Real Option Approach to Ship Investment Valuation

by

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Approval Page

This dissertation, which is an original work undertaken by Mr. Chi-Yeol Kim in partial fulfillment of the requirements for the degree of Master of Science in Shipping Management, is in accordance with the regulations governing the preparation and presentation of dissertations at the Graduate School in the Korea Maritime University, Republic of Korea.

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Abstract

Real Option Approach to Ship Investment Valuation

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This paper investigates a new valuation method of shipping investment. From the view of traditional valuation methods, uncertainty increases risk of investment and discounts the value of it. However, in the Real Option Analysis(ROA), the new method in this article, uncertainty means some additional value of flexibility so that the model can produce a more exact judgement.

A ship, as an investment, has been regarded as a very risky asset. Before financing it, investors have to consider several risks such as market, political, and timing. Among the risks, market risk has a very negative effect, because supply inelasticity makes the economic cycle of the freight market more volatile.

The most frequently used valuation technique, up to now, is the Discounted Cash Flow(DCF), such as the Net Present Value(NPV) or the Internal Rate of Return(IRR). However, the DCF has some shortcomings. For instance, it depreciates the investment as uncertainty increases, and cannot reflect the value of managerial flexibility as market conditions change.

In this paper, the ROA is presented as an alternative to the DCF. Based on the pricing model of option, a financial derivative, ROA analyzes and evaluates the flexibility inherent in the investment. Reviewing the characteristics of it, fleet investment can be seen having several rights: a right to abandon, a right to contract, and a right expand the investment before maturity.

In order to assess the value of option, we use the Binomial Option Pricing Model by Cox, Ross, and Rubinstein in 1979. In addition, by applying them to evaluating the same investment, both methods, the DCF and the ROA are compared.

국문초록

실물옵션가치평가법을 활용한 선박투자 가치평가

본 논문은 위험 자산으로 분류되는 선박에 대한 투자가치 평가시 새로운 대안을 제시하는 데에 목적을 둔다. 불확실성이 증가할수록 가치가 낮아지는 기존의 가치평가법을 대체, 실물옵션가격결정법을 제시하여 기존의 방법이 간과하고 있는 유연성의 가치를 발견 및 측정하여 좀 더 정확한 가치를 평가하기 위함이다.

선박은 전통적으로 위험 자산으로 분류된다. 시장위험, 정치적 위험, 자연적 위험 등 수많은 위험에 노출되기 때문이다. 특히 해운경기는 공급의 비탄력성으로 인해서 경기변동폭이 크기 때문에 시장위험은 선박의 투자가치에 매우 부정적인 영향을 미친다.

현재까지 투자가치평가에 가장 널리 쓰이는 방법은 현금흐름 할인법으로 순현재가치법과 내부수익률법이 대표적이다. 이러한 기존의 방법은 불확실성이 높아질수록 투자에 대한 요구수익률이 높아지므로 투자안의 현재가치를 감소시키는 상황이 발생한다. 또한 투자안의 가치가 평가 당시에 정한 요소, 예를 들어 할인율, 현금유입, 현금유출 등에 의해 결정되기 때문에 추후 상황에 따라 전략을 변경하는 경영상의 유연성을 제대로 반영하기 어렵다.

본 연구에서는 이러한 현금흐름할인법을 대체하기 위하여 새로운 투자평가기법인 실물옵션가격결정법을 이용하고자 한다. 실물옵션 가격결정법이란 금융 파생상품인 옵션의 가격결정모형을 이용하여 투자안에 내재된 유연성을 파악하고 그 가치를 평가하는 방법이다. 가치평가 대상의 특성을 고려해 볼 때, 선대투자는 포기옵션, 축소옵션, 확장옵션 등 여러 종류의 실물옵션을 내재하고 있다.

실물옵션의 평가모형은 Cox, Ross, Rubinstein의 이항옵션평가모델을 기초로 한다. 끝으로, 현금흐름할인법과 실물옵션가격결정법을 실제 선대투자 가치평가에 적용하여 두 방법에 대한 비교를 하고자 한다.

Chapter 1. Introduction

1. Objective and Background

Few industries are as international or dynamic as shipping.[1] Freight rates in shipping markets, especially tanker and dry-bulker, fluctuate significantly. For instance, the Baltic Dry Index(BDI), an index covering freight rates in dry bulk shipping, had soared about fourfold from 2,620P in early September 2007 to 11,039 in mid November 2007. The index, however, had been slashed to 5,948, nearly by half, in late January 2008.

Supply inelasticity is one of key factors to such volatile movement of freight rates. Contrary to the supply curve of the general economic theory which moves about linearly upwards in relation to increasing demand, the supply curve in shipping is completely different. It moves vertically upwards.[2]

Due to such uncertainty in income, a ship, as an investment, has been regarded as a very risky asset. Borrowing money for ships needs more required rate of return for lenders. Such risk or

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1) C. Th. Grammenos and E. M. Xilas, *Shipping Investment & Finance*, Cass Business School, 2004, Intorduction

2) B. Volk, "The Dynamics of Supply and Demand in Tramp Shipping," *Launceston*, 2002, pp. 2-9

uncertainty makes shipping investment less attractive to investors. According to the rules of the discounted cash flow(the DCF hereafter), the most dominant investment valuation method up to now, high risk requires high return to investors. Consequently, the value of the project is depreciated as the discount rate goes up.

However, the DCF overlooks some opportunities in investments because it assumes that every factor in the investment is static, that is, the expected cashflows and the required rate of return will not change during the project life. Contrary to the assumption, there are a lot of contingencies in business practices. The management has options or managerial flexibilities, for example, they can postpone the project until the market conditions are expectable, or they can expand the investment when the market is bullish, or they can dispose of the asset and get the salvage value when the market is extremely bearish, and so on.

The real option analysis(ROA) or, the real option pricing model(ROMP), emerged as an alternative to the DCF in early 1980s. Some celebrated scholars intuitively investigated the similarity between the asymmetric payoffs of options and the additional opportunities in investments. The ROA finds and assesses the value of managerial flexibilities or real options, inherent in the investments by borrowing principles from the financial option pricing models.

In this paper, a fleet investment is illustrated and analyzed using the DCF and the ROPM. Given the volatility in shipping market, the ROA can discover some additional value in the investment that the DCF cannot and help the management evaluate the investment more accurately.

2. Methodology and Sturucture

This paper uses the binomial option pricing model to evaluate the real options in the fleet investment. An option to abandon can be regarded as a put option; an option to shrink(or contract) can be seen as a put option; and an option to expand can be seen as a call option. In addition, there is no time restriction to exercise, which means that the options can be exercised before its expiration. Thus, as much as the values of american options are inherent in the project.

This thesis is organized as follows. Chapter 2 theoretically reviews the existing valuation methods, such as the NPV and the IRR, and the option pricing models. Chapter 3 discusses limits of the DCF and introduces the real options. Chapter 4 compares between the DCF and the ROA by applying both methods to a real investment project. Chapter 5 summarizes and discusses limits and extensions of the study.

Chapter 2. Theoretical Background

The ROA is a new valuation method which is based on the DCF. Therefore to analyze and assess inherent options in investments, the DCF analysis should be done first. In this chapter, theoretical backgrounds of those two methods will be reviewed.

1. Existing Valuation Methods

Money received in different time periods is of different value[3]. The DCF technique, mostly represented by the Net Present Value(NPV) and Internal Rate of Return(IRR), is designed to take into account the time value of money.

