Firm Valuation By Using Real Options:Empirical Evidence For Selected Firms In Turkey

A Thesis
by

UMUT TURAN
105664005

ISTANBUL BILGI UNIVERSITY
INSTITUTE OF SOCIAL SCIENCES
MSc in INTERNATIONAL FINANCE

Advisor: OKAN AYBAR

May 2008

Firm Valuation By Using Real Options:Empirical Evidence For Selected Firms In Turkey

Umut Turan
105664005

Tez Danışmanının Adı Soyadı (İMZASI) : ....
Jüri Üyelerinin Adı Soyadı (İMZASI) : ....
Jüri Üyelerinin Adı Soyadı (İMZASI) : ....

Tezin Onaylandığı Tarih : ....

Toplam Sayfa Sayısı:

Anahtar Kelimeler (Türkçe)
1) Gerçek Opsiyonlar
2) Değerleme
3) Belirsizlik
4) Esneklik
5) Yatırım

Anahtar Kelimeler (İngilizce)
1) Real Options
2) Valuation
3) Uncertainty
4) Flexibility
5) Investment

ABSTRACT

The specific goal of this dissertation is to provide evidence that when uncertainty about the future cash flow is high, the real option valuation gives more accurate result because of its risk neutral valuation. Thus, increases the value o the project and the firm. Real options are investments in real assets that give firms the right, but not the obligation, to undertake some future specified action, and they provide firms the twin organizational benefits of containing downside risk as well as capturing upside opportunities. The dissertation consists of two examples that aim to test real options theory in the firm valuation. I use real option analysis approach for Sinpas' Halkali project and, Reysas's vehicle inspection project. Both of the firm is listed on Istanbul Stock Exchange (ISE).

DEDICATION

Dedicated to my parents

ACKNOWLEDGEMENTS

I would like to express my sincere appreciation to my dissertation advisor, Okan Aybar, for his insightful guidance and support throughout the process of developing and presenting my thoughts on this topic. The insight and experience was greatly appreciated. I would like to thank Prof.Dr.Oral Erdoğan and Yrd.Doç.Dr. Cenktan Özyıldırım for their participation in making this research endeavor.

TABLES OF CONTENTS

Page

LIST OF TABLES

LIST OF FIGURES

1. INTRODUCTION

Net present value and discounted cash flow methods are a kind of blocks for financial analysis. NPV is simply the present value of the cash inflows less the present value of the cash outflows. If the NPV is greater than or equal to zero, the project is acceptable. The primary difficulty of NPV analysis is discerning the appropriate discount rate for the project.

Real option analysis evaluates the cash flows of a project assuming that particular future events can be avoided. Since these future events can be avoided, the value of the project has option-like characteristics and can be valued using an option pricing formula. Many option-pricing formulas take advantage of being able to price in a risk-neutral framework. Most of the real option applications benefits from a risk-neutral framework. Risk-neutral framework creates the appearance that real option analysis is different from net present value analysis.

Section one consists the literature review of real options. Section two defines the traditional valuation tools. Comparison of the real options to DCF valuation model, and decision tree process is explained in section three. Section four includes explanation of the option valuation methods, B&S and Binomial Lattice, for real options. Lastly, section five shows the application of real options on two selected firms.

1.1 Literature Review

Real options theory is emerging in the field of strategic management (Adner & Levinthal, 2004; McGrath, Ferrier, & Mendelow, 2004). Behind this, the practical concern that strategic investment decisions are often made under uncertainty (Dixit & Pindyck, 1994). The broader objective of this dissertation is therefore to improve existing understanding of real options theory's applications in the domain of corporate strategy.

According to Ford et al (2002), if future conditions are uncertain and changing the strategy later incurs substantial costs, then having flexible strategies and delaying decisions can increase project value when compared to making all key strategic decisions early in the project. The project manager is the option holder. Project managers must therefore focus on managing uncertainty in order to add to project value.

The theory's organizational implications are that real options investments confer the investing firm the twin benefits of reducing downside risk and claiming upside opportunities (Bowman & Hurry, 1993; McGrath, 1997, 1999). Indeed, in McGrath's (1997) words, "the distinguishing characteristic of an options approach lies in firms making investments that confer the ability to select an outcome only if it is favorable"

According to Trigeorgis (1996), just as corporate liabilities can be viewed as collections of call or put options on the value of the firm. Real investment opportunities can be seen as collections of similar real call and put options on the value of the project. And just as option-based valuation can be useful in quantifying the value of flexibility in financial instruments, so can it be useful in quantifying the value of operating flexibility and strategic adaptability implicit in real opportunities. Flexibility can be viewed as the collection of options associated with an opportunity, be the asset financial or real.

According to Amaram and Kutilalka, an option is the right, but not the obligation, to take an action in the future and a real option is a right without an obligation to take specific future actions depending on how uncertain conditions evolve on a real asset. Options are valuable because they provide flexibility. Non-paper assets are called real assets and options in real assets are called real options.

Myers (1977) first coined the term real options to refer to a firm's future investment, or growth opportunities. These growth opportunities can be viewed as real options because their value ultimately depends on the firm's discretion to invest in the future, and whether or not the firm will actually choose to make these investments is contingent on the future states of the world.

There is close analogy between real options and financial options (Kester, 1984; Bowman & Hurry, 1993; Kogut & Kulatilaka, 2001). Real options are real because the investments are in real (physical or human) assets, as opposed to financial assets in the case of financial options. Real options are options because like financial options, once invested, they confer the firm the right, but not the obligation, to undertake some future specified action.

2. TRADITIONAL PROJECT VALUATION

The aim of the project valuation is not only the evaluate the project with its merit. Sometimes it’s important to compare the project that how it stacks up against to other projects. Today’s firm are using portfolio approach to maximize their returns. The project portfolio is designed for maximizing the value of the firm. Portfolio can be maximize by assessment, prioritization, selection, tarcking, and accomplishment of projects based on strategic golas of the organization.

Funnel and Filter model represents the portfolio of each projects. Each projects end-to-end life cycle is characterized by assesment, development,and production phases.

In the assesment phase, project ideas are initiated and evaluate with is own merit. Each projects compare with other competing ideas. The ideas go through a filter, which is used for selecting the beneficial’s and reject those that are not. The selected ideas becomes suitable projects and enter the next phase. This phase is the development phase. The objective of the development phase is to develop the target project. In this phase, there are extra filters that ease management’s decision. This decision can be abandon, expend, contract, or continue the project at the planned stage. The end of the this phase is marked by launch of the project.

In the third and last phase, if the project results in a product, it will be supported. At the end of the production phase, if a product becomes obsolete, it’s no longer supported by organization. So product retires from its life cycle. If a product is considered for improvement to take a new form, or expanded and contracted, it is identified as a new project idea and goes through a new life cycle starting at the top of funnel.

Project valuation is the most important part of the selection process. In a broad sense, the project value is the net difference between the project revenues and cost over its entire life cycle. If the project's cash inflow during the production phase are higher than the investment cost , the project is considered as worthy of investment. There is so many tool that are available for calculating the value of the investment. The quality of the valuation is related to the validity of the tools and how effectively they include the three important factor.

i-Cash flow streams through the entire project life.

ii- Discount rate used to discount the future cash flows to account for their uncertainty.

iii- Avalilability of management's contingent decisions to change the course of the project.

2.1 The Investment Problem

Firms continually invest funds in assets and these assets produce income and cash flows that the firms can then either reinvest in more assets or pay to the owners. These assets represent the firm's capital. Capital is the firm's total assets. It includes all tangible and intangible assets. These assets include physical assets (such as land, buildings, equipment, and machinery), as well as assets that represent property rights (such as accounts receivable, securities, patents, copyrights). Capital investment contains the firm's investment in its assets.

2.2 Investment Decision and Owners' Wealth Decision

Company must evaluate a number of factors in making investment decisions. Not only does the financial manager need to estimate how much the firm's future cash flows will change if it invests in a project, but the manager also must evaluate the uncertainty associated with these future cash flows.

The firm today is the present value of all its future cash flows. It is needed to understand better where these future cash flows come from. They come from:

■ Assets that are already in place, which are the assets accumulated as a result of all past investment decisions, and

■ Future investment opportunities.

The value of the firm is therefore,

Value of firm = Present value of all future cash flows = Present value of cash flows from all assets in place + Present value of cash flows from future investment opportunities

Future cash flows are discounted at a rate that represents investors' assessments of the uncertainty that these cash flows will flow in the amounts and the timeframe expected. To evaluate the value of the firm, it's needed to evaluate the risk of these future cash flows.

For example, suppose a firm invests in a new project. How does the investment affect the firm's value? If the project generates cash flows that just compensate the suppliers of capital for the risk they bear on this project (that is, it earns the cost of capital), the value of the firm does not change. If the project generates cash flows greater than needed to compensate them for the risk they take on, it earns more than the cost of capital, increasing the value of the firm. If the project generates cash flows less than needed, it earns less than the cost of capital, decreasing the value of the firm. How do we know whether the cash flows are more than or less than needed to compensate for the risk that they will indeed need? If all the cash flows are discounted at the cost of capital, how this project affects the present value of the firm is become assessable. If the expected change in the value of the firm from an investment is:

■ positive, the project returns more than the cost of capital;

■ negative, the project returns less than the cost of capital;

■ zero, the project returns the cost of capital.

2.3 Cash Flow From Investment

2.3.1 Project cash flow

Free cash flow may be more predictive of future potential success than is net income, although the conventional wisdom is that historical net income is better for predicting future cash flows. Net income can be manipulated somewhat by delaying the write-off of bad debts, increasing the estimated useful life of assets or reclassifying trading investments as available for-sale investments, to name just a few examples. Free cash flow is less subject to judgment, and its analysis can be a useful addition to the tools used to analyze the financial picture of a company. Free cash flow is typically defined as cash flow from operations minus capital expenditures. Making decisions today regarding future cash flows requires understanding that the value of money does not remain the same throughout time. A dollar today is worth less than a dollar some time in the future for two reasons.

Reason No. 1: Cash flows occurring at different points in time have different values relative to any one point in time. One dollar one year from now is not as valuable as one dollar today. After all, you can invest a dollar today and earn interest so that the value it grows to next year is greater than the one dollar today. This means that the time value of money have to be taken into account to quantify the relation between cash flows at different points in time.

Reason No. 2: Cash flows are uncertain. Expected cash flows may not materialize. Uncertainty stems from the nature of forecasts of the timing and/or the amount of cash flows. We do not know for certain when, whether, or how much cash flows will be in the future. This uncertainty regarding future cash flows must somehow be taken into account in assessing the value of an investment.

A firm invests only to increase the value of their ownership interest. A firm will have cash flows in the future from its past investment decisions. When it invests in new assets, it expects the future cash flows to be greater than without this new investment.

2.3.2 Incremental cash flows

The difference between the cash flows of the firm with the investment project and the cash flows of the firm without the investment project— both over the same period of time—is referred to as the project's incremental cash flows.

To evaluate an investment, we'll have to look at how it will change the future cash flows of the firm, and, hence, the value of the firm. The change in a firm's value as a result of a new investment is the difference between its benefits and its costs:

Project's change in the value of the firm = Project's benefits − Project's costs

A more useful way of evaluating the change in the value is the breakdown of the project's cash flows into two components:

1. The present value of the cash flows from the project's operating activities (revenues minus operating expenses), referred to as the project's operating cash flows (OCF); and
2. The present value of the investment cash flows, which are the expenditures needed to acquire the project's assets and any cash flows from disposing the project's assets.

Change in the value of the firm = Present value of the change in operating cash flows provided by the project + Present value of investment cash flows

The present value of a project's operating cash flows is typically positive (indicating predominantly cash inflows) and the present value of the investment cash flows is typically negative (indicating predominantly cash outflows).

The value of a firm today is the present value of all its future cash flows. These future cash flows come from assets that are already in place and from future investment opportunities. These future cash flows are discounted at a rate that represents investors' assessments of the uncertainty that they will flow in the amounts and when expected:

Value of firm = Present value of all future cash flows = Present value of cash flows from all assets in place + Present value of cash flows from future investment opportunities

The objective of the financial manager is to maximize the value of the firm and, therefore, owners' wealth. The financial manager makes decisions regarding long-lived assets in the process refer to capital budgeting. The capital budgeting decisions for a project require analysis of:

■ Its future cash flows,
■ The degree of uncertainty associated with these future cash flows, and
■ The value of these future cash flows considering their uncertainty.

2.4 Investment Valuation Techniques

To evaluate investment projects and select the one that maximizes wealth, cash flows must be determined from each investment and then the uncertainty of all the cash flows should be assessed. There are six techniques that are commonly used to evaluate investments:

1. Payback period
2. Discounted payback period
3. Net present value
4. Profitability index
5. Internal rate of return
6. Modified internal rate of return

2.4.1 Payback period

The payback period for a project is the length of time it takes to get your money back. It is the period from the initial cash outflow to the time when the project's cash inflows add up to the initial cash outflow. The payback period is also referred to as the payoff period or the capital recovery period. If you invest $10,000 today and are promised $5,000 one year from today and $5,000 two years from today, the payback period is two years—it takes two years to get your $10,000 investment back.

Payback period analysis is a type of "break-even" measure. It tends to provide a measure of the economic life of the investment in terms of its payback period. The more likely the life exceeds the payback period, the more attractive the investment. The economic life beyond the payback period is referred to as the post-payback duration. If post-payback duration is zero, the investment is worthless, no matter how short the payback. This is because the sum of the future cash flows is no greater than the initial investment outlay. And since these future cash flows are really worth less today than in the future, a zero post-payback duration means that the present value of the future cash flows is less than the project's initial investment.

Payback should only be used as a coarse initial screen of investment projects. But it can be a useful indicator of some things. Because a dollar of cash flow in the early years is worth more than a dollar of cash flow in later years, the payback period method provides a simple yet crude measure of the value of the investment.

The payback period also offers some indication of risk. In industries where equipment becomes obsolete rapidly or where there are very competitive conditions, investments with earlier paybacks are more valuable.

