MCS in New Product Development, Moore Pharmaceuticals Case Study

Alireza Sheikh-Zadeh, Ph.D.

Example New-Product Development- Without Randomness

Moore Pharmaceuticals needs to decide whether to conduct clinical trials and seek FDA approval for a newly developed drug. First, we assume everything is deterministic.

Given data:

- R&D cost = $700 million
- Clinical trials cost = $150 million

project cost = R&D cost + Clinical trials cost

- Market size = 2 million people
- Market size growth = 3% per year

Market Size in Year t = (current market size) × $(1 + \text{Market size growth})^{t-1}$

- Market share = 8%
- Market share growth = 20% per year

Market share in Year t = (Market share) × $(1 + \text{Market share growth})^{t-1}$

Sale in year t = (Market Size in Year t) × (Market share in Year t)

- Monthly revenue/prescription = $130

Total Revenue at year t = 12 × (Sale in year t) × (Monthly revenue)

- Monthly variable cost/prescription = $40

Total Cost at year t = 12 × (Sale in year t) × (Monthly variable cost)

Profit at year t = Total Revenue at year t - Profit at year t

Then There is a formula in accounting for measuring the net present value (NPV) of future earnings based on a given discount rate.

- Discount rate = 9%

$$NPV = \sum_{t=0}^{n} \frac{R_t}{(1+i)^t}$$

where:

R_t = net profit during a single period t

i= discount rate or return that could be earned in alternative investments

t = number of time periods

The company needs to know how long it will take to recover its fixed expenses and the net present value over the first 5 years.

```
# Data
marketSize = 2e6
marketSizeGrowth = 0.03
marketShare = 0.08
marketShareGrowth = 0.2
unitRevenue = 130
unitCost = 40
discountRate = 0.09


# Project Cost
rdCost = 700e6
clinicalCost = 150e6

projectCost = rdCost + clinicalCost
projectCost
```

```
## [1] 8.5e+08
```

```
#Model
AnnualProfit = function(year, marketSize, marketSizeGrowth, marketShare,
marketShareGrowth, unitRevenue, unitCost){
  marketSize = marketSize*(1+marketSizeGrowth)^(year-1)
  marketShare = marketShare*(1+marketShareGrowth)^(year-1)
  sale = marketSize*marketShare
  annualRevenue = 12*sale*unitRevenue
  annualCost = 12*sale*unitCost
  return(annualRevenue-annualCost)
}

# Annual profit for the first 5 years
year = 5
profit <- AnnualProfit(1:year, marketSize, marketSizeGrowth, marketShare,
marketShareGrowth, unitRevenue, unitCost)

# how long it will take to recover its fixed expenses
cumsum(profit)-projectCost
```

```
## [1] -677200000 -463619200 -199633331  126653203  529943358
```

```
# Company recover its fixed expenses by year 4.
```

```r
# net-present profit model
netPresentProfit <- function(discountRate, profit, year){
  netProfit <- 0
  for(t in 1:year) {
    netProfit <- netProfit + profit[t]/(1+discountRate)^t
  }
  return(netProfit)
}


# Net present profit in year 5
npvProfit <- netPresentProfit(discountRate, profit, year)

# Net present value in year 5
npv = npvProfit - projectCost
npv
```

```
## [1] 185404860
```

```r
# The net present value over the first 5 years is $185,401,860
```

Example New-Product Development- With Randomness - Simulation Application

In practice, many of parameters are stochastic.

- Market size: normal with mean of 2,000,000 units and standard deviation of 400,000 units
- Annual market growth factor: triangular with minimum = 2%, maximum = 6%, and most likely = 3%
- Annual market share growth rate: triangular with minimum = 15%, maximum = 25%, and most likely = 20%
- R&D costs: uniform between $600,000,000 and $800,000,000
- Clinical trial costs: normal with mean of $150,000,000 and standard deviation $10,000,000

1. What is the risk that the net present value over the 5 years will not be positive?
2. What are the chances that the product will show a positive cumulative net profit in the 3 years?

Answer to part 1:

```r
library(triangle)
```

```
## Warning: package 'triangle' was built under R version 3.5.3
```

```r
set.seed(123)
```

```r
# Non-stochastic parameters
marketShare = 0.08
unitRevenue = 130
unitCost = 40
discountRate = 0.09



# Other parameters are stochastic, and we need to simulate them.
num_sim = 1000
# Data
year = 5
# Here, in each iteration, we only produce one random variate for each
parameter.
# We repeat the process num_sim times
# Then we record each calculated npv into a vector called simulated_npv
simulated_npv <- c()
for(i in 1:num_sim){
  marketSize = rnorm(1, 2e6, 4e5)
  marketSizeGrowth = rtriangle(1, a = 0.02, b = 0.06, c = 0.03)
  marketShareGrowth = rtriangle(1, a = 0.15, b = 0.25, c = 0.20)

  # Project Cost
  rdCost = runif(1, 600e6, 800e6)

  clinicalCost = rnorm(1, 150e6, 10e6)

  projectCost = rdCost + clinicalCost

  profit <- AnnualProfit(1:year, marketSize, marketSizeGrowth, marketShare,
marketShareGrowth, unitRevenue, unitCost)

  npvProfit <- netPresentProfit(discountRate, profit, year)

  npv = npvProfit-projectCost

  simulated_npv <- c(simulated_npv, npv)
}



# Q1: Risk:
mean(simulated_npv<=0)
```

```
## [1] 0.177
```

Answer to part 2:

```
set.seed(123)
num_sim = 1000

# Data
year = 3

simulated_cumNetProfit <- c()

for(i in 1:num_sim){
  marketSize = rnorm(1, 2e6, 4e5)
  marketSizeGrowth = rtriangle(1, a = 0.02, b = 0.06, c = 0.03)
  marketShareGrowth = rtriangle(1, a = 0.15, b = 0.25, c = 0.20)

  # Project Cost
  rdCost = runif(1, 600e6, 800e6)

  clinicalCost = rnorm(1, 150e6, 10e6)

  projectCost = rdCost + clinicalCost

  profit <- AnnualProfit(1:year, marketSize, marketSizeGrowth, marketShare,
marketShareGrowth, unitRevenue, unitCost)

  cum_profit <- cumsum(profit)

  # This time, we do not need to find the net present profit

  simulated_cumNetProfit <- c(simulated_cumNetProfit, cum_profit[year]-
projectCost)
}

mean(simulated_cumNetProfit>0)

## [1] 0.091

hist(simulated_cumNetProfit)
```