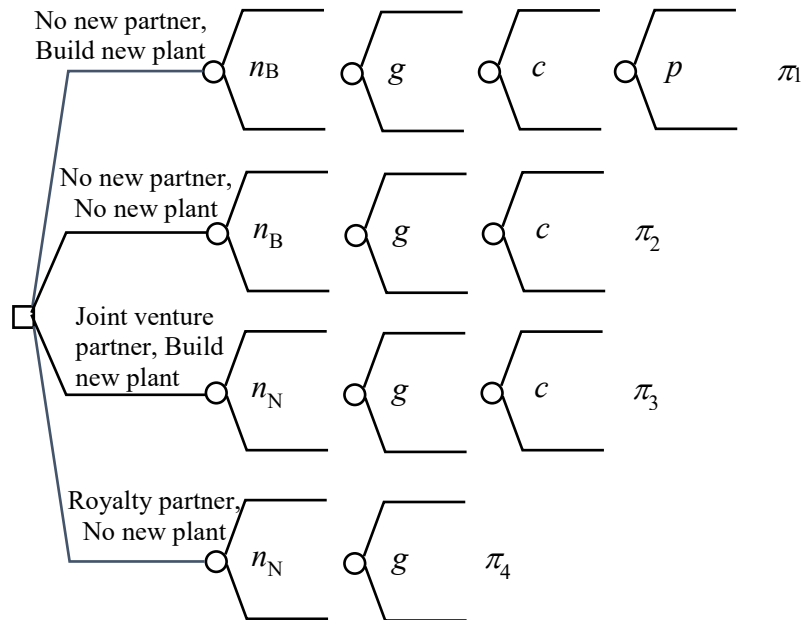
- n_B : number of units sold, if marketed by Biotekno (million)
- n_N : number of units sold, if marketed by National Diagnostics (million)
- g : annual growth rate, %.
- c : cost of production (million \$)
- p : plant cost (million \$)

Decision Diagram and Tree

Influence Diagram



The Generic Decision Tree



Value (Business) Models

Alternative I: No partner, Build new plant:

$$\begin{aligned}\pi_1 &= (20 - c)[n_B + n_B(1 + g)] - p \\ &= (20 - c)n_B(2 + g) - p\end{aligned}$$

Alternative II: No partner, No new plant:

$$\pi_2 = (20 - c)[\min(n_B, 4) + \min((1 + g)n_B, 4)]$$

Alternative III: Joint venture partner, Build new plant:

$$\begin{aligned}\pi_3 &= 0.5(20 - c)[n_N + n_N(1 + g)] \\ &= 0.5(20 - c)n_N(2 + g)\end{aligned}$$

Alternative IV: Royalty partner, No new plant:

$$\begin{aligned}\pi_4 &= 0.02(20)[n_N + n_N(1 + g)] \\ &= 0.02(20)n_N(2 + g)\end{aligned}$$

Deterministic Structuring

Deterministic Base Case Analysis

- The base values for all the variables are:

Variables	Symbol	Base Value
Plant construction cost (million \$)	p	15
Sales growth rate (%)	g	20
Sales, 1st year, Biotekno (million \$)	n_B	3
Sales, 1st year, National Diagnostics (million \$)	n_N	4
Unit production cost (\$)	c	9

- The 2-year profit for the four alternatives are:

Alternative		2-year profit (\$million)
I	No partner, new plant	57.600
II	No partner, no plant	72.600
III	Joint venture partner, new plant	48.400
IV	Royalty partner, no plant	3.520

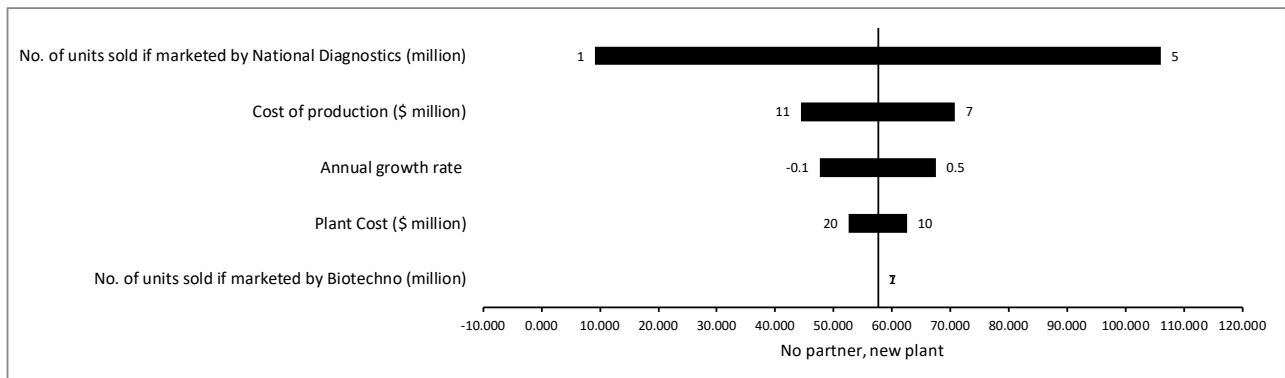
One-Way Range Sensitivity Analysis

- The low, base, and high values based on 5, 50, and 95 percentiles are:

Variables	Symbol	Low	Base	High
Plant construction cost (million \$)	p	10	15	20
Sales growth rate (%)	g	-10	20	50
Sales, 1st year, Biotekno (million \$)	n_B	1	3	5
Sales, 1st year, National Diagnostics (million \$)	n_N	1	4	7
Unit production cost (\$)	c	7	9	11

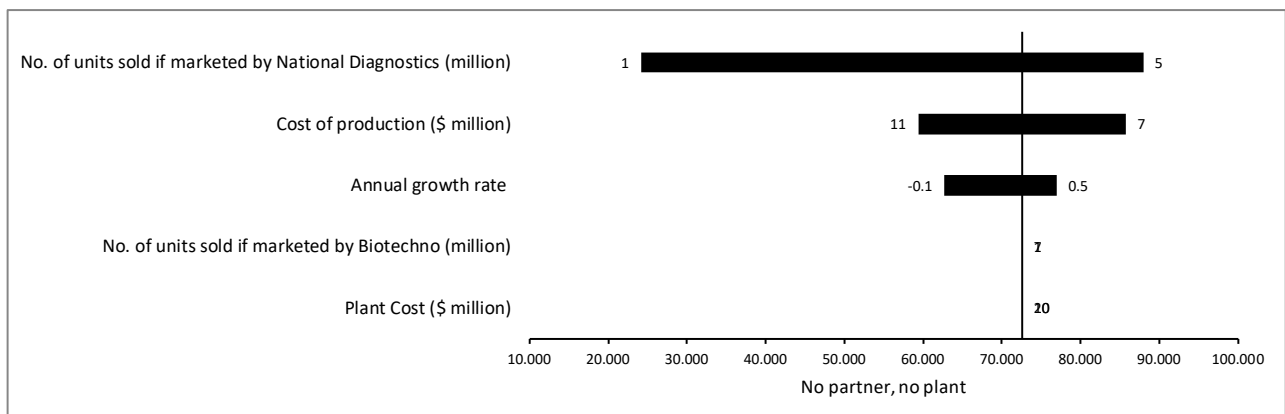
Alternative I: No partner, Build new plant

	Input Variables			No partner, Build new plant			
Variable	Low	Base	High	Low	Base	High	Swing
n_B	1	3	5	9.200	57.600	106.000	96.800
c	11	9	7	44.400	57.600	70.800	26.400
g	-0.1	0.2	0.5	47.700	57.600	67.500	19.800
p	20	15	10	52.600	57.600	62.600	10.000
n_N	1	4	7	57.600	57.600	57.600	0.000



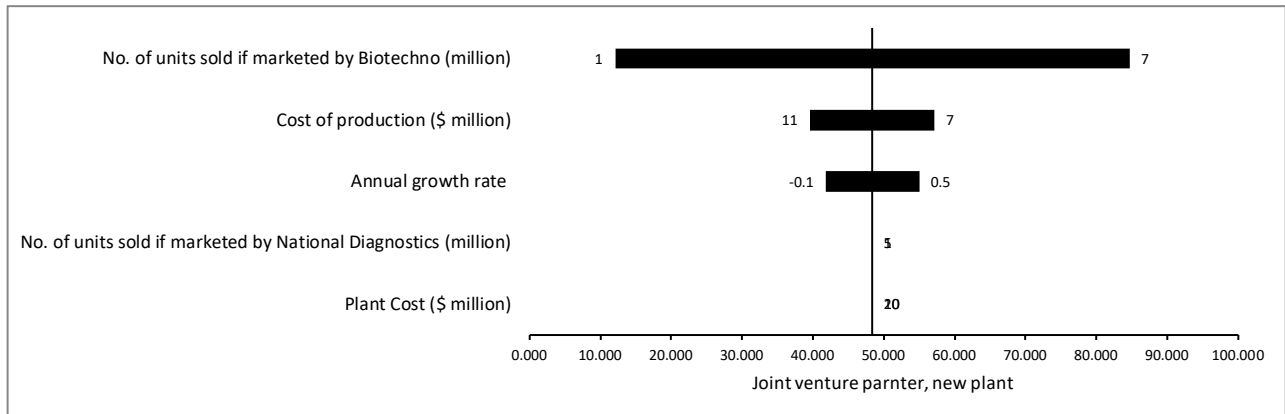
Alternative II: No partner, No new plant

	Input Variables			No partner, No new plant			
Variable	Low	Base	High	Low	Base	High	Swing
n_B	1	3	5	24.200	72.600	88.000	63.800
c	11	9	7	59.400	72.600	85.800	26.400
g	-0.1	0.2	0.5	62.700	72.600	77.000	14.300
n_N	1	4	7	72.600	72.600	72.600	0.000
p	10	15	20	72.600	72.600	72.600	0.000