That's because cash flows farther into the future are more uncertain and therefore have lower present value. In the personal computer industry, for example, the fierce competition and rapidly changing technology require investment in projects that have a payback of less than one year as there is no expectation of project benefits beyond one year. Further, the payback period gives us a rough measure of the liquidity of the investment. However, because the payback method doesn't tell us the particular payback period that maximizes wealth, we cannot use it as the primary screening device for investments in long-lived assets.

2.4.2 Discounted payback period

The discounted payback period is the time needed to pay back the original investment in terms of discounted future cash flows. Each cash flow is discounted back to the beginning of the investment at a rate that reflects both the time value of money and the uncertainty of the future cash flows. The more uncertain the future cash flows, the greater the cost of capital. From the perspective of the investor, the cost of capital is the required rate of return (RRR), the return that suppliers of capital demand on their investment.

2.4.3 Net present value

The net present value (NPV) is the present value of all expected cash flows.

Net Present Value = Present value of all expected cash flows or, in terms of the incremental operating and investment cash flows,

Net present value = Present value of the change in operating cash flows + Present value of the investment cash flows

It's the difference between the change in the operating cash flows and the investment cash flows. Often the change in operating cash flows is inflows and the investment cash flows are outflows. Therefore net present value refers as the difference between the present value of the cash inflows and the present value of the cash outflows. Using summation notation, where t indicates any particular period, represents the net present value, CFt represents the cash flow at the end of period t, r represents the cost of capital, and N the number of periods comprising the economic life of the investment:

$$\text{NPV} = \sum_{t=0}^{N} \frac{CF_t}{(1+r)^t}$$

Cash inflows are positive values of CFt and cash outflows are negative values of CFt. For any given period t, all the cash flows (positive and negative) are collected and net them together.. A positive net present value means that the investment increases the value of the firm—the return is more that sufficient to compensate for the required return of the investment. A negative net present value means that the investment decreases the value of the firm—the return is less than the cost of capital. A zero net present value means that the return just equals the return required by owners to compensate them for the degree of uncertainty of the investment's future cash flows and the time value of money.

2.4.4 Profitability index

The profitability index (PI) is the ratio of the present value of change in operating cash inflows to the present value of investment cash outflows:

$$PI = \frac{\text{Present value of the change in operating cash inflows}}{\text{Present value of the investment cash outflows}}$$

Instead of the difference between the two present values, PI is the ratio of the two present values. Hence, PI is a variation of NPV. By construction, if the NPV is zero, PI is one.

Suppose the present value of the change in cash inflows is $200,000 and the present value of the change in cash outflows is $200,000. The NPV (the difference between these present values) is zero and the PI (the ratio of these present values) is 1.0.

The profitability index tells that how much value investor gets for each dollar invested. If the PI is greater than one, we get more than $1 for each $1 invested—if the PI is less than one, investor gets less than $1 for each $1 invested. Therefore, a project that increases owners' wealth has a PI greater than one.

If the projects are mutually exclusive and have different scales, selecting a project on the basis of the profitability index may not provide the best decision in terms of owners' wealth. As long as investor doesn't have to choose among projects, so that investor can take on all profitable projects, using PI produces the same decision as NPV. If the projects are mutually exclusive and they are different scales, PI cannot be used. If there is a limit on how much we can spend on capital projects, PI is useful. Limiting the capital budget is referred to as capital rationing. Capital rationing limits the amount that can be spent on capital investments during a particular period of time.

2.4.5 Internal rate of return

An investment's internal rate of return (IRR) is the discount rate that makes the present value of all expected future cash flows equal to zero; or, in other words, the IRR is the discount rate that causes NPV to equal $0.

The decision rule for the internal rate of return is to invest in a project if it provides a return greater than the cost of capital. The cost of capital, in the context of the IRR, is a hurdle rate—the minimum acceptable rate of return.

2.4.6 Modified internal rate of return

The modified internal rate of return technique is similar to the IRR, but using a more realistic reinvestment assumption. The modified internal rate of return is a return on the investment, assuming a particular return on the reinvestment of cash flows. As long as the MIRR is greater than the cost of capital—that is, MIRR > cost of capital—the project should be accepted. If the MIRR is less than the cost of capital, the project does not provide a return commensurate with the amount of risk of the project. MIRR can be used to evaluate whether to invest in independent projects and identify the ones that maximize owners' wealth. However, decisions made using MIRR are not consistent with maximizing wealth when selecting among mutually exclusive projects or when there is capital rationing.

2.5 VALUATION OF INVESTMENT PROJECT

2.5.1 Discounted Cash Flow Method

Discounted cash flow methods are based on concept that involves calculation of the net present value of a project over its entire life cycle. It contains investment costs and the production phase free cash flows. If the investment costs are incurred over a short period of time, there is no need for discounting, but for longer time frames, the investment costs have to be discounted back to today using the PV calculation. Free cash flows are realised over a long period of production phase. They have to be discounted back to today using an appropriate discount factor. The discounted factor should represents the risk associated with the project. One single rate is used to discount cash flow streams. The use of only one set of input variables making DCF model more deterministic. However, since the input variables rather behave in probabilistic fashion, sensitivity analysis varies these variables to study their impact on the final NPV. "The NPV is a function of free cash flows, the duration of the project, and the Weighted Average Cost of Capital (WACC). WACC is defined as the after-tax marginal cost of capital" (Copeland & Antikarov, 2001). If the NPV based on DCF analysis is greater than zero, the project is considered financially attractive. In other words, the project is deemed worthy of investment.

2.5.2 Monte Carlo Simulation

The Mone Carlo method involves simulation of thousands of possible scenarious, calculation of the project NPV for each scenario using the DCF method. It analysis the probability distribution of the NPV results. The appropriate discount rate should be used in the discounting the cash flows to reflect their uncertainty. There is different ways that this method can be used. The most common approach is that each project scenario is created by taking a random value for each one of the input parameters of the DCF method.

2.5.3 Decision Tree Analysis

Decision Tree Analysis is another of the traditional tools used for the valuation of projects. Decision tree shows a strategic road map, and depicting alternative decisions.
Copeland and Keenan (1998a) describe DTA as a tree structure depicting all possible states of a project, the probabilities of occurrence for each state, and the decisions management can take in response to these states. "The tree is evaluated by discounting the expected cash flows, a function of the probabilities of occurrence, with an appropriately selected discount rate" (Copeland & Keenan, 1998a).

3 REAL OPTIONS ANALYSIS

“For most investment projects, management can adapt their investment strategy as the environment of the project changes and, thus, can influence the cash flows of a project even after the initial investment has been made. Practitioners frequently recognize these opportunities as "strategic" issues, “but they fail to assign a value to this flexibility. (Brealey/Myers, 1996; Howell/Jägle,1997) Traditional discounted cash flow (DCF) valuation or the net present value rule are not able to reflect this flexibility as they assume a stationary structure of future cash flows. Uncertainty and flexibility in an investment project are neglected” (Kim/Seth, 2001)
“Consequently, practitioners and academics have started to use real options transferring the option valuation methods discussed above to real investment projects or decisions.” (Koch,1999 ; Trigeorgis, 1993) “Based on the traditional DCF valuation, real option methodology corrects for the value of managerial choices by explicitly valuing them as options: the DCF value of a project is increased by the value of its options”. (Kogut, 1991)

The traditional approach to project evaluation and investment decisions uses discounted present value (DPV) or discounted cash flow (DCF) methods. These methods explicitly assume the project will meet the expected cash flow with no intervention by management in the process. All the uncertainty is handled in the (risk-adjusted) discount rate. This process is static. At most, the expected value of the cash flow is incorporated into the analysis.

Management’s flexibility to make decisions as states of nature are revealed is assumed away by this methodology. However, management discretion has value, which is not incorporated into the DPV. The real options methodology goes beyond this naive view of valuation and more closely matches the manner in which firms operate. It allows for a firm's flexibility to abandon, contract, expand or otherwise modify its actions after nature has revealed itself. If investors wish to emulate the competitive process, they cannot rely on the application of naïve DCF methods in cost models.

3.1 Real Option Theory

The techniques that allow investments to be analyzed while taking flexibility and uncertainty into account are called real options. Trigeorgis (1996) provides the following definition:

"Similar to options on financial securities, real options involve discretionary decisions or rights, with no obligation, to acquire or exchange an asset for a specified alternative price."

Real options are investments in real assets that confer firms the right, but not the obligation, to undertake some future specified action, and they provide firms the twin organizational benefits of containing downside risk as well as capturing upside opportunities. Existing research on real options theory in strategy has tended to take a decision-theoretic approach to studying these investments, and as a result has provided insufficient direct empirical evidence on the theory's central propositions

Real option is right to make favorable future choices regarding real asset investments. More precisely, a real option is an opportunity for voluntary future investment in a non-financial asset when at least a part of the required investment expenditure is certain or, alternatively, when at least a part of the required investment expenditure is not perfectly positively correlated with the project's present value.

Irreversible investments frequently involve great uncertainty concerning the future benefits connected to the project. Given that managers inherit some flexibility in deciding when to invest, such a project is always worth more than a similar project without flexibility. Real option models argue that the value of a firm can be seen as

$$V_{firm} = NPV + value\ of\ options$$

Flexibility in decision-making includes options to delay, abandon, expand, contract, extend and shorten operations. These options are referred to as real options since they exhibit a claim on real assets. Real option theory can be applied to valuation of natural resources, firms in financial distress, R&D projects, current project expansion or contraction, new product launches, investments in environmental technologies, and the decision to penetrate new markets.

Going through with an irreversible expenditure means foregoing the opportunity to wait for new information, thereby taking on an opportunity cost, which should be included in the investment decision. Greater uncertainty will increase project value, thereby reducing the actual investment the firm will undertake. The critical spot price S^* is the oil price where the firm should invest, since the option premium at this point is zero. It means that the real option value equals the net present value. Dixit, (1994) provide evidence that the critical value S^* increases with project volatility. The resemblance to the decision of exercising an American call option is obvious. Exercising an in the money option is not always optimal, since we need to account for the value of waiting before deciding whether to exercise.

3.2 Real Options or Discounted Cash Flow

"The body of empirical work emphasizing that standard capital budgeting techniques understate the value of projects is growing rapidly. Critics of the DCF criterion argue that cash flow analysis fails to account for the flexibility in business decisions" [Triantis and Hodder (1990), Hayes and Abernathy (1980)]. "Real option models are more focused on describing uncertainty and in particular the managerial flexibility inherited in many investments. Discounted cash flow (DCF) and net present value (NPV) are traditional tools used for evaluation of projects and investment decisions. This method determines project value by discounting expected future cash flows at an appropriate risk-adjusted rate and then subtracts the cost of any investments "(Copeland & Keenan, 1998a). "The resulting value of this calculation is the project's NPV. Projects are then evaluated on the determined NPV. Projects with a positive NPV are accepted and projects with a negative NPV are rejected" (Copeland & Keenan, 1998a).

A limitation of the NPV formulation is that it does not assign a value to the capability of management to make certain strategic decisions (abandon, defer, shutdown, etc.) during the course of a project's life cycle. Harvey (1999) noted that these strategic options, are truly real options and do not generate value in standard DCF. These strategic decisions have a value, which may alter the decisions made regarding a project's viability.

In contrast to option approaches the DCF criterion implicitly assumes that the investment is reversible or if not that the firm has to act now or never. Dixit, (1994) points out that many ventures do not meet these conditions; therefore, presence of flexibility in projects should affect the investment decision. Defenders of cash flow methods propose a solution by creating a decision tree and performing NPV calculations at each node, to better capture flexibility.

Practitioners refer to the decision tree method as dynamic DCF valuation. Although it constitutes an improvement over the standard DCF method it still fails to incorporate the volatility of the project.

On the other hand, the defenders of cash flow models claim that the DCF approach has the ability to take into account the options inherent in a project. Of course, this demands that the discount rate changes through project life to reflect the varying risk of future cash flows. While feasible in theory, it is not always achievable in reality.

Real option analysis is often considered separate from net present value (NPV) analysis in regard to project evaluation. One reason for this perception is that real option analysis frequently uses risk-neutral pricing to generate the value of a project. In reality, real option analysis is no different than NPV analysis.

3.3 Real Options or Decision Tree Analysis

Decision Tree Analysis is another of the traditional tools used for the valuation of projects. Copeland and Keenan (1998a) describe DTA as a tree structure depicting all possible states of a project, the probabilities of occurrence for each state, and the decisions management can take in response to these states. The tree is evaluated by discounting the expected cash flows, a function of the probabilities of occurrence, with an appropriately selected discount rate (Copeland & Keenan, 1998a).

An advantage of DTA is its graphical depiction of the project, decision points, and probabilities; which facilitate an ease of explanation and understanding. Unlike DCF, DTA actively assesses the uncertainty of the project life and management's ability to respond to these uncertainties. “Decision analysis and real options would appear to produce the same results; both methods map out the possible outcomes of the project, accounting for project uncertainty and recognizing management’s flexibility to respond to this uncertainty. In this regard, decision analysis and real options valuation are closely related, as decision analysis can lead to options analysis. However, the two approaches differ on the discount rate used for the valuation. Decision analysis uses a constant discount rate for the entire project; while real options adjusts the discount rate at each point of the project” (Copeland & Keenan, 1998b). “By adjusting the discount rate, the evaluation more realistically accounts for the changes in risk at the various stages of the project” (Copeland & Keenan, 1998b).

4 TYPES OF REAL OPTIONS AND VALUATION

4.1 Real Option

"The similarity between financial options and real options extends to the types of options as well. Like financial options, real options can be defined as either a "call" option or a "put" option. "Call" options represent the right to buy the underlying asset at a prescribed exercise price; they are evaluated on the relationship between the option price and the exercise price. If the value of a "call" option exceeds the value of the exercise price, the option is said to be "in-the-money" (Copeland & Antikarov, 2001). "If the value of the exercise price exceeds the value of the "call" option, the option is considered to be "out-of-the-money" (Copeland & Antikarov, 2001). In contrast to a "call" option, a "put" option represents the right to sell the underlying asset at a prescribed exercise price.