1) Net Present Value

The net present value(NPV) of an investment is the sum of all net cashflows discounted using a single, previously specified discount rate, usually the cost of capital to the investor.[4] The NPV calculation can be expressed as,

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3) C. Th. Grammenos and E. M. Xilas, *Shipping Investment & Finance*, Cass Business School, 2004, pp. 8-7.
4) Drewry Shipping Consultants, *Shipping Finance: A High Risk-Low Return Business?*, 1996, pp. 67.

$$NPV = \sum_{t=1}^{n} \frac{CI_t - CO_t}{(1+r)^t} \qquad (equation\,1)$$

Where : CI_t is the cash inflow at the end of year t

CO_t is the cash outflow at the end of year t

r is the discount rate

n is the project life

The NPV is used to determine the cumulative benefit of future net cashflows in current terms.[5] In terms of the NPV, if the result is positive, the investment is acceptable, and vice versa.

The discount rate used in calculating the NPV is the most important factor to the investment valuation and there is an inverse relationship between the discount rate and NPV[6], i.e. as the rate goes up, NPV goes down, and vice versa. As reviewed in later chapter, this is the main objection of the NPV analysis because calculating the appropriate discount rate is somewhat a complicated and tough task and, even if it is calculated, there is no certainty that the discount rate appropriate at the beginning of the investment would stay the same during the project life.

2) Internal Rate of Return

The Internal Rate of Return(IRR) on an investment is the required return that results in a zero NPV when it is used as the discount

5) op. cit.
6) op. cit.

rate.[7] The basic principle of the IRR is that an investment can be considered as the purchase of a series of future cashflows[8] or up to what level the discount rate can rise to before the NPV becomes zero.[9] The IRR equation can be expressed as :

$$\sum_{i=1}^{n} \frac{CI_t - CO_t}{(1+IRR)^i} = 0 \qquad (equation\,2)$$

Where: CIt is the cash inflow at the end of year t
COt is the cash outflow at the end of year t
IRR is the internal rate of return
n is the project life

According to the IRR rule, an investment is profitable or should be undertaken if the IRR is higher than the investor's cost of capital, i.e. required rate of return, and it should be rejected otherwise.

It is also discussed in later chapter, the IRR, however, has several drawbacks, such as multiple rates of return problem in nonconventional cash flows and misleading in choosing between mutually exclusive investments.

3) Payback Period

The payback peroid is the time period required for an investment to

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7) S. A. Ross, R. W. Westerfield, and B. D. Jordan, *Fumdamentals of Corporate Finance*, 6th. edition, 2003, pp. 288.
8) op. cit., pp. 68
9) op. cit., pp. 8-10.

generate sufficient cash to recover its initial capital expenditure. The shorter the payback period, the greater the attractiveness of the project.[10)]

Although the payback period rule has its own advantage, simplicity, it has a number of severe limitations. First, it intends to find the nominal break-even point, i.e. it ignores the time value of money. Second, it fails to consider cashflows occuring after the targeted period. The method, however, can be useful to shipping investment because recovering the capital invested quickly is a key determinant considering highly volatile cashflows in the industry.

2. Option Pricing Model

An option is the right, not the obligation, to buy or to sell the underlying asset by a predetermined date(expiration date or maturity) for a fixed price(exercise price or strike price). A call option gives the holder the right to buy the asset; a put option gives him or her the right to sell the asset. Options can be categorized into the "american options" and the "european options". An american option can be exercised at any time up to the expiration date and an european option can be done only on the expiration date.

Two most celebrated and frequently used option pricing models are introduced in this part : the Black-Scholes Model and the Binomial Option Pricing Model. Each model was presented in 1973 and in 1979, respectively. Both are based on the Arbitrage Pricing Theory, which

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10) op. cit., 8-12

means that a portfolio, the set of underlying assets and options, should earn risk-free rate of return, regardless the movement of the asset price.

1) Black-Scholes Model[11)]

In 1973, Fisher Black and Myron Scholes developed the option pricing formula for the european call option paying no dividend by using partial equation differential.

The model assumes 'ideal conditions' in the market for the stock and for the option to be derived.[12)]

1) The short-term interest rate is known and is constant through time
2) The stock price follows a random walk in continuous time with a variance rate proportional to the square of the stock price. Thus the distribution of possible stock prices at the end of any finite interval is lognormal. The variance rate of the return on the stock is constant.
3) The stock pays no dividends or other distributions.
4) The option is “European", that is, it can only be exercised at maturity
5) There are no transaction costs in buying or selling the stock or the option
6) It is possible to borrow any fraction of the price of a security to buy it or to hold it, at the short-term interest rate.

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11) Fischer said that it is OK that the model should be called 'Black-Scholes-Merton Model' because he acknowledged Merton's contribution.
12) F. Black and M. Scholes, "the pricing of options and corporate liabilities," *The Journal of Political Economy*, Vol. 81, No. 3, 1973, pp. 4.

7) There are no penalties to short selling. A seller who does not own a security will simply accept the price of the security from a buyer, and will agree to settle with the buyer on some future date by paying him an amount equal to the price of the security on that date.

Due to its complexity for calculation, here we just try to derive the fomula briefly.

The option price can be expressed as the function of underlying asset price and time.

$$\frac{dSt}{St} = \mu dt + \sigma dt \qquad (equation\ 3)$$

Where : μ is the annual rate of return of the underlying asset S

σ is the standard deviation(volatility) of the underlying asset

From Ito's Lemma, a function F of S and t is written as

$$dF = [F_s\mu + \frac{1}{2}F_{ss}\sigma^2 + Ft]dt + F_s\sigma dt \qquad (equation\ 4)$$

The portfolio can be risk-free if the variance dt is resolved.

$$\tau F = \tau F_s S_t + F_t + \frac{1}{2}F_{ss}\sigma_t^2 \qquad (equation\ 5)$$

Thus, the price of european call option at time T on the boundary condition is

$$c = SN(d1) - Xe^{-r_f(T-t)}N(d2) \qquad (equation\,6)$$

$$d_1 = \frac{\ln(S/X) + (\tau_f + \sigma^2/2)(T-t)}{\sigma\sqrt{T-t}},$$

$$d_2 = \frac{\ln(S/X) + (\tau_f - \sigma^2/2)(T-t)}{\sigma\sqrt{T-t}}$$

Where : N(x) is the cumluative probability distribution function for a standardized normal distribution.

