

Decision theory and phase essay sample



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Methodology

The decision analysis that we did encompassed a number of different aspects. First we had to describe what the optimal decision would be based on the probabilities and the payoffs. For this, we designed a decision tree model to reflect the decisions that we to be made at each step, furthermore, the events that are out of control of the company are represented by chance nodes. After completing the outline of the model, we proceeded to “foldback” the tree to find out which decision would give us the highest Expected Monetary Value (EMV) calculated using the following formula: $EMV = PAMA + PBMB$ (Dont worry about the formatting yet...we will do that section later)

Where:

PA = Probability of event A

PB = Probability of event B

MA = Payoff of event A

MB = Payoff of event B

Based on this analysis, we have can make a decision that will maximize our long term expected monetary value. Further, the decision tree allows the user to visualize the decision outcomes and the associated likely hoods involved with each decision.

(Added the Following Section)

The concept of risk was an important conclusion of the decision tree. After discussion, we contacted the consulting firm of Foresight Consulting to help manage this risk. They informed us that they have a method to determine

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the outcome of Phase I and Phase II before actually conducting these experiments, however, they did not quote a price. To further advance this analysis, we calculated the Expected Value of Perfect Information (EVPI). This figure tells Merck the maximum they should be willing for Foresight's services.

Another method of examination was to consider a sensitivity analysis. We used the existing decision tree model and applied a Monte Carlo simulation on some of the variables. The Monte Carlo simulation is used in stochastic and nondeterministic fields by using a pseudorandom algorithm to calculate a forecast cell. A total of three simulations were run. In the first simulation we varied costs associated of each Phase and the payoffs of successful drug release. For the second simulation we varied the probabilities accompanying each successful outcome. And the third simulation was a combination of the last two where we varied both the dollar amounts and the probabilities associated with each outcome. For each of the simulations we were given a mean and standard deviation for the forecast cell. Furthermore, we were able to perform a sensitivity analysis that shows which variable affects the forecast cell the most. Based on these sensitivity numbers we came up with ways so that Merck can control their risks and avoid losing too much money.

Analysis and Key Findings

(Need a transition paragraph)

Decision Tree

Expected Monetary Value

Two possible alternatives were examined: to buy the patent for KL-798 or not

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to buy. If the drug is purchased and Merck follows through with the research then the Expected Monetary Value of this option would be a loss of \$ 260 000. 00. This Criterion is calculated using the decision tree in Appendix A Decision Tree Diagram on page ZZ (When Referencing to the appendix we need to make sure we mention the page number).

The Decision tree shows what decision should be made given the circumstances. First, assuming that Merck will proceed with the purchase of KL-798, Merck will have to make a choice as to whether to complete Phase I, which only has 60% chance of success and will cost 5Million dollars. If they pass phase I, according to the EMV criterion, it would be advisable to continue on to phase II which has a number of different outcomes. Firstly, there is a chance that they could cure obesity only, cholesterol only, or both cholesterol and obesity.

If phase II gives an indication that it cures obesity, then Merck should continue on with Phase III and seek FDA approval. If phase II gives an indication of cholesterol success then Merck would be advised not to continue with phase III. This is for two reasons, firstly, a cholesterol drug will not make any money for the company, furthermore, Merck already has Zocor which is a drug proven to have adverse effects on the cholesterol level in human body. In both of these cases Phase III will cost 140Million.

Phase II showing signs that it can produce results that indicate it is a potential cure for both obesity and cholesterol. Surprisingly this outcome is less preferred than being a cure for obesity only, because continuing to phase III will require a significantly larger investment of 140Million. Phase III

can lead to FDA approval of the following drugs, obesity, cholesterol, or both a cholesterol and obesity drug. If FDA approval is granted then Merck should release the drug, except in the case of cholesterol only due to the fact Merck already has a similar drug.

(I am not sure if we need all these numbers here. It kind of makes it too confusing to read) If Phase 1 results are completed, then Merck would have a 60 percent chance to obtain a return of \$ 22. 9Milion dollars and a 40 percent chance of loosing 35Million. Furthermore, favorable Phase 1 results showing a positive effect of KL- 798 on the obesity of people could lead to a 10 percent chance of obtaining a return of \$ 197. 5Million. A loss of \$ 75Million dollars is associated solely with high cholesterol treatment; concurrently with 30 percent probability of \$160. 5Million in profits associated with the treatment of both diseases. And, there is also 50 percent probability of loosing 75Million if drug testing fails to provide any reliable results.

At this stage when Phase 2 results show positive effect of KL 798 on the treatment of High Cholesterol level economic efficiency would prevent Merck from pursuing testing any further. Another reason to stop research on KL-798 at this stage lies with the existence of the Zocor, drug with proven adverse effects on the cholesterol level in human body. This product is already in the market, consequently, Merck& Co is free of obligation to create another drug despite the loss.

