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Real Option Valuation and Strategy Planning Case Study

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Abstract

Technology companies today have to embrace new technology to generate future income. Due to market uncertainty, being the first mover may not result in strategic or financial advantage in an unfavorable market condition. Conversely being late in the competition, may result in no market share for profit and growth. Success depends on the condition of the market. The challenge for managers is the timing to choose to adapt the technology and the type of technology to be employed.

In this paper, real option valuation in the context of strategic planning is used to tackle this challenge. Methods proposed in this paper show that managers can quantify market uncertainty which can help to optimize the investment financial and strategic value of new technology investment.

Table of Contents

List of Tables

List of Figures

1. Introduction

Real Option Valuation is a valuation method that assists in decision making under uncertainty by adapting the techniques developed from financial options to real life decisions. In contrast with traditional corporate finance tools like Net Present Value (NPV), option are more with uncertainty and variability and it is the option value that will allow a company to grow in the future.

Technology companies have to adapt new technology to generate future income for the company. In a time where the product life cycle is getting shorter and shorter adapting to the right technology mean survivability. However, what often occur is that first mover may not have the strategic or financial advantage. Conversely being late in adapting the new technology means no room in the market for profit and growth. Therefore the timing of adaption is vital to the project's strategic and financial success.

RD managers are faced with difficult situation when to commit to an investment given the uncertain market demand. These market uncertainties often are accompanied with voices of vague, overly optimistic and questionable market growth estimates. Because of these reason, it is difficult for managers to make a decision of what and when to make the investment. Moreover, the corporate financial tool offered like the tradi-

tional Net Present Value (NPV) is unable to help with this market uncertainty situation. So managers typically have to rely on their intuition and experience to guide them in strategic investment. Manager's intuition and experience is important but when situation turn worse manager needs a tool to reassure and back up his/her decision. Furthermore, a company's value creation depends on a series of interrelated investment to get to the intended strategic position. Manager's needs a tool to help them on this obscure and low visible path.

This paper seeks to use real option valuation to address managerial discretion in strategic and financial planning to optimize the timing to adapt to a technology to maximize its strategic and financial value.

Target Group

The target group for this paper is mainly for technology company management practitioners. It seeks to use Real Option Valuation in the project valuation process within a company without significantly hampering the valuation process by using difficult financial theories or increasing the workload.

The paper is also for equity research analyst and scholars with an interest in financial valuation theory whether this addition to the real option theory is applicable on any level.

Delimitation

This thesis is method-oriented and will thus focus on application of ROV for practitioners with limited financial background or non-financial background who are valuing technology development projects. This thesis is NOT for valuation of company or projects for the stock market.

Methodology

The paper seeks to use both qualitative analysis and quantitative analysis. The qualitative analysis will be used to evaluate the use and limits of the valuation method in the company as well as analyzing the case background environment.

The quantitative analysis is to use the Real Option Valuation method in the company by using fictitious project data through actual company data and industry report. The advantage of such method allows construction of complete data. The disadvantage is that the case study result does not directly relate to any specific company.

Source criticism

The primarily project data used are sources from industry contacts which maybe colored with some biases. On the other hand, sources used from secondary sources, from business articles and industry report are also biased in the way they are overly op-

timistic. Given the fictitious nature of the overall data, they are used in purely for comparison purpose and does not have any representation in actual situation

2. Options

2.1. Financial Options

Option originated in the financial world as a mean to give a person to the right according to a contract to buy or sell an asset at an agreed fixed price on or before a given date or before it (Jordan, Ross, Westerfield, & Jaffe, 2011, p. 561). The owner of the contract can decide to exercise the right if it is advantageous to do so. If it is not advantageous to the person the owner of contract can simply abandon the option and the only loss would be the cost of the option contract. Whether it is advantageous or disadvantageous to exercise the option depends if the contracted price is above or below the agreed fixed price.

Two common types of options are traded today. The first is the call options which give the owner of the contract to buy an asset at a fixed price before a particular time. The second is the put option which gives the owner of the contract to sell the underlying asset. For a call option, the option owner profits if the asset market price is above the exercise price. Vice versa for a put option, it is profitable if the asset's market price is

below the exercise price.

The value of an option can be decomposed into two parts. The first part is the intrinsic value of the option from the difference of expected exercise price and the current asset's underlying price. This is based on the assumption that the expected exercise price is at low or no risk. The second part is the time premium value the extra the investor is willing to pay based on the possibility that the underlying asset will rise (if it is a call option) or fall (if it is a put option) prior to the expiration. This possibility or variability is the interesting part about option because the greater the variability of the underlying asset the more valuable the option will be. In comparison, stock will decrease in market value as it rises in variability.

Due to option's characteristic of risk and reward, many investors develop investment strategy to incorporate option into their investment portfolio. Option can be purchased for high risk assets while mixing lower variability asset investment. The outcome of such portfolio is maximized.

2.2. Real Options

Options to develop "real asset" for a company is dependent on the choices of business investment. When the options or choices follow a specific intent or plan, these real options become strategic maneuvers to fulfill a purpose. Although different type of

purpose maybe to reach a specific position or product portfolio, the end goal boils down to maximizing the timing of business opportunities in the market in order to maximize the earnings.

For a venture capitalist the real option is to decide whether to finance the next stage of a start up. Or a retail chain deciding whether where and how to expand its store. Or a multinational company to shift operations to a plant to another country, to out-source or to abandon an unprofitable division. Real-options are an integrated part of business development and implementation. Using Real-option offers new insight to how the business development should be planned to how business should be implemented in an uncertain future.

Like its financial market option, real options are more valuable with greater variability. Unlike financial options, real options cannot be traded. For example, investment in R&D cannot be easily traded on the market. Even if the R&D outcome in term of patent can be traded, it has limited liquidity.

Table 1 Real Options practiced in business shows different types of real options and its effect studied by academics. The most notable and basic ones are the option to defer and growth option which allows managers to choose the timing and recognize that option leads other options. It implies that manager "can and do obtain valuable information after a project is launched, and that their informed actions can make a big dif-

ference". (Reach, 2003)

Category	Description	typical industries	Relevant industries
Operation flexibility			
Option to defer (simple option)	Management holds a lease on on (or the option to buy) valueable land or natural resources. It can wait to see if output prices justify constructing a building or plant ofr developing a field	all natural resources extraction industries, real estate development, farming, paper products	Tourinho 1979 titman 1985 MacDonald and Siegel 1986 Paddock, Siegel and Smith 1988 Ingersoll and Ross 1992
Growth option (compound option)	an early investment (e.g, R&D, lease on underdeveloped land or oil reserve or strategic acquisition) or a strategic investment is a prerequisite or a link in a chain of interrelated projects, opening up future growth opportunities (e.g., a new generation product or process, oil serves, access to a new market, strengthening of core capabilities, strategic positioning investment).	all industries that invovle sequential investment process (e.g., harmaceuticals, electronics, oil, chemicals et.c)	Myer 1977 Kester 1984, 1993 Trigeorgis 1988 Pindyck 1988 Chung and Charoenwong 1991 Smit 1996
option to abandon	if market condition decline severely, management can abandon current operations permanently and realize on secondary markets the resale value of capital equipment and other assets	capital intensive industries with tangible assets, such as airlines and railroads, financial services, and new product introduction in uncertain markets	Myer andMajd 1990 Kemna 1988
option to expand, contract, or extend the life of a facility	if market demand turns out to be more favorable than expected, management may increase capacity or accelerate resource utilization. Management may also extend production if the life of the product is longer than expected. Conversely, management may reduce the scale of operations	facilities planning and construction in cyclical industries; fashion apparel; commercial real estate	McDonald and Siegel 1985 Trigeorgies and Mason 1987 Pindyck 1988 Kemna 1988
option to temporarily shut down the production process	if operations are less favorable than expected, management may temporarily half and then start up again.	natural resource industries such as mine operation	Brennan and Schwartz 1985a, 1985b
option to switch(e.g., raw materials, final products)	if prices or demand changes, management may change the product mix of the facility ("product flexibility"). Alternatively, the outputs can be produced by different production process or inputs 9" process flexibility").	product switches Any good sought in small batches or subject to volatile demand, e.g., consumer electronics, toys, specialty paper, machine parts, automobiles input switches all feedstock-dependent facilities, e.g., oil, electric power (oil/gas), crop switching, sourcing.	Margrabe 1978 Kensinger 1987 Kulatilaka 1988, 1995a Aggarwal 1991 Kamrad and Ernst 1995
financial flexibility			
option to default	if profits are less favorable than expected and the value of the firm declines below the promised bond repayments, the firm can go bankrupt. With this option to default, the liability of equity holders is limited to the equity invest in the firm.	All levered firm	Black and Scholes 1973 Mason and Merton 1985
staged financing	if the firm's performance is less favorable tan expected, the venture capitalist has the option to exit early	Start up ventures. Small firms operating in uncertain growing or emerging markets, requiring sequential investment	Trigeorgis 1993b Sahlman 1988 Wilner 1995

Table 1 Real Options practiced in business[1]

Thus far real options have been discussed in the context of the business world and business strategy. In general sense, real option resembles human decision behaviors and occurrence in daily life. It is a common expression to keep open options and only decide to exercise these options if events turn out favorable. Intuitively it is understood that

[1] (Trigeorgis & Smit, 2004, p. 108~109)

each option has its cost and the goal is to weight the cost benefit relationship based on the situation in order to maximize the utility.

One common example of real option in real life is going to the movie theater to watch a movie. The movie Titanic received recommendations and praises from critics and spectators. However a person who hasn't seen the film won't know if it's good until he or she purchases the admission ticket and watch the movie. In such case going to see the movie is an option. The exercise cost is the admission ticket (or time spent in the theater) and the value is the entertainment utility.

Another example is going on vacation. A family may have different vacation plans and each with its own cost. These different plans vary from going to the nearby park to travel to another country. The further away the vacation spot is, the greater the chances are the enjoyment of the vacation. There are uncertainty in utility value going out of country but it is precisely this uncertainty which may create a memorable experience.