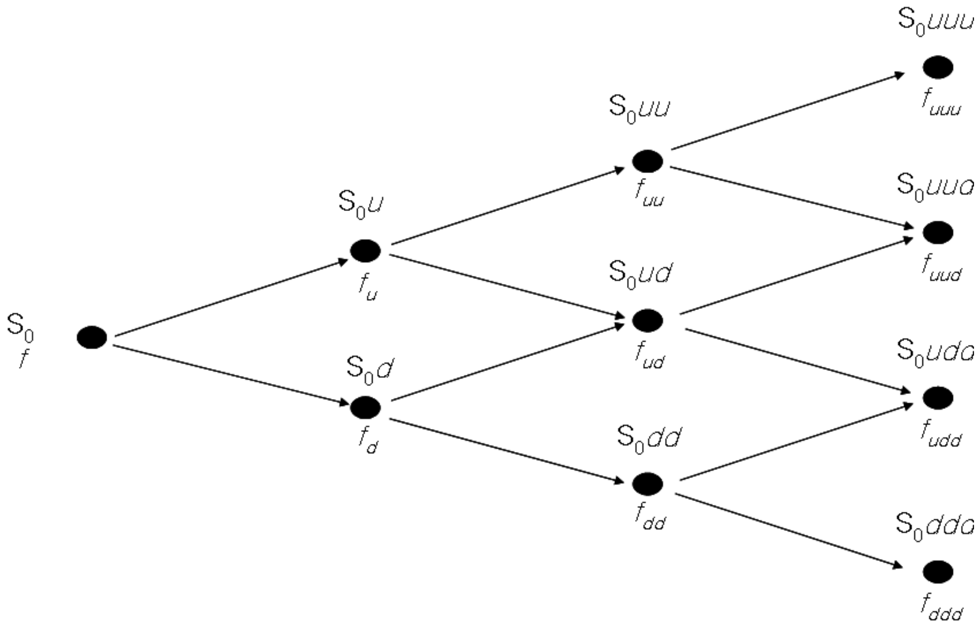
2) Binomial Option Pricing Model[13)]

The binomial option pricing model, developed by Cox, Ross, and Rubinstein in 1979, is simpler to be derived than the Black-Scholes Model. It starts from the assumption that the price of the underlying asset can either increase or decrease from the current level(S_0) to $Su(u > 1)$ or $Sd(d < 1)$.

As the figure below shows, we can suppose that f_u is the payoff from the option when S_0 moves up; f_d is the payoff from the option when S_0 moves down. The situation can be illustrated as below when we extend the time period to multi-step.

13) J. C. *Hull, Options, Futures, and Other Derivatives*, Pearson International Edition, 2006, pp. 234-244.

[Figure 1] multi-step binomial tree



If there is only one time period, for the convenience of calculation, the call option price on the expiration date can be

f_u = Max(Su–X, 0), when the asset price goes up
f_d = Max(Sd–X, 0), when the asset price goew down

In either case, the portfolio value should be equal, because we have already supposed that there is no arbitrage opportunities.

$$\Delta Su - fu = \Delta Sd - fd \qquad (equation\,7)$$

Where : Δ is the number of the underlying asset to make the portfolio riskless

We can figure out the Δ from the equation above.

$$\Delta = \frac{Su - Sd}{fu - fd} \qquad (equation\,8)$$

If there is no arbitrage opportunities, as mentioned before, the present value of the portfolio should be discounted by *r*, the risk-free interest rate

$$\Delta S - f = (\Delta Su - fu)e^{-rT}$$

$$f = \Delta S(1 - ue^{-rT}) + fu \qquad (equation\,9)$$

Δ can be replaced with *equation 8*, and the equation can be simplified to

$$f = e^{-rT}[pfu + (1-p)fd] \qquad (equation\,10)$$

Where : $p = \frac{e^{rT} - d}{u - d}$

This is binomial option price calculation procedure during one time period. In the multi-time period, most principles are also used, but the only difference is the starting points. Details of the option pricing in the multi-step are demonstrated in the chapter 4, the empirical study.

Chapter 3 Real Option Application to Investment under Uncertainty

As reviewed in the previous chapter, there are several investment valuation methods. In this chapter, the limits of the DCF are examined and some basic concepts of real options are addressed.

1. Limits of the existing methods

The DCF, up to now, has been the most frequently used investment valuation method. It was found, in a research, that an average of 86% of 424 large firms used the NPV in 1978 increasing from 19% in nearly two decades ago.[14)] This is because the concept of the technique is exactly apt to for the principle of corporate finance: maximizing shareholder's wealth. It implies that shareholder's wealth will increase or decrease as much as the calculated result.

However, the DCF techniques, the NPV or the IRR, have several drawbacks from internal or external factors

14) T. Copeland and V. Antikarov, *Real Option: a practitioner's guide*, Thomson Texere, 2003, pp28

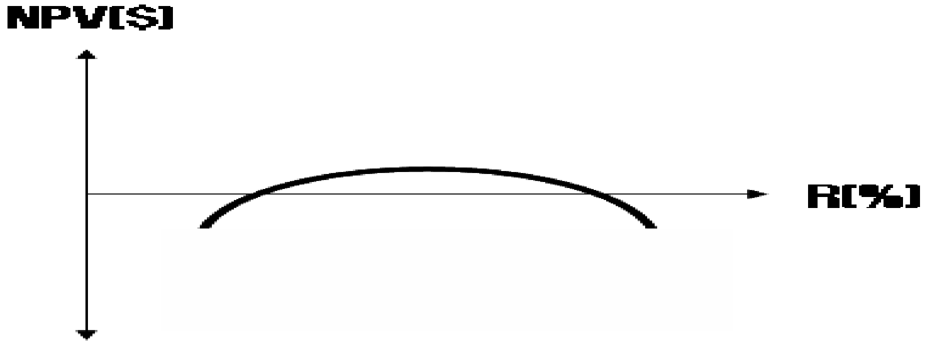
First, it fails to reflect the managerial flexibility in investment. As seen in the equation 1 in Chapter 2, decision makers have to depend on the expected future cashflows and discount rate "at the time of valuation" and assume that it will be "constant through time". Considering today's dynamic business conditions, the most basic principle of the method could be the most unrealistic assumption. Thus, it also fails to advise the management how to respond to risks.

Second, the DCF is not suitable for investment under uncertainty: with unpredictable cashflows and high risks. That is, setting the appropriate discount rate is very difficult task because the discount rate is the only parameter that reflects uncertainty. Thus, DCF tends to conservatively depreciate the project as volatility becomes high, i.e. it makes the discount rate up.

Third, the DCF has a serious problem of its own. The IRR, for example, can mislead investors when the cashflows are not conventional or when choosing the best one among multiple choices. In case of nonconventional[15] cashflows, the result is not one, but multiple; in case of mutually exclusive investment decisions, it has a chance to choose the one with the highest return, but not with the largest NPV.

15) Conventional cashflows means that the first cash flow is negative and all the rest are positive.

[Figure 2] IRR in multiple rates of return



2. Introduction of real option

1) General Concepts

In corporate finance, real option analysis(ROA) applies put option or call option valuation techniques to capital budgeting decisions. In other words, to be more faithful to the definiton of option, real option is the right, but not the obligation, to take an action(e.g., deferring, expanding, contracting, or abandoning) at a predetermined cost for a predetermined period of time.[16] Coined by Stewart C. Myers around 1977, ROA has been academically investigated as the alternative to the DCF.

Real options, as deducible from its terminology, borrows its basic concepts from financial options. Thus, the value of real options are also function of the value of the underlying risky asset(S), the exercise price(X), the time to expiration(T), the standard deviation of

16) op. cit. pp 5

the value of the underlying risky asset(σ), the risk-free rate(r_f), and the dividends(D).