"Real options are also defined by the style of the option. The various styles of options include American, European, Asian, and Bermuda. The discussions in this review will focus on both American options and European options. American options can be exercised at any point during its life before it expires" (Copeland & Antikarov, 2001). "Therefore, American options generally have a greater value as the option can be exercised at any point, thereby allowing the option to be exercised at a point when the market volatility increases the option value the most. In contrast, European options can only be exercised upon maturity of the option" (Copeland & Antikarov, 2001) which may cause it to possibly miss out on the potential for greater gains before option maturity. "Contrarian positions exist which suggests that a "rational" trader would not necessarily exercise an American option early in an attempt to delay and gain more value on the option" (Sapienza, 2003).

The value of a real option is defined by six characteristics. Copeland and Antikarov (2001) and Alleman (2002) agree on four of these basic characteristics. Copeland and Antikarov (2001) add two additional characteristics, a project's risk-free interest rate and any potential dividends, to the list of characteristics. "Market volatility increases the option value the most. In contrast, European options can only be exercised upon maturity of the option" (Copeland & Antikarov, 2001) which may cause it to possibly miss out on the potential for greater gains before option maturity. "Contrarian positions exist which suggests that a "rational" trader would not necessarily exercise an American option early in an attempt to delay and gain more value on the option" (Sapienza, 2003).

"The final element of a real option is the type of strategic action taken on the underlying asset. These classifications of actions depict the type of flexibility exercised in strategic decision making" (Alleman, 2002; Copeland & Antikarov, 2001). Alleman (2002) identifies several actions that might be exercised. These actions reflect the strength of real options, which is the ability to respond to the uncertainty of a project and its market conditions (Alleman, 2002). Leslie and Michaels (1997) and McGrath (1999) noted that this type of flexibility could affect an organization's perception of uncertainty and entrepreneurship, thus changing management's philosophy from one of "fear uncertainty and minimize investment" to "seek gains from uncertainty and maximize learning."

4.2 Components of Real Options

The basic components that are useful to value a call option on a financial asset are:

• Assets: For financial options assets are traded securities in the financial market whose fluctuations largely determine the value of the option.

• Exercise price: The specified price at which the contract may be exercised, whereby a buyer can buy or a buyer can sell the asset.

• Option price: It is the amount per share that an option buyer pays to the seller.

• Volatility: It is the relative rate at which the price of a security moves up and down. If the price of a stock moves up and down rapidly over short time periods, it has high volatility. If the price almost never changes, it has low volatility.

• Expiration date: The date on which an option, right or warrant expires, and becomes worthless if not exercised. It is also, the date on which an agreement is no longer in effect.

• Risk free rate of return: It is a theoretical interest rate that would be returned on an investment, which was completely free of risk.

• Dividends: A taxable payment given to the shareholders of the company from its current or retained earnings. Cash flows from a project are similar to dividends on a stock.

Financial option	Real option
Share price V_0	Present value of future cash flows of underlying asset
Strike price X	Necessary investment to exercise real option or present value of strike asset
Maturity t	Length of time during which opportunity exists
Volatility of security price σ	Volatility of cash flows of basis asset
Risk free rate r	Generally risk free rate, alternatively volatility of cash flows of strike asset[26]
Option price P_C or P_p	Initial investment into the project that creates the option

Table 1: Differences between financial and real options

A call option gives the buyer of the option the right to buy the underlying asset at a fixed price, called the strike or the exercise price, at any time prior to the expiration date of the option: the buyer pays a price for this right. A put option gives the buyer of the option the right to sell the underlying asset at a fixed price, again called the strike or exercise price, at any time prior to the expiration date of the option. The buyer pays a price for this right. An American option can be exercised at any time between the purchase date and the expiration date. This is the opposite of a European-style option, which can only be exercised on the date of expiration. An American option provides an investor with a greater degree of flexibility than a European style option. European option can only be exercised for a short, specified period of time just prior to its expiration, usually a single day. Asian option is an option whose payoff depends on the average value of an asset over a specified period.

Increase in variable	Call Option Value	Put Option Value
Asset Value	Increases	Decreases
Exercise Price	Decreases	Increases
Interest rate	Increases	Increases
Time to expiration	Increases	Increases
Volatility	Increases	Decreases

Table 2: reflections of the changes in the prices of call and put options

	Characteristics	Effect on Value
1)	The value of the underlying asset: the value of the physical asset, "whether it is a project, investment or acquisition".	Increases
2)	The exercise price: the money that will be spent if a call option is exercised or the money to be gained if a put option is exercised.	Decreases
3)	The time to expiration of the option: The duration of time that the option is available to be exercised, with longer durations creating greater value.	Increases
4)	The volatility of the market for the underlying asset: The risk of the underlying asset in the market, with higher degrees of market uncertainty generating greater value because of the potential for greater upside benefits.	Increases
5)	The risk-free rate of interest for the life of the option: As the risk-free rate increases so to does the value of the options.	Increases
6)	The dividends that may be paid out from the underlying asset: If dividends are paid the value of the option will be impacted.	Decreases

Table 3: Characteristics of real options

Real options give the firm the opportunity but not the obligation to take action. Such project options typically include the possibility to delay, expand, contract, or liquidate an investment.

4.3 Types of real options

"The numerous types of real options can be classified into three main categories: learning options, growth options and insurance options. These categories, distinguish several option types" (Hommel/Pritsch, 1999). Table depicts an overview of these real option types along with the equivalent financial options.

Category	Option Type	Equivalent Financial Option
Learning Options	Options to Defer	Call Option
	Time to Build Option	Compound Call Option
Growth Options	Option to Expand	Call Option
	Option to Innovate	Call Option
Insurance Options	Option to Contract	Put Option
	Option to Shutdown and restart	Call Option
	Option to Switch	Combined Call/Put Option
	Option to Abandon	Put Option

Table 4: Real option types and their financial equivalents

4.3.1 Learning options offer management the opportunity to react to changes in the environment and to adapt investment strategies to new information that they may acquire at a future point of time. An *option to defer* allows management to wait to invest into a project and gather more information on the project; oil leases are an example for defers options. *Time-to-build options* exist when investments are staged, i.e. the company can stop an investment project before making all the investments; research and development efforts are usually staged investments.

4.3.2 Growth options let the company react to positive market or project developments: Management may be able to expand their business activities in a market or their commitment to a project by making additional investments (*option to expand*). Companies can also acquire new knowledge or skills through investment projects, generating opportunities for follow-up projects based on these skills, i.e. *options to innovate*.

..**4.3.3 Insurance options** can be found whenever a company is able to react to (negative) changes in the market environment by adapting an existing investment project or abandoning it altogether. An *option to contract* lets management reduce the company's activities once market conditions deteriorate. An *option to shutdown and restart* represents a special case of an option to contract, allowing the company to completely shut down operations for a certain period and restart them as soon as the market environment improves. If management can put the company's assets to another, more profitable use, it has an *option to switch*, i.e. exchange one investment project for another. Finally, a company can leave the market altogether and shut down operations permanently in exchange for the salvage value (*option to abandon*).

"Real options are not mutually exclusive; investment projects can create several types of options at the same time. Another characteristic of real options that is important for the choice of the correct valuation methodology is its exclusiveness"(Trigeorgis, 1996). "Depending on the competitive situation; exclusive options can only be exercised by one company, while collective options may be exercised by competitors as well"(Tomaszewski, 2000). Valuing collective options requires taking into account the competitive situation: Premature exercising of an option might be necessary to preempt competitors and avoid losing value.

In addition to simple actions, there are more complex interactions of options; these are referred to as compound options, rainbow options and compound rainbow options. "Compound options are described as options on options" (Copeland & Antikarov, 2001). In a compound option, the options available to a manager are contingent upon the options from previous phases of the project. Research & development (R&D) efforts are representative of the type of effort that might contain compound options. R&D efforts typically involve multiple phases such as design phase, engineering phase, test phase, and a production phase. Each phase contains the option to abandon, defer, switch, or contract at the end of the phase, before committing to any follow-on activities. “Rainbow options are described as options driven by multiple sources of uncertainty” (Copeland & Antikarov, 2001). “Finally, there are compound rainbow options. A compound rainbow option is an option driven by multiple sources of uncertainty containing options on options” (Copeland & Antikarov, 2001).

	Type of Option	Reference
Defer	an American call option to delay the start of a project, giving management the opportunity to await the return of a favorable or "good" state of nature	(Alleman, 2002) (Copeland & Antikarov, 2001)
Abandon	an American put option which can be exercised at a predetermined fixed price, to salvage some value from an poorly performing project	(Alleman, 2002) (Copeland & Antikarov, 2001)
Contract	option to sell part of a project for a fixed price and downsizing the remaining operations, if the market conditions are in a down state	(Alleman, 2002) (Copeland & Antikarov, 2001)
Expand	Option to pay more to scale up the project, allowing operations to take advantage of markets in an up state	(Alleman, 2002) (Copeland & Antikarov, 2001)
Switch	Option to exercise a portfolio of call and put options, which enable switching between different modes of operation for a fixed cost.	(Alleman, 2002)
Shutdown and Restart	Option to shutdown and restart is the ability to cease or resume operations of at fixed cost predicated upon the state of the prevailing markets.	(Alleman, 2002)
Growth	Option to take advantage of future interrelated opportunities	(Alleman, 2002)

Table 5: Types of real options and descriptions

4.4 Real Option Valuation

Valuation depends on the particular feature and complexity of the application. There are three approaches to follow:

i) The Black-Scholes equation is well suited for simple real options with a single source of uncertainty and a single decision date. Sporleder and Zeuli (2000) used this model to value the real option of investing in a "new generation cooperative".

ii) "For more complex applications, specialized mathematical tools such as *numerical methods* are required. One robust and not very complicated method is the *binomial option valuation* model, which is suitable for a large range of real options applications and retains the appearance of a DCF approach" (Amram 1999).

iii) Luehrman (1998) propones a "…framework that bridges the gap between the practicalities of real-world capital projects and the higher mathematics associated with formal option pricing theory". He says that even though this framework takes some liberties it provides much more insight about a project than other DCF methodologies do.

4.5 Option valuation

This section reviews basics of option valuation and real options and discusses the value drivers of real options. We use two methods to value options, the binomial model developed by *Cox, Ross and Rubinstein (1979)* and the continuous valuation formula of *Black and Scholes (1973)*. Both valuation methods are briefly reviewed at the beginning of the section.

4.5.1 Valuing financial options

"A financial option represents the right of the option holder to purchase (call option) or sell (put option) shares at a set price (the strike price) and at a predetermined time (in the case of a European option) or within a predetermined period of time (in the case of an American option)" (Cox/Ross/Rubinstein, 1979) The value of an option is determined by the value of the underlying security at the time of exercise. Let C and P denote the value of a call and put option, respectively. X the strike price and V the value of the underlying security. The option value when exercised (i.e. the intrinsic value) can then be written as:

(E.1) $C = Max\,(0; V - X)$

(E.2) $P = Max\,(0; X - V)$

4.5.1.1 Binomial option valuation

The binomial model to value options is based on a series of assumptions (Cox/Ross/Rubinstein, 1979)

(A.1) The model assumes that the price of the underlying security follows a binomial process and either increases by u or decreases by d in each discrete time period. The two states are mutually exclusive and are realized with probabilities p or (1 - p) respectively. The rates of return (u - 1) and (d - 1) are based on the volatility σ so that

$$\text{(E.3)} \quad u = e^{\sigma} \text{ and } d = \frac{1}{u}$$

Consequently, the call option value C in period t = 1 is either Cu = Max (0; uV0 - X) or Cd = Max (0; dV0 - X), where V0 denotes the value of the underlying asset at t = 0.[9] Similarly, the put option value is either Pu = Max (0; X - uV0) or Pd = Max (0; X - dV0).

(A.2) The financial markets are considered to be frictionless with no transaction costs, taxes or arbitrage opportunities. The risk free rate r is known and constant. Securities are freely divisible and can be purchased and sold without limitation. Short sales of securities with full use of the proceeds are allowed. Investors can borrow and lend without limitations at identical rates.

(A.3) There are no dividends.

(A.4) All options will exclusively be exercised at the expiration date. Based on these assumptions, the option value can be determined by creating an equivalent portfolio that has an identical pay-off structure and the same risk as the option. The portfolio is composed of □shares of the underlying security and riskless bonds with a market value of B. Assuming no arbitrage opportunities; the option value must equal the portfolio value. The option value can then be expressed as (Cox/Ross/Rubinstein, 1979 ; Brealey/Myers ,1996)

$$\text{(E.4)} \quad C = \Delta V_0 - B \text{ where}$$

$$\text{(E.5)} \quad \Delta = \frac{C_u - C_d}{(u-d)V_0} \text{ and}$$

$$\text{(E.6)} \quad B = \frac{dC_u - uC_d}{(u-d)} \cdot \frac{1}{1+r}$$

In order to value more than one period, an iterative backward process is used: the options are valued period by period using the above shown methodology, starting with the last period and moving backwards. When using intervals different from years, the annual risk free rate r has to be adjusted to the respective lengths of the individual periods (Brealey/Myers;1996)

Dividends paid to the holder of the underlying security change the value of options based on that security. As a call option holder, dividends paid on the security are not received unless the option is exercised; therefore, the present value of dividend payments has to be deducted from the share price (i.e., the value of the underlying asset). For the holder of a put option, dividends represent opportunity cost in case he exercises the option before a dividend payment. To include dividends D into the binomial valuation model, Cu and Cd (for calls) and Pu and Pd (for puts) are adjusted for those periods where dividends are paid. (Amram/Kulatilaka, 1999)

(E.7) $Cu = Max\ (0; (uV0 - D) - X)$ and $Cd = Max\ (0; (dV0 - D) - X)$

(E.8) $Pu = Max\ (0; X - (uV0 - D))$ and $Pd = Max\ (0; X - (dV0 - D))$

Assumption (A.4) supposed that all options are exercised at the expiry date. American options, however, can be exercised anytime before they expire. Premature exercising, therefore, is an issue.