Despite its long history in commercial and financial market use, option did not become a main stream investment tool until early 1970's. Nobel Laureates Robert Merton and Myron Scholes published in 1973, "The pricing of Options and Corporate Liabilities", putting forth the famous Black-Scholes model. They laid the ground work for options and derivative pricing, thus expanding the scope of options by considering equity as an "option of the firm". (Trigeorgis & Smit, 2004, p. 93). Ever since that year, op-

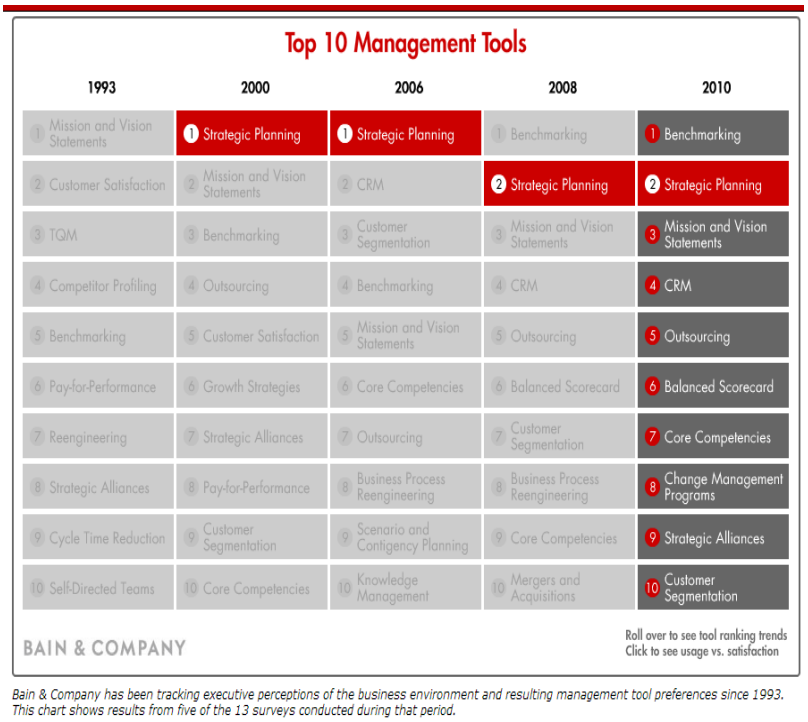
tions have developed to become a fundamental part in global capital markets. Real options have developed since then by borrowing the methods from the financial markets. It gained momentum in 1990s with numerous academic papers and books being published hailing it as the next evolution of Net Present Value in corporate finance. The research has been led by academics like Professor Lenos Trigeorgis (University of Cyprus), Professors Eduardo Schwartz (from UCLA), Gonzalo Cortazar (from PUC), Michael Brennan, and Avinash Dixit. It has seen exposure in public media like Wall street journal and Harvard Business Reviews. It is even taught in some business school's MBA curricula.

2.3. Current ROV World Adaption

In 2000, Bain & Company conducted a survey of 451 senior executives across more than 30 industries regarding their use of 25 management tools. Just 9% used real options, which ranked next to bottom on the list (only market-disruption analysis, a "new economy" technique, scored lower). And whereas the average defection rate for all tools in the study was 11%, 32% of real-options users abandoned the technique in 2000. As for "basic" capital-budgeting tools, net present value (NPV) topped the list at 96%. (Reach, 2003)

Real Option Valuation (ROV) in practice today is mostly limited to pioneering

consultants and academics. Academic communities are backing up the support of ROV, notably "real option org"[2] which holds annual international conference on real option. Papers on the applications of ROV have been published on pharmaceutical projects and natural resources mining. Consultants specializing in ROV method provide business modeling, software tools and ROV training courses. Both communities are doing their part to spread the merits of ROV method. However in the eyes of business community Real Options Valuation is a "black box." The sophisticated mathematics (such as partial differential equations) of real options, and the consequent lack of transparency and simplicity, are real concerns.



Bain & Company has been tracking executive perceptions of the business environment and resulting management tool preferences since 1993. This chart shows results from five of the 13 surveys conducted during that period.

Table 2 Bain Consultant Survey of Top Management Tool[3]

[2] www.realoptions.org
[3] (Bain & Company)

In Table 2 Bain Consultant Survey of Top Management Tool, Real Option Valuation is not listed in the past decade. Strategic planning on the other hand has been on top of list and on management's mind. One of the reasons, for its popularity is management's need to address the dynamics of the changing environment. ROV is such a tool despite its lack of recognition.

From the aforementioned obstacles, this paper is proposing to apply ROV based on simple math and strategic planning framework. The real option analysis and valuation method applied in this paper is based on the book, strategic investment: real options and games, by Han T.J Smit and Lenos Trigeorgis.

3. Strategic planning

Strategic planning is the balance between commercialization of cash generating investment and the development of future growth opportunities. A proper balance between current cash and future cash among these is necessary for the long term strategic and financial success of the firm. Companies must often pursue parallel strategies with one focus on today's capabilities while simultaneously developing new capabilities for the future (Abell, 1999). The balance between the present and future focus partly depends on the situation. The future component acquires more importance during volatile periods while the present focus component dominates more in more stable times.

Traditional product portfolio planning approaches have tried to address this problem through the famous BCG matrix developed in the 1970s. The matrix has two main metrics: short term profitability metric and a growth potential metric. The intent is to find the optimized portfolio of business the company. By placing the product and services position (star, cow, dog, question mark) within the matrix, the company can make tradeoff decisions between current profitability versus future growth (as in option space).

To consider future growth is to ask a company what market opportunities exist for economizing use of its resources. A firm must identify growth opportunities in market and activities in which its distinctive capabilities are relevant, and then put together complementary resources needed to capitalize on these growth opportunities. Once management understands which of its resources and core capabilities are most important and relevant, it can make the right investments to enhance its competitive advantage.

To understand the nature of competitive advantage is to distinguish between those resources and capabilities that are idiosyncratic to the firm and those that can be readily acquired in the market place. If a particular resource or capability can be bought readily in the market place or is controlled by several competing firms, it is unlikely to be a source of enduring competitive advantage as a competition will erode any above-normal profits (Barney, 1986). The exploitation of such firm-specific resources is considered a

fundamental determinant of value creation by the firm (Wernerfelt, 1984)

3.1. Competition and strategy

How well a company competes in the market significantly changes the outcome of the intended plan. One particular view on competitive strategy is to employ flexibility and inflexibility in the market. As the competitive environment changes quite frequently, flexibility in strategic investment allows firms to optimize their investment and value creation. A firm should invest in those resources and competences that will give it a distinct advantage given the right favorable market condition.

Inflexibility on the other hand, based on industrial organization economics and game theory shows that strategic commitment can be valuable. When a firm commits itself in an irreversible way to an investment or strategic plan, it can influence the strategic actions of its competitor (through game theory analysis). By consolidating the resource position and affecting the acquisition cost (exercise price) and the profit stream (underlying value) of the other player, the former can put the competitor in a weaker position.

4. Strategic planning and Real Option Valuation

Companies attempt to manage both positions simultaneously while making a gradual transition to the new position as the old one matures or deteriorates. Option theory can add significant insight to such an adaptive approach as it does not treat the amount, trajectory, and pattern of related outlays in a static way but rather permits periodic adjustment and revision of decision depending on market growth and unexpected market development. Option analysis allows for adjustment or switching along various alternative path as the strategy unfolds, making it possible to determine the value (and reap the benefits) of a flexible strategy.

Strategic investments for R&D projects can no longer be looked at as in independent, stand alone project but rather as links in a chain of interrelated project. To get to the intended strategic position the earlier investment are the prerequisite for the one to follow after. A pilot venture, a first generation technology, a new drug, or a strategic acquisition in a new geographical area may bring additional strategic value to the firm by generating follow-on investment opportunities.

4.1. Real Option Growth Matrix

The Real Option Growth matrix proposed below embeds the dynamic options-based valuation as part of the two main dimensions of portfolio-planning analysis (like BCG matrix) as presented in Figure 2 Value of Call Option.

The total value creation (expanded NPV) of a project consists of the Net Present Value (NPV) plus the Present Value of the Growth Option (PVGO). The first dimension(base NPV) represented by the horizontal axis captures the value of the stream of earnings or cash flows expected from current operation or existing assets under a steady-state or no-further growth policy.

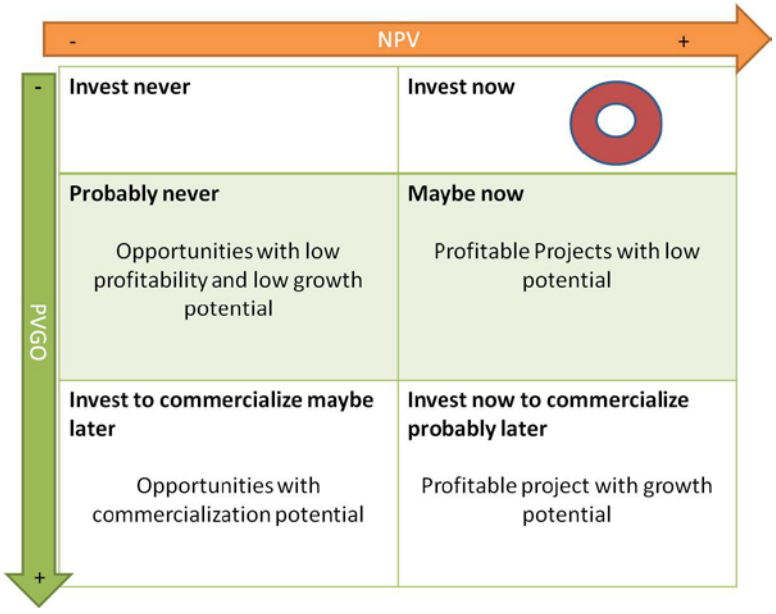


Figure 1 Real Option Space[4]

Expanded (strategic) NPV = base NPV + PVGO Equation 1

[4] (Trigeorgis & Smit, 2004, p. 77)

The second dimension represented by the vertical axis is the Present Value of Growth Option (PVGO). It is a measure that incorporates both the volatility and managerial flexibility/adaptability. It involves not just volatility in price or demand from the market but also management's ability to respond to technological change, competitor's moves and other unexpected developments.

The location of an investment opportunity is determined by its NPV and its PVGO metrics. Opportunities (projects, business units, or firms) may fall in different regions in option-value spaced based on their current profitability and relative growth option value (PVGO).

The filled circle is the underlying asset value of the project and the unfilled circle is the exercise price. As the project tends to maturity it moves upward and if the plan goes well (with market condition favorable) the project move toward positive NPV space. This is the preferred path of a project's development.

4.2. Call option valuation

Investing in R&D derives strategic value from generating the opportunity to commercialize later under the right circumstances. This is like a call option with a right to buy or sell an asset but implies no obligation to do so. The call option value is determined by finding exercise value in the up state and down state as seen in Figure 2 Value

of Call Option. Next by deducting the exercise value by exercise cost at each state at the exercise time the underlying value at that point can be obtained. If the resulting call value is positive after deducting the exercise cost then the option should be invested. Vice versa, if the resulting call value after deducting the exercise price is negative then the option should not be invested.