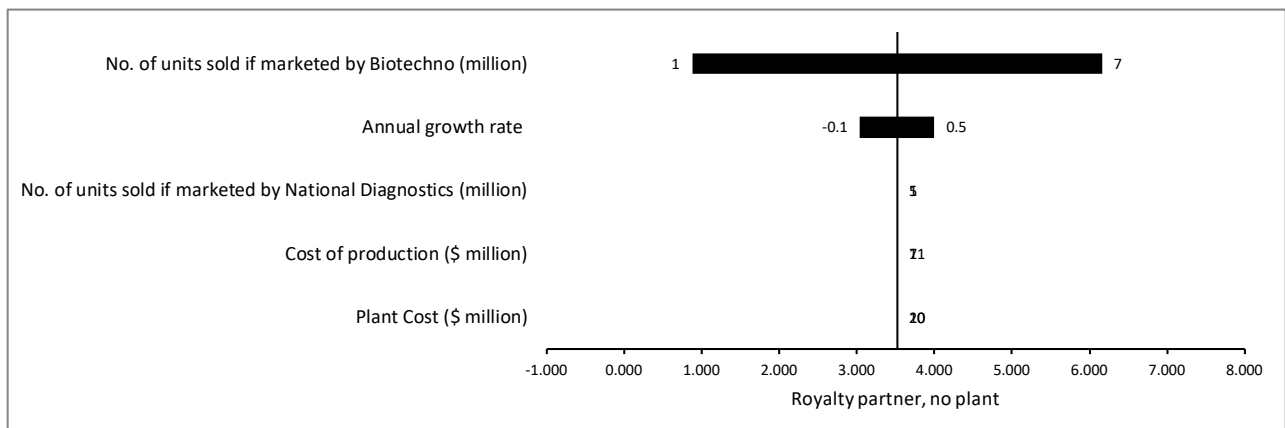
Alternative III: Joint venture partner, Build new plant

	Input Variables			Joint venture partner, New plant			
Variable	Low	Base	High	Low	Base	High	Swing
n_N	1	4	7	12.100	48.400	84.700	72.600
c	11	9	7	39.600	48.400	57.200	17.600
g	-0.1	0.2	0.5	41.800	48.400	55.000	13.200
n_B	1	3	5	48.400	48.400	48.400	0.000
p	10	15	20	48.400	48.400	48.400	0.000

