MGTA 453 Business Analytics Case Study #1

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Investor's Dilemma

Introduction

Carlos Morales considers launching his new product but encounters two uncertainties: technical feasibility and market favorability. He has completed his research and estimated the probabilities of success for both uncertainties. Meanwhile, he is informed of the first stage investment cost, further R&D cost, and the estimation of the potential revenue and loss. However, to better predict product performance, he is thinking about hiring a marketing research team. Carlos favors for success; therefore, he reached out to us for decision analysis. What path will generate the best optimal outcome: no market test, market test then technical feasibility, or technical feasibility then market test?

Summary of Data (Known Attributes)

Probabilities Data

success is 50% for technical feasibility, and 60% for market favorability. In addition, the marketing research company provides us the probability of positive tests given success is 70% and the probability of negative tests given failure is 80%. These probabilities provided a base to calculate P(Positive test) = 50% and P(Negative test) = 50% (please see appendix). Therefore, the market test identifies the product correctly 50% of the time. Then, we calculated the probability of success and failure provided the test is positive or negative. Given a positive test, the product will be 84% successful and 16% failure. Given a negative test, the product will be 36% successful and 64% failure.

Revenues, Losses, and Cost Data

Carlos estimates the product's revenue will be $1.5M and losses will be ($300K). In addition, the first stage product development cost is $50K, market research cost is $10K, and second stage R&D cost is $500K.

Decision Tree Analysis

The decision tree in Appendix describes the situation when Carlos Morales's estimations are right. From the decision tree, we can know that:

1. The optimal decision is to conduct market research first.
2. If we get a positive outcome for market analysis, Carlos Morales should invest $50000 in the first stage as product development (to make sure whether the technology is feasible), or he should quit the project if the outcome is negative.
3. The optimal EMV for the project is $143,000 (assuming all the data given in the case is true)

Sensitivity Analysis

Assumptions: We assumed that the probabilities of the product's success and failure the marketing research company provided are accurate. Sensitivity analysis is conducted on each of the variables mentioned below keeping all other variables constant.

The following are the variables that might be biased under Carlos Morales' estimation which might affect our decision analysis and detailed explanations are provided in the Appendix.

- The probability of technology to be feasible
- The probability of the product to succeed in the market
- The possible revenue when the product is successful
- First stage investment cost for product development
- Cost of hiring Market Research firm
- Second stage investment cost for R&D
- Loss

From our sensitivity analysis we inferred that except the cost of the hiring market research firm, no other variable impacts our final analysis to a greater extent (Neglecting the variation of first stage investment below $15000, probability of market success higher than 0.85, and revenue is higher than $2,200,000,)

Conclusion

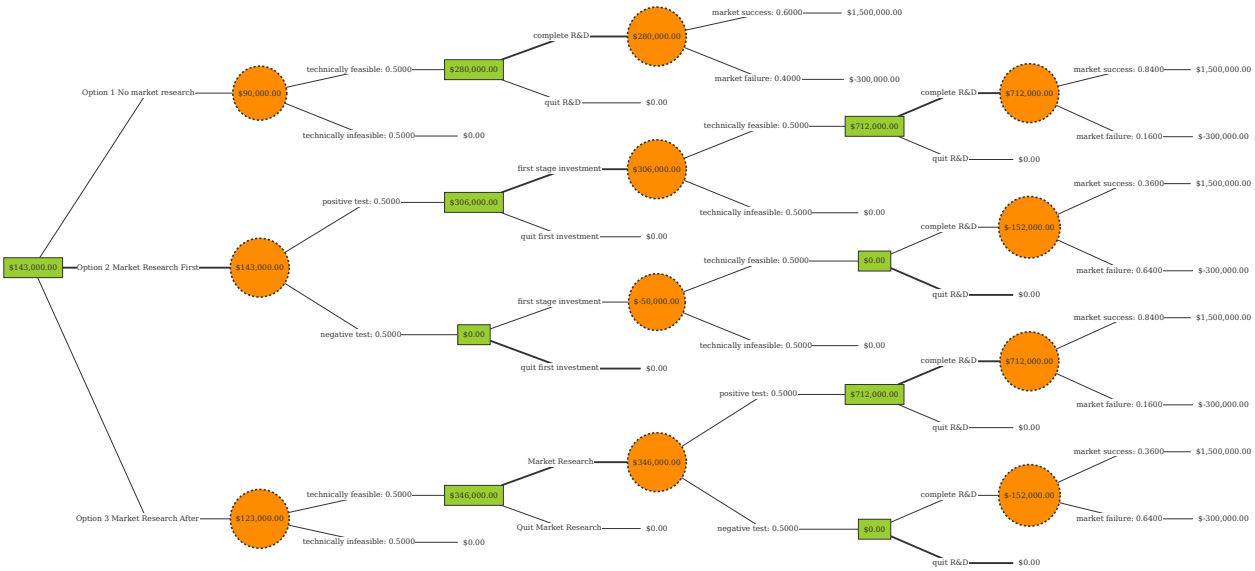
Based on our analysis, we recommend hiring a market research firm before establishing the technical feasibility of the product provided market hiring costs are $50,000 as mentioned in the case. However, if we assume that the cost of conducting market research can change, the optimal decision will be:

- No market research if cost < $50,000
- Market research first if $50,000 <= cost < $75,000
- Market research after if cost >= $75,000

Appendix

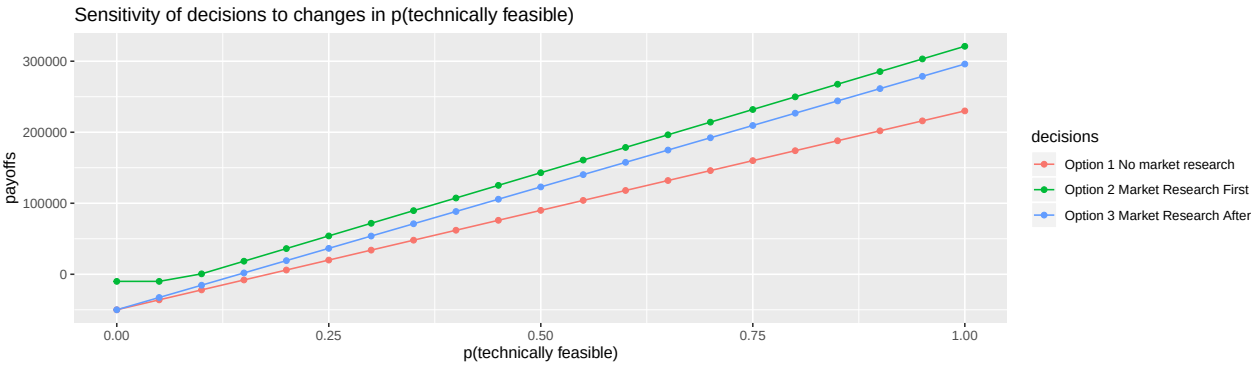
Decision Tree

```
result1 <- dtree(yl = yaml::yaml.load_file("InvestorsDilemma_dtree_input.yaml"))
# summary(result1, input = TRUE, output = FALSE)
plot(result1, final = TRUE) %>% render()
```



Sensitivity for p(technically feasible) 0.5

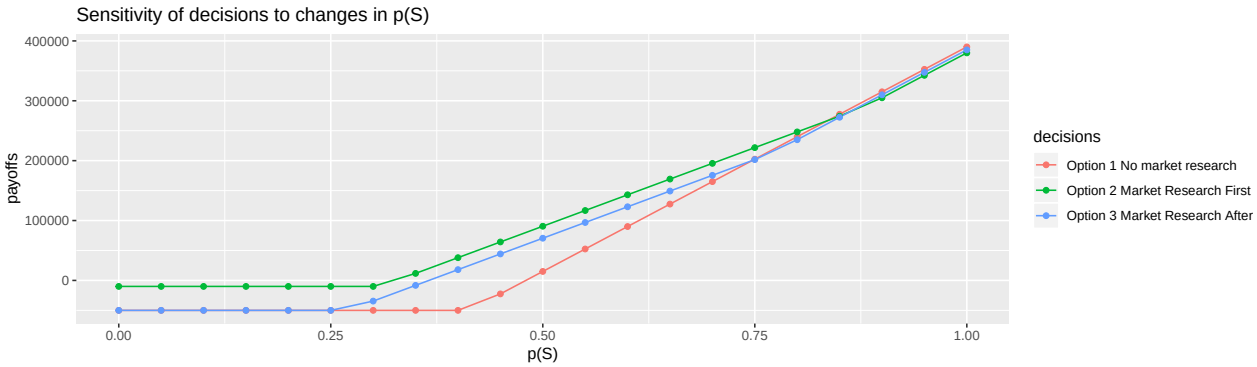
```
sensitivity(result1, vars = "p(technically feasible) 0 1 0.05", decs = c("Option 1 No market research",
"Option 2 Market Research First", "Option 3 Market Research After"), custom = FALSE)
```