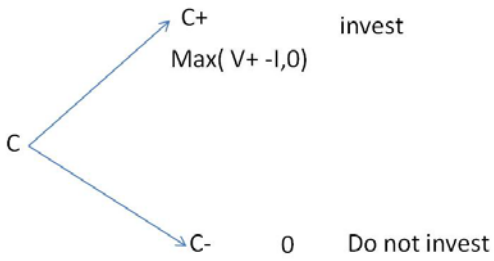


Figure 2 Value of Call Option

Finally by using the binomial neutral valuation as in $C = \frac{\left[pC^{+}+(1\text{-}p)C^{-}\right]}{(1+r)}$

Equation 2 the call option value at time zero can be determined.

$$C = \frac{[pC^{+}+(1-p)C^{-}]}{(1+r)} \qquad \text{Equation 2}$$

Where,

$$p = \frac{[(1+r)V-V^{-}]}{V^{+}-V^{-}} \qquad \text{Equation 3}$$

And,

r = risk free discount rate

Note that if there are no options or other asymmetries, applying this risk-neutral probability p would give the same present value as traditional DCF valuation

4.3. Project development and Risk

The R&D project process generally can be broken down into three stages: concept study, design verification and implementation and launch. At the concept study stage the company make exploration of different options available in the industry. Company must ask the question does this business opportunity realize its value primarily through direct measureable cash flow or through growth options or strategic values. At the end of the study the company can identify and create reachable option or options of different projects to be realized to generate future cash flow or strategic position.

At the development stages, firm assembles its resources and manpower to develop product from the drawing board to physicality. In this stage the firm faces specific technical or resource allocation uncertainties. In parallel company may and will probably face similar product development competition from rival companies.

At the end of the development, the company faces uncertainties over cash flows primarily from uncertainties in demand, competition or cost of production fluctuation.

Risk in an investment project can be categorized as endogenous and exogenous. Endogenous risks are firm specific risk. They are the managerial effectiveness in using firm’s asset through firm’s process to create its specific value. These risks are foreseeable and controllable by the firm themselves. The exogenous risks in contrast are un-

foreseeable and uncontrollable to the firm. They are the consumer response risks, market competition risks and macroeconomic risks.

The future cash flow forecast based from primary variable such as the costs of labor, material and the price of the products sold are firm specific. The uncertainty presented in the exogenous risks is the main worry managers have to contend with in order to ensure the project meet its intended success. The resolution of (various types of) uncertainty is important for portfolio planning as it determines the relative attractiveness of growth option value and the time-trajectory of the project evolution in option space.

It may be worthwhile to wait and see or to commit to a project depending on the competitive landscape. The timing of exercising the option is the tradeoff between strategic commitment effect and flexibility effect to wait and see. This can be represented by the pay off table in game theory. This is taken competitive strategy and environment in to effect where it is no longer an internal option portfolio optimization.

5. Case Study

Mark has been sitting in front of his laptop for two hours. He has been staring blankly at his screen and feeling lost for the task he has to accomplish. The deadline to present the result of his findings in three days and Mark has to be able to find a way to navigate through market uncertainty and risk for his projects and present justifiable

course of action to the management team.

Being a project manager in a LCD television consumer electronics manufacturer, he has been trusted by his company with an innovating project that will change the way television is used. Company A is pioneering a new platform that will greatly increase functionality thus making the TV “smart”.

5.1. Smart TV

Company A is LCD TV set maker using Design A to build the new platform TV. Design A is using a modular design build from existing CPU. Although it’s processing power is very high it lacks all the functionality that would complete the platform. Thus, to complete Design A functionality, it would require additional IC components which increases the overall cost of the Design.

Joining company A is an alliance of other companies in the LCD TV value chain who believe this “smart” TV is the next step of LCD TV technology evolution. With the alliance, Mark is able to assemble a good team of engineers with the right skills and other relevant resources needed to develop the new platform. The daunting task now for Mark is to show that the platform is not only technically feasible but also business feasible. He will have to evaluate the value of this project.

From his market and business study, Mark has found that the company’s primary

market in United States has a TV population of 290 million who own at least one TV and 114.7million household with at least one TV (Nielsen, 2011, p. 2). Couple with that the United States has 192 million broadband owners and 85.9 million household with broad band (Nielsen, 2011, p. 2). The target populations for smart TV are both the TV population and broad band owner.

Overall the market is greatly saturated. Around 30 million of LCD TV was sold in 2010 and the overall forecast would decline for the first time since volume shipments began in 2006. According to market research firm, 83% of people in the US weren't going to buy a new TV in the forthcoming year; only 13% did plan to. That was worse than earlier in the year, when 66% were saying they wouldn't buy. The reason for lowered consumer demand is the 2008 economic recession that was still fresh in people's mind. People wanted HDTV bought one while credit was cheap and don't need to replace them (Arthur, 2011). Despite the gloomy market forecast, other analyst believes there is still a great demand due to the recent rise and availability of online streaming video. Consumer wants more video contents and most importantly they want to have the control of the video contents. This mean they want to have the right video contents whenever and wherever they want to watch it. Still, the top priority for LCD TV purchasing consideration is the price which then is followed by the features like smart TV. Still, Price is the determining factor that changes the competitive nature and market

landscape of LCD TV.

5.2. Product and positioning

The new platform top feature emphasizes on its performance to watch online video content. It packs the computing power borrowed from computer to enable parallel flash video performance. More over due to the full functionality operating system on the power computing power it boasts the same experience to surf internet as well as allowing users to install APPs/software. In addition, the versatile operating system enables full web browsing compatibility (like HTML 5, flash and Java). In addition, the new platform includes video camera to allow video conferencing and social media interaction.

There are numerous obstacles the development the team has to address in order to have a successful product. The first obstacle is the user interface to control the TV. There are numerous feature enabled in the smart platform that requires complicated command of inputting, browsing and selecting. The design team has chosen a similar interface that borrows from computer mouse and keyboard.

The second obstacle is to design the smart TV to be smart enough to find the right video content and display it at the time the user desires. For this the design team has made tracking software that allows the user to select the preference and follow up on

filtered video content. However, due to the video content ownership issue, the platform team can only make the software compatible to few of the video content source websites like YouTube.

The third obstacle is to design the smart TV to behave like a TV. This will differentiate itself from its substitutes like tablet or PC. One particular example of TV behavior, the development team has to optimize the operating system to allow on screen display within seconds turned on like a normal TV.

The last obstacle is for the development team to differentiate the Smart TV from other connected TV. The main difference between Smart TV and Connected TV is Connected TV has no control of what App/software is installed. In contrast the Smart TV allows the user to control the App/software to install. The connected TV does not have a fully functional operating system. The Smart TV has a fully functionally operating system.

The new platform is at the point to cross the chasm to the majority of users. The technology is at its embryonic stage with early adaptors owing earlier version of technology. The industry recognizes the potential of the opportunity and is responding accordingly. It has altered its value chain and distribution channel in response to catch the first wave of early majority users. The developers from the value chain have thus far delivered the right hardware functionality to meet the needs of early majority.

The company is hoping to position itself in a new emerging market- the TV software/service market. This way the company is hoping to transform its business model from one time purchase of a piece of hardware equipment to repeated purchase of extended product/service. If successful, the company will become the new channel reaching directly into the heart of consumer's home. This will generate additional profit for years to come.

5.3. Industry & competition

The LCD TV Industry is always seeking business opportunity. This is done in two ways. First way is through technology innovation and entices consumers to adapt and purchase. For the smart TV, the industry is divided into two different product strategies. One strategy is to make the TV smart by make it the hub to all internet enable device at home. The other strategy is to make the TV dumb by make it into a simple monitor with large expansive input and output capability to other devices like smart phone, PC and Tablet.

The second way is to improve its operational bottom line. This is done by forming strategic alliance between key component makers like panel and system integrators to lower the overhead and material cost of both companies.

Price war is common amongst brand. This in turn has created the expectation for

price drop in consumer's mind reinforcing the price war. Therefore, promotional events with deep price cut are common and are treated as useful way to generate revenue.

Due to the advent of technology and the company driving them, there are numerous new entrants to TV industry. Typically, the entry barriers for TV industry is high because of the high financial cash flow needed to fund the operation. However, the new entrants are titans in their own industry with resources and capital like Intel and Apple. These companies are making related diversification to provide additional product and service to their existing customer through their existing channels. Similarly there are outside players who are participating indirectly in the industry adding opposing force to the development of the smart TV. With the announcement of launch of Sony Google TV in 2010, ABC, CBS, NBC joined Hulu blocking Google TV from accessing full episodes (Goyal, Cambel, & MacGuire, 2011, p. 39)

Innovation in the industry sighted well in advance. Typically, the numbers of available new technologies are limited because the technology needs numerous supporting business partners. The more disruptive the technology the more partners are needed to support it. Therefore, the adaption to new technology is to join the right alliance and hope it will become the de-facto standards. For example, to build High Definition TV needs HD IC and HD panels (which in turn needs its own HD driver IC).

Mark has reviewed all the market and industry information. He is quite excited that

there is chance that the new platform can be a disruptive innovation. At the same time he is worried how the consumer will respond and adaption rate of the new platform. Specifically when will the platform reach a tipping point to become widely accepted (maybe in two year, three years?).

Mark is also concerned that the development of Eco-system through attraction of platform's third party developers and content provider won't be fast enough to create a sizable Eco-system to differentiate the product and attract users. Should Company A develop the platform now while at embryonic stage?

In three days, Mark will have to present his findings to management to make a managerial decision.

5.4. The Investment outlay

The total project development time is expected to be two years. The investment outlays are broken down into five different categories: Tooling cost, manufacturing equipment cost, sample cost, licensing cost, man power cost. The Tooling cost plastic injection mold, metal stamping molding. Not all parts require new tooling or molding because some parts can be common parts sharing from other TV.

Most the equipment needed for the production is already available in the factory. The additional equipments are automated test machines designed to test operating sys-

tem and software response of the TV. For licensing, budgets are needed to purchase rights to the use of video and audio codec and software app to be pre-installed. In the case for Smart TV, the alliance has agreed to burden most of the cost thus majority of licensing cost is paid for and decreasing the investment needed. Although cost effective, the down side is that the new platform developed will be shared proprietary technology.

Hardware engineers, software engineers as well as mechanical engineers constitute the main project team. Due to the complexity of new platform software four hardware engineers and ten software engineers are needed. Two mechanical engineers and three support personnel consisting project managers and production engineers are estimated to design the mechanical structure and coordination of the project. During the development, development samples are needed for each functional team (ME, SW, HW) to develop and verify their design. In addition these development samples are needed to run quality and reliability test as well as sending out out-house developers to verify and certify the design.

The above assumptions for the new platform development are estimated with cost and summarized in Table 3 New Platform Investment Outlay. The total cost of development of new platform comes to a total of 4.025 million USD for the first year and 0.95 million USD for the second year.