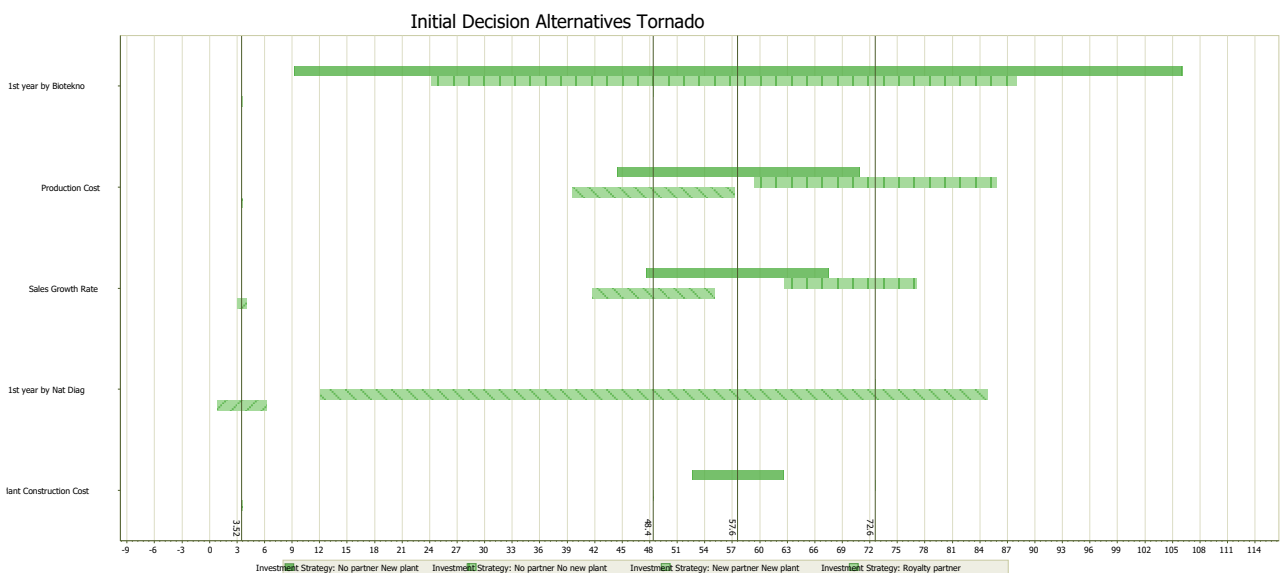
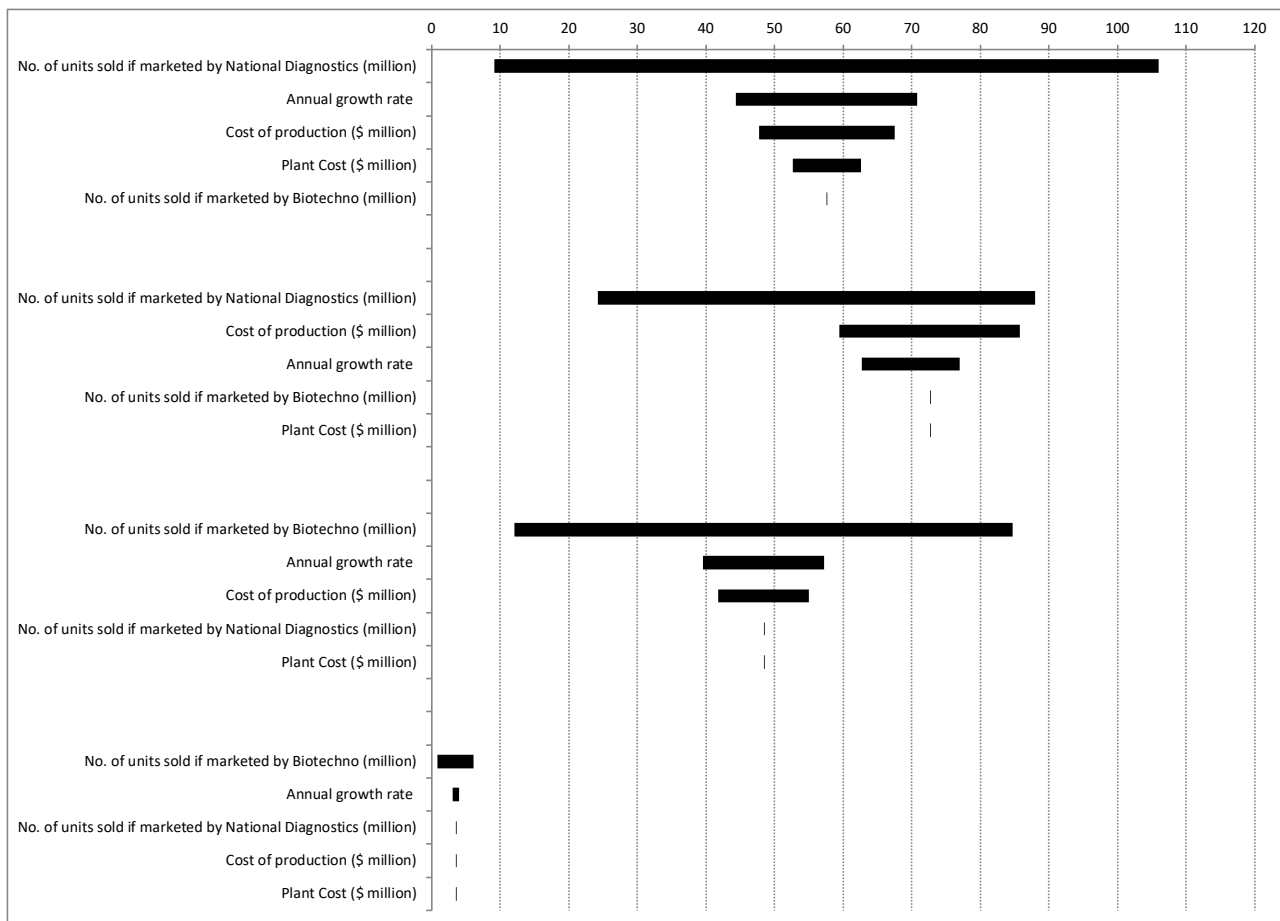


Alternative IV: Royalty partner, No new plant

	Input Variables			Joint venture partner, New plant			
Variable	Low	Base	High	Low	Base	High	Swing
n_N	1	4	7	0.880	3.520	6.160	5.280
g	-0.1	0.2	0.5	3.040	3.520	4.000	0.960
n_B	1	3	5	3.520	3.520	3.520	0.000
c	7	9	11	3.520	3.520	3.520	0.000
p	10	15	20	3.520	3.520	3.520	0.000



Combined Tornado Diagrams



Results of Deterministic Sensitivity

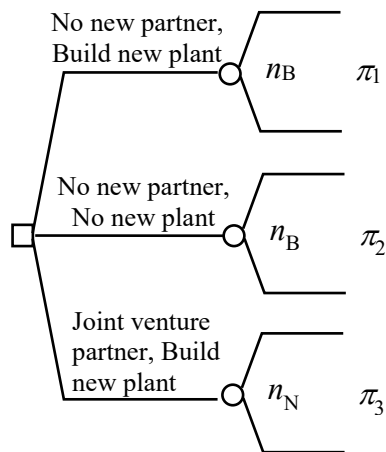
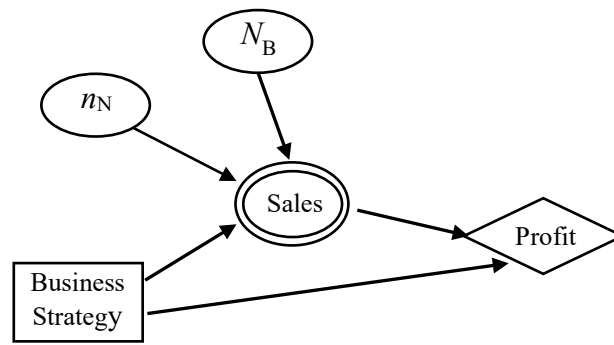
- The sales variables are much more sensitive than the other variables.
- Sensitive variables: n_N and n_B .