An American call without dividends should never be exercised prematurely. The value of a potentially positive future development of the share price plus the interest payments on an investment of the strike price is always larger than zero, making the investor wait until the expiry date. An American put option without dividends, on the other hand, should be exercised before expiry if the value of interest payments on the proceeds from the sale exceeds the value of future share price changes. In the case of dividends, premature exercising can be reasonable if, in the case of a call, the value of the dividend payments exceeds the interest proceeds from the strike price or vice versa for a put. (Merton,1973)

Premature exercising can be integrated into the binomial model by comparing the option value when exercised immediately to the value of holding out for another period. Immediate exercising is only reasonable if the exercise value is higher then the value of waiting. The respectively higher value is then used for subsequent calculations.

4.5.1.2 Black/Scholes Valuation

Option valuation experienced a breakthrough, in 1973 when Black and Scholes (Black and Scholes, 1973) presented their analytical option valuation model for European (financial) options, which was enhanced by Merton (Merton, 1973). After the Black and Scholes article a number of techniques for valuing European and American options have emerged. These techniques include lattice techniques (binomial and multinomial trees), e.g., (Cox and Ross, 1976), (Cox, Ross, and Rubinstein, 1979) and (Boyle, 1988), finite-difference methods, e.g., (Brennan and Schwartz, 1977), (Brennan and Schwartz, 1978), and (Schaider and Kandel, 1977), and quadrature methods, e.g., (Andricopoulos et al., 2003). The two most commonly used methods, to the best of our knowledge, are the Black and Scholes model and binomial option pricing. The Black and Scholes model is based on a replication argument: the value of a call option is equal to the value of a combination of other instruments giving the same expected cash flows. The model uses a combination of lending and of buying the underlying stock in the future. There are three main sets of assumptions underlying the model,

i) about interest rates,

ii) about the volatility of the return from the underlying, and

iii)about the markets.

i) interest rate is assumed to be the risk free rate of return (due to no arbitrage) and it is assumed to remain constant

ii) volatility of the return from the underlying is assumed to remain constant and is assumed to be deterministic

iii) the markets are assumed to be complete and efficient (no arbitrage), where assets are continuously traded, where assets can be split, where there are no taxes or transaction costs, and where asset prices follow geometric Brownian motion (GBM).

Under these assumptions the result from the Black and Scholes model is most accurate.

The Black and Scholes option valuation formula, as enhanced by Merton, calculates the call option value (V) as,

$$\mathrm{V} = S_0 e^{-\delta T} N(d_1) - X e^{-rT} N(d_2)$$

where,

$$d_1 = \frac{\ln(S_0/X) + (r - \delta + \sigma^2/2)T}{\sigma\sqrt{T}}$$

$$d_2 = d_1 - \sigma\sqrt{T}$$

and

So = Stock price
X = Exercise price
T = Time to expiry
s = Volatility of the underlying stock
d = Dividend payments
r = Risk-free rate of return

Similar assumptions underlie both, the Black-Scholes model and the binomial model. The main difference is that the binomial model uses a discrete-time framework to trace the evolution of the underlying (markets) via a binomial lattice to approximate the continuous process used in the Black-Scholes model. In fact, for European options, result from the binomial option valuation converges to the result from the Black and Scholes option pricing formula (Benninga and Wiener,1997), i.e., the Black-Scholes model is a continuous time version of the binomial option valuation model. It has been the choice of the author to select the Black-Scholes option pricing formula to be the option valuation model to be used in this thesis. The selection is based on the fact that, to the best of our knowledge, the Black-Scholes formula is the most commonly used option-pricing model and, because the Black-Scholes formula is the continuous time version of the binomial option valuation model (implicitly includes the binomial model), which is the other relevant model choice.

4.6 Real options valuation

4.6.1 Options and real investment projects

Real option valuation (ROV) is based on the observation that the possibilities financial options give their holder resemble the possibilities found in real investments, i.e., managerial flexibility, e.g., "an irreversible investment opportunity is much like a financial call option" (Pindyck, 1991). Real option valuation is treating managerial flexibility as options and valuing managerial flexibility with option valuation models; the term, real options, was introduced in (Myers, 1977). Using option valuation models designed originally for financial options in valuing managerial flexibility means that the model variables need to be adjusted for real investments. Figure shows the analogy between the variables used for valuing financial and real options.

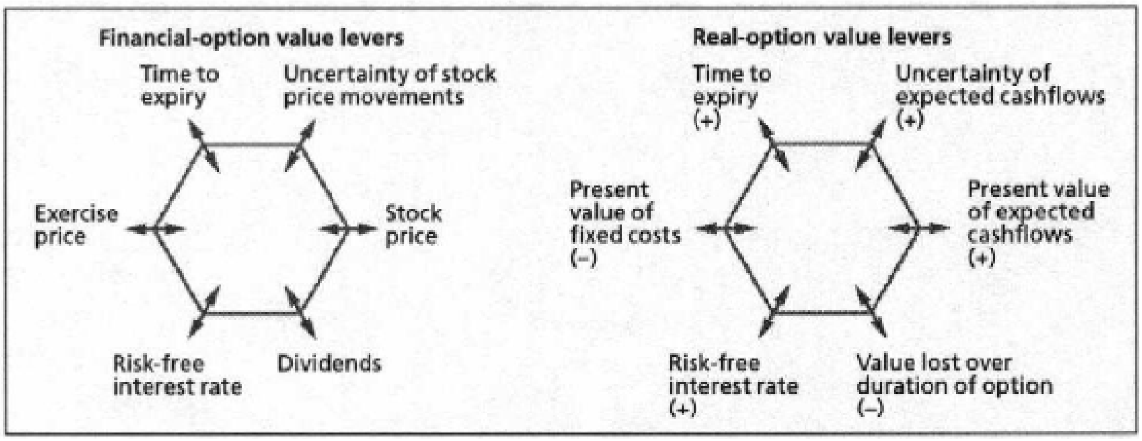

Figure 1: Variables of financial and real options, figure from (Leslie and Michaels, 1997)

For most investment projects, management can adapt their investment strategy as the environment of the project changes and, thus, can influence the cash flows of a project even after the initial investment has been made. Practitioners frequently recognize these opportunities as "strategic" issues, but they fail to assign a value to this flexibility. (Howell/Jägle ,1997)

Traditional discounted cash flow (DCF) valuation or the net present value rule is not able to reflect this flexibility as they assume a stationary structure of future cash flows. Uncertainty and flexibility in an investment project are neglected. (Kim/Seth, 2001)

Consequently, practitioners and academics have started to use real options transferring the option valuation methods discussed above to real investment projects or decisions. (Meise, 1998)

Based on the traditional DCF valuation, real option methodology corrects for the value of managerial choices by explicitly valuing them as options: the DCF value of a project is increased by the value of its options. (Trigeorgis, 1996)

$$NPV_{Opt} \equiv -CF_o + \sum_{t=1}^{T} \left(\frac{E(CF_t)}{(1+WACC)^t} \right) + E\left(V_{Options}\right)$$

NPVOpt represents the net present value of the project taking into account the initial investment [CF0], the expected cash flow in period t [E(CFt)], the weighted average cost of capital [WACC] and the expected real options value [E(VOptions)]. The last term represents the expected value of options created by managerial flexibility. In order to value it, the real option concept exploits an analogy between real investment projects and financial options: Similar to financial options, the flexibility inherent to many investment projects can be interpreted as the right to acquire or to sell the cash flows of an underlying asset in exchange for an additional investment or the cash flows of a strike asset. (Trigeorgis, 1996) Whether these rights are explicit (e.g., contractual agreements) or implicit (e.g., the flexibility to abort an R&D project) is a secondary concern. This analogy allows us to use option models to value the options included in an investment by transferring the model parameters to their real equivalents, as depicted in Table at below. (Luehrman, 1998)

Financial option	**Real option**
Share price V_0	Present value of future cash flows of underlying asset
Strike price X	Necessary investment to exercise real option or present value of strike asset
Maturity t	Length of time during which opportunity exists
Volatility of security price σ	Volatility of cash flows of basis asset
Risk free rate r	Generally risk free rate, alternatively volatility of cash flows of strike asset[26]
Option price P_C or P_p	Initial investment into the project that creates the option

Table 6: Equivalent real options parameters

4.7 Advantages of Real Options

It is believed that real options will become an increasingly important tool in project analysis. Real options provide the analytical flexibility that standard valuation frameworks lack. The major points of our analysis are as follows:

* *Real options defined.* The real options approach applies financial option theory—the best-known form is the Black-Scholes model—to real investments, such as manufacturing plants, line extensions, and R&D investments. This approach provides important insights about businesses and strategic investments, insights that are more important than ever given the rapid pace of economic change.

* *The marriage of strategic intuition and analytical rigor*. The real options approach is best viewed as a complement to standard DCF analysis. For those comfortable with DCF, real options have substantial intuitive appeal. By adding an important dimension of analytical flexibility, real options allow for a better melding of strategic intuition and analytical rigor.

* *Evolution of strategy and finance.* Most traditional businesses can be valued using DCF, as the general focus is optimization—doing things better today than yesterday. Emerging businesses are best valued using real options, as the focus is on "the next big thing." As the strategic landscape evolves, so too must the tools to evaluate it.

There is a growing gap between how the market is pricing some businesses— especially those fraught with uncertainty—and the values generated by traditional valuation models such as discounted cash flow (DCF). Managers and investors instinctively understand that selected market valuations reflect a combination of known businesses plus a value for *opportunities that* *are to come*. Real options— a relatively new analytical tool—bridge this gap between hard numbers and intuition.

4.8 Real Options in Practice

Real options have been adopted by numerous industries, replacing or supplementing traditional methods of project valuation such as DCF and DTA. Triantis and Borison (2001) noted that many firms are drawn to the notion of real options over concerns of management's tendency to overvalue, overpay, and over invest in projects or other corporate investments, as these firms are motivated to capitalize on fleeting economic opportunities and establish market leadership positions. In addition to the notion of commonly expressed concerns and motivations, firms using real options share several common traits. These traits have been described by Triantis and Borison (2001), Leslie and Michaels (1997), and Copeland and Keenan (1998b) in their respective studies on the application of real options, and are summarized in Table.

	Common Industry Traits
1)	Investment intensive industries
2)	Large investments with uncertain returns
3)	Traditional valuation models are inadequate
4)	Engineering sciences needing sophisticated analytical tools
5)	Phased developments
6)	Cyclical processes

Table 7: Common traits of firms using real options

The early acceptance of real options was markedly slow, as only a few industries implemented this methodology, namely pharmaceuticals and oil and natural gas exploration firms (Mehta, 2005). Early adoption of real options was hampered by its complexity (Mehta, 2005). As firms have become more familiar with the theory and methodology, more have sought to integrate this tool into their practices. The variety and scope of industries and firms currently employing real options has grown and represents a diverse group of firms, as presented in Table 5 (Alleman, 2002; Copeland & Antikarov, 2001; Faulkner, 1996; LCDR Cesar G. Rios, Housel, & Mun, 2006; Triantis & Borison, 2001).

4.9 Practical Limitations to Real Options

Real options provide a powerful alternative to the traditional means of project valuation. However, there are limitations; as Professor Stewart Myers once stated, "quantification of option value can be quite difficult" (Mehta, 2005). This is particularly true for large projects with numerous options; as the number and combination of options grow, so to does the complexity of the option valuation (Kemna, 1993).

Additionally, the uncertainty of the underlying project is difficult to determine (de Neufville, 2003b; Kemna, 1993). In financial options, there is extensive statistical history to evaluate in order to determine the options uncertainty. However, with projects there is generally little historical precedent to rely upon to generate an appropriate measure of uncertainty (de Neufville, 2003).

The majority of organizations use some sort of quantitative analysis methods to capture the estimated costs and benefits associated with a proposed project. The most popular methods include internal rate of return, net present value, and payback however, these methods have some associated assumptions that can result in the value of an investment being underestimated. They assume management's passive commitment to a certain "operating strategy" .The methods also ignore the synergistic effects that an investment project can create. Sometimes the performance of one project will allow you to perform a second project that would not have been possible without the first. Therefore, the analysis usually underestimates investment opportunities because it ignores management's flexibility to alter decisions.

5. APPLICATION

5.1 SINPAS (Halkali-Bosphorus Real Estate Project) – Sequential Option

The main difference between financial options and real options is that the undelying asset for real options is physical rather than financial. Moreover, real options model incorporate a manager's ability to adapt to changing conditions for representing the option holder's ability to directly influence the value of the underlying asset.

Any action that manager can take to adjust uncertainty or mitigate risk is real option. When we look at real estate development, it becomes evident that various real options exist. The real options that are common to real estate are the option to defer or expand a project(a call), the option to abondon a project (a put), a option to phase a project(a compound call).

Phase development is the prior research in applying real option analysis. When a developer can build an intial phase of a project and respond to its performance in designing future phases, a phasing option occurs. For example, large and multi-building developments, it does not make sense to commit fully to the construction schedule at time zero. Rather, it reduces risk to divide the project into seperate phases. The first phase may be committed at time zero, but the developer maintains the flexibility to delay or cancel additional phases if they do not make economic sense in the future. A phasing option can be either compound or parallel.

Numerous additional examples of real options in real estate become apparent when one considers instances in which there exists a right but not an obligation to take a course of action based on new information. The following are just a few of these examples:

Developers often have the option to change the intended use of a project (a call option). For instance, consider an office building that can be converted to residential. Here the underlying asset is the value of the proposed residential project with the value of the office building (plus the construction or conversion cost) as the strike price. Another example would be an apartment building that can be converted to condominiums.

The option to expand or contract applies to many development projects. Common examples are scaling a residential building down in size in order to save costs.