Year	item	cost	Note
0	Tooling cost	2M	
0	Manufacturing Equipment cost	0.2M	Additional Testing equipment and fixtures
0	Sample cost	0.375M	250 units at 1500 USD each
0	Licensing Cost	0.5M	
0,1	Manpower cost (4xHW+2xME + 10xSW+ 3x Support = 19)	0.950M/Year	Each Man power assume 50K USD/year
	Total year 0 cost	4.025 M USD	
	Total year 1 cost	0.95 M USD	

Table 3 New Platform Investment Outlay

For the follow up project, it is following a water fall product strategy to take as much existing parts and functionality of new platform and update to market competitive product specification. As such, the development of the follow up project is simpler. The total project development time is expected to complete in one year. The look of the TV is modified to provide new look to the consumers therefore new plastic and metal moldings are still needed. Additional manufacturing equipments are bought to accommodate the expanded production capacity. Overall facility and production capacity are expected to satisfy the demand of the follow up forecast. Additional licensing costs are expected to incur as additional SW/APP features are need to remain competitive in the market .Both the man power and the development sample are reduced due to the smaller amount of work needed. The aforementioned assumptions are summarized and a total cost is estimated to be 1.82 Million USD in shown in Table 4 Follow Up Project In-

vestment Outlay.

item	cost	Note
Tooling cost	1.2M	
Manufacturing Equipment cost	0	
Sample cost	0.12M	100 units of samples
Licensing Cost	0.25M	
Manpower cost (1x HW +2 x SW + 1x ME + 1 Support= 5)	0.25M	Each Man power assume 50K USD/year
Total cost	1.82M	

Table 4 Follow Up Project Investment Outlay

5.5. Product costing and forecast

Mark has discussed with engineers, sales and marketing and decided on a "water fall" product strategy with each product life of two years. Table 5 Smart TV total product line product costing shows a summary of the product strategy.

	New Platform	Follow Up Project
Retail Price	1400	1100
Expected Profit (%)	4	4
Expected Profit ($)	56	44
Product Position	Premium, innovation showpiece	Middle, competitive
Product Life	2 years	2 years
Product Promotion	Price drop 10% per year	Price drop 15% per year

Table 5 Smart TV total product line product costing

The new platform allows company A to develop additional follow up projects (wa-

terfall model strategy) that enables firm B to capture additional value from the platform developed. This will mean that the premium model launched at year 2 will repositioned to be middle competitive model launched in year 4. It is expected that the both the new platform and the follow up products to be reduced in price to stay competitive in the market.

The forecast for a new technology is tricky. Mark has discussed with sales, marketing and channel to present the forecast in Table 6 Total Product Line Forecast.

Year	Average (M) units	Product
2	0.1580	New Platform
3	0.3000	New Platform
4	0.6000	Follow Up
5	0.8000	Follow Up

Table 6 Total Product Line Forecast

The forecast in Table 6 Total Product Line Forecast is based on experience of past shipment, value chain commitment level, manager confidence level and channel distribution survey. Other forecasting method considered are to use similar product referencing by taking similar product models in the past history and use it as a guide to its product introduction onto market and product life cycle progress. This is done by considering the usage model (how it is used), its price level, purchasing habit (where it is purchased) and preferences (form, color factor). However, Mark had problem with

finding a similar referencing model based on the above criteria. Other comparison models are either too small, the price level not in range or product is too old with the market environment changed a lot since then.

Another forecasting method to consider is the market Share forecast analysis. This is done through the use of external data and industry analyst projection. By taking the analyst global projection and the North America region market share and finally the brand market share in the region, Mark have found a forecast in comparison with forecast he has received from sales department. However, since the analyst forecast is usually overly optimistic and the market share changes drastically each year, the market share forecast could not be used to make direct comparison and adjustment to the company forecast.

The last method Mark is considering in using is the replacement ratio of TV. This method is good because the TV market has saturated. The replacement ratio still need to consider the expected TV brand market share as well as the Smart TV expected adaption rate both of which is subject to change and produces only reference result.

6. Static NPV Analysis

6.1. Company A Rate of Return

Capital Asset Pricing Model's expected return on a security as defined by

$$E(R) = R_f + \beta \times (E(R_m) - R_f) \quad \text{Equation 4}$$

(Jordan, Ross, Westerfield, & Jaffe, p. 384)

Where,

- R_f = Risk-free rate= 1.88% (Trading Economics)
- β = Beta of the security = 1.07 (Morningstar)
- $E(R_m)$ = Expected return on market = 8% (Fernandez, Aguirreamalloa, & Corres, 2011, p. 3)

Re= 1.88% + 1.39 x (8% – 1.88%) = 8.43%

Next, Weight Average Cost of Capital (WACC) is defined by

$$WACC = \left(\frac{S}{S+B}\right) \times R_s + \left(\frac{B}{S+B}\right) \times R_B \times (1 - t_c) \quad \text{Equation 5}$$

(Jordan, Ross, Westerfield, & Jaffe, 2011, p. 414)

Where,

- R_s= Equity discount rate = 8.43% (from Capital Asset Pricing Model)
- R_B= Debt discount rate = 2.46% (Amtran, 2012, p. 30)
- $\left(\frac{S}{S+B}\right)$= Portion of total value by equity = 0.52 (Amtran, 2012, p. 8)

- $\left(\frac{B}{S+B}\right)$= Portion of total value by debt = 0.48 (Amtran, 2012, p. 8)
- (t_c)= Corporate tax rate= 15.29% (Amtran, 2012, p. 8)

WACC = 8.43%*0.52 + 2.46% x 0.48 x (1-0.1529) =7.5613%+0.1861%= 5.386 %

The discount rate to be used for the following static NPV calculation is 5.39%.

6.2. Static NPV calculation

By representing visually the cash outflow and cash inflow over time, Figure 2 can be generated to aid the Net Present Value (NPV) calculation.

$$\text{NPV} = \sum_{i=0}^{T} C_i, \text{where } C_i \text{ is cashflow} \qquad \text{Equation 6}$$

$$\text{NPV} = -4.525 - \frac{0.95}{(1+0.0539)^1} + \frac{8.85}{(1+0.0539)^2} + \frac{15.12}{(1+0.0539)^3} = 15.46$$

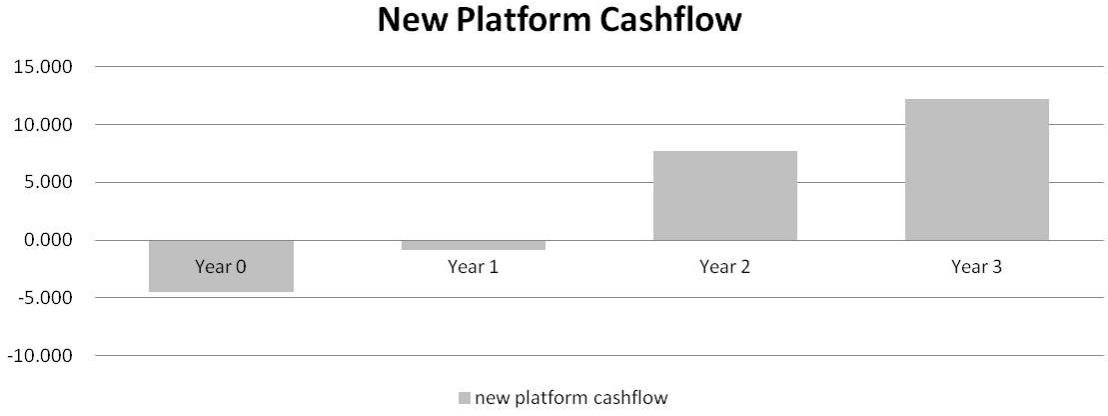


Figure 3 New Platform Cash Flow

Traditional static NPV using discount cash flow (DCF) method calculates the project to be $15.46 M. The cash flow is discounted at a rate of 5.39%.Given the positive result of the calculation, the static NPV would suggest to the managers to invest in the project. This is based on management committing to the investment of year 0 and year 1

R&D investment for the project. Similarly for the total product line which includes new platform and follow up project, the cash flow can be represented as Figure 4 Total Product Line Cash Flow.

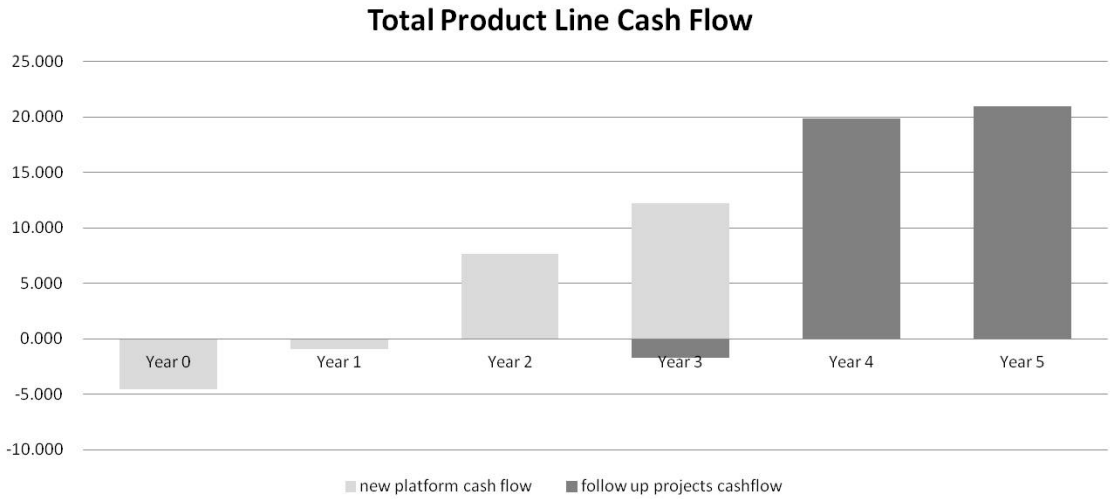


Figure 4 Total Product Line Cash Flows

For the follow up project, applying the Net Present Value (NPV) is:

$$\text{NPV}= \sum_{i=0}^{T} C_i, \text{where } C_i \text{ is cashflow} \qquad \text{Equation 6.}$$

The result is $58.06M. Again, the cash flow is discounted at a rate of 5.39%. Since this is also a positive result bringing in revenue stream, NPV method would suggest to the managers to invest and commit to investment in the new platform and follow up project.

The static NPV would be accurate if the forecast is the same as the actual demand. Unfortunately there is uncertainty in the market demand. This would make the investment calculation invalid due to the changing nature of the market. Managers will most

likely need to make additional or corrective calculation when there are new inputs from the market status update. Or managers will have to include contingency planning or calculation to take into account the market dynamics.

The static NPV also doesn't take into account the grow option of the new platform. In another word, the more lucrative revenue stream of the follow up project would follow only after the development of the new platform project. The independent evaluation nature doesn't indicate however the strategic importance of new technology nor the value of the new competence.