Tornado Dominance

- The best outcomes for alternative IV are always worse than the worst outcomes for alternatives I, II and III.
- Hence alternative IV can be dropped from further consideration.

Probabilistic Evaluation

The Reduced Decision Model



The Reduced Value Model

$$\begin{aligned}\pi_1 &= (20 - 9)n_B(2 + 0.2) - 15 \\ &= 24.2n_B - 15\end{aligned}$$

$$\begin{aligned}\pi_2 &= (20 - 9)(\min(n_B, 3) + \min(1.2n_B, 3)) \\ &= 11(\min(n_B, 4) + \min(1.2n_B, 4))\end{aligned}$$

$$\begin{aligned}\pi_3 &= 0.5(20 - 9)n_N(2 + 0.2) \\ &= 12.1n_N\end{aligned}$$

Assessing Probability Distributions for n_B and n_N

Using the 5, 50, and 95 percentiles:

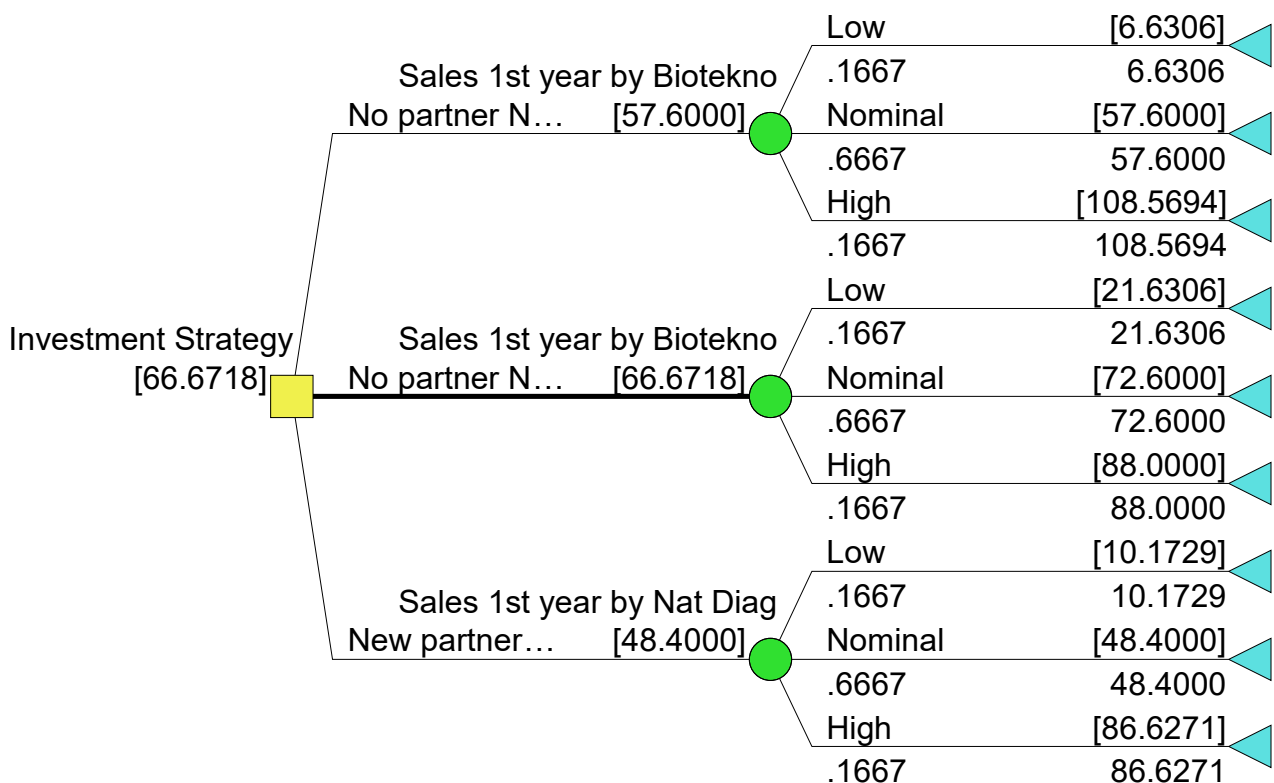
- n_B may be represented by a Normal distribution with
Mean = 3
Standard deviation = 1.216
- n_N may be represented by a Normal distribution with
Mean = 4
Standard deviation = 1.824