Options can also be applied to project financing. For instance, the equity provider in a levered real estate project has a call option on the project with a strike price equivalent to the outstanding value of debt. In other words, if the value of the property is above the value of the debt, it is "in the money" and the equity provider has positive value of his equity.

(Barman/Baabakand, E.Nash/Kathryn, 2007)

5.1.1 Compound option

Many project initiatives are multistage project investments where management can decide to expand, scale back, or abandon the project after gaining new information to resolve uncertainty. For example, a capital investment project divided into multiple phases , which includes permitting, design, engineering, and construction, can be either terminated or continiued into next the next phase depending upon the market condition at the end of the each phase. These are compound options where exercising one option generates another, thereby making the value of one option contingent upon the value of another option. A compound option derives its value from another option. It's not derives its value from the underlying asset. The first investment creates the right but not the obligation to make a second investment, which in turn gives you the option to make a third ,nvestment, and so on.You have the option to abandon, contract, or scale up the project at any time during its life.

A compound option can either be sequential or parallel. If you must exercise an option in order to create another one, it is considered a sequential option. For example, you must complete the design phase of factory before you can start to building it. In a parallel option , however, both options are available in the same time. The life of the independent option is longer than the dependent option. A television broadcaster may be building the infrastructure for digital transmission and acquring the required broadcast spectrum at the same time, but cannot testing complete testing of the infrastructure without the spectrum license. Acquring the spectrum gives broadcaster the option to complete the infrastructure and launch the digital broadcast service. (Kodukula and Chandra, 2006)

5.1.1.1 Sequential Option

This part includes a sequential compund option example. Sequential option is applied to Bosphorus City Project and of Sinpas, one of the homebuilder Reit in Turkish Market.

5.1.1.2 Framing the application

Sinpas REIT is Sinpas Group's real estate company exposed solely to the residential market. The company was formed in 2006 with five residential projects and vacant lands transferred from the parent as capital in kind. The company was listed on June 22, 2007 through a 49% IPO.The company plans to construct over 10,700 dwellings in Istanbul, Bursa and Ankara over the next seven years.

The main shareholder, Sinpas Yapi, has a history of more than 30 years in Turkey's construction/development market. Over the past 15 years (1992-2007), the group has developed 11 residential real estate projects with a construction area of 740,756 sqm, constituting 0.5% of the permitted construction area or 2% of the occupancy permits issued in Istanbul over this time frame. Mr. Avni Celik, who is also the chairman of Sinpas REIT, founded Sinpas Yapi. According to the rules governing REIT formation, one-third of the board of directors must be independent and have no current ties to the company or existing shareholders. Accordingly, Sinpas has two independent members on its board: Mr. Ekrem Pakdemirli (Deputy Prime Minister in 1991) and Mr. Osman Akyuz (ex-general manager of Albaraka Turk, one of the participation banks in Turkey). Management comes across as confident and hands-on. However, Sinpas REIT is not its sole enterprise in the development arena, as Sinpas Yapi (still held privately by the Celik family) is looking for commercial or possibly mixes use projects in and outside of Istanbul.

The company plans to sell a total of 12.7K housing units during 2008-2013 and initiatives are already taken to achieve this target. Company's ongoing and planned projects are located in Istanbul, Ankara, and Bursa.

Cakmak, Halkali, Avangarden, Rumeli Konaklari, Lagun, Zeytinburnu, and Sarigazi projects are locate in Istanbul. Yenimahalle, Polatli, Dikmen projects are locates in Ankara, and Ottomanors project locates in Bursa.

It can be optimistic regarding the long-term prospects for residential development in Turkey since four key demand factors (ie, disposable income, employment, urban household growth, and the outlook for interest rates) look favourable. The municipalities' urban regeneration efforts and the low quality of the existing housing stock are additional catalysts. Furthermore, residential investment is popular with the average citizen, as it is often regarded as a safety net for retirement.

The Turkish development market is highly competitive with virtually no barriers to entry due to the underlying pre-selling method. Sinpas's market share in this highly fragmented market is insignificant (0.5% judged by construction permits).

Homebuilders in the developed world are mainly valued based on NAV and the build-out value of their existing projects/landbank. Given the peculiarity of Turkish NAVs (ie, they reflect only cost of the project until the title deeds are transferred to owners even if pre-selling is completed), relying on NAV as a valuation tool, without any adjustment, is not only incomplete but also wrong. Hence, in order to reach the build-out value of the company's existing projects, we used cash flow analysis (DCF).

Company is considering to build 3.070 housing unit till to 2013. Sinpas has some market uncertainty regarding future sales; therefore the options approch to value the project for deciding a go/no-go decision is used. Binomial tree approach calculates the asset values over the life of the option by using one-year time intervals for five years.

5.1.1.3 The Halkali Project – Istanbul

This project will be the largest in the company's history. The project, which will be constructed on a plot spanning 446.000 square meters owned by Sinpaş GYO, will include a total of 3,070 housing units. The Bosphorus City project will include the characteristic features of Bebek Parkı, İstinye Koyu, Yeniköy, Paşabahçe, Emirgan Çınaraltı, Kanlıca, Anadolu and Rumeli Hisarı, Kandilli and Çengelköy squares. The project will have sports grounds, walking paths, social facilities and flora, specific to the districts. Green area of 79,473 square meters, open sports ground of 11,550 square meters, social facility area of 10,019 square meters and a day nursery of 647 square meters will also be constructed in the project. Bosphorus city has modern and classic architectural that Saraybahçe Houses, Yeditepe Towers, Waterfront villa provide different life alternative up to 5+2 from 1+1 at between 68 m2 - 615 m2 on second bosphorus of istanbul city.

5.1.1.4 Valuation, Assumptions, and Sensitivity Analysis

Sinpas REIT plans to develop 3,070 housing units with three phases. All in all, the project is expected to start in April 2008 and completed by the end of 2013. Nevertheless, as the project will be completed in phases, its contribution to NAV will be gradual.

*** Assumptions;**

* Company is going to sold totally 373K square meter housing are, which is equal to 3.070 housing unit. The size of the home is change between 68m²-615m² and square meter of each is between 1.900 USD/sqm-3500 USD/sqm. Table below shows the projected revenues for Halkali project. Selling prices of each type of house unit is taken from company's financials.

Type of House	Avg. Selling Price(000 US$)	# of Units	Revenue(US$mn)
Waterfront Villa	2350	26	61
Waterside Apartments	700	245	172
Yeditepe Towers	153	2349	359
Saraybahce Houses	550	450	248
TOTAL		**3070**	**839**

Table 8: Selling Price of Each House Unit

* At the end of the project expected revenue is US$839mn. On the other hand, company's projected costs are estimated as US$541mn. The average revenue per square meter is US$2250 sqm/m² and average cost per square meter is US$1471 sqm/m².

* Actually project has started at 2006 by Sinpas but in our case estimated starting date of the project will be in 2009. The project divides into 3 phases. The first phase will be completed in one year. The first phase is about land acquisition and permitting. The second phase is designing and the last phase is construction. Second phase and third phase will be take 2 years to complete. So end of the 2013 the project will be finished.

* Company will kick-off to collect revenues in 2011 when the designing phase will complete. This will help company to finance the project. The construction phase will start in 2012 and will finish at the end of 2013. When construction phase will finish, the sales of houses will also complete.

* Although starting year of the project is 2009 company has intended to collect land in 2008, This circumstances won't effect the project since there is an opportunity to evaluate land in another real estate project if current project will be abandoned.

* According to investment scenario, company will buy land in 2009, then it will continue with designing phase in 2010 and 2011, and lastly Sinpas will do construction in 2012 and 2013.

* NPV method is used for valuing the Sinpas's Halkali project. 30-year US$ dominated Eurobond interest rate, which is 8%, is selected as a risk free rate. Further, market risk premium is taken as 5% and beta is decided as 1, since real estate sector have positive correlation with general economic outlook. The company is fully financed with equity. Under these assumptions the rwacc is calculated as 13%.

*** NPV Calculation:** According to NPV valuation, value of the firm is found US$110mn.

US$ million	2008E	2009E	2010E	2011E	2012E	2013E	TOTAL
Revenues	0	0	0	210	342	287	**839**
Construction Costs	90	70	27	42	147	173	**549**
FCF	-90	-70	-50	168	208	132	
NPV	**110 TL**						
Rf	8%						
Risk Premium	5%						
Beta	1						
Rwacc	13%						

Table 9: DCF Valuation of Halkalı project

*** Sensitivity Analysis**

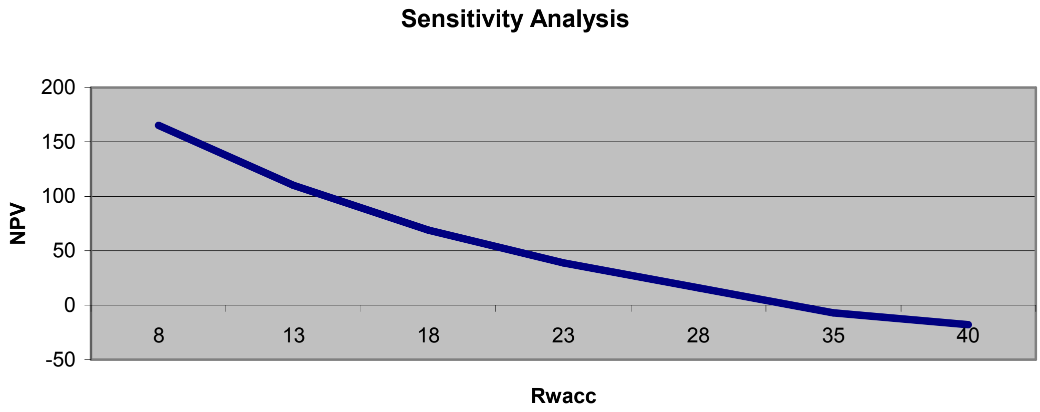

Figure 2: Sensitivity Analysis of Halkali Project DCF Valuation

Although project has positive NPV, there is probability that value of the project could decrease. According to sensitivity analysis the value of the project diminishes, if weighted average cost of capital will rise. For instance, if rwacc exceeds 30%, project becomes invaluable.

5.1.1.5 Why Using Real Options in Valuation is More Meaningful?

The DCF of Halkali Project shows US$110mn value, which is thought as an acceptable. On the other hand, this is not certain that project will have positive value since project will take five years to complete. During that time macroeconomics outlook could change negatively, thus could happen to fluctuation at the cost of investments. A rise in investment cost could result for negative project value. Real options analysis is a fairly new approach for valuing managerial flexibility in investment decisions. These decisions can be related for example to deferring, extending or abandoning the project. According to real options thinking, investments are characterized by sequential and irreversible investments made under conditions of uncertainty (Dixit and Pindyck 1995). The expression real options stems from utilizing and adapting the mathematics commonly used in valuing financial options related to some uncertain real investments.

Halkali project of Sinpas will take 5 years to complete. Since the project takes long time to complete, uncertainty of accomplishment of the project is high. Pindyck (1993) discusses in detail the implications for investment decisions of two types of cost uncertainty for projects that take time to complete. The first type of cost uncertainty is technical uncertainty, i.e., uncertainty over the physical difficulty of completing a project, such as how much time, effort, and materials will ultimately be required for completing the project. Such uncertainty is only resolved as the investment proceeds but is largely diversifiable. The second type of cost uncertainty is input cost uncertainty, i.e., uncertainty over the prices of construction inputs or over government regulations affecting construction costs. Such uncertainty is external to the firm and may be partly non-diversifiable.

Divide project into sequential phases is useful for decreasing the uncertainty. Project will continue, if there is positive cash flow on each phase. In other words, previous phase is the prerequisite of the following phase. The project contains five years of investment with costs of US$150, US$50, US$250 millions for each phases. The company considers whether the project has positive expectation at the end of each year and whether it should be continued or not. After each phase will complete with a positive NPV, company will pass the next phase.

Traditional approaches of valuation such as discounted cash flows analysis actually cannot capture the whole project. Since it is assumed that investment decision is irreversible, and interactions between today decisions and future decisions are not considered. Furthermore, Traditional investment theory holds that investments should be made when the simple NPV of an investment opportunity equals or exceeds zero and assumes that the investment must be made either now or never. Such an investment approach, however, fails to consider that management can adapt and revise its strategies in response to unexpected market and technological developments that cause cash flows to deviate from their original expectations. The traditional approach thus ignores the possibility that capital investments can be started at some other time.

"Real option models are more focused on describing uncertainty and in particular the managerial flexibility inherited in many investments. Discounted cash flow (DCF) and net present value (NPV) are traditional tools used for evaluation of projects and investment decisions. This method determines project value by discounting expected future cash flows at an appropriate risk-adjusted rate and then subtracts the cost of any investments "(Copeland & Keenan, 1998).

According to Copeland and Antikarov, NPV, the dominant approach for valuing investments, "systematically undervalues every investment opportunity" because of its failure to incorporate management flexibility. They argue that "real options will replace NPV as the central paradigm for investment decisions" within ten years. (Copeland and Antikarov, 2001.) Precisely, they claim that their approach to real options is applicable to every, or nearly every, major corporate investment decision where value maximization is the goal. Further, Trigeorgis (1998) takes a similar view. The goal of the firm is to maximize its market value, and consequently the wealth of its shareholders. NPV provides inadequate guidance in this effort because of its inability to value flexibility and learning appropriately. Real options analysis expands the concept of NPV to include these factors, and provides a more accurate estimate of value for virtually all corporate investments.

Amram and Kulatilaka argue that various kinds of investments, including those where flexibility and/or uncertainty has relatively little impact. They mention that real options analysis is not needed in these cases. In contrast, it is needed in staged investments with considerable uncertainty and the possibility of learning. (Amram and Kulatilaka, 1999)

While the project is operated, managerial flexibility can generate additional value for an investment opportunity because managerial capability can respond when new information presents. Management can use real options to increase asset value under favorable situations or limit loses under unfavorable circumstances.