Theoretically the project budget is allocated and committed. However in real life the annual budgets are made year by year with inputs as to project status and market outlook. The managers could base on these inputs make alterations to continue or discontinue with the project. However, the manager would never find out if he or she doesn't make the first year 0 investment.

7. Real Option Valuation

Mark has learnt about Real Option Valuation calculation in his MBA school. He is keen to put what he has learnt to the test. Especially, he is looking forward to presenting the project valuation with a holistic view to his boss.

There are various decision points that the manager can consider to continue in-

vestment in the project. These are major decision points that management have to consider to continue or to abandon and divert the resources to other projects for value creation. Below illustrates the correlating decision points to the investment outlay and cash flow to represent different timing points of decision

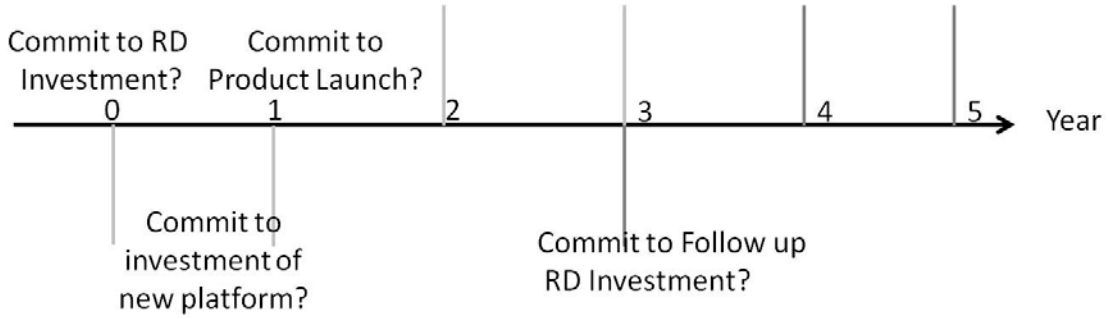


Figure 5 Decision Points along Project Development for Defer Option

The timing of decision is a not exact but a window of opportunity. This should be correlated with the relationship of development lead time and market launch time. For example for Christmas boxing day sales, the company should launch to product to market two month in advance to allow distribution to channel and advertisement events to promote awareness. Including the R&D development lead time, management should be making the decision total of 8 month prior to decide whether to invest in the project. In addition, management should also take into account competitor's product portfolio around the same time frame. Therefore there are only specific time-frames managers can make a choice.

Taking in time frame into consider, R&D manager should consider whether the

company should commit to new platform R&D first year investment given the market condition and internal resource and capability. Should the company commit to the second year new platform R&D investment (as well as the necessary market investment) to launch the product into the market after R&D results are known? Finally, should the company commit to the follow up project investment given the market condition?

7.1. Forecasting and market trend

To take in account of the market dynamics, Mark is preparing to include an extra element in the forecast: the market dynamics. First of all, sales forecast reflect the company ability and value creating to the market. This should be done first to evaluate the firm's position in the market. In a way it represents his/her confidence level of forecast (product) in the market. High confidence means lower variability and low confidence means higher variability of the accuracy of the forecast.

The up and down trend of market variation represents manager's response of his/her forecast to the market. It is his/her sentiment whether the market is bull or bear like financial market. It is a representation whether the market is in good economy so consumer has good purchasing ability. It is also a representation whether or not the consumer is acceptable to the product (their willingness to purchase).

Mark is estimating the market upward trend to be a factor of 2 for the better than

expected case and the market downward trend to be a factor 04 for the worse than expected case. Since there is no evidence to back up this, Mark feels that ultimately these factors are decided by the senior manager's interpretation.

7.2. Real Option Valuation calculation

The first step of Real Option Valuation calculation is to calculate the value of the CF of the project at time zero. The present value (PV) of new platform is calculated to be at $19.88M. The PV is discounted at a risk neutral rate of 1.88% (Trading Economics).

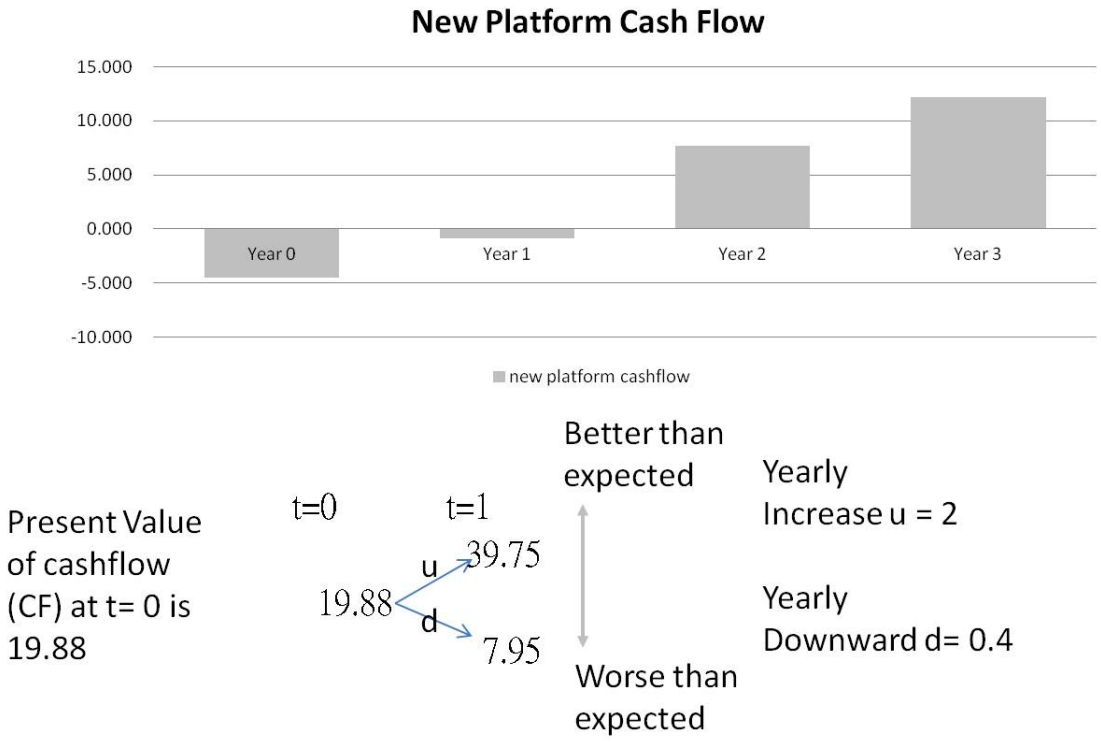


Figure 6 New Platform Cash Flows Expected Outcomes

The second step is to estimate the market variation of upward trend and downward

trend. In this case the management and the project team estimate the market upside to have a yearly increase of 2 times and downside to have yearly decrease of 0.4 times. Given these estimates, the market variations is projected to the point where product is launched by multiplying the Present Value of the Cash flow with the upward trend of 2 times and downward trend of 0.4 times. This is shown in Figure 6 New Platform Cash Flow Expected Outcome. Using the upward and downward trend factors, the market variation varies between better than expected and worse than expected result from the forecast.

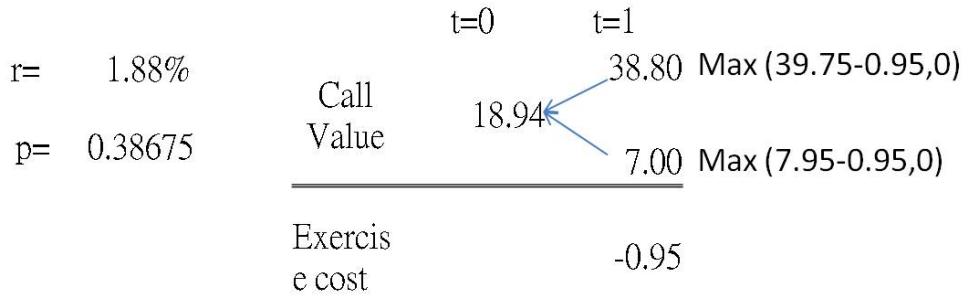


Figure 7 New Platform Call Options Valuation

The third step is to calculate the option value and deduct the exercise cost. Taking the expected value at year 1, where the option can be exercised with a cost of 0.95M, the call option value can be obtained. Next, using the binomial risk neutral calculation, the call value can be obtained at $18.94M. The binomial risk neutral probability is at a factor 0.38675.This is shown in Figure 7 New Platform Call Option Valuation.

The final step is to calculate the static NPV new platform.

NPV	t=0	t=1	t=1
outcome		D+	D-
Cashflow PV	19.88	39.75	7.95
investment	-4.525	-0.95	-0.95
NPV	15.35	38.80	7.00

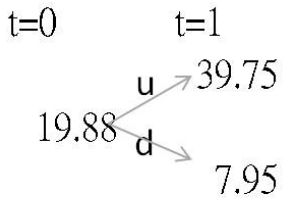


Table 7 New Platform Static NPV and Variation Outcomes

Differently from the static NPV presented before, the static NPV calculated in option valuation depends on the number of investment that has been invested. For new platform, first stage at year 0 is committed for the calculation and is deducted from the PV of cash flow. At year 1, there are no more option values and the expanded NPV would simply be the static NPV value. Given the different variation of the new platform, the year 1 investment is deducted to determine different NPV outcomes. This is shown in Table 7 New Platform Static NPV and Variation Outcomes. At year 1, both state of the remaining static NPV are positive outcomes. This indicates that the project is a go for investment.

The total expanded NPV would be 16.36 plus 19.95 which would total $36.31M. The result is positive and would indicate an investment decision to the new platform project.

The follow up project would follow the same step as the new platform by using the

same upward and downward trend factors with the different that it would vary over a longer period of time. Again, the follow up project present value of cash flow is discounted at a risk neutral rate of 1.88% (Trading Economics).This is shown by Figure 8 and Figure 9.