[Table 1] Comparison between real options and financial options

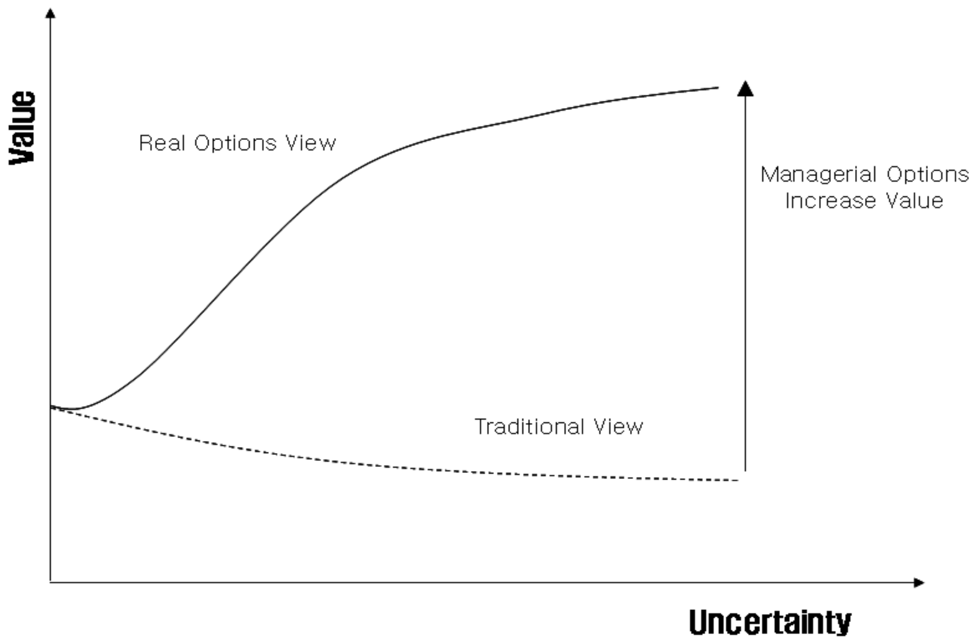
Real Options	*Parameter*	*Financial Options*
Expected NPV of Cashflows	S(+*)	Value of the Underlying Asset
Investment Cost	X(-*)	Exercise Price
Time to expire	T(+)	Time to expiration
Uncertainty about the NPV	σ(+)	Standard Deviation of the Underlying Asset
Risk-Free Rate	r_f(+)	Risk-Free Rate
Other Costs of opportunities	D(-)	Dividends

*'+' means positive; '-' means negative, and they are all in case of call option

** Copeland and Antikarov(2001)

One of the significant properties of the ROA is 180-degree attitude to uncertainty. Contrary to the traditional DCF, which decipreciate the value of the investment as much as volatility increase, the ROA tries to find and value managerial flexibility, i.e. embedded option, in the project. The figure below represents the two viewpoints.

[Figure 3] Real options view on uncertainty



Amram and Kulatilaka(1999)

2) Taxonomy of Real Options

Real options are classified by the type of flexibility that they offer.[17)]

17) op. cit. pp. 12.

[Table 2] Types of real options

Terminology	*Right Type*	*Option Type*
Deferral Option	right to delay the start of a project	American Call
Option to Abandon	right to abandon a project for	American Put
Option to Contract	right to sell a fraction of project	American Put
Option to Expand	right to scale up the project	American Call
Switching option	right to switch between two models	Conbination of American Call and Put

Copeland and Antikarov(2001)

In addition, there are also compound options, i.e. options on options and rainbow options on investment with multiple sources of uncertainty.

3. Analysis of Precedent Studies

Academical studies on real option had been carried out since early 1980s. Hayes(1980), Abernathy(1980), and Garvin(1982) pointed out that the DCF valuation neglected the value of strategic flexibility and proposed the need of new method.

Myers(1984), who coined the word 'Real Options', demonstrated four major limits of the DCF. He criticized that the DCF failed to link "Today's investments" to "Tomorrow's opportunities" and compared the ROA to "Bridging the gap between financial theory and corporate strategy"

Mcdonald and Siegel(1986), Majd and Pindyck(1987) presented the model to evaluate the options to defer. Trigeorgis and Mason(1987) demonstrated the merits of applying the decision tree analysis, one of real option pricing models, to real investments. Myers and Majd(1990) developed the model for assessing abandonment value using option pricing theory. Dixit and Pindyck(1995) asserted the need to apply financial option pricing models to investment valuations. Copeland and Antrikarov(2001) insisted that the binomial option pricing model is more apt for corporate finance practices than the Black-Scholes Model.

In addition, practical studies on applying real options are listed below.

[Table 3] Practical studies on real options

Authors	*Year*	*Field*
Brennan, Schwartz	1985	LNG Development
Kemna	1993	Oil Exploring
Micalizzi	1999	Pharmaceutical R&D
Benaroch, Kauffman	1999	IT Investment
Abadie	2006	Power Stantion Development

In the fields of shipping, port, and logistics, Tvedt(1997) calculated the value of VLCCs using real option analysis. Bendall(2003) applied real option approach to investment strategy of liner shipping. Sodal(2004) assessed the value of switching options for combination carriers. Pireira(2006) analyzed the optimal development timing for an international airport.

Chapter 4. Empirical Study

1. Shipping Investment Overview

To illustrate real option analysis of shipping investment, a fleet investment will be reviewed in this section.

1) Deal Specification

A shipping company is considering fleet expansion for future operation. The plan consists of 3-ULCS(Ultra Large Container Ship, 60,000dwt Class) purchase and 2-ULCS-option to purchase. Each vessel has 25 durable years including the building period. The first vessel will be delivered after 3 years from now on, and next delivery will take 1 year after each delivery.

The liner has an option purchase 1 or 2 more vessel of the same class until the delivery of the third ship. i.e. in 5 years. The shipbuilder gives the investor a favor of limiting the maximum price of each vessel to the current level.

2) Financing Conditions

The carrier can borrow 80% of the vessel price from banks and the interest rates for the lending is 6.5% of the outstanding balance.

3) Invest and Payback Plan

The capital, 20% of the vessel price, will be invested seperately: A quarter at the beginning, a quarter at the year 1, and the rest at the year 3.

The principle will be paid back by 7.5% of the total lending after delivery and the rest of the outstanding balance will be cleared after 11 years from delivery.

The overall capital plan of the project is illustrated as below:

[Table 4] Overall Capital Plan of the Project

Year	***0***	***1***	***2***	***3***	***4***	***5***	***6***	***7***	**····**
Vessel 1				***Delivery***					
- Capital Invest[1)]	5%		5%	10%					
- Debt Invest[2)]	16%	16%		32%	16%				
- Debt Payback[3)]					7.5%	7.5%	7.5%	7.5%	····
Vessel 2					***Delivery***				
- Capital Invest		5%		5%	10%				
- Debt Invest		16%	16%		32%	16%			
- Debt Payback						7.5%	7.5%	7.5%	····
Vessel 3						***Delivery***			
- Capital Invest			5%		5%	10%			
- Debt Invest			16%	16%		32%	16%		
- Debt Payback							7.5%	7.5%	····

1) percentage of the vessel price

2) percentage of the vessel price

3) percentage of the total lending for a vessel

2. Investment Valuation by NPV

To assess the net present value of the project, cashflow analysis should be done first. Cashflows of the investment consists of cash inflows and cash outflows. In this investment, there are only one cash inflow: freight income. Cash outflows are cargo handling variable costs, operation variable costs, operation fixed costs, administration costs, taxes, interests, payback of the principal, and other sales and purchase costs.

1) Cash Inflows

Each vessel has freight incomes during the life. Incomes depend on market conditions that are three cases: the best, moderate, and the worst. In the best case, revenue per TEU is USD 1,500 with loading factor of 80%; in the moderate case, revenue per TEU is USD 1,300 with loading factor of 70%; and, in the worst case, revenue per TEU is USD 1,100 with loading factor of 60%.