Phase 3 of the testing would be based on successful findings of the Phase 2, when KL-798 provides evidence for effective treatment of obesity or both

diseases. First finding could lead to a 75 percent chance of obtaining positive return of \$305Million, and 25 percent of loss of \$ 125Million if FDA does not grant approval to the drug.

Second result, due to a higher research cost of 140 million, provides smaller positive returns with 60 and 15 percent probability for gains of 295million and 215 million correspondingly. However, losses associated with this option are also great: 10 percent chance of losing 165Million and 15 percent chance of negative \$215 million.

The risk of this ventures is also great. Only three out of the ten possible outcomes are positive and substantial in profits. Initial testing in Phase 1 grants a 60 percent chance of success and accounts to overall 18 percent chance of obtaining a return after all 3 Phases of testing and approval are completed. Profitable investment is possible only if KL- 798 tests positive as a drug for obesity or obesity and high cholesterol simultaneously.

Furthermore, according to Merck's historical track record, in the pharmaceutical industry, only 5 out of 16 new products would become a success (Citation Needed). Therefore, EMV and Pay Off calculations could become subject to adjustment for this coefficient of market return.

Expected Value of Perfect Information

Research offered by Foresight Consulting can predict the outcome of Phase I and Phase II effectively eliminating the uncertainties Phase I and Phase II and thus reducing risk risk. However the questions becomes, how much should Merck be willing to pay for this service. To determine the maximum amount Merck will pay, Expected Value of Perfect Information (EVPI) is

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calculated. Given perfect information, there are four possible results to Foresights Consulting research and the corresponding probability is the joint probability of result in Phase I and result in Phase II. For example

$$\text{Pr}[\text{Pass Phase I and Phase II (Obesity)}] = \text{Pr}[\text{Pass Phase I}] * \text{Pr}[\text{Phase II (Obesity)}]$$

If Merck contracts the research by foresight consulting, Merck will know the result of Phase I and Phase II before it makes the decision of purchasing the rights to KL-798. Therefore it will know if it wants to buy KI-798 and conduct Phase I and Phase II simultaneously. The criterion for making decision is to choose the path with higher EMV. Using the calculation listed in methodology, the perfect information one has an expected value of 40.72 million. The EMV without perfect information is -0.26 million. So EVPI equals the difference of the two number 41 Million (40.72 - (-0.26)), which is the maximum amount that is worth paying for any information about the results of Phase I and Phase II. If Foresight Consulting charges a cost higher than that, Merck should refuse to conduct the research.

Sensitivity Analysis (I need to fix the pictures, which I will do tomorrow.)

A sensitivity analysis is a great way to determine the robustness of the analytical decision. For our investigation we performed a Monte Carlo Simulation using Crystal Ball 7. Essentially Crystal Ball allowed us to select which variables we want to fluctuate according to certain statistical rules. We ran this simulation a total of ten thousand times under three different conditions. For the first condition, we wanted to see what the effect of varying costs of completing each phase and the payoff for a successful

marketing of the drug. Each variable was assumed to be normally distributed with a mean equal to the number stated in the case, and the standard deviation to be equal to 10% of the mean. (For examples the lump sum payment would have a mean of -30Million and standard deviation of 3Million).

We found, that under these assumptions, the mean expected monetary return for purchasing the drug to be -0.18Million. However, this number comes at a high variability, with the standard deviation equal to 7.51. Therefore we can be 95% confident that if we purchase the drug, we will have an EMV between -14.81 and 14.45. Furthermore, as shown Figure 1, the Payoff for curing both diseases has the greatest affect on the overall EMV accounting for 54.1% of the variation.

Conclusion

(I was thinking that maybe we should change this title to Recommendations)
Findings of this report utilized Tree Diagram as a decision making tool and abbreviated on the Expected Monetary Value criterion. Given the limitations of the information and techniques, Merck & Co is expected to lose 260Million dollars if it proceeds with the purchase of the KL-798. However, assuming the fact that the vision statement of the founders of the company would guide a decision making process, Merck& Co will complete a purchase of the patent. Estimated probabilities of success in three different phases of the testing provide that the highest return should be expected if KL-798 proves its efficacy in treatment of obesity solely.

Profits are expected to reach 305 Million dollars for an investment of 125 million. Second highest number in sales would be generated upon success in treatment of high cholesterol level and obesity simultaneously, 295 Million with the 60 percent chance upon success in Phase 2 followed by identical findings in Phase with joint probability of 10.8%. Third positive outcome \$215 million in revenues is possible with the probability of 2.7 percent, if KL-798 indicates treatment of obesity in Phase 3, given positive treatment of both diseases in Phase 2. Nevertheless, a high degree of risk is involved. Sensitivity analysis evaluates possible outcomes due to variance in the probability measures. Decision analysis is most dependable on the initial success in Phase 1. Expected value of perfect Information provides for the cost of a more reliable and consistent data about probability of outcomes. This amount is estimated to be \$41 million