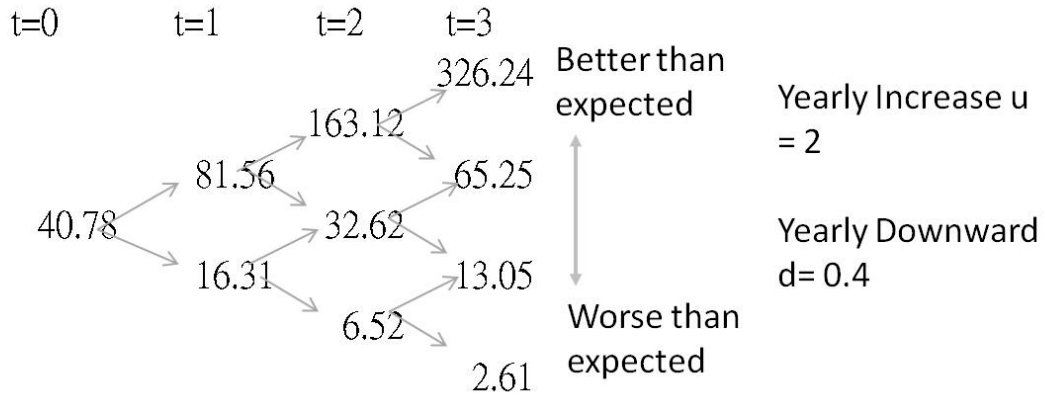


Figure 8 Follow Up Project Cash Flow Expected Outcomes

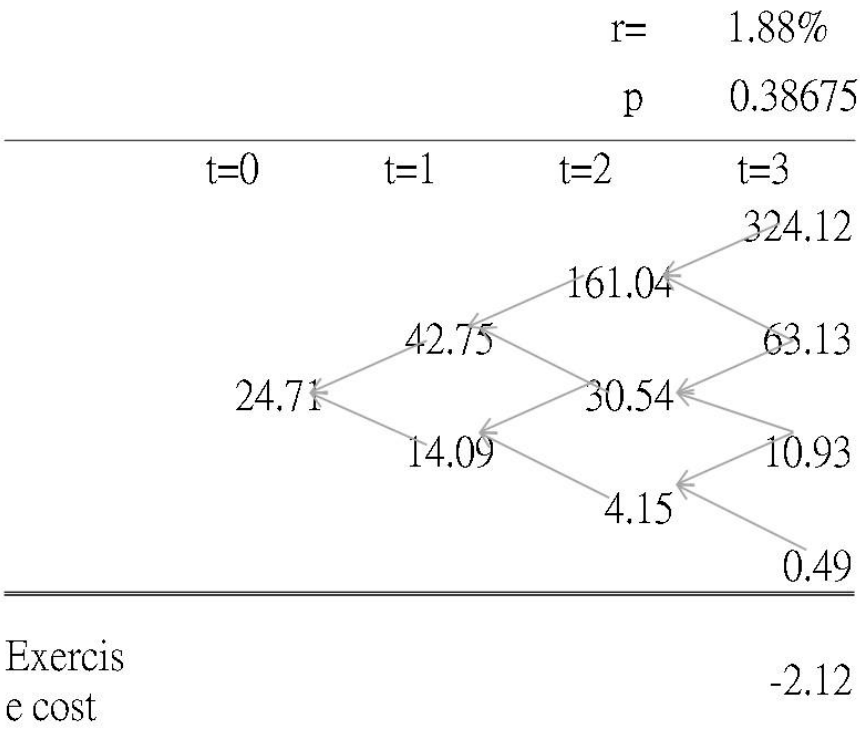


Figure 9 Follow Up Call Options Valuation

At year 3, the option can be exercised with a cost of 1.82M. Taking the difference, the call option value is obtained. Then by using the binomial risk neutral calculation, the call value can be obtained at year 0 as shown in Figure 9 Follow Up Call Option Valuation.

NPV	t=0	t=3	t=3	t=3	t=4
outcome		D+++	D++-	D+--	D---
Cashflow PV	40.78	434.23	78.95	14.35	2.61
Investment	0	-2.12	-2.12	-2.12	-2.12
NPV	40.78	432.11	76.83	12.23	0.49

Table 8 Follow Up Project Static NPV and Various Outcomes

At year 0, the cash flow is simply the PV of future cash inflow of year 3 and 4. There is no investment outlay to deduct because the project investment cost is deducted as option exercise cost in year 3. Compare to new platform, the outcome variations for follow up project is much larger because the project is longer in time and thus more uncertain. At this point, there is no more option value and the expanded NPV would simply be the static NPV value. This is shown in Table 8 Follow Up Project Static NPV and Various Outcomes.

The total expanded NPV would be 40.78 plus 24.71 resulting in positive outcome of $65.49M. This would indicate the follow up project to be a worthy investment. To get to follow up project, the company would have to invest in the new platform first. This is like multiple investments in different stages and inter-related project. The new platform can be seen as the cost to get to the lucrative follow up projects. For the Real Option Valuation, the new platform is an option on option for the follow up projects.

Year	Project	NPV	PVGO	Expanded NPV (NPV+ PVGO)	Decision
0	New platform investment (traditional NPV)	15.46	0.00		invest
0	Total Product Line (traditional NPV)	58.06	0.00		Invest
0	New platform investment (Expanded NPV)	16.36	19.95	36.31	invest
0	Follow up investment (Expanded NPV)	44.41	26.96	71.38	invest
0	Total Product Line (Expanded NPV)			107.68	invest
1	new platform launch - If demand goes up	40.82	0.00	40.82	invest
1	new platform launch - If demand goes down	7.40	0.00	7	invest
3	Follow Up Investment - If demand goes up D+++	353.18	0.00	353.18	invest
3	Follow Up Investment - If demand goes up D++-	68.94	0.00	69	invest
3	Follow Up Investment - If demand goes up D+--	12.09	0.00	12	invest
3	Follow Up Investment - If demand goes up D---	0.72	0.00	0.72	invest

Table 9 Summary table for static NPV and ROV and Decisions

From Table 9 Summary table for static NPV and ROV and Decisions, the static NPV total product line is $68.01M and comparatively the Real Option Valuation (ROV) is $99.78M. Both results would show that the investment is a go. The difference between the two is ROV account for the uncertainty in the market and quantify it as option value. Thus, ROV total product line result is greater than static NPV product line. However, the results can change based on how market condition turns and managers should adapt to the changing situation. This can be illustrated by the decision tree analysis as shown in Figure 10 Total product line decision tree analysis.

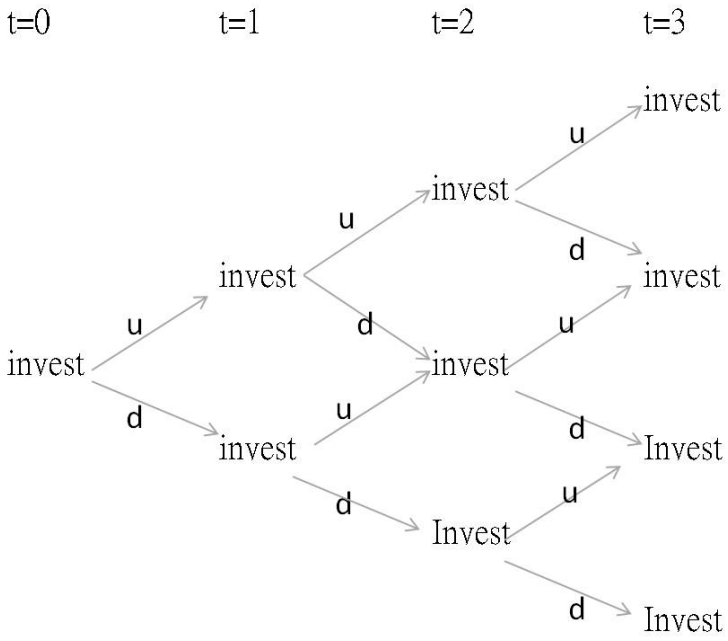


Figure 10 Total product line decision tree analysis

Year 0 and Year 1 is the investment decision for new platform and Year 2 and Year 3 is the investment decision points for follow up projects. The crucial decision points are mentioned before in figure 6. Because all the expanded NPV are positive for new platform and follow up in various decision points all points would be a go decision.

7.3. Real Option Drivers

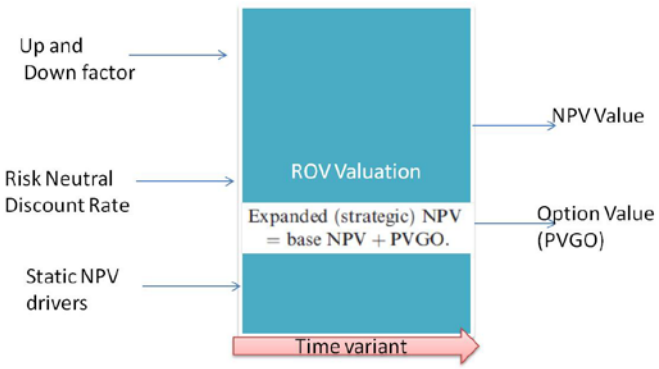


Figure 11 Real Option Drivers

In Figure 11 Real Option Drivers illustrates the drivers for Real Option Valuation method. Beside the static NPV drivers, the only additional real option valuation key drivers are the upward and downward trend factors. Real Option Valuation method proposed is an add-on of existing static NPV thus making static NPV drivers as important drivers to proposed ROV method.

Planning stage, forecast are projected based on product pricing and sales. The product pricing is based on marketing position to either enter a market or defend a position in the market. In addition, product pricing which is about development of a product is about the strategic position in which the company is to acquire a key technology to enhance its innovative capability. Given the scope and importance involved in the process, in most company, sales, market, R&D and management are involved in shaping the product concept.

With the product pricing assumption in hand, the product can be forecasted for projected sales. The product is tested based on its functionality, form factor and price how many people will be accepting the new product as compare to competitor brands. In the case of innovative product the question then becomes how many people will adapt to the new product compare to its substitutes. For most company the methods to quantify acceptability and adaptability into projected sales are based on experience, market research and analysis or comparable product in the market. All these methods

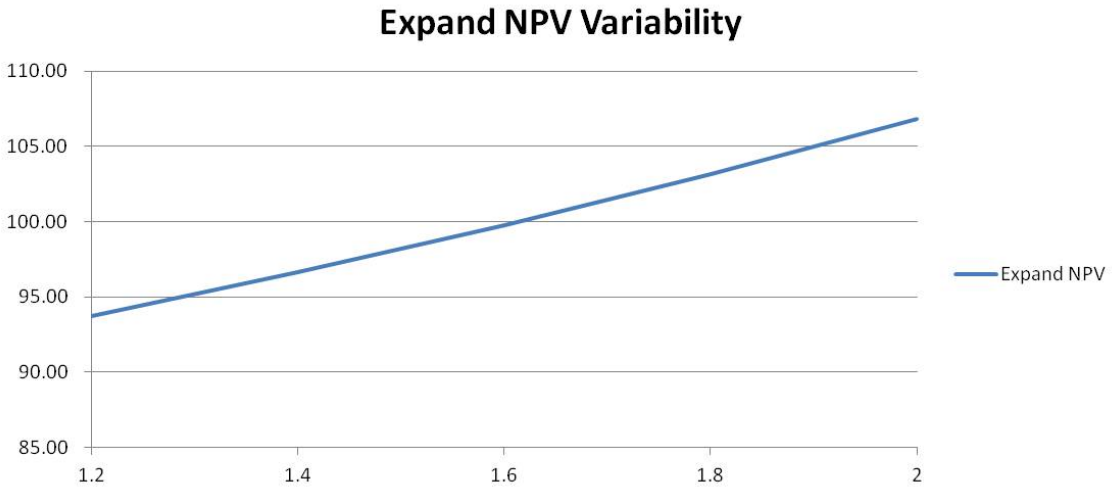
are subjective based on the assumption of person in charge and are based on limited information. Note, although there is more complicated mathematical model available in theory, most company chooses to keep it simple for the sake of understanding.