[Table 5] Annual Freight Incomes of Each Vessel

(unit : USD 1 million)

Year		*4*	*5*	*6*	*7*	···	*21*	*22*	*23*	*24*	*25*	*26*	*27*
Vessel 1	Best	239	239	239	239	···	239	239	239	239	239	-	-
	Moderate	182	182	182	182	···	182	182	182	182	182	-	-
	Worst	132	132	132	132	···	132	132	132	132	132	-	-
Vessel 2	Best	-	239	239	239	···	239	239	239	239	239	239	-
	Moderate	-	182	182	182	···	182	182	182	182	182	182	-
	Worst	-	132	132	132	···	132	132	132	132	132	132	-
Vessel 3	Best	-	-	239	239	···	239	239	239	239	239	239	239
	Moderate	-	-	182	182	···	182	182	182	182	182	182	182
	Worst	-	-	132	132	···	132	132	132	132	132	132	132

* 21 rounds of voyage in a year

2) Cash Outflows

(1) Cargo Handling Variable Costs

Cargo handling variable costs are composed of costs of charging and discharging, delivery, and agent fees.

① *Charging and Discharging*

This is the result of multiplication of the unit price, rounds of voyage, loading factor. It is assumed that the cost will increase by 1% a year.

② ***Delivery***

This is also the result of multiplication of the unit price, rounds of voyage, loading factor. It is assumed that the cost will increase by 1% a year.

③ ***Agnet Fees***

This is the predetermined portion of annual freight incomes. The liner gives its agent 2% of the income.

(2) Operation Variable Costs

Operation variable costs consists of port charges and fuel costs.

① ***Port Charges***

This is the multiplication of the annual average port charges and the number of voyages.

② ***Fuel Costs***

This the function of the fuel price per ton, daily consumption, and the number of operating days.

(3) Operation Fixed Costs

① ***Manning***

This is the multiplication of the number of crews and annual average costs of crewing. This cost is assumed to increase by 3% a year.

② ***Maintenance***

This is the average annual costs for maintenance of the hull and its equipment. This is assumed to increase by 1% a year.

(4) Administration

This is 4.5% of auunal average freight incomes.

(5) Taxes

Thanks to the tonnage tax system, it is fixed at the level of USD 36,000 per year, regardless of the earning before interest and taxes.

(6) Capital Costs

For debt, its interest rate is 6.5% and for capital, the required rate of return is 15%.

(7) Other Costs

In this part, there are brokerage, and other commissions.

[Table 6] Cash Outflows In Moderate Case

(unit : USD 1,000)

Year	Cargo Handling Variable Costs	Operation Variable Costs	Operation Fixed Costs	Administration	Taxes	Capital Costs	Other Costs
0	0	0	0	0	0	8,642	3,000
1	0	0	0	0	0	18,676	3,000
2	0	0	0	0	0	21,460	3,000
3	0	0	0	0	0	32,886	0
4	120,937	14,448	2,560	8,170	36	38,527	0
5	244,220	28,949	5,243	16,339	72	50,852	0
6	369,884	43,502	8,055	24,509	108	45,327	0
7	373,474	43,661	8,250	24,509	108	43,631	0
8	377,100	43,822	8,450	24,509	108	41,934	0
9	380,762	43,984	8,656	24,509	108	40,238	0
10	384,461	44,148	8,868	24,509	108	38,541	0
11	388,196	44,313	9,086	24,509	108	36,845	0
12	391,969	44,481	9,309	24,509	108	35,148	0
13	395,780	44,650	9,539	24,509	108	33,452	0
14	399,629	44,820	9,776	24,509	108	31,755	0
15	403,516	44,992	10,019	24,509	108	40,905	0
16	407,442	45,166	10,268	24,509	108	30,320	0
17	411,408	45,342	10,525	24,509	108	20,300	0
18	415,413	45,520	10,789	24,509	108	0	0
19	419,459	45,699	11,060	24,509	108	0	0
20	423,544	45,880	11,339	24,509	108	0	0
21	427,671	46,063	11,626	24,509	108	0	0
22	431,839	46,247	11,920	24,509	108	0	0
23	436,048	46,434	12,223	24,509	108	0	0
24	440,300	46,622	12,535	24,509	108	0	0
25	444,594	46,813	12,855	24,509	108	0	0
26	299,287	31,272	8,790	16,339	72	0	0
27	151,104	15,668	4,508	8,170	36	0	0

3) Weighted Average Cost of Capital

To calculate the compnay's cost of capital, capital structure analysis should be done first. This project, if apart from other cashflows of the compnay, has 20% of equity and 80% of debt. The equation to calculate the Weighted Average Cost of Capital(WACC) is

$$WACC = \frac{E}{V} \times R_E + \frac{D}{V} \times R_D(1-t) \qquad (equation\,11)$$

Where : E = market value of the equity

D = market value of the debt

V = combined market valud of the equity and the debt

R_E = required rate of return of the capital

R_D = interest rate of the debt

t = corporate tax rate

In this investment, as mentioned before, the tax effect of the debt can be ignored thanks to the tonnage tax system.

As a result, the WACC of the project is 8.20%.

4) Summary

Now, all the pieces of information necessary to calculate the net present value of the investment. The NPV is USD 983,229,274 in the best case; USD 194,184,049 in the moderate case; and USD -431,100,595 in the worst case.

3. Investment Valuation by Real Option Analysis

1) Four-Step Process for Valuing Real Options

[Figure 4] shows the four-step process for valuing real options arranged by Copeland and Antikarov.

[Figure 4] The four-step process of valuing real options

	Step 1	Step 2	Step 3	Step 4
	Compute base case Present value without Flexibility using DCF Valuation model	**Model the Uncertainty using event trees**	**Identify and Incorporate managerial Flexibilities creating a Decision tree**	**Conduct Real Options Analysis (ROA)**
Objectives	Compute base case present value without Flexibility at t=0	Understand how the present value develops over time	Analyze the event tree to identify and Incorporate managerial flexibility to respond to new information	Value the total project using a simple algebraic methodology and an Excel spreadsheet.
Comments	Traditional present value without flexibility	Still no flexibility; this value should equal the value from Step 1. Estimate uncertaint using either historica data or management estimates as input	Flexibility is incorporated into event trees, which transforms them into decision trees. The flexibility has altered the risk characteristics of the project, therefore, the cost of capital has changed	ROA will include the base case present value without flexibility plus the option (flexibility) value. Under high uncertainty and managerial flexibility, option value will be substantial.

Copeland and Antikarov(2001)

The first step is to calculate the net present value of the project using traditional methods. The result, without saying, has no value of flexibility.

The second step is to build an event tree of the project. The tree visually and systematically shows the uncertainty that drives the volatility of the underlying asset during the project life. There are two types of assumption of uncertainty. One is the consolidated approach, which assumes that the multiple uncertainties can be combined; the other is the separated approach, where two or more sources of uncertainty must be estimated separately. In most case, except the cases that decisions depend on a particular uncertainty, the consolidated approach is more frequently used.