Using the moments matching method, the 3-branch discrete approximations for the two variables are:

n_B	
Value	Probability
0.8938	1/6
3.0000	2/3
5.1062	1/6

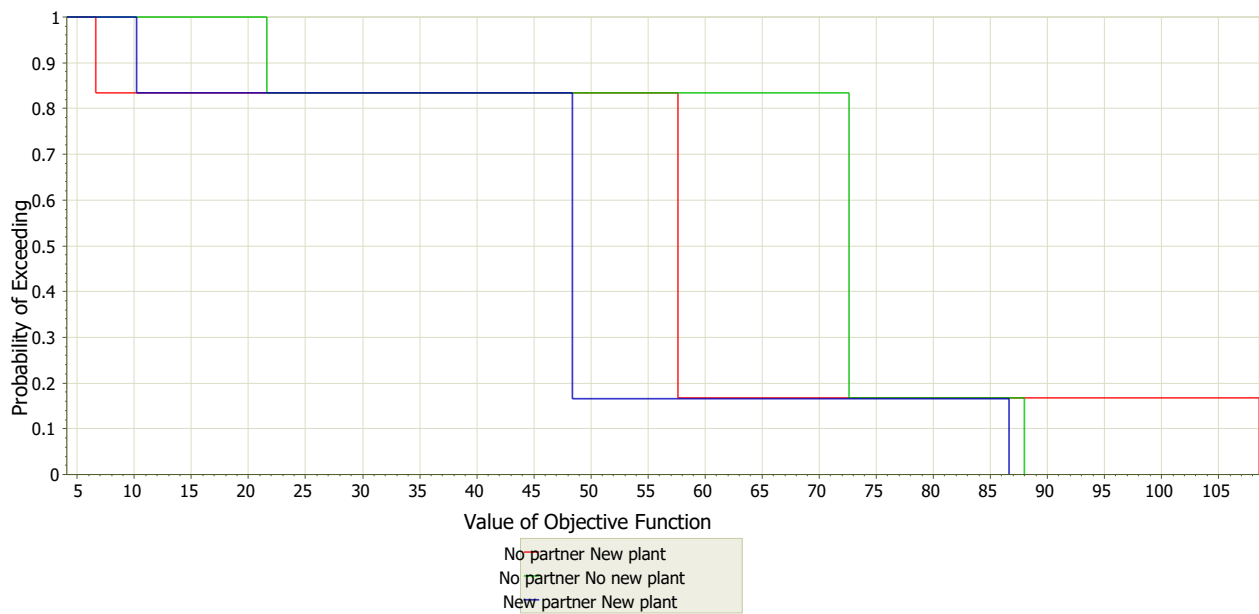
n_N	
Value	Probability
0.8407	1/6
4.0000	2/3
7.1593	1/6

The Decision Tree and Optimal Decision Policy



The best decision is Alternative II: No Partner, No new plant.

Risk Profiles and Stochastic Dominance Analysis



Observation:

- Alt II first-order stochastically dominates Alt III
- Alt II second-order stochastically dominates Alt I

Alternative III will never be chosen under all attitudes (risk-averse and risk-seeking)
Alternative I will never be chosen under all risk-averse conditions.

Recommendation:

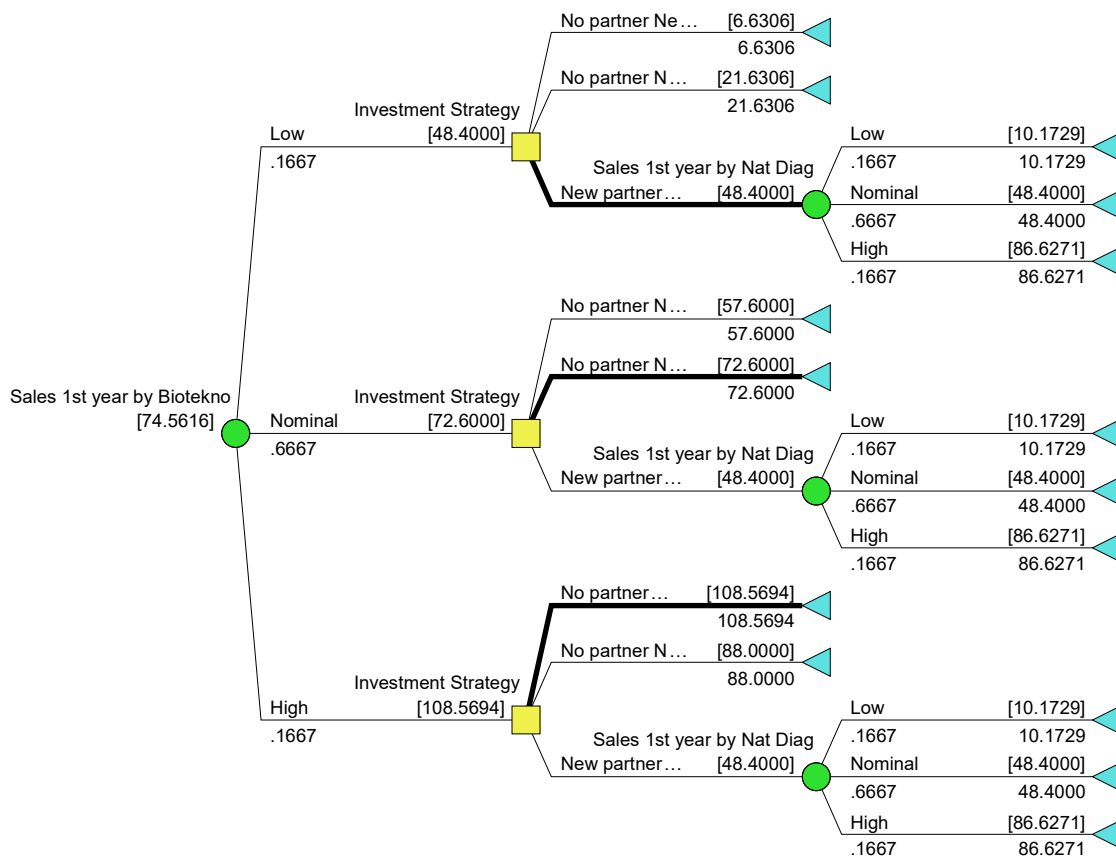
Chose Alternative II - Do not go with a partner, do not build a plant.