From the chart, we can see that the decision is not sensitive to the probability of technology to be feasible. The reason is that no matter which choice to take, Carlos Morales will quit the project if the technology is not feasible. No matter how large the probability of technical feasibility is, Option 2, conducting market research first, will be the optimal decision.

Sensitivity for p(S) 0.6

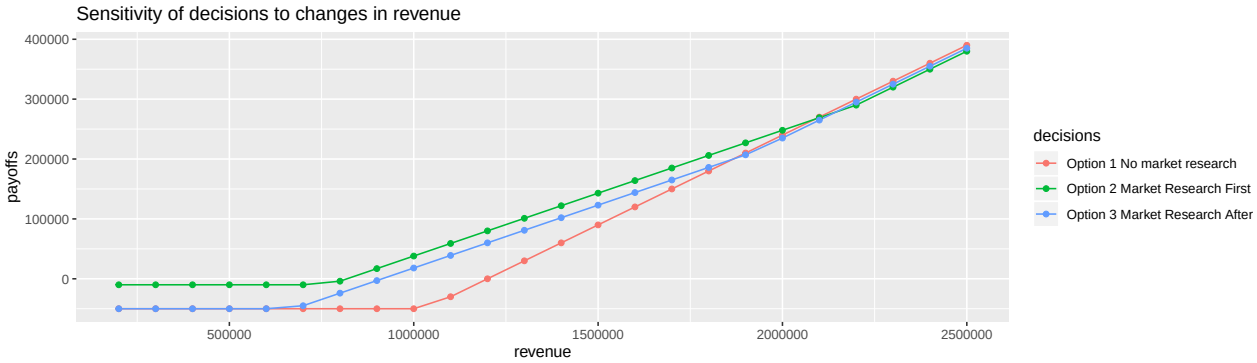
```
sensitivity(result1, vars = "p(S) 0 1 0.05", decs = c("Option 1 No market research",
"Option 2 Market Research First", "Option 3 Market Research After"), custom = FALSE)
```



From the chart, we know that when the probability of the product to succeed in the market is higher than 0.7, the optimal choice is to do no market research. The reason is that, in this situation the product is very likely to succeed in the market and we don't need market research to help us make a decision. Also, conducting market research requires additional cost, so it is a waste of money when we can make sure the success in the market.

Sensitivity for product revenue 1,500,000

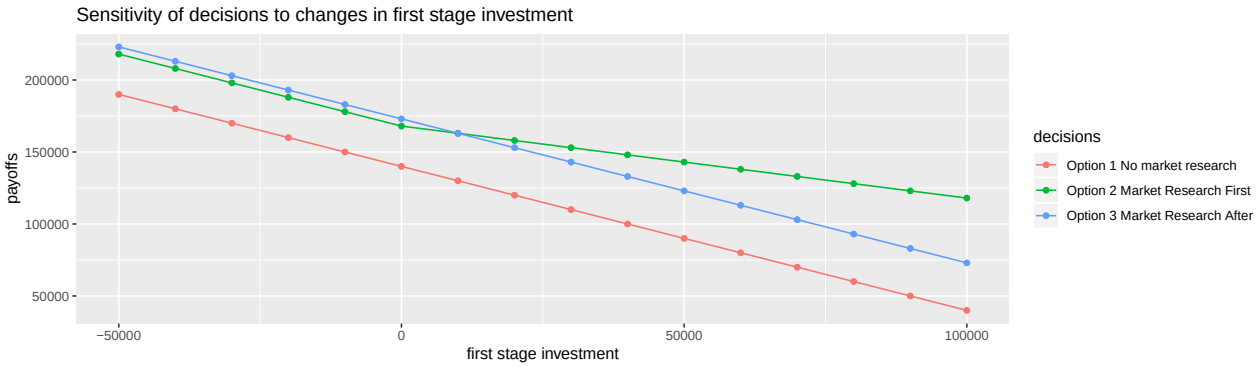
```
sensitivity(result1, vars = "revenue 200000 2500000 100000;", decs = c("Option 1 No market research",
"Option 2 Market Research First", "Option 3 Market Research After"))
```



If product's revenue is less than $2000000, conducting market research before testing the technical feasibility will be the optimal decision. Otherwise, the payoffs of three decisions will be indifferent.