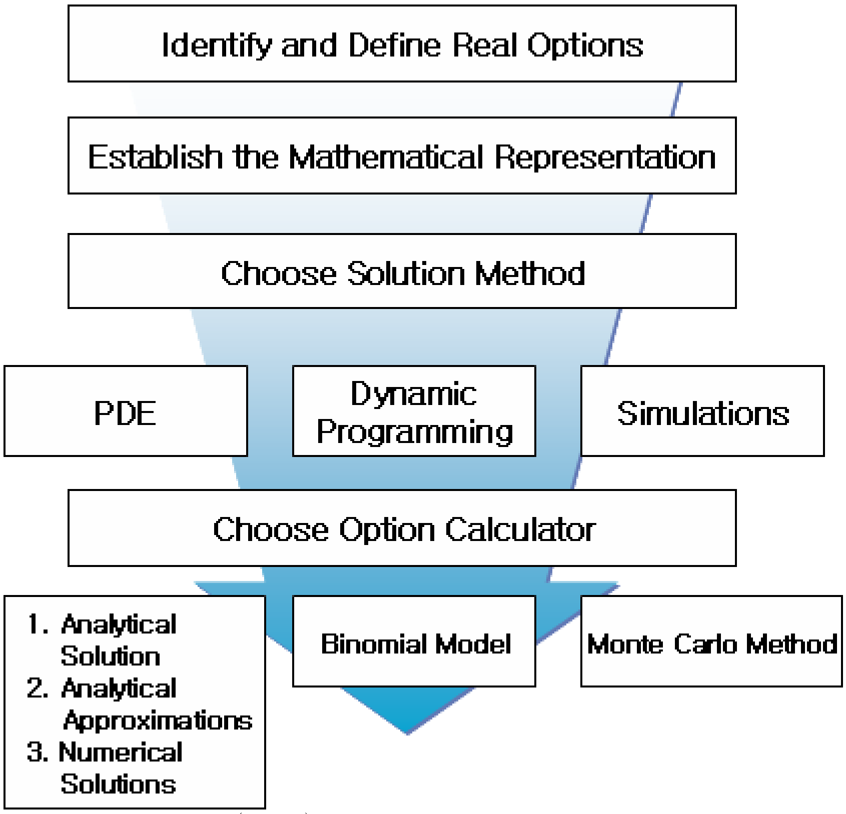
The third step is to turn the event tree into a decision tree by putting management decisions into the nodes. While the event tree shows the possible values of the underlying asset may go through, the decision tree does the payoffs from optimal decisions.

The fourth step is to conduct the real option analysis and to value the total project. The result is combined values of the net present value without flexibility and the payoffs of the real option in the project.

2) Types of Option Calculator

There are three kinds of option calculator: the partial differential equation(PDE), the dynamic programming, and the simulations. However, it does not matter which method to be used if the model can accurately reflect every business contingency in the project; if it can, all the results from the three equations are same.

[Figure 5] Flow chart of ROA method



Amram, and Kulatilaka(1999)

The PDE approach uses a partial differential equation and boundary conditions to mathematically express the option value and its dynamics. It is based on the Black-Scholes equation for the European call option without dividend.

The Dynamic programming rolls out every possible values of the underlying asste(rolling forward process), and then, finds optimal decisions in the future by tracking back from the final nodes of the decision tree(recursive backward iteration).

The simulation models rolls out a huge number of possible paths of evolution of the underlying asset to the maturity of the options. The option value is expressed by averaging the payoffs discounted to the present.

3) Real Option Analysis of the Fleet Investment

The shipping company has 6 options in this investment: an option to abandon the project, options to shrink the investment(1 or 2 vessels), options to expand the investment(1 or 2 vessels), and an option of combination. In this paper, the Binomial Option Pricing Model will be used as an option calculator. Considering the feature of this investment i.e. exercising before maturity, option pricing model for american one is more suitable than others, and the binomial model has more flexibility in its application.

(1) Parameters

Before valuing the options, several parameters should be proposed. The parameters are the volatility , the upward movement, and the downward movement of the underlying asset, and risk-free rate.

① *Volatility of the Underlying Asset*

In this paper, the standard deviation of the Howe Robinson Container Index from January 2000 to April 2008 is used as the volatility(σ) of the underlying asset. Its volatility is 423.3, or 37.34% of the average.

[Figure 6] Howe Robinson Container Index

② ***Upward and Downward Movement of the Underlying Asset***[18)]

Cox, Ross, and Rubinstein(1979) proposed the value of the upward(u) and downward(d) movement of the underlying asset to match the volatility of it. The solution they proposed is

$$u = e^{\sigma\sqrt{\Delta t}}, \quad d = e^{-\sigma\sqrt{\Delta t}}$$

③ ***Risk-Free Rate***

In this paper, the average interest rate of the government bond with 3-year maturity for the last ten years is used as the risk-free rate.

18) op. cit. pp. 253.

(2) Marketed Asset Disclaimer[19)]

The binomial option pricing model uses the replicating portfolio approach or the twin security approach. To value the option price, it artificially makes the replicating portfolio consisting of Δ units of underlying asset and options. In financial options, it is possible to find the twin security whose payoffs are perfectly correlated with the underlying asset, however, in real option it is almost impossible. Copeland and Antikarov asserts that the net present value of the project without flexibility is the best unbiased estimate of the market value of the project were it a traded asset. This assumption is called "Marketed Asset Disclaimer". In this paper, the net present value of the fleet will be used the twin securiy of the project.

(3) Structuring the Binomial Tree

By rolling forward process, the binomial tree of the project is as shown below

19) op. cit. pp. 94.

[Table 7] Movements of the Underlying Asset

(unit : USD 1,000)

Year	0	1	2	3	4	5	6
	S_0	uS_0	u^2S_0	u^3S_0	u^4S_0	u^5S_0	u^6S_0
	194,184	282,084	409,774	595,265	864,721	1,256,150	1,824,765
		dS_0	duS_0	du^2S_0	du^3S_0	du^4S_0	du^5S_0
		133,674	194,184	282,084	409,774	595,265	864,721
			d^2S_0	d^2uS_0	$d^2u^2S_0$	$d^2u^3S_0$	$d^2u^4S_0$
			92,020	133,674	194,184	282,084	409,774
				d^3S_0	d^3uS_0	$d^3u^2S_0$	$d^3u^3S_0$
				63,346	92,020	133,674	194,184
					d^4S_0	d^4uS_0	$d^4u^2S_0$
					43,607	63,346	92,020
						d^5S_0	d^5uS_0
						30,018	43,607
							d^6S_0
							20,664

(4) Option to Abandon

During the project life, the carrier has an option to abandon the project if market conditions are not favorable. If they decide to dispose the vessels, the management can get 40% of the fleet price(I ∗ 0.4).

