2C05
Application of Real Options to Healthcare Technology Startup

Md. Nur-Al-Ahad
Toyohashi University of Technology, Japan.
Email: md.mba13@grad.putrabs.edu.my
Takao Fujiwara, PhD
Toyohashi University of Technology, Japan
Email: fujiwara@las.tut.ac.jp

Abstract

Today's world is characterized by the rapid growth and adoption of technology. The essence of technology is more eminent in the healthcare sector. The global medical technology industry is a big industry with a growth rate of 5% per year. Investment in the healthcare sector is capital-incentive in nature; the pace of returns is quite slow compared with investment particularly in developing countries. Having this in mind, the aim of this study has been set to find out the application of real options analysis in healthcare technology startup from a perspective of developing county.

Introduction

According to the forms of economies and other characteristics, the world is divided into developed countries, developing countries and under-developed countries. Developing countries are special type of countries falling in the midpoint between developed and under-developed countries. Developing countries around the world face problems of differing types and dimensions. Of all these problems, the problem of appropriate healthcare is the most prevalent one. Nearly all the developing countries are struggling with the problem of advanced healthcare.

The world around us is changing. Perhaps, the biggest tides of changes are coming in the areas of technology. In addition, this very technology is shaping the world of healthcare too. Developing countries are having challenging times in many avenues of healthcare and healthcare technology is one of them. These days, various types of healthcare technologies are in place to detect diseases more accurately and thereby helping patients all over the world. Developing countries are in dire need of them in order to develop their healthcare sector. However, there is special challenge in adopting such technologies for healthcare, and that challenge entails the cost factor. The aim of this study is to study a particular healthcare technology for a developing country perspective and analyze its potential benefits by applying the concept of real options analysis.

Literature Review

In the world of finance, option occupies an important place. Option is one of types derivatives used extensively in the world of finance. Derivatives are financial assets, which derives their value

from something underlying (Pirie & Kritzman, 2017). Option theory acts as the foundation for identifying, valuing, and exercising Real Options. The pricing of options occupies an important place in the world of finance. There are two basic types of options in the world of finance namely call option and put option (Hull, 2017). A call options gives the holder the right to buy the underlying asset by a certain date for a certain price. A put option gives the holder the right to sell the underlying asset by a certain date for a certain price (Hull, 2002).

There are again two types of options based on the exercise pattern namely- European options and American options. Distinction is made between European and American options. The basic and foremost difference is that the European option can only be exercised at the exact maturity date, whereas American options can be exercised at any time up to the maturity date

Real Options

The foundation of real options lies within the framework of financial options (Lucius, 2001). While financial options are more precisely applied to financial assets, real options are reserved for real assets. A real option is the right to undertake a certain business-related action. In real option context, the costs of investment are seen as the exercise price of the option and the time until the opportunity disappears are viewed as the time to maturity. Financial options deal with current stock price and stock value uncertainty for calculation purposes. On the other hand, real options takes into consideration the present value of expected cash flows and the project uncertainty for calculation purpose. Real options are deemed to be attractive to the management since it provides flexibility (Kandel & Pearson, 2002). The concept of “Real option” was initiated by the model of financial options by Fischer Black and Myron Scholes and it was modified by Robert Merton. Subsequently, it was coined by Stewart Myers in 1977.

There are different types of real options models. Lenos Trigeorgis, (1993) has proposed 6 different types of real option models namely-

Category	Description with Applicable Areas
Option to Defer	The key here is to be able to delay investment without losing the opportunity, creating a call option on the future investment. This type of option is suitable for all natural resource extraction industries, real estate development, farming industry and paper manufacturing industry etc.
Option to Default	A generic project with a series of outlays, which consists of building stage and operating stage. This option is suitable for all R&D intensive industries, especially in medicine industry and long-term development projects etc.