Sensitivity for first stage investment 50,000

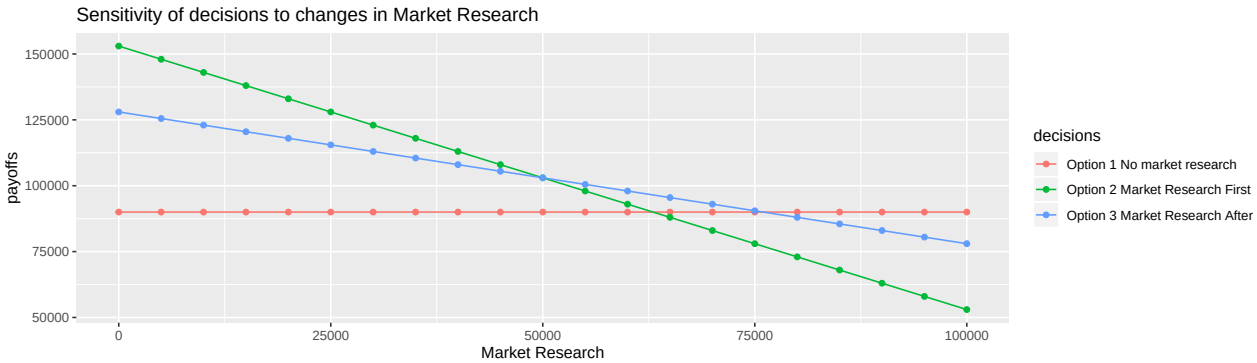
```
sensitivity(result1, vars = "first stage investment -50000 100000 10000", decs = c("Option 1 No market
"Option 2 Market Research First", "Option 3 Market Research After"), custom = FALSE)
```



If the first stage investment is less than $15000, the Option 3 will be the best decision. Otherwise, Option 2 will be the optimal choice.

Sensitivity for Market Research 10,000

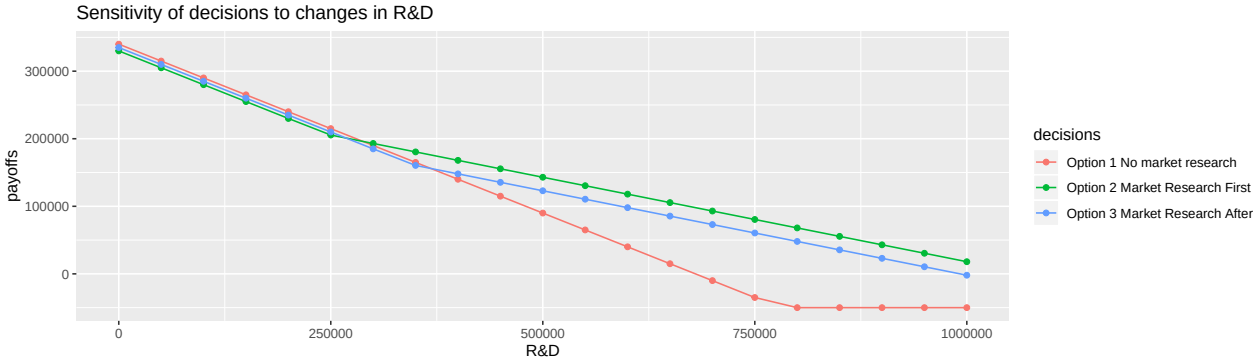
```
sensitivity(result1, vars = "Market Research 0 100000 5000", decs = c("Option 1 No market research",
"Option 2 Market Research First", "Option 3 Market Research After"), custom = FALSE)
```



In our sensitivity analysis on Market Research, we found if the cost of doing market research is less than $50000, Option 2 will be the most ideal decision. If the cost is between $50000 and $75000, Option 3 will be the optimal one. If the cost is larger than $75000, we should choose Option 1 to maximize the payoff.