This is a typical american put option. The exercise price of the option is 40% of the fleet price. If $d^{6-i}u^iP$ denotes the values of the options at nodes of the binomial tree at year 6, the option prices are

$$Max[0, I\times 0.4 - d^{6-i}u^iS_0]$$

$$(i = 0, 1, 2, 3, 4, 5, 6)$$

By recursive backward iteration, the values of the options at nodes at year t are

$$Max[(p\times d^{t-i}u^{i+1}P + (1-p)d^{t-i+1}u^iP)e^{-rt}, I\times 0.4 - d^{t-i}u^iS_0]$$

$$(i = 0, 1, 2, 3, 4, 5,\ \ t = 0, 1, 2, 3, 4, 5,\ \ t \geq i)$$

The process of the option value is as below

[Table 8] Option to Abandon the Project

(unit : USD 1,000)

Year	0	1	2	3	4	5	6
Option Value	34,332	17,748	4,961	-	-	-	-
Decision		Go	Go	Go	Go	Go	Go
Option Value		53,913	29,235	10,002	-	-	-
Decision		Go	Go	Go	Go	Go	Go
Option Value			81,980	49,802	20,166	-	-
Decision			Abandon	Go	Go	Go	Go
Option Value				110,654	81,980	40,660	-
Decision				Abandon	Abandon	Go	Go
Option Value					130,393	110,654	81,980
Decision					Abandon	Abandon	Abandon
Option Value						143,982	130,393
Decision						Abandon	Abandon
Option Value							153,336
Decision							Abandon

(5) Option to Shrink

During the project life, the carrier has options to contract the project if market conditions are not favorable. If the option to abandon 1 vessel is exercised, the value of the project will decrease by a third and there will be some cash inflow by the amount of 40% of the vessel price; if the option to abandon 2 vessels is exercised, the value of the project will decrease by two thirds and there will be some cash inflow by the amount of 40% of the two-vessel price. The option to shrink is a kind of american put option with the exercise price of $d^{t-i}u^iS_0 \times \frac{2}{3} + I \times \frac{1}{3} \times 0.4$.(in the case of abandoning 1 vessel)

The values of options at the nodes of the binomial tree when t=6 are

$$Max[0, d^{6-i}u^iS_0 \times \frac{2}{3} + I \times \frac{1}{3} \times 0.4 - d^{6-i}u^iS_0]$$

$$(i = 0, 1, 2, 3, 4, 5, 6)$$

And the values of options at the other nodes are

$$Max[(p \times d^{t-i}u^{i+1}P + (1-p)d^{t-i+1}u^iP)e^{-rt},\ \frac{1}{3}(I \times 0.4 - d^{t-i}u^iS_0)]$$

$$(i = 0, 1, 2, 3, 4, 5,\ t = 0, 1, 2, 3, 4, 5,\ t \geq i)$$

Option values are as shown

[Table 9] Option to Abandon 1 Vessel

(unit : USD 1,000)

Year	0	1	2	3	4	5	6
Option Value	11,444	5,583	1,654	-	-	-	-
Decision		Go	Go	Go	Go	Go	Go
Option Value		17,971	9,745	3,334	-	-	-
Decision		Go	Go	Go	Go	Go	Go
Option Value			27,327	16,601	6,722	-	-
Decision			Shrink	Go	Go	Go	Go
Option Value				36,885	27,327	13,553	-
Decision				Shrink	Shrink	Go	Go
Option Value					43,464	36,885	27,327
Decision					Shrink	Shrink	Shrink
Option Value						47,994	43,464
Decision						Shrink	Shrink
Option Value							51,111
Decision							Shrink

[Table 10] Option to Abandon 2 Vessels

(unit : USD 1,000)

Year	0	1	2	3	4	5	6
Option Value	22,888	11,166	3,307	-	-	-	
Decision		Go	Go	Go	Go	Go	Go
Option Value		35,942	19,490	6,668	-	-	-
Decision		Go	Go	Go	Go	Go	Go
Option Value			54,653	33,201	13,444	-	-
Decision			Shrink	Go	Go	Go	Go
Option Value				73,770	54,653	27,106	-
Decision				Shrink	Shrink	Go	Go
Option Value					86,929	73,770	54,653
Decision					Shrink	Shrink	Shrink
Option Value						95,988	86,929
Decision						Shrink	Shrink
Option Value							102,224
Decision							Shrink

(6) Option to Expand

The options to expand are inherent in the project. The management can decide purchase 1 or 2 more vessels when market conditions are favorable. If the option to purchase 1 more vessel is exercised, the value of project will be increase by 20% for the price of one vessel; if the option to purchase 2 more vessel is exercised, the value of the project will be increase by 40% for the price of two vessels. The option to expand is a kind of american call option with exercise price of $d^{t-i}u^i S_0 \times \frac{6}{5} - I \times \frac{1}{3}$ (in the case of purchasing 1 more vessel).

The values of options at the nodes of the binomial tree when t=6 are

$$Max[0, d^{6-i}u^i S_0 \times \frac{6}{5} - I \times \frac{1}{3} - d^{6-i}u^i S_0]$$

$$(i = 0, 1, 2, 3, 4, 5, 6)$$

And the values of options at the other nodes are

$$Max[(p \times d^{t-i}u^{i+1}C + (1-p)d^{t-i+1}u^i C)e^{-rt}, d^{t-i}u^i S_0 \times \frac{1}{5} - I \times \frac{1}{3}]$$

$$(i = 0, 1, 2, 3, 4, 5, \ t = 0, 1, 2, 3, 4, 5, \ t \geq i)$$

Option values are as shown

[Table 11] Option to Purchase 1 more Vessel

(unit : USD 1,000)

Year	0	1	2	3	4	5	6
Option Value	3,502	7,140	14,458	29,041	57,775	113,577	219,953
Decision		Go	Go	Go	Go	Go	Expand
Option Value		535	1,180	2,604	5,743	12,669	27,944
Decision		Go	Go	Go	Go	Go	Expand
Option Value			-	-	-	-	
Decision			Go	Go	Go	Go	Go
Option Value				-	-	-	-
Decision				Go	Go	Go	Go
Option Value					-	-	-
Decision					Go	Go	Go
Option Value						-	-
Decision						Go	Go
Option Value							-
Decision							Go

[Table 12] Option to Purchase 2 more Vessels

(unit : USD 1,000)

Year	0	1	2	3	4	5	6
Option Value	7,005	14,280	28,915	58,083	115,549	227,154	439,906
Decision		Go	Go	Go	Go	Go	Expand
Option Value		1,070	2,361	5,208	11,487	25,337	55,888
Decision		Go	Go	Go	Go	Go	Expand
Option Value			-	-	-	-	-
Decision			Go	Go	Go	Go	Go
Option Value				-	-	-	-
Decision				Go	Go	Go	Go
Option Value					-	-	-
Decision					Go	Go	Go
Option Value						-	-
Decision						Go	Go
Option Value							-
Decision							Go

(7) Combination Option

In business practice, it is more possible to assume that a project allows any of simple options, such as options to abandon, options to shrink, and options to expnad to be exercised at each node of the binomial tree. In this project there are up to five simple real options: an option to abandon the project, an option to shrink(1 vessel), an option to shrink(2 vessels), an option to expand(1 more vessel), an option to expand(2 more vessels). The movements of the underlying asset remains the same as before, and the option values at the nodes when t=6 is,

$$
\begin{array}{ll}
Max\,[0, & \text{-- not exercised} \\
\quad I \times 0.4 - d^{6-i}u^iS_0, & \text{-- option to abandon} \\
\quad d^{6-i}u^iS_0 \times \frac{2}{3} + I \times \frac{1}{3} \times 0.4 - d^{6-i}u^iS_0, & \text{-- option to abandon 1 vessel} \\
\quad d^{6-i}u^iS_0 \times \frac{1}{3} + I \times \frac{2}{3} \times 0.4 - d^{6-i}u^iS_0, & \text{-- option to abandon 2 vessels} \\
\quad d^{6-i}u^iS_0 \times \frac{6}{5} - I \times \frac{1}{3} - d^{6-i}u^iS_0, & \text{-- option to purchase 1 more vessel} \\
\quad d^{6-i}u^iS_0 \times \frac{7}{5} - I \times \frac{2}{3} - d^{6-i}u^iS_0] & \text{-- option to purchase 2 more vessels}
\end{array}
$$

