INTRODUCTION

Market researchers wouldn't be able to survey the entire market to conduct a product performance estimation, or quality control department wouldn't be able to test every product they've made to keep the fully satisfied feedback (Evans, 2013). Therefore, Sample statistics would be the information that help us to calculate the population parameters, perform simulation modeling, and eventually, make the decisions based on statistical inference.

The real world example of simulation that I am going to mention is the performance of the Insomnia Pill, Melatonin (Dollins, 1994). In a MIT study, neuroscientists conducted a experiment to discover the effectiveness of Melatonin, a sleeping-inducing hormone. They let healthy adult took Melatonin or placebo (a dummy dedication without Melatonin) and lay down in a dark room at midday. The time of fall in sleep was recorded. We have information from the previous research is that the volunteers fall asleep in 15 mins by taking placebo (i.e., no hormone). This time, there are 20 young male volunteers taken Melatonin. 18 (90%) volunteers took less than 15 minutes to fall asleep. Set up H0 is the drug is not effective by assuming only 50% of volunteers fall in sleep less than 15 mins. Then calculate the proportion of H0. According to the Central Limit Theorem, the sampling distribution proportion is normally distributed. Therefore, the binomial proportion value was calculated as 0.079. Then convert the sample proportion to a standard normal z value, the result is almost 0. In another word, there is almost no chance of observing 90% of sample is effective if the true proportion of fall asleep took less than 15 mins is 50%. So there is enough evidence to reject H0. The true value of proportion for taking the Melatonin pill is much higher than 50%.

In simulation modeling, calculation is always the easy part if we have all the accurate information on hand. So the challenging part would be how to gather the experiment data. In this case, all the volunteers needed to provide a physical exam report to be eligible and 1.5 hours training sessions were taken to get familiar of the testing process. On the experiment day, there were mood questionnaires automated to reduce the possibility of experimenter- induced bias.

ANALYSIS

Quadratic programming ﻿﻿is a form of non-linear programming. The objective function contains at least one squared variable, such as: ax2 + bx +c = 0. the constraints are linear, whether they are equalities or inequalities. An example of quadratic programming is the portfolio optimization problem. In this example, we have 4 assets with total investment of $10,000. The covariance matrix of asset returns is shown as below. The expected value or return is [0.05, -0.2, 0.15, 0.30]. What would be the best allocation of each asset when we are expecting growth to be at least 10%.

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Based on the matrix above, the quadratic equation would be written as:

Objective:

Constraints:

X1 + x2 + x3 + x4 <= $10,000

0.05x1 – 0.2x2 + 0.15x3 + 0.30x4 >= $1,000

X1, x2, x3, x4 >= 0

Therefore,

Z: investment risk, the variance of the portfolio’s total return

X: investment amount of each asset

Q =

C = 0

A =

b =

after calculation, the formulation has been solved as below,

x1 = 3,452, x2 = 0, x3 = 1,068, x4 = 2; 223

The Markowitz Portfolio Theory, also known as KPT, is an optimization model in finance to calculate the minimum risk of a portfolio returns with certain level of growth. The example that mentioned early is actually solved by KPT. It is a quadratic model when Ct equals to zero. The decision variables are the investment amount of each asset. The objective function is:

Minimum Variance of Portfolio = A close up of a logo

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Where s is the sample variance in the return of asset i, or covariance between assets i and j. The constraints would be the investment limits, expected level of returns, and the nonnegativity assumption. If the decision variables are all positive, it means that the short sells are not allowed, vice versa.

CONCLUSION

Option Pricing and Volatility models are the quadratic models that calculate the theoretical value of an option, as known as the fair value. The assumption of the model is all the price are lognormal distributed. The decision variables are the price of underlying asset, strike price, volatility, risk-free interest rate, and time to maturity. The objective function is shown as below. The constraints are volatility and the risk-free interest rate are assumed to be constant.

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