5.1.1.6 Valuation of Halkali Project by Using Real Options

The valuation process is done according to the four stages process of Copeland and Antikarov (2001). The first step in the model is the calculation of the net present value of the project less the investment costs using weighted average cost of capital or some other justified discounting rate. This is assumed to represent project value without flexibility. In the second stage, an event tree is built to model the uncertainty and dynamic behavior of the underlying value describing how much the value is likely to move up and down during the investment period. This is usually done with CRR binomial tree (Cox, Ross and Rubinstein 1979). The third step is to identify and incorporate managerial flexibility into the event tree. In fourth step, the real options analysis is conducted using simple binomial methodology with back-rolling and risk-neutral valuation.

Real options analysis (ROA) is a fairly new approach for valuing managerial flexibility in investment decisions. These decisions can be related for example to deferring, extending or abandoning the project. The real option approach is used for valuing Halkali project of Sinpas. The investment decision has been taken by comparing future cash flows of revenues and costs. The all steps of Copeland and Antikarov's valuation method is applied to Halkali case of Sinpas. The value of the real option analysis solved by binomial method is US$132mn. It represents additional US$22mn to firm value because the project value was US$110mn according to NPV. Binomial valuation of Halkali project is shown at below.

5.1.1.7 Identify the input parameters for Halkali Project

*** The Underlying Asset (So):** The value of the underlying asset is represented by present value of projected cash flows and it is calculated from NPV of the project. It's calculated as US$452mn for Sinpas Halkali project.

*** The Exercise Price (X):** It represents investment cost of the project. In Sinpas case there is 3 different strike pirces because project is divided into three phases. These phases are landing and permitting, designing, and constructing phases, respectively. The strike price of the first phase is US$150mn, second phase is US$50mn, and last phase is US$250mn.

*** Time to Maturity (δt):** Project will take five years to complete. The time of the first phase is one year, second and third phases are two years. Time intervals for binomial model is one year.

*** Risk Free Rate (r):** 30 year US$ denominated Turkish Eurobond is used as risk free rate.

*** The Volatility of Underlying Asset (σ):** It's most difficult element to find because the underlying asset is not traded. Monte Carlo simulation is use for deciding variance. In a Monte Carlo simulation, various cash flow profiles are simulated over the project life, and a volatility factor is associated with each simulations. Luehrman (1998) advised that the observed risk for a financial market index could be used a proxy for the project. Secondly, the volatility could be estimated from historical data regarding similar projects from related industries. Thirdly, volatility could be obtained from probability distribution of projected cash flows, when applying Monte Carlo simulation.

The input data is generated based on historical information and management estimates. In sinpas case, the revenue estimate volatility and cost estimate volatility from logaritmic returns of projected revenue and cost cash flows is calculated. Monte Calo simulation is used for calculat,ng variance because number of observation using for calculating the variance is limited. Therefore, the simulation method creates more insightful results for the variance of underlying asset. In a Monte Carlo simulation results shows that average annual volatility of 35% for the underlying asset value with a standard deviation of 10%.

Volatility Factor Estimation
DCF - Monte Carlo Simulation

Input Data

Investment	$343	million
Revenue estimate volatility	10%	annual %
Risk-adjusted discount rate	8%	annual %
Cost estimate volatility	12%	per cent

Results ($ million)

Average volatility	35%
Std dev of volatility	10%
Max	102%
Min	15%

Table 10: Monte Carlo Simulation

S_o = \$452 million

X_1, X_2, and X_3 = \$150, \$50, \$250 million, respectively.

T_1, T_2, and T_3 = 1,3, and 5 years, respectively (cumulative option life for each stage)

$\sigma = 35\%$

$r = 8\%$

$\delta t = 1$ year

Calculation of the option parameters

$u = \exp(\sigma\sqrt{\delta t})$

$= \exp(0.35*\sqrt{1})$

$=1.419$

$d = 1/u$

$=1/1.419$

$= 0.705$

$p = (\exp(r\delta t)-d) / (u-d)$

$p = (\exp(0.08*1) – 1) / (1.419-0.705)$

$p = 0.530$

5.1.1.8 Binomial Model for Bosphorus Model

Sequential Option
Sinpas-Bosphorus Project

Input Data

Present value of future cash flows	$452	million
Volatility	35,0%	annual
Risk-free interest rate	8,0%	annual
Option life for Phase I	1	years
Investment cost of Phase I	$150	million
Option life for Phase II	3	years
Investment cost of Phase II	$50	million
Option life for Phase III	5	years
Investment cost of Phase III	$250	million
Discount rate for investments	13%	annual
Time step	1	year(s)

Results ($ million)

PV Phase I investment	$150
PV Phase II investment	$39
PV Phase III investment	$153
NPV	$110
ROV	$132
Value added	$23

Calculated Parameters

Up factor (*u*)	1,419
Down factor (*d*)	0,705
Risk-neutral probability (*p*)	0,530

Asset Valuation Lattice

Time period	0	1	2	3	4	5
Valuation of underlying asset	$452	$641	$910	$1.292	$1.833	$2.601
($ million)		$319	$452	$641	$910	$1.292
			$224	$319	$452	$641
				$158	$224	$319
					$111	$158
						$79

Option Valuation Lattice (Phase III)

Time period	0	1	2	3	4	5
Valuation of Phase III option	$295	$463	$714	$1.079	$1.602	$2.351
($ million)		$158	$263	$428	$679	$1.042
			$67	$123	$221	$391
				$16	$34	$69
					$0	$0
						$0

Option Valuation Lattice (Phase II)

Time period	0	1	2	3
Valuation of Phase II option	$258	$421	$667	$1.029
		$121	$217	$378
			$36	$73
				$0

Option Valuation Lattice (Phase I)

Time period	0	1
Valuation of Phase I option	$132	$271
		$0

Combined Valuation Lattice

Time period	0	1	2	3	4	5
Valuation of combined option	$132	$271	$667	$1.029	$1.602	$2.351
		$0	$217	$378	$679	$1.042
			$36	$73	$221	$391
				$0	$34	$69
					$0	$0
						$0

Table 11: Binomial model for Bosphorus project

5.1.1.9 Binomial Tree and Calculation the Asset Value of Node

Sinpas is considering to invest to build 3.070 housing unit till to 2013. Despite the positive expectation for the sales, there is still some market uncertainty regarding future sales; therefore the company wants to use the options approch to value the project for a go/no-go decision. The project is divided into 3 sequantial bases; land acquisition and permitting, designing, engineering and construction. Each phase should be completed before the next phase begin.

The construction will take two years to complete, and hence the company has a maximum five years to decide whether to start construction.The design phase will take two years to complete, and since design is a prerequisite to construction, the company has maximum has three years to invest in design and engineering phase. The permitting process will take two years to complete, and it must be completed before the desing phase can begin,the company has maximum of one year from today to decide on permitting. Permitting and land acquisition is expected to cost US$150 million, design will cost US$50 million, and construction will cost US$250 million. Discounted cash flow analysis using an appropriate risk adjusted discount rate values the plant at US$452 million. The annual volatility of the logarithmic returns for the future cash flows of the plant is estimated to be 35%, and the risk free rate is taken as 8% for the period.

Binomial tree calculates the asset values over the life of the option. Start it So and multiply it by up factor and the down factor to obtain Su and Sd, respectively. For the first time step: Su = US$452 million * 1.419 = US$641 million; Sd = US$452 * 0.705 = US$319 million.

There are three sequential options available on this project. Construction is depend on design, which in turn is dependent on permitting. The option value calculation are done in sequence. First of all option values should be calculated by using binomial tree. By using backward induction the option values becomes the underlying asset for the preceding option. The longest option is the construction option which is asset value for design option. And also design option is the underlying asset value for permitting and land acqusition option.

Asset Valuation Lattice

Time period	0	1	2	3	4	5
Valuation of underlying asset	$452	$641	$910	$1.292	$1.833	$2.601
($ million)		$319	$452	$641	$910	$1.292
			$224	$319	$452	$641
				$158	$224	$319
					$111	$158
						$79

Table 12: Asset valuation lattice for Bosphorus project

Figure shows the option values for the longest dependent option, which is construction, at each node of the binomial tree calculated by backward induction. Each terminal node represents the value maximization of exercising the option by investing US$250 million versus letting the opiton expire. Each intermediate nodes represents the value maximization of continuation versus exercising the option.

At node Su5, the expected asset value is US$2.601 million. If company invest US$250 million, the net payoff will be US$2.601- US$250 million = US$2.351. As company's objective is maximize the return, company would exercise the option by investing. Thus the option value at this node becomes US$2.351.

At node Sd5, the expected value is US$79 million. Company would not invest, because the expected value is less than the investment cost of US$250 million. Therefore, the option value would be zero.

At node Su4, one step away fro the last time step, the value of the node is 1.602. The calculation is,

[p(Su5) + (1-p)(Su4d)] * exp (-rδt)

= [0.530(US$2351 million)+ (1 – 0.530)*(US$1042 million)] * exp(-0.08)(1)

=US$1602 million.

If the option exercised by investing US250 million, the expected value of the asset would be US$1583 million. Company would not exercise the option, since it is less than the US$1602 million. So the option value in this node would be US$1602 million.

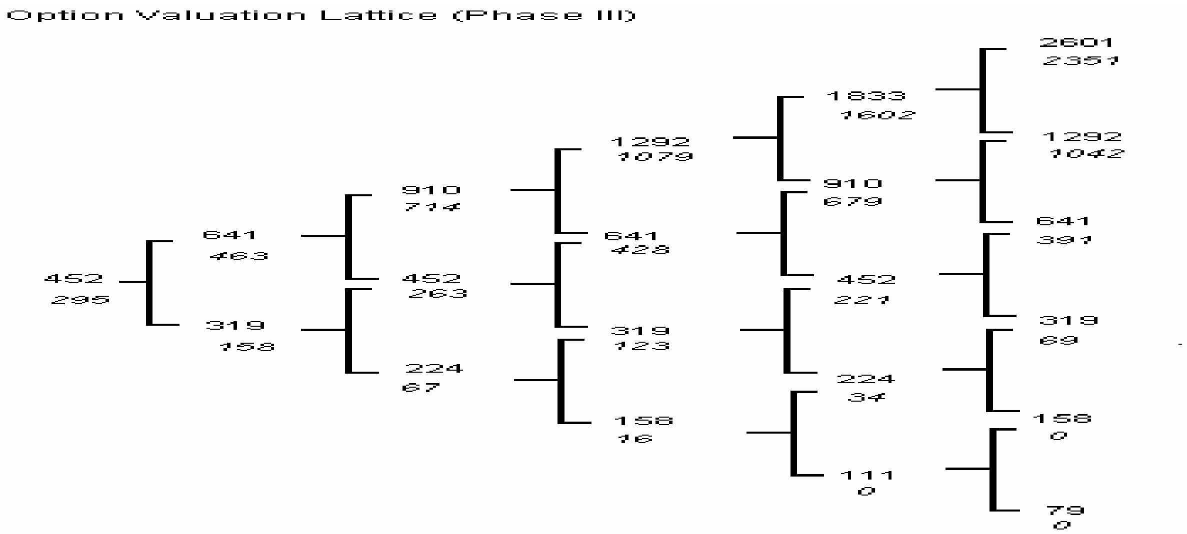

Figure 3: Option Valuation Lattice (Phase III)

5.1.1.10 Designing and Engineering Option

Exercising the option to design creates the option to construct.; hence construction option values are treated as the underlying asset values for the calculation. Figure shows the underlying asset values for the first three years, which are the same as the option values for the construction option.

Option Valuation Lattice (Phase III)

Time period	0	1	2	3
Valuation of Phase III option	$295	$463	$714	$1.079
($ million)		$158	$263	$428
			$67	$123
				$16

Table 13: Designing option valuation lattice

Each node represents the value maximization of investing versus continuation, where company have the option to either invest US$50 million in the project or continue to keep option open until it expires. At the terminal nodes, company would invest if the payoff is greater than the investment of US$50 million.

At node Su^3, the expected value of the asset is US$1079 million. If company invest US$50 million to design the housing, the net payoff will be US$1029 million. Company would exercise the option by investing, because of the companies objective is maximize the return.

At node Sud^3, the expected value of the asset is US$16 million. Since this is less than the investment cost of US$50 million, company would not invest and would let the option expire. Therefore, the option value would be zero.

At node Su^2, the expected asset value for keeping the option open is US$667 million. The calculation is,

$[p(Su^3) + (1-p)(Su^2d)] * \exp(-r\delta t)$

= [0.530(US$1029 million)+ (1 – 0.530)*(US$378 million)] * exp(-0.08)(1)

= US$667 million.

On the other hand, if the option is exercised by investing US$50 million, the expected value of asset would be US$714 million-US$50 million = US$664 million.

Company would not exercise the option because the option value is less US$667 million. At a result , the option value at this node would be US$667 million.

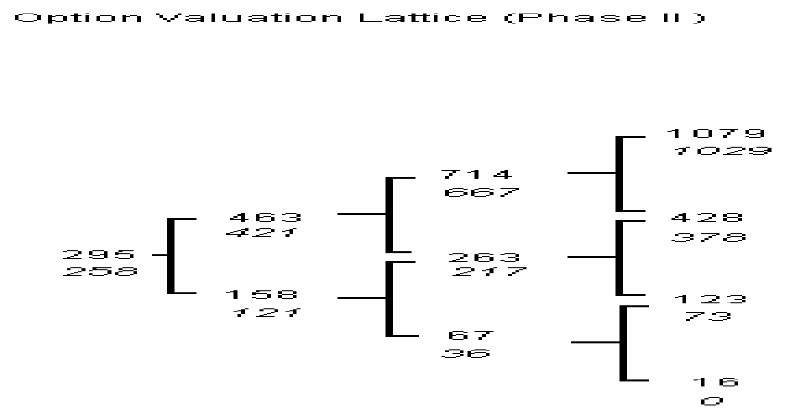

Figure 4: Option Valuation Lattice (Phase II)

5.1.1.11 Permitting and Land Aquisition Option

The life of the permitting and acquisition option is one year, and the underlying asset values of this option are the same as the option values for the design and engineering option. Exercising the option to apply for permit creates the option to design the housing, and so the the desin option values are treated as the underlying asset for the calculation.