Sensitivity for R&D 500,000

```
sensitivity(result1, vars = "R&D 0 1000000 50000", decs = c("Option 1 No market research",
"Option 2 Market Research First", "Option 3 Market Research After"), custom = FALSE)
```

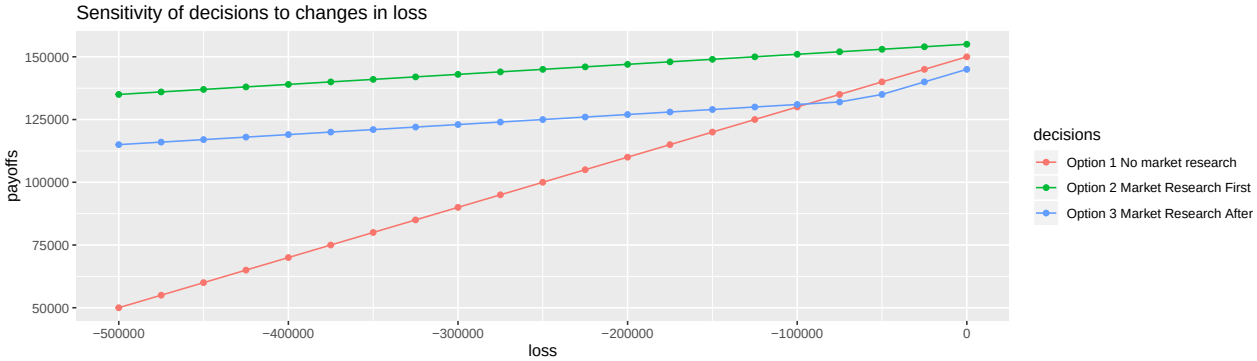


If R&D cost is larger than $300000, Option 2 will be the optimal decision. If R&D cost is less than $300000,

the payoffs of 3 options will be at similar levels.

Sensitivity for loss -300,000

```
sensitivity(result1, vars = "loss -500000 0 25000", decs = c("Option 1 No market research",
"Option 2 Market Research First", "Option 3 Market Research After"), custom = FALSE)
```



Based on the graph, Carlos should pick either option 2 or option 3 because no market research produces the steepest downfall between all options. For the most optimal, market research first provides the highest payoff among others from the range of losses.

Conditional probability calculation

	A	B	C	D	E
1					
2	**Available, given information**				
3					
4	*Prior beliefs about market success*				
5	**In words**	**In Math**	**Probability**		
6	Overall probability of market success	P(S)	60%		
7	Overall probability of market failure	P(F)	40%		
8					
9	*Market research firm test history*				
10	**In words**	**In Math**	**Probability**		
11	Positive test accuracy (i.e., correctly ident	P(Positive|S)	70%		
12	Negative test accuracy (i.e., correctly ident	P(Negative|F)	80%		
13					
14	*Market research firm test history (derive this first)*				
15	**In words**	**In Math**	**Probability**		
16	Positive test inaccuracy	P(Positive|F)	20%		
17	Negative test inaccuracy	P(Negative|S)	30%		
18					
19	**What we need**				
20	*Market research test results*				
21	**In words**	**In Math**	**Probability**		
22	Probability of a Positive test result	P(Positive)	50%		
23	Probability of a Negative test result	P(Negative)	50%		
24					
25	*Success and Failure probabilities according to research firm*				
26	**In words**	**In Math**	**Probability**		
27	Probability of Success when test is Positive	P(S|Positive)	84%		
28	Probability of Failiure when test is Positive	P(F|Positive)	16%		
29	Probability of Success when test is Negative	P(S|Negative)	36%		
30	Probability of Failiure when test is Negative	P(F|Negative)	64%		
31					
32	**Alt. approach**				
33	**Probability Table**				
34					
35		P(Positive)	P(Negative)	Total	Check
36	P(S)	0.4200	0.1800	0.6000	Consistent
37	P(F)	0.0800	0.3200	0.4000	Consistent
38	Total	0.5000	0.5000	1.0000	Consistent
39					
40					