Expected Profit under 2-year study period = \$66.6718 million

Value of Information Analysis

EVPI for n_B

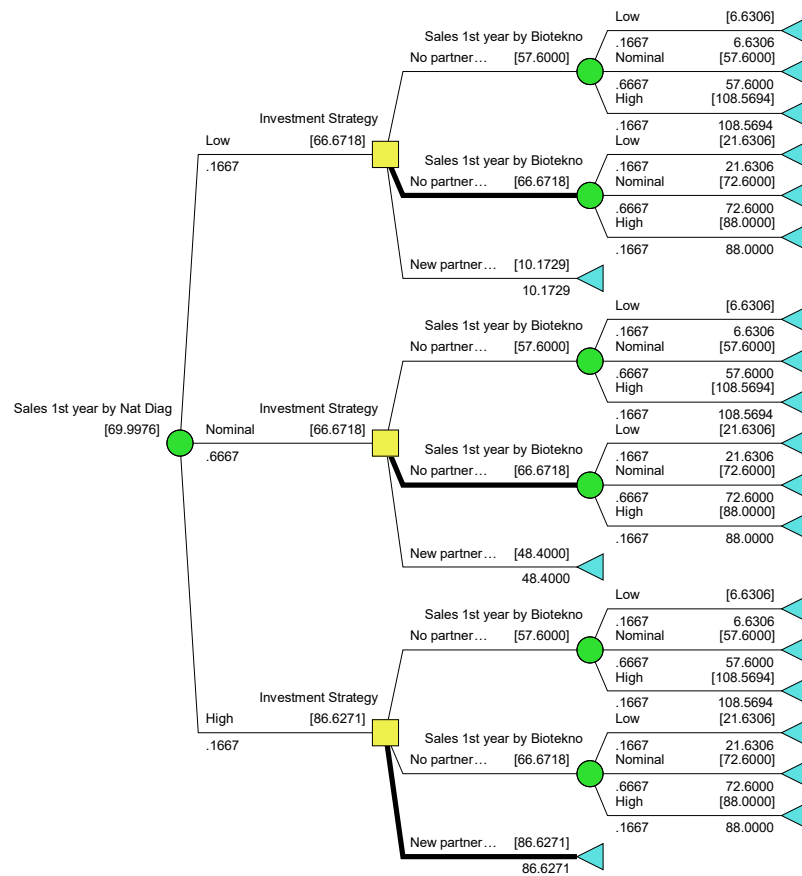
Decision model with free perfect information on n_B



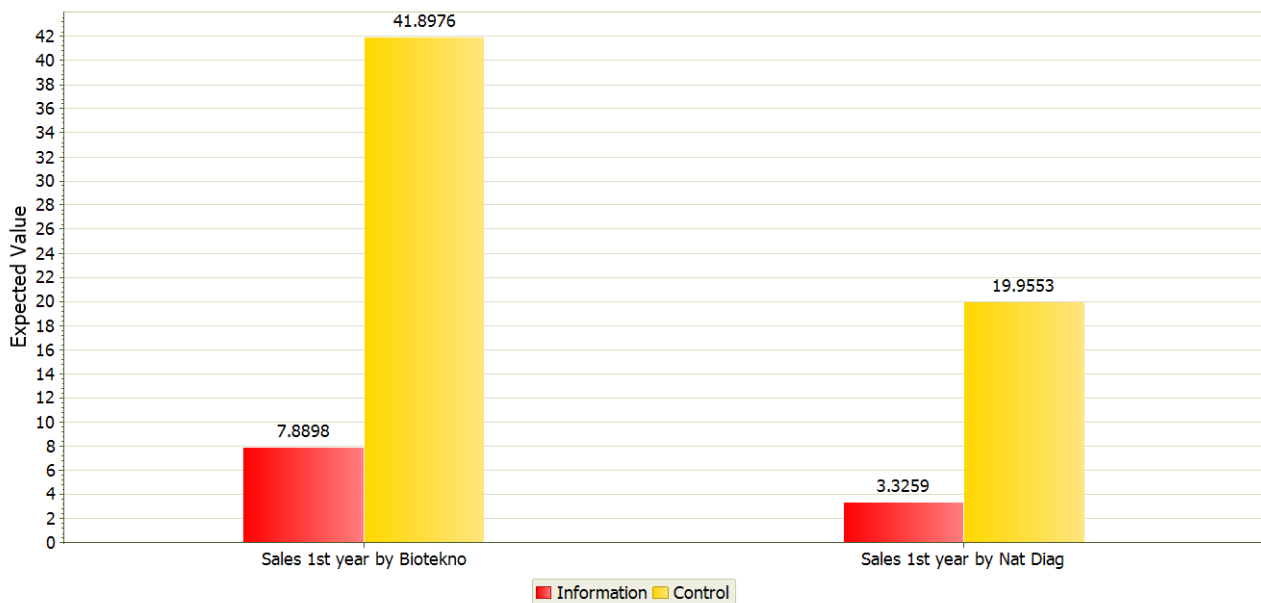
Expected Value of Perfect Information for $n_B = 74.5616 - 66.6718 = \7.8898 million.