Scaling Option (e.g., to expand, to contract, to shut down or restart)	With this option, Management can increase or decrease the level of production based on market conditions. It is suitable for natural resource industries such as mine operations, facilities planning and construction in cyclical industries, fashion industry, consumer goods industry and commercial real estate etc.
Option to switch (e.g. outputs or inputs)	Management can alter the input or output based on demand under this option. It is suitable for consumer electronics, toys, specialty paper and machine parts. Input shifts: oil electric power, chemicals, crop switching, sourcing etc.
Corporate Growth Options	Although the cash flow of early project is lower than expected, corporate growth options open up company's future growth opportunities (e.g., new product or process, oil reserves, access to new market and competition power) This option is suitable for all infrastructure-based or strategic industries, especially high-tech, R&D or manufacturing industry with multiple product applications (e.g. computers, medicines),multinational operations and strategic acquisitions etc.

Real Options Valuation Methods

Several capital budgeting tools are in practice around the world. Among all of them, three tools are practiced widely namely the internal rate of return, the net present value method and the payback period (Smart, 2008). In traditional settings, net present value (NPV) method is simply defined as the present value of the future cash flows minus the purchase price (the invested amount at present). The present value (PV) of the future cash flows (FCF) is calculated by discounting the cash flows by the rate of return (r) –

$$\mathrm{PV}\ (\mathrm{r}, \mathrm{N}) = \frac{FCF\ at\ time\ t}{(1+r)^t}$$

$$\mathrm{NPV}\ (\mathrm{r}, \mathrm{N}) = -\mathrm{Initital\ Investment} + \frac{FCF\ at\ time\ t}{(1+r)^t}$$

As it is evident, NPV only considers project when it crosses certain threshold as per the formula of NPV. Hence, it lacks the flexibility. On the other hand, real option analysis includes next to the static net present value also the value of the real options involved and puts a value on flexibility by doing this.

Healthcare Technology Case

Several healthcare technologies are available around the world. In this study, a new type of healthcare technology has been considered. Ultrasonic microscope development has been taken as the case example for this study. Technology products has some inherent uncertainties when they first introduce to the market. Ultrasonic microscope is the first of its kind in the developing world and hence there are uncertainties surrounding it. Real option analysis is highly suitable for technology fields as there are several dimensions of uncertainties involved in such investment (Lee, 2011). Several studies have been conducted on the application of real options for technology investments ((LINT, 1992; (Lee, Shyu & Dai, 2009; Siu, Ching, Xie & Song, 2018). Following is the figure showing the cash flow patterns for the project-

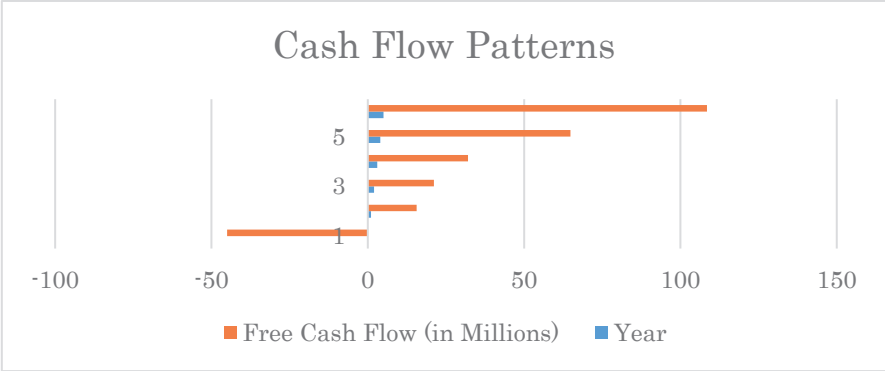

Figure 1: Cash Flow Patterns for Healthcare Technology Project

Binomial Lattice for the European Call Option

The investment in healthcare technology has been considered as European call option. Applying Crystal Ball software for the healthcare technology yield the following-