Option Valuation Lattice (Phase II)

Time period	0	1
Valuation of Phase II option	$258	$421
		$121

Table 14: Permitting option valuation lattice

The figure shows the underlying asset values for the first year. The option values are the same design option values. Each node represents the value maximization of investing versus continuation, where company has the option to either invest US$150 million to obtain the permit and benefit from the payoff or continue to keep the option open until it expires. At the terminal nodes, company would invest if the payof is greater than the investment of US$150 million.Otherwise, company would let the option expire worthless.

At node Su, the expected value od the asset is US$421 milion. If company invest US$150 million to apply for land acquisiton and permits, the net payoff will be US$421 million – US$150 million = US$271 million. So company would exercise the option by investing. Therefore, the option value at this node becomes US$271 million.

At node Sd, the expected asset value is US$121 million. If company invest US$150 million for land acquisition and permits, the net payoff will be $US121 million - $US150 million =

-US$29 million. Since company's objective is to maximize the return, company would not exercise its option. Thus, the option value at this node becomes zero.

At node So, the expected asset value for keeping the option open is US$132 million. The calculation is;

[p(Su) + (1-p)(Sd)] * exp (-rδt)

= [0.530(US$421 million)+ (1 – 0.530)*(US$O million)] * exp(-0.08)(1)

= US$132 million.

If the company exercise the option by investing US$150 million, the expected aset value would be US$258 million – US$150 million = US$108 million. Since this value is less than the US$132 million, Sinpas would not exercise the option, and the option value at this node would be US$132 million.

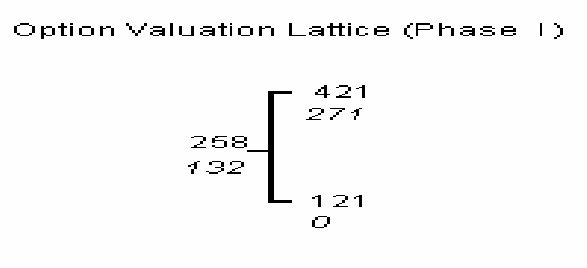

Figure 5: Option Valuation Lattice (Phase I)

5.1.1.12 Analyze the Results

Input Data

Present value of future cash flows	$452	million
Volatility	35,0%	annual
Risk-free interest rate	8,0%	annual
Option life for Phase I	1	years
Investment cost of Phase I	$150	million
Option life for Phase II	3	years
Investment cost of Phase II	$50	million
Option life for Phase III	5	years
Investment cost of Phase III	$250	million
Discount rate for investments	13%	annual
Time step	1	year(s)

Results ($ million)

PV Phase I investment	$150
PV Phase II investment	$39
PV Phase III investment	$153
NPV	$110
ROV	$132
Value added	$23

Table 15: Results of sequential option

First , the NPV of the project should be calculated by taking the difference between the expected payoff and the investment costs. The expected payoff is US$452 million and the PV of total investment amount is US$342 million., which represents US$110 million NPV. Although The project has positive NPV, real option approach increases the NPV by adding US$23 million.The real options value show a total project value of US$132 million, yielding a additional value of US$23milion. Thus, consideration of the flexibility embedded in the project makes it more attractive.

If the market uncertainity clears by the end of the design phase and the project payoff is expected to be higher than the US$250 million required for the construction, Sinpas can move forward with the project. Otherwise, company may abandon it or wait for later consideration.

Multiple phase projects have a particular advantage in an option framework, when competitors face significant barriers to entry and there is a great deal of uncertainty about the market demand. The disadvantages include higher costs due to loss of economies of scale and loss of market to a competitor that may have entered the market full scale.

A examination of Halkali project options results indicates that the ROVs for to land acquisition and permit, desing, and construct are US$132 million, US$258 million, and US$295 million, respectively. The value of the option increases because of the increase in uncertainty as afunction of time.

In this example, option lives of one, three, and five are used for permitting, design, and construction, respectively. The individual option lives represent the amount of time the company has to make go/or no go decision on the next phase and invest in it. For example, Sinpas has a maximum of three years to decide to go forward with the design and invest in it. Then the company has an additional two years to decide on and start the construction. The total and individual option lifes depend on the amount of time it takes to complete each of the phases.

If expected pay off realizes less than the invested amount, company can use real options to prevent losses. Sinpas can abandon, wait, and contract the project if it correspond with negative cash flow in each phase.

Breaking a project into phases offers advantages when company afford to delay the project possibly due to competitors facing high barriers to entry, significant investment costs especially toward the frontend of the project, and potential future opportunities for expansion. However, company may lose economies of scale, resulting in higher costs, and allow the competition to capture the market. Whereas the availability of the squential compound options is obvious in multiphase projects, formal valuation of the options provides quantitative data to help management make more rational decisions.

5.2 REYSAS (Vehicle Inspection Project) – Option to Abandon

Reysas is one of the leading logistics and container transportation companies in Turkey, with two significant business lines, logistics operations comprised of integrated logistics and warehousing, and transportation (road and railway transportation).

With a total fleet size of around 1,634 (trucks and trailers) and its effective network locations, Reysas has long-term contracts to provide Just-in Time and Optimization Logistics services to some of the largest Turkish corporate firms.

The company's IPO was in February 2006 at a price of YTL4.0/share, resulting in a cash injection of YTL60mn (US$45 mn). Free float was 34.5% at that time; however, following the participant's sales on ISE in October 2006 and January 2007, the free float increased to 58.8%.

Since its IPO, Reysas not only kept its promise to the market (especially in the warehousing and logistics segments) but also established new affiliates to focus more on maritime transportation. Company facilitates in auto transportation, warehousing, logistics (*by trucks and by non-fuel railway cars),* petroleum products transportation, and container transportation.

Besides these operations, company has get franchise license from Tüvturk for operate 5 vehicle inspection services in Turkey.

5.2.1 Vehicle Inspection

TUVTURK, a joint venture of Dogus Otomotiv, Akfen Holding, and German TUV SUD, was finally awarded a 20-year concession contract on 15 August 2007 to operate and build vehicle inspection stations following the decision of the Supreme Privatization Board. The deal covers the construction, maintenance, and operation of 189 stationary stations, 433 inspection lanes, and 38 mobile stations. In other words, the consortium has to maintain an inspection network covering 88 cities of Turkey within 18 months. Therefore, the consortium decided to hand over the inspection centers' concession rights to regional subcontractors in exchange for franchising and a royalty fee. Note that TUVTURK already franchised all the vehicle inspection stations to subcontractors; Reysas became one of the main beneficiaries by signing five contracts to perform inspection business in five different cities of Turkey.

5.2.2 Rysas's Vehicle inspection project

Reysas acquired the operating rights to five inspection centers located in the cities of Zonfuldak, Bartin, Karabuk, Kastamonu, and Eskişehir in Turkey. Based on the 20- year concession contract between TUVTURK and Reysas, the company is obliged to pay a license fee of US$21 million for five regions and a royalty fee in varying rates during the concession duration (7% of annual gross revenues for the first 10 years and 20% till the concession ends).

In exchange for the license fee, TUVTURK is responsible for the construction process, including machinery, equipment, IT, and the training of personnel Reysas will conduct periodic inspections and exhaust emission tests, and at the same time will issue date-specific certificates starting in October 2008.

However, the severe increase in royalty fees and treasury share starting in the eleventh year of the concession will mute the possible growth opportunity for Reysas.

Note that the revenue growth in the second half of the concession contract is projected to be elevated on the back of increased car park and the higher capture rate. The inspection capture rate stands at 60%, relatively lower than inspection rate of EU countries, which stands at around 80%.

5.2.3 Vehicle inspection project valuation

To determine the implied value for vehicle inspection project, I used a 20- year DCF valuation method to capture the effects of all inspection stations located at five different cities. I did not compute a terminal value in our 20-year DCF model, as Reysas will operate under a concession contract that will be valid until October 2028. The set of assumptions, key facts, and figures is summarized;

5.2.4 Key facts and figures

• The concession contract signed between TUVTURK and Reysas will be valid for 20 years.

• As a subcontractor of five inspection centers, Reysas will pay a total franchising fee of US$21 million plus a royalty fee in varying rates during the concession duration.

• Reysas is obliged to pay 25% of the total license fee in advance; the remaining 75% will be paid within 18 months before the inspection centers become operational.

• The vehicle inspection prices are determined by the General Directorate of Highways and increased by the revaluation rate each year.

Vehicle Inspection Prices exc. VAT (TRY)	
Passenger Vehicles	88
Minibus	88
Bus	117
Trucks	117
Motorcycles	46
Multipurpose Vehicle	88
Tractor	46

Source: TUVTURK

Table 16: Vehicle inspection prices

• Car park in Turkey increased by 7.3% per annum between 1992 and 2006. With economical and political stability and the increase in GDP per capita, TUVTURK estimates the car park fleet to grow by 7% each year going forward.

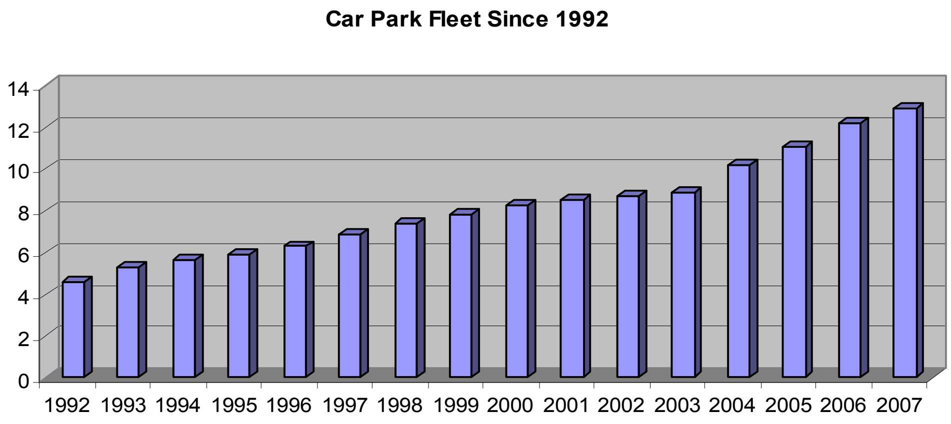

Figure 3: Car park fleet in Turkey

• The General Directorate of Highways sets the mandatory timeline for inspection periods according to the type of vehicle. For example, passenger vehicles must be inspected every two years after the third year, but commercial vehicles are subjected to inspection every year after the first year of use.

Vehicle Inspection Periods
Private Passenger Vehicles
At the end of the first years, later every 2 years
Official Passenger Vehicles (state owned)
At the end of the first years, later 2 years
2 and 3 wheeled vehicles
At the end of the first 3 years, later every 2 years
All other motor vehicles
Every year
Source: TUVTURK

Table 17: Vehicle inspection periods

5.2.5 DCF Model Assumptions

5.2.5.1 Car park level

TUVTURK foresees the Turkish car park being elevated by 7% per annum in the coming decade. However, to be on safe side, i expect the car park in Reysas's operating regions to rise averagely by 4%. The car park expansion in the Eskisehir region is 1pp higher than other cities, since Eskisehir is one of the Turkey's foremost industrial cities

Reysas Car Park (units)	2009E	2010E	2011E	2012E	2013E	2014E	2015E	2016E	2017E	2018E
Eskisehir	177.500	186.375	195.694	205.478	215.752	226.540	237.867	249.760	262.248	275.361
yoy chg(%)		5%	5%	5%	5%	5%	5%	5%	5%	5%
Zonguldak	96.600	100.464	104.483	108.662	113.008	117.529	122.230	127.119	132.204	137.492
yoy chg(%)		4%	4%	4%	4%	4%	4%	4%	4%	4%
Bartin	27.900	29.016	30.177	31.384	32.639	33.945	35.302	36.714	38.183	39.710
yoy chg(%)		4%	4%	4%	4%	4%	4%	4%	4%	4%
Karabuk	38.400	39.936	41.533	43.195	44.923	46.719	48.588	50.532	52.553	54.655
yoy chg(%)		4%	4%	4%	4%	4%	4%	4%	4%	4%
Kastamonu	72.000	74.880	77.875	80.990	84.230	87.599	91.103	94.747	98.537	102.478
		4%	4%	4%	4%	4%	4%	4%	4%	4%
TOTAL	412.400	430.671	449.762	469.709	490.552	512.332	535.090	558.873	583.725	609.697

Table 18: Estimated car park level assumption in Turkey

5.2.5.2 Capture Rate

I assign several capture rates for each inspection center, as the capture rate differs among the regions. In DCF period, the capture rate for each inspection center generally rises to 80% in 10 years, and then remains at same level for the rest of the concession contract.

Capture Rate (%)	2009E	2010E	2011E	2012E	2013E	2014E	2015E	2016E	2017E	2018E
Eskişehir	75%	76%	77%	77%	77%	78%	78%	78%	79%	80%
Zonguldak	71%	72%	74%	75%	75%	76%	75%	76%	76%	77%
Bartin	70%	71%	72%	72%	72%	73%	75%	74%	75%	76%
Karabük	77%	78%	78%	79%	79%	79%	79%	79%	80%	80%
Kastamonu	72%	73%	73%	74%	74%	74%	74%	75%	76%	77%

Table 19: Estimated capture rates for inspection centers

5.2.5.3 Inspection fee & total number of inspected vehicles

The vehicle owners are required to pay an official inspection fee, which thus far is determined by General Directorate of Highways. The inspection fees are increased by the revaluation rate each year going forward.