So far the two important drivers, product pricing and forecast sales, the result produced from planning process are all based on condition that is changing with time. This makes controlling them very difficult and often time futile since changes will certainly occur. Once a change occurs the static NPV must be recalculated to reflect the new situation. Methods have been developed like contingency planning to take into account the changing of situation. However, contingency planning does not present the whole picture of the valuation of the project as well as the contingency cost and or value to the risk and opportunity of the situation.

Comparatively, the market and corporate rates is taken from more constant nature to the product costing and projected sales forecast. Corporate rates are derived from accounting information based on company current and past financial status. The market rates are taken from market references. Both rates are comparative less volatile and more certain because longer time needed to change to macroeconomic or the financial structure of a company. The corporate and market rates are derived independently by financial and accounting department. They would work together with sales and marketing to forecast next year revenue and budget needed to develop the projects to meet the

target. Most likely, for financially healthy company the corporate finance structure (equity and debt) and capital financing policy is kept at the same keep the sustainability of the company. Any financially troubled company would likely to avoid investing in uncertain projects and stick with cash generating projects until the financial status improves.

7.4. Changing variability and changing forecast



Var	Expanded NPV	Risk Neutral probability
1.2	93.73	0.349
1.4	96.67	0.371
1.6	99.78	0.387
1.8	103.15	0.399
2	106.81	0.409

Figure 12 Changing variability and ROV outcomes

Variability is defined as the difference between upper and lower factors. For example the initial forecast of upper factor multiplication 2 and the lower range multiplica-

tion 0.4, the difference would be 1.6. Increasing variability increases the expanded NPV because the option value would change as represented by Figure 12 Changing variability and ROV outcomes. The reason why there is a shift in variability can be because the market outlook has turned better or worse. Either way, changing the variability is changing the basic assumption of Real Option Valuation modeling and should do so if the range of the original variability does not encompass the new market condition.

Changing the forecast would directly affect the median point of the risk neutral probability thus affecting both the static NPV value and option value. The higher the median (forecast), the higher the result expanded NPV (while keeping variability constant). Conversely, lowering the forecast the outcome expanded NPV would be lower. The reason forecast should change in Real Option Valuation should be because there is a change in company strategy or a change in industry value chain.

7.5. Competition

The purpose of competitor profiling is to find how the competitor will behave so that the company can predict the competitor's future strategy and position. In doing so, company can adjust its own plan to eliminate rivals dominant strategy and establish its own dominant strategy

The company has for the past few years now competing with company B for mar-

ket share. Company B has the higher market share position and it is bigger in size. Company B's product line is both broader and deeper than Company A. Company B is delivering products that are industry leading company. Therefore over the past couple of years, Company B is able to command a higher profit compare to industry average. Its competitive behavior usually follows committing and offensive pattern.[5]

Comparatively, company A is smaller in company size but focused primarily on television products. Its successful formula is to deliver cost effective value to the customer. Company is proud to be flexible on the bottom line while delivering innovative products. Its competitive behavior usually follows flexible and offensive pattern.

Based on competitor's product strategy and position, company A estimates the following cash flow scenario in Figure 13 Company B Cash Flow.

[5] See Appendix Competition strategy frame work

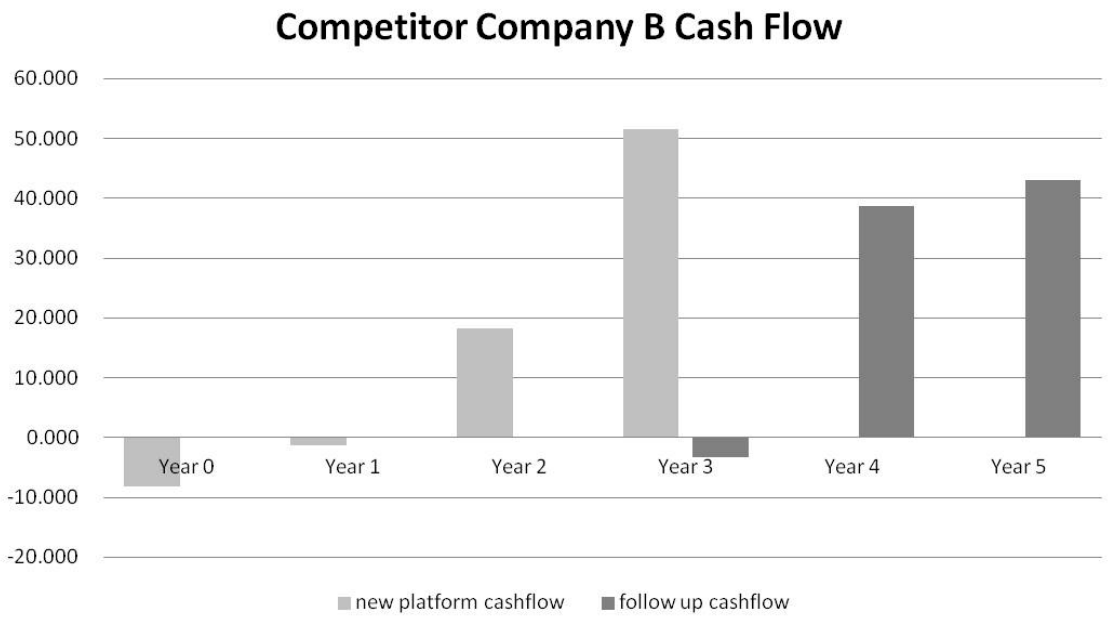


Figure 13 Company B Cash Flows[6]

If there is direct competition for market share cost each company to reduce their revenue, Company A estimates that for new platform company A will suffer a 5% reduction in forecast for new platform. Conversely, company B would suffer 3% reduction in forecast. This would be the case if market condition is better than expected (V+). Similar estimates for follow up are company A would suffer 25% and company B would suffer 20%. This would be the case if the market condition turns out better than expected (at V+++).

The new platform has less effect in forecast from competition because the new technology is seeking to expand the market pie. On the contrary, the follow up project highly competitive for the market pie. Also, it is a contest to set industry and innovation

[6] See Appendix Competitor information

standard. Competition driver at this point would probably emphasize on operation efficiency and scale competition.

Game theory can be applied to find the dominant strategy to wait or invest for both companies. In the cases where both company invest and compete, both company would suffer a reduction in forecast due to competition as aforementioned. In the case of wait, real option valuation would be applied for both company A as well as company B. In the case where one company invest and other waits, there would be no reduction in forecast from competition. The result of such evaluation is represented by Table 10 Game Competition between Company A and B.

		Company B			
		wait		invest	
Company A	Wait	91.84	191.83	0.00	112.66
	Invest	58.06	0.00	48.13	101.18

Table 10 Game Competition between Company A and B

The dominant strategy for company A is to wait. The dominant strategy for company B is also to wait. In such case, company A would lock company B in a prisoner dilemma and Nash equilibrium would be achieved.

Despite the predicament in year 0, the market condition could change in year 3. For

the best market condition of D+++ for new platform, there is direct competition between the two companies. This would result in $282.54M for company A and $410.08M for company B. Conversely for the worst market condition of D---, there would be no competition because the worst case Company A would result in $0.49M and company B would result in $0.47M outcome.

Mark is now able to produce a comprehensive plan through the real option analysis and valuation. He is able to deliver a value over uncertainty as well show how competition can affect the outcome. In addition, he has given a map to the company and informs them where they are and how they can get to its destination. Now he has to consider the possibility that the market will still perform worse and out of expectation of market trend forecast. For this Mark is creating two additional options into the project plan.

7.6. Additional Real Options

Managers can create additional real options to adapt to the market condition. If the market turned out to be outside the estimated market trend then the manager can abandon the project by choosing the salvage and switch options to minimize the sunk cost. These additional options can be incorporated in advance as part of the valuation process and carried out based on the condition.

The switching option allows the company to change product type from TV to set

top box. Engineers can be switched to work on the new product type. Mechanical molds can be switch to be used in current product or next generation product line (some parts are switchable but some parts are one way ticket). Production equipment can be modified or sold on the market. However the switch to a different product will likely to incur additional cost for example new mechanical parts or additional time and documentation. There is also the timing for this option execution. In consideration of the market launch schedule, design modification lead time, there are points with no turning back where there is no more room for flexibility.

The Salvage option is relatively straightforward as to sell the production equipment and allocate the engineers to other projects. There could also be a timing issue for executing this option because the resale value depends on the resale market's trend.

7.7. Total Product Line in Option Space

Representing visually of the projects in the option space, it can be shown how the project can be travelled on a preferable path Figure 14 Total Product Line Prefer Path in Option Space. Both projects are presented by their best and worst case scenario. The new platform can be seen as option on option for the follow up project (compound option). It is in the "maybe now" region because it can derive additional value from the spin-off project of the follow up project. In both projects where the best case scenarios

presents competition there will be erosion of the underlying asset's value as represented by the dash circle in Figure 14 Total Product Line Prefer Path in Option Space. The total product line value can be monitored across option space so that the project team can track and correct to ensure optimal path. In the case where there market is outlier of the market trend (upward and downward) prediction, the additional option of switching product type can ensure survivability of the project until such time where the market condition is more receptive.