EVPI for n_N

Decision model with free perfect information on n_N

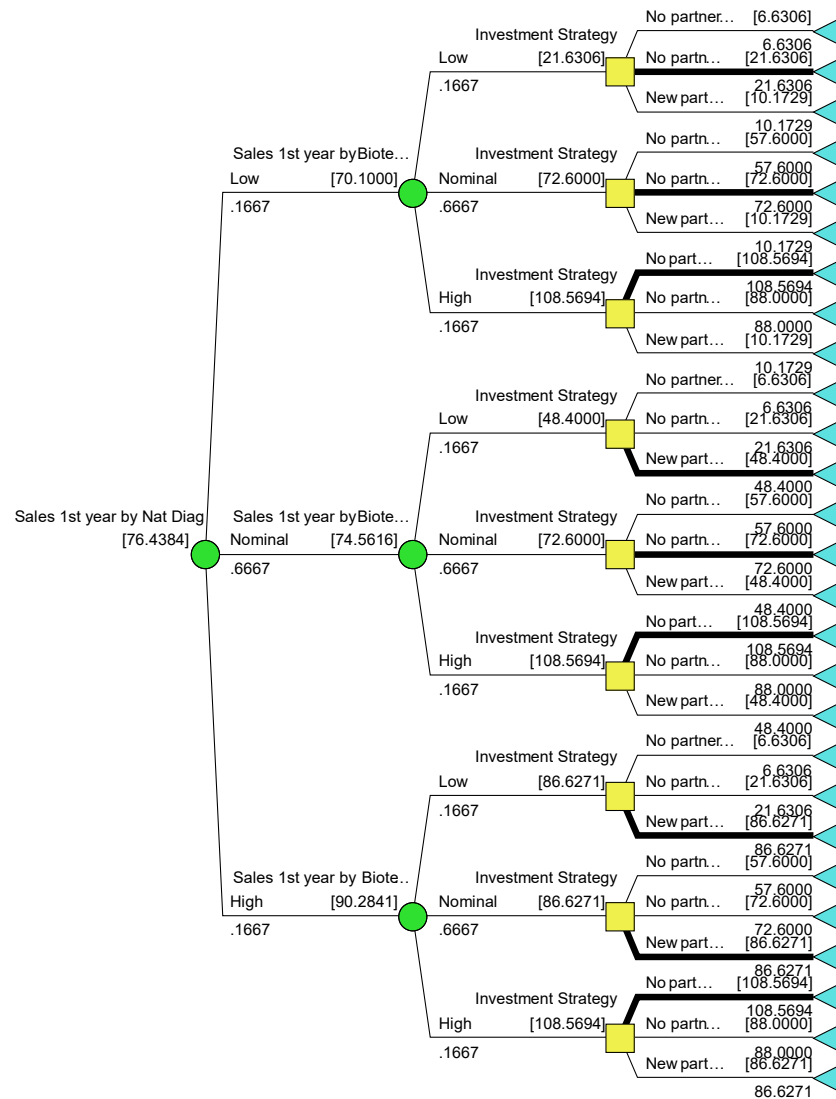


Expected Value of Perfect Information for $n_N = 69.9976 - 66.6718 = \3.3258 million.



Joint EVPI for n_N and n_B

Decision model with free joint perfect information on n_N and n_B



Expected Value of Joint Perfect Information for n_N and $n_B = 76.4384 - 66.6718 = \9.7666 million.

Areas of Further Consideration

- Why were the pricing issues fixed and not a decision variable?
- Are there other ways to expand existing production capacity?
- Would the partnership offer be more attractive if Biotekno explicitly considered the cost of marketing the product?
- The sales distribution seems rather tight. There may be an anchoring bias.
- It doesn't seem reasonable that a small company would be risk neutral in this range of values.
- The no partnership/build plant alternative might be more attractive if possible uses of the plant beyond two years were considered.
- The two-year time frame seems unrealistic, despite fast product cycles.