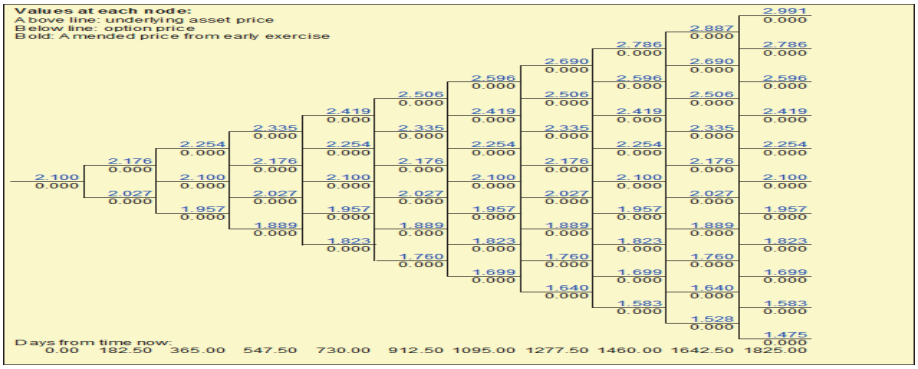

Figure 2: Binomial Lattice for Healthcare Technology Project

From the above lattice, it is visible that within the specific time, the option will have positive values.

Monte Carlo Simulation Outcome

For the healthcare technology project, a Monte Carlo simulation with six assumptions has been run. The number of trials has been set at 10,000 and confidence interval has been set at 95% for the simulation. Following is the sensitivity diagram for project-

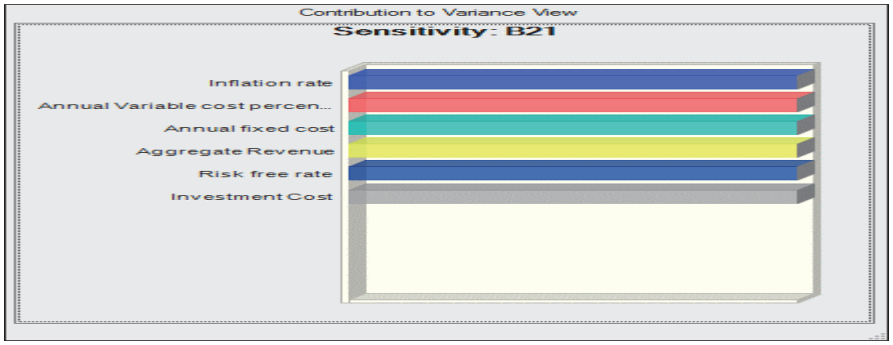

Figure 3: Sensitivity Diagram

Following is the chart for NPV, the decision variable for the simulation,

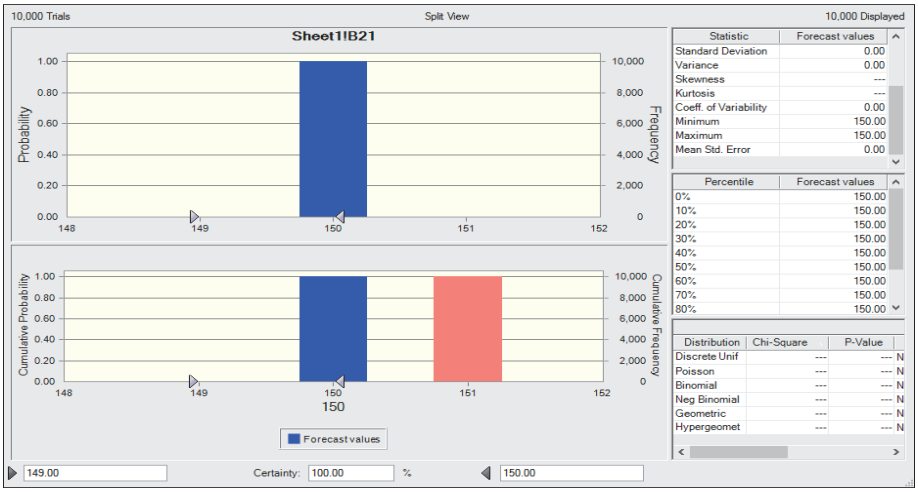

Figure 4: Forecast Chart for NPV

From the analysis, it is visible that this healthcare technology project will offer positive cash flows for both NPV and real options analysis. Even though there are some uncertainties exist in the market, but the long-term market potential is good for the product.