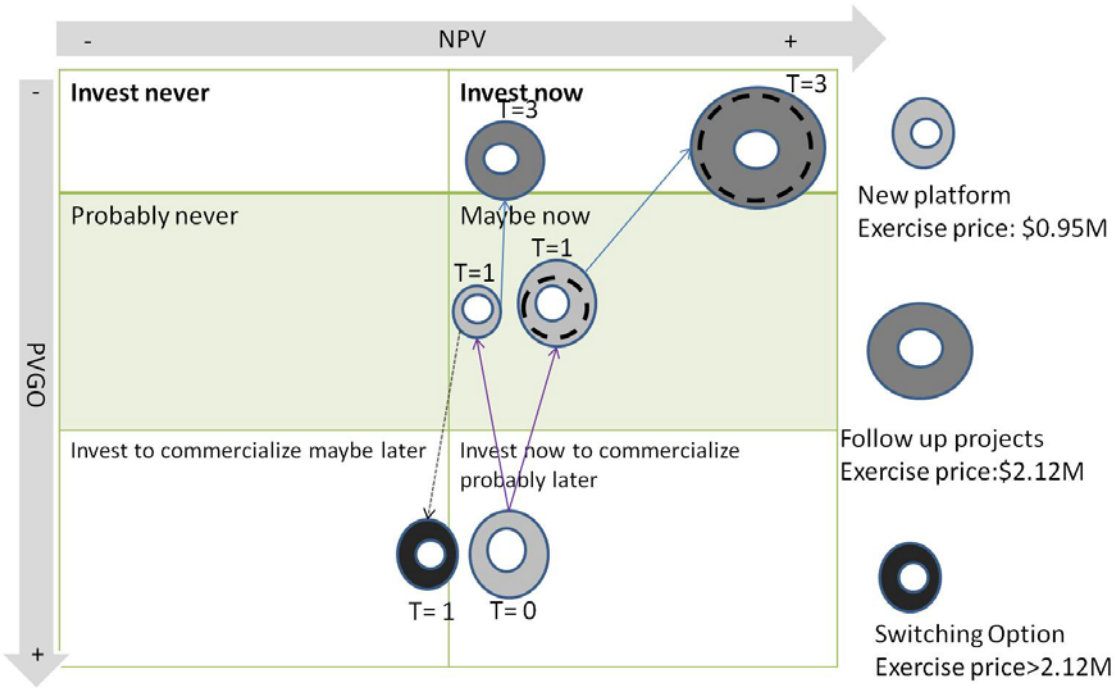


Figure 14 Total Product Line Prefer Path in Option Space.

Given the forecast and upward and downward trend, each project can break even by itself (Expanded NPV>investment outlay). To go off into to the wrong path is if the project is below the break even. This would only happen for new platform if market

turned out to 0.134x (downward trend) smaller than forecast. Similarly for follow up project it would be 0.052x (downward trend) smaller than forecast. These two factors are out of range (upward 2x, downward 0.4x) of the upward and down trend given its project scope. However, there is also a chance that the market is not growing fast enough or digresses to a niche market. Therefore it is important to monitor market response and prepare for abandonment and execute switching or salvage option.

8. Conclusion

Real Option Valuation is the tool to help to justify risky investments and provide guidance in the course of project development. By quantifying the uncertainty in the market, managers can judge more accurately the value of a project. In doing, a company can be more profitable and increase in share holder value. In addition the option map as proposed is a map charted out in the planning stage managers that can help adjust and to adapt strategies to the dynamics of market in a faster speed. Adaptability is the success factor for a project in the competitive business environment today.

In the case, the static NPV total product line is $58.06M and the Real Option Valuation line is $107.68M. Although both results would show that the investment is a go, the real option valuation is much more valuable. Thus, ROV total product line result is greater than static NPV product line. This however all depends – on the market.

Through visual maps like the option space and decision tree, managers can adapt by include additional options or sub competitive game to the changing situation both of which can be quantified.

NPV drivers are still very important because it is the basis of the modeling and assumption. This is especially true for the making of the forecast. Different sources with different motives will see the forecast differently. Forecaster thus have to take them into account and present their own believe when making the forecast. The process to make the forecast is as valuable as the result because only in making the forecast will a person understand the market. This understanding is vital to the determining of market uncertainty driver: upward and downward trend.

Competitive strategy through game theory is a complementary and useful tool to determine competition outcomes. This way it accounts for the competition uncertainty and managers can make adjustment to their plan. Through the profiling of rivals and their product strategy, managers can also gain insightful understanding of their own strategy. This is vital because all products eventually end up on the shop floor competing for customer interest. As important as all the financial data and market forecast information, it all comes down to the product design and the customer whom the design is intended for.

Real Option Valuation is the next evolution to NPV. Business world today need a

tool to figure out how to manage with uncertainty. It may even help to improve the organizational culture and align stake holder's interest to the project.

Real Option Valuation Implementation in the company

In implementing a strategy, managers should seek out matching control process and organizational structure. The strategy sets the plan with the control process executing the plan and finally with the organization structure to support the efficiency of process to meet the plan at the intended time. This creates congruence and strategic fit to the intended plan. This is especially important for ROV method which requires inputs from the status of the market.

The process of control in Real Option Valuation is a matter of gathering the right information and identifying the matching scenario to execute the option. All stakeholders interfacing with different part of the value chain can contribute dynamics of real time decision from the management. The controlling process is much easier to implement and information travels faster now with the availability of information technology system. With understanding and agreement to the ROV key drivers, stake holders can feed back information which will improve the overall adaptability of the company to the changing environment.

The organization structures to support ROV method are structures that work well with uncertain future. Structure like strategic business unit, matrix project structure or

market or customer group all emphasizes on adaptability to uncertain environment. This is evident in many of the technology companies. Furthermore such structure emphasizes on autonomy to improve the reaction speed to the environment through decentralized and flatter organization.

One of the biggest worry for an employee in a technology company is to be assigned to an uncertain project that may perform poorly in financial result. Often the employee's performance is linked to the financial performance of the project. A project maybe strategically important but it is of little financial value. In such a case, project members are not compensated for its strategic value. The feeling of resentment and abandonment may creep up over the moral of the team members.

Through Real Option Valuation, company can re-align interest and performance evaluation with employee. Typically, uncertainty in the project is undesirable to the project stakeholders since they are compensated by the financial success of static NPV calculation. Uncertainty to ROV on the other hand is valuable which in turn is also valuable to the stake holder because they can be compensated for risky projects.

In this way, the stakeholder's compensation does not depend entirely on the market performance of the project which is exogenous to the firm. Company and project members can reach an agreement on work performance evaluation that is based on executing the option and the timing to do so. Stake holder's interest would then turn to reaction of

the situation and the speed to do so. More involvement from different functional group can mean more adaptability to project's dynamics in the market which would probably improve the financial success rate of the project.

Obstacles in Applying Real Option Valuation and solutions

Real Option Valuation method would require more time and man power to plan and control it despite being the simpler math and concept proposed in this paper. Initially it would prove to be difficult due to the learning curve of understanding the concept of option valuation. The understanding of basic financial theory like NPV is low for a typical company. The adaption for ROV is going to prove even tougher. Furthermore, while management can be sole user for NPV to make decision, ROV involves all stake holders' participation. ROV method compare to NPV has no definite answer. For NPV the definite answer to invest or not to invest rest on whether the outcome is positive or negative. ROV on the other hands depends on the market dynamic making everything dependent on further subjective interpretation.

As with all financial tools, Real Option Valuation is a tool to help guide manager's intuition. Conversely, it could be used to justify and cement the manager's faulty position. This is could be the undoing of ROV method because ROV accounts for different possibility which managers could use to cement its faulty intuition. It could drive the course of the project to disaster.

In typical financial option, the exercise timing is clear. This is not the case for real option exercising timing. For real option, the exercising time is a time frame at which a company can adjust its strategy to the environment. However no one can say exactly the size of the time frame and the effect for exercising early or late in the time frame.

For accuracy the sampling timing for the decision tree should be finer (with more variations) but too much variation makes it conceptually difficult to understand. Converse may also prove to be a problem where the decision tree variation level is too broad to be anything accurate. In general, how much decision tree variation level is enough is hard to say and really depend on the project, the company and on the situation. There is also the problem with uncertainty over the time scope of the project. If the project is much longer like public construction of a dam which could take decades to complete, the variation level can be too much and uncertain to assist in decision making because the outcome would be too inaccurate.

This all ends up with the upward and downward trend. To estimate the upward and downward is one of the biggest obstacles ROV practitioners have to face.

Follow up work

One of the toughest tasks for Real Option Valuation analysis and valuation is the estimation of upward and downward trend. What number to use and how to justify the factors is not clear. The upward and downward trend encompasses too many factors and

each one bears no direct relationship to the construct of the upward and downward trend. In addition, to back up the upward would need some sort of statistical referencing which is yet to be researched upon.

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Appendix

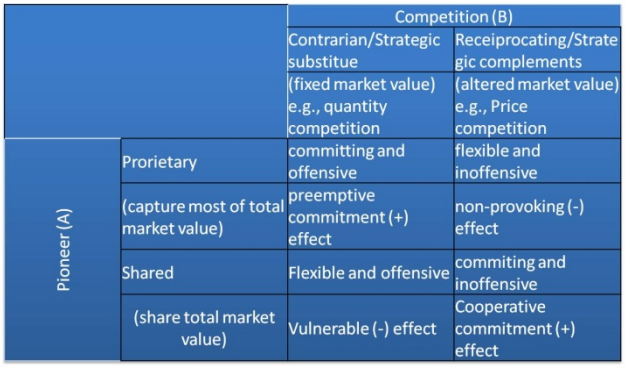
Competitor information

item	cost	Note
Tooling cost	1.2	
Manufacturing Equipment cost	0.1	
Sample cost	0.195	150 units at 1300 USD each
Licensing Cost	1.2	
Manpower cost (2xHW +5xSW + 2x ME + 2 Support=11)	0.55	Each Man power assume 50K USD/year
Total cost	3.245	M USD

Year	item	cost	Note
0	Tooling cost	3.5	
0	Manufacturing Equipment cost	0.3	Additional Testing equipment and fixtures
0	Sample cost	0.56	350 units at 1600 USD each
0	Licensing Cost	2.5	
0,1	Manpower cost (5xHW+3xME + 15xSW+ 4x Support = 27)	1.35	Each Man power assume 50K USD/year
	Total year 0 cost	8.21	M USD
	Total year 1 cost	1.35	M USD

	New Platform	Follow Up Project
Retail Price	1400	1100
Expected Profit (%)	5	
Expected Profit ($)	80	44
Product Position	Premium, innovation showpiece	Middle, competitive
Product Life	2 years	2 years
Product Promotion	Price drop 10% per year	Price drop 13% per year

Competitive strategy frame work



		Competition (B)	
		Contrarian/Strategic substitue (fixed market value) e.g., quantity competition	Receiprocating/Strategic complements (altered market value) e.g., Price competition
Pioneer (A)	Prorietary (capture most of total market value)	committing and offensive preemptive commitment (+) effect	flexible and inoffensive non-provoking (-) effect
	Shared (share total market value)	Flexible and offensive Vulnerable (-) effect	commiting and inoffensive Cooperative commitment (+) effect

Competitive strategies depending on type of investment (proprietary vs shared) and nature of competitive reaction (contrarian vs reciprocating) (Trigeorgis & Smit, 2004, p. 232)

Company B simulated rate of return

WACC = 9.9%*65% + 4.1% * 35% = 7.9%

- Re= 9.9% (Park, 2012)
- E/V= Weighted equity = 65% (Park, 2012)
- D/V= Weighted debt = 35% (Park, 2012)
- Rd = 4.1% (tax adjusted) (Park, 2012)
- Rf = 3.25% (trading economics)