$(i = 0, 1, 2, 3, 4, 5, 6)$

And the values of options at the other nodes are

$$Max[(p\times d^{t-i}u^iP+(1-p)d^{t-i+1}u^iP)e^{-rt},$$
$$I\times 0.4-d^{t-i}u^iS_0,$$
$$d^{t-i}u^iS_0\times\frac{2}{3}+I\times\frac{1}{3}\times 0.4-d^{t-i}u^iS_0,$$
$$d^{t-i}u^iS_0\times\frac{1}{3}+I\times\frac{2}{3}\times 0.4-d^{t-i}u^iS_0,$$
$$d^{t-i}u^iS_0\times\frac{6}{5}-I\times\frac{1}{3}-d^{t-i}u^iS_0,$$
$$d^{t-i}u^iS_0\times\frac{7}{5}+I\times\frac{2}{3}-d^{t-i}u^iS_0]$$

$$(i=0,1,2,3,4,5,\ t=0,1,2,3,4,5,\ t\geq i)$$

The values of combination option are as follows

[Table 13] Combination Option

(unit : USD 1,000)

Year	0	1	2	3	4	5	6
Option Value	41,337	31,028	33,876	58,083	115,549	227,154	439,906
Decision		Go	Go	Go	Go	Go	Expand 2 vessels
Option Value		54,984	31,596	15,209	11,487	25,337	55,888
Decision		Go	Go	Go	Go	Go	Expand 2 vessels
Option Value			81,980	49,802	20,166	-	-
Decision			Abandon	Go	Go	Go	Go
Option Value				110,654	81,980	40,660	-
Decision				Abandon	Abandon	Go	Go
Option Value					130,393	110,654	87,980
Decision					Abandon	Abandon	Abandon
Option Value						143,982	130,393
Decision						Abandon	Abandon
Option Value							153,336
Decision							Abandon

Chapter 5. Conclusion

1. Summary and Implications of Study

In this paper, a new viewpoint to capital investment has been presented. Contrary to traditional manners, the ROA, the new method, not only captures new business opportunities incorporated in the investment, but mathematically calculates the value of managerial flexibility. Through the existing DCF methods, in spite of the support of the sensitivity analysis, or the scenario model, that additional value cannot be reflected. Moreover, considering very explosive movements of the shipping market, it is not appropriate for investors to assume that important variables, such as freight incomes or operating costs, will not deviate from the expected cashflows.

The empirical study indicates that the ROA is more opt for valuation of the projects with uncertainty than the DCF, because it reflects the managerial flexibility. The result from the ROA is never lower than that of the DCF. It has something to do with the payoff of options: it is the right to act, not the obligation. Some, however, criticizes the ROA for the reason that option value is always positive and the ROA can be misused to justify projects that should be rejected. In answer to such critics, Copeland and Antikarov explain two reasons: first, the NPV cannot recognize the value of flexibility, thus it systematically undervalues everything. Second, the price for flexibility that is always positive, often exceeds its value.

The ultimate purpose of the ROA is not how to calculate the value of the option inherent in the investment, but how to gain insight into the investments, that is, a new way of looking at uncertainty adverse to traditional manners. Harmonized with the NPV, the ROA can give investors more accurate information and prevent them from abandoning the investments with huge potentials.

2. Recommendations for Future Studies

The ROA has been discussed as the alternate valuation method to the traditional DCF. It, however, also has some shortcomings.

First, even though it can captures managerial flexibility in the investment that the DCF fails to, its starting point is still the NPV. It regards the net present value of the project as the underlying asset of the option. Although it eliminates arbitrage opportunities by applying the Marketed Asset Disclaimer(MAD) assumption which forms replicating portfolios with the net present value of the project without flexibility and options, the MAD's validity is still controversial.

Second, in the ROA, it is still a tough job to estimate the cashflows, especially cash inflows, of the project. Cash outflows are also variable, but historical data in shipping industry imply that the change of cash inflows is much more volatile than that of cash outflows.

Third, in this paper, setting the exercise prices of each option is more or less artificial. In the case of the option to expand, the exercise price is the additional value of operational expansion minus that of additional investment; in the case of the option to abandon or shrink, the exercise price is the continuing or salvage value of the project or the vessel minus losses of operational shrink. Those have something to do with estimating future cashflows.

Last, but not least, there is the matter of volatility of the underlying asset. This is the most arguable matter in the ROA like the discount rate in the DCF. However, contrary to other fields such as research and development, venture investment, and so on, there are fortunately a lot of historical data in the shipping industry. Some more studies can produce solutions to it.

In this paper, the empirical study illustrates the fleet expansion plan of a particular liner company. Considering option's attribute that it has more value as the movement of the underlying asset becomes more volatile, the ROA can develop more interesting implications in the tramper shipping.

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감사의 글

2년이라는 시간이 참으로 빨리 흘러간 것 같습니다. 제가 79년생으로 올해 서른이 되었으니, 20대에 시작해서 30대가 되어서 석사과정의 마침표를 찍었습니다. 10년 아닌 10년이라는 시간 동안의 미약하지만 소중한 결실을 이제야 내놓습니다. 논문이 나오기까지의 과정 중 제 몫은 1할 정도라고 해도 너무 많은 것 같고, 대부분은 많은 가르침과 격려를 주신 선후배님들의 몫이라고 생각합니다.

학부 때부터 많은 가르침을 주시며, 때론 친한 선배처럼 지금까지 잘 이끌어주신 류동근 교수님, 논문 심사과정에서 많은 지도를 해주신 조성철 교수님, 이기환 교수님, 그리고 학위과정 동안 많은 격려를 주신 신한원 교수님, 안기명 교수님, 신용존 교수님, 장명희 교수님, 유성진 교수님께 감사드립니다.

별다른 비전 없이 시간을 보내던 저를 학문의 길로 인도해주신 김성봉 어학원 김성봉 원장님, 해운이라는 분야에 대해서 새로운 눈을 뜨게 해주신 세동양행 김재승 대표이사님께도 깊은 감사를 드립니다.

학과선배로서, 회사상사로서 항상 많은 지도와 격려를 주시는 한국무역협회 허문구 박사님, 갓 상경한 촌놈의 사회생활에 멘토가 되어주신 건국대학교 박광서 교수님, 국방부 송용섭 박사님, 생업에 바쁜 와중에도 논문작성을 위해 매주말을 같이 보냈던 한진SM 김재관 부장님, 대한통운 이인찬 부장님, 인천항만공사 김성철 과장님, 연구실의 보라, 동희, 민정, 철화 그리고 대학원 원우님들께도 감사의 말씀을 올립니다.

능력이 부족하여 학위과정 내내 정신없이 보내는 저를 이해해주시며, 대부분의 경조사에 불참해도 넉넉히 이해해주신 한국무역협회 임직원들과 영재, 철윤, 성준, 승우, 정한, 정환, 우현, 의갑 등 벗들에게는 용서를 빌어야겠습니다.

막내아들이 언제쯤 철들지 걱정하시지만 항상 저를 믿어주시는 부모님, 항상 내 편이 되어주는 큰누나, 작은누나, 자형, 그리고 무럭무럭 자라나는 조카 건우에게도 이제는 가족의 일원으로서 제 할 일을 하겠다고 다짐을 해봅니다.

끝으로, 학문의 동반자이자 인생의 동반자가 되어줄 한국해양대학교 신영란 박사님께 이제는 '앞으로 잘하겠다'가 아니라 '지금부터 잘하겠다'고 약속드립니다.