Scenario Analysis

Conducting a scenario analysis with the assumptions and decision variables yield the following results-

	Trial values	Revenue	Aggregate	Annual fixed	Annual	Inflation rate	Investment	Risk free rate
60.00%	20		1,074.63	1.14	0.69	0.05	44.39	0.07
70.00%	10		935.24	1.21	0.69	0.06	45.99	0.07
75.00%	9		924.79	1.21	0.67	0.06	46.06	0.08
76.00%	42		872.13	1.30	0.70	0.06	46.24	0.07
77.00%	43		793.88	1.24	0.74	0.05	44.80	0.07
78.00%	44		957.61	1.11	0.70	0.06	42.60	0.07

79.00%	39	918.59	1.14	0.74	0.06	45.32	0.07
80.00%	40	940.92	1.22	0.65	0.05	46.70	0.07
Minimum		734.27	1.09	0.65	0.05	40.58	0.07
Mean		932.23	1.20	0.70	0.06	45.16	0.07
Maximum		1,122.22	1.31	0.75	0.06	48.46	0.08
Std Dev		100.39	0.07	0.03	0.00	1.98	0.00

The scenario analysis yields different values for the assumption variables while keeping forecast variable NPV intact.

Conclusion

Real options analysis is good for analyzing situations involving uncertainties. For the healthcare technology example, NPV analysis yield positive result but it fails to take into consideration the market uncertainties. A new product or service is always susceptible to several uncertainties. For the healthcare technology, six different types of uncertainties are taken into consideration. After considering these uncertainties, the Monte Carlo analysis yield positive feedback for the project. So, this project is highly recommended. And this project is suitable in the developing country perspective with several uncertainties.

References

I. Hull, J. (2017). Fundamentals of futures and options markets. Boston: Pearson.

II. Kandel, E., & Pearson, N. (2002). Option Value, Uncertainty, and the Investment Decision. The Journal of Financial and Quantitative Analysis, 37(3), 341. doi: 10.2307/3594984

III. Lee, K., Shyu, D., & Dai, M. (2009). The Valuation of Information Technology Investments by Real Options Analysis. Review of Pacific Basin Financial Markets and Policies, 12(04), 611-628. doi: 10.1142/s0219091509001770

IV. Lee, S. (2011). Using real option analysis for highly uncertain technology investments: The case of wind energy technology. Renewable and Sustainable Energy Reviews, 15(9), 4443-4450. doi: 10.1016/j.rser.2011.07.107

V. Lint, L. (1992). Real options analysis in advanced manufacturing technologies. International Journal of Computer Integrated Manufacturing, 5(3), 145-152. doi: 10.1080/09511929208944523

VI. Lucius, D. (2001). Real options in real estate development. Journal of Property Investment & Finance, 19(1), 73-78. doi: 10.1108/14635780110365370

VII. Pirie, W., & Kritzman, M. (2017). Derivatives. John Wiley & Sons, Incorporated.

VIII. Smart, S. (2008). Corporate finance. Cengage Learning.

IX. Trigeorgis, L. (1993). Real Options and Interactions with Financial Flexibility. Financial Management, 22(3), 202. doi: 10.2307/3665939

X. Siu, T., Ching, W., Xie, Y., & Song, N. (2018). A real option approach for investment opportunity valuation. Retrieved from http://dx.doi.org/10.3934/jimo.2016069