Number of Inspected Vehicles	2009E	2010E	2011E	2012E	2013E	2014E	2015E	2016E	2017E	2018E
Eskişehir	66.563	70.823	75.342	79.109	83.065	88.351	92.768	97.407	103.588	110.144
Zonguldak	34.293	36.167	38.659	40.748	42.378	44.661	45.836	48.305	50.237	52.934
Bartin	9.765	10.301	10.864	11.298	11.750	12.390	13.238	13.584	14.319	15.090
Karabük	14.784	15.575	16.198	17.062	17.744	18.454	19.192	19.960	21.021	21.862
Kastamonu	25.920	27.331	28.424	29.966	31.165	32.412	33.708	35.530	37.444	39.454
Inspection Fee (US$)	76	79	82	85	89	92	96	100	104	108
		4%	4%	4%	4%	4%	4%	4%	4%	4%

Table 20: Estimated inspection fee & total number of inspected vehicles

5.2.5.4 Treasury share and royalty fees

According to the 20-year concession agreement, Reysas is obliged to pay 7% of its revenue as a royalty fee to TUVTURK for the first ten years; afterward, the share of royalty fee will increase to 20%. The treasury share in the second half of the concession contract also officially soars to 50%.

Cost Breakdown	1-10 years	10-20 years
Treasury*	37%	50%
Royalty Fee	7%	20%
Personnel Cost	7%	7%
Other Expenses	4%	4%

* First 3 years treasury will get 30% of sales and the rest of 7 years it will get 40% of sales.

Table 21: Treasury share and royalty fees

5.2.6 Vehicle Inspection DCF Valuation

Using a risk-free rate of 8% and an equity risk premium of 5%, and 9% cost of debt, i reached a WACC of 12%. Model does not contain a terminal value and implies the fair value of inspection centers as US$5 million, in which Reysas owns 90% of the company.

I take cost of debt as 9% because company has taken up a US$10 mn loan at the end of the 2007 from an international bank by paying yearly Libor+3,60. The US$ 12 month libor rate was 5.40 during that time.

I assign US$0.5 million to long-term maintenance CAPEX after the completion of the inspection centers.

DCF valuation for the vehicle inspection project yields an equity value of US$5 million, indicating Reysas's stake as US$4.5 mn at Reysas Tasit Muayene Istasyonlari Isletim AS. DCF model reaps the cash flow impact till the concession ends.

Reysas- Vehicle Inspection Project DCF Valuation (US$ mn)

	2009E	2010E	2011E	2012E	2013E	2014E	2015E	2016E	2017E	2018E	2019E-2028E
Revenues	**8,4**	**9,4**	**10,5**	**11,6**	**12,6**	**13,9**	**15,1**	**16,5**	**18,3**	**20,4**	*176,7*
Growth		12%	11%	10%	9%	11%	8%	10%	11%	11%	
Eskişehir	3,8	4,3	4,8	5,2	5,7	6,4	7,0	7,6	8,5	9,5	*84,9*
Zonguldak	1,9	2,1	2,4	2,6	2,8	3,1	3,3	3,7	4,0	4,4	*37,4*
Bartin	0,5	0,6	0,6	0,7	0,8	0,8	1,0	1,0	1,1	1,2	*10,5*
Karabük	0,9	1,0	1,0	1,2	1,2	1,3	1,5	1,6	1,7	1,9	*16,0*
Kastamonu	1,4	1,6	1,7	1,9	2,1	2,2	2,4	2,7	3,0	3,3	*27,8*
EBIT	**4,7**	**5,3**	**5,9**	**5,3**	**5,8**	**6,4**	**6,9**	**7,6**	**8,4**	**9,4**	*40,6*
EBITDA	**5,7**	**6,3**	**6,9**	**6,3**	**6,8**	**7,4**	**7,9**	**8,6**	**9,4**	**10,4**	*46,4*
EBITDA Margin	*68%*	*67%*	*66%*	*55%*	*54%*	*53%*	*53%*	*52%*	*51%*	*51%*	
Eskişehir	1,7	1,9	2,1	2,8	3,1	3,4	3,8	4,1	4,6	5,1	*65,4*
Zonguldak	0,8	0,9	1,0	1,4	1,5	1,7	1,8	2,0	2,1	2,4	*28,8*
Bartin	0,2	0,3	0,3	0,4	0,4	0,5	0,5	0,5	0,6	0,7	*8,1*
Karabük	0,4	0,4	0,5	0,6	0,7	0,7	0,8	0,9	0,9	1,0	*12,3*
Kastamonu	0,6	0,7	0,8	1,0	1,1	1,2	1,3	1,4	1,6	1,8	*21,4*
Operating Profit	**4,4**	**4,9**	**5,5**	**4,9**	**5,3**	**5,8**	**6,3**	**6,9**	**7,7**	**8,6**	*33,6*
Operating Margin	*52%*	*52%*	*52%*	*42%*	*42%*	*42%*	*42%*	*42%*	*42%*	*42%*	
Eskişehir	0,15	0,17	0,19	0,21	0,23	0,25	0,28	0,30	0,34	0,38	*3,4*
Zonguldak	0,07	0,08	0,09	0,10	0,11	0,13	0,13	0,15	0,16	0,18	*1,5*
Bartin	0,02	0,02	0,03	0,03	0,03	0,03	0,04	0,04	0,04	0,05	*0,4*
Karabük	0,03	0,04	0,04	0,05	0,05	0,05	0,06	0,06	0,07	0,08	*0,6*
Kastamonu	0,06	0,06	0,07	0,08	0,08	0,09	0,10	0,11	0,12	0,13	*2,08*
Tax	0,9	1,0	1,1	1,0	1,1	1,2	1,3	1,4	1,5	1,7	*6,7*
Depreciation	1,0	1,0	1,0	1,0	1,0	1,0	1,0	1,0	1,0	1,0	*5,8*
Capex	21	0,5	0,5	0,5	0,5	0,5	0,5	0,5	0,5	0,5	*2,9*
Free Cash Flow	-18	2	3	2	3	3	4	4	5	5	*18,2*
PV of Free Cash Flows	5										
Risk Free Rate	8%	8%	8%	8%	8%	8%	8%	8%	8%	8%	
Risk Premium	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	
Cost of Equity	13%	13%	13%	13%	13%	13%	13%	13%	13%	13%	
Cost of Debt	9%	9%	9%	9%	9%	9%	9%	9%	9%	9%	
Cost of Debt After Tax	7%	7%	7%	7%	7%	7%	7%	7%	7%	7%	
Weight of Equity	75%	75%	75%	75%	75%	75%	75%	75%	75%	75%	
Weight of Debt	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%	
WACC	12%	12%	12%	12%	12%	12%	12%	12%	12%	12%	

Table 22: DCF model for Rysas's vehicle inspection project

Reysas has got license from Tüvturk to operate 5 vehicle inspection stations for 20 year. Company has paid US$21 million for the royalty fee. Project will start at the begining of the 2009. According to the 20-year concession agreement, Reysas is obliged to pay 7% of its revenue as a royalty fee for the first ten years; afterward, the share of royalty fee will increase to 20%. The treasury share is 30% for the first three years; afterward it will increase to 40% till to 10 th year agreement and also in the second half of the concession contract also officially soars to 50%.

These conditions are pressing the profit margin of the company. On the other hand, this project provides stable revenue for the Rysas. As the uncertainty raises and if the payoff loss its attractiveness, company can abandon project early on without incurring a significant losses. The losses can be minimizing by selling off the project.

The discounted cash flow analysis on Reysas's vehicle inspection project shows that the present value of the payoff discounted at an appropriate market risk-adjusted rate would be US$4,5 million. At any time during the next five years Rysas can either continue or sell off its rights for salvage of US$10 million. Actually main problematic side of the abandonment option is deciding the salvage value. The abandonment option is valid for 5 years. Company has paid US$21mn for the licence fee. Actually licence has 20-year useful life, it depreciates equally for US$1mn in every year. At the end of the fifth year salvage value of the licence will decrease to US$15mn. I decided salvage as US$10mn because of the reason that value will give attractiveness to project for assuring potential buyers. The annual volatility of logarithmic returns of the future cash flows is 30%, and the riskless free rate is 8% (30 year Turkish-Eurobond).

5.2.7 Identify the input parameters for vehicle inspection project

So = $4,5 million

X = 10.

T = 5 years

σ = 30%

r = 8%

δt = 1 year

Calculate the option parameters

$u = \exp(\sigma\sqrt{\delta t})$

$= \exp(0.20*\sqrt{1})$

$=1.350$

$d = 1/u$

$=1/1.419$

$= 0.741$

$p = (\exp(r\delta t)-d) / (u-d)$

$p = (\exp(0.08*1) – 1) / (1.419-0.705)$

$p = 0.562$

5.2.8 Binomial Model for Rysas's vehicle inspection project

Option To Abandon
RYSAS- TUVTURK Project

Input Data

Present value of future cash flows	$5	million
Volatility	30%	annual
Risk-free interest rate	8%	annual
Time to expiration	5	years
Salvage value	$10	million
Time step	1	year(s)

Results ($ million)

NPV	$4,5
ROV	$10,0
Value added	$5,5

Calculated Parameters

Up factor (*u*)	1,350
Down factor (*d*)	0,741
Risk-neutral probability (*p*)	0,562

Asset Valuation Lattice

Time period	0	1	2	3	4	5
Valuation of underlying asset	$5	$6	$8	$11	$15	$20
($ million)		$3	$5	$6	$8	$11
			$2	$3	$5	$6
				$2	$2	$3
					$1	$2
						$1

Option Valuation Lattice*

Time period	0	1	2	3	4	5
Valuation of abandonment option	$10	$10	$10	$12	$15	$20
($ million)		$10	$10	$10	$10	$11
			$10	$10	$10	$10
				$10	$10	$10
					$10	$10
						$10

Table 23: Binomial Model for Rysas's vehicle inspection project

Each node represents the value maximization of abandonment versus continuation. At every node, company has an option to abandon the project for a salvage of US$10 million or continue keeping the option open until it expires.

At node Su5, the expected asset value is US$20 million, compared to the salvage value of US$10 million. Since company want to maximize the return, Reysas, would continue rather than abandon the project. Therefore, the option value at this node is US$20 million.

At node Sud4, the expected asset value is US$2 million, compared to the salvage value of US$10 million. This makes sense to sell off right and abandon the project, which makes the option value at this node is US$10 million.

At node Su4 the expected value of the asset is US$15 million. The calculation is;

[p(Su5) + (1-p)(Su4d)] * exp(-rδt)

= [0.562*(US$20 million) + (1-0.562)*US$11 million] * exp(-0.08)

= US$11 million

Rysas would keep the option open and continue, because this value is larger than the salvage value of US$10 million.

5.2.9 Analyze the result

The NPV value of the project is US$4,5 million. ROA, however, shows a total project value of US$10 million, yielding an extra US$5,5 million due to abandonment option.

There are many different paths leading to each node.The number of paths contributing to each node must be calculated before estimating the probability of exercising the option at the end of the option life. This can be done by using Pascal's triangle.

Pascal's Triangle	
Time 0	1
Year 1	1 - 1
Year 2	1 - 2 - 1
Year 3	1 - 3 - 3 - 1
Year 4	1 - 4 - 6 - 4 - 1
Year 5	1 - 5 - 10 - 10 - 5 - 1

Table 24: Pascal's triangle

Each node's value in this triangle is the sum of the values of the two nodes that lead up to that node. In five-step binomial lattice, this number is 32. The total number of paths corresponding to the four bottom end nodes where the abandonment option will be exercised in project is 26. Therefore, the probability that the project will be abandoned at the end of the option life is 26/32 = 72%.

PART 6

6.1 CONCLUSIONS

Traditional investment theory holds that investments should be made when NPV of an investment equals or exceeds zero and assumes that investment must be made either now or never. This investment approach, however, fails to consider that company can adapt and revise its strategies to unexpected market changes, which cause cash flows to deviate from their original expectations. So, traditional approach ignores the possibility that capital investment can be start at some other time. As Copeland and Antikarov say NPV systematically undervalues every investment opportunity because of its failure to incorporate management flexibility. (Copeland and Antikarov, 2001). Further, Trigeorgis (1998) has stated that "NPV provides inadequate guidance because of its inability to value flexibility and learning appropriately. And he added that real options analysis expands the concept of NPV to include these factors, and provides a more accurate estimate of value for virtually all corporate investments." Real options increase the value of the project by adding abandon, expand, contract, or wait option. In addition to this, it cuts the downside risk of the project. Real options are complementary of DCF valuation.The dissertation approves that real option increases the value of the project when uncertainty increase. The real option approach is applied to Sinpas's Halkali project and Reysas's vehicle inspection project. In sinpas case its assumed that there will be high uncertaintyin future outlook. Sequential option that gives right to owner is used to abandon, wait, or expand the project. The value of the project is to increase by phasing the project. Phasing a project is one of the characteristics of sequential option. Moreover, In Reysas case, the abandon option is applied. The right of the selling the asset from its salvage value when the value of the asset is lower than payoff soars the Net present value of the project. These examples show that when uncertainty increases, the real options cut the downside risk of the project. Thus, increases the net present value of the project when uncertainty becomes irreversible.

References

Adner, R., and Levinthal, D. A. (2004). What Is Not a Real Option: Considering Boundaries for the Application of Real Options to Business Strategy. *Academy of Management Review, 29*(1), 74-85.

Allen, L., and Pantzalis, C. (1996). Valuation of the Operating Flexibility of Multinational Corporations. *Journal Of International Business Studies, 27*(4), 633-653.

Alessandri, T., Ford, D., Lander, D. Leggio, K., and Taylor, M., (2004) "Identifying and Valuing Uncertainty in Capital Budgeting Projects: Beyond Discounted Cash Flow Analysis",The Quarterly Review of Economics and Finance.

Amaram, M. and Kulatilaka, N. (1999). "Real Options: Managing Strategic Investment in an Uncertain World" Harvard Business School Press, Cambridge, MA

Arnold, T & Falcon, T, (2004), "The NPV Intuition of Real Option Analysis", University of Richmond, 6-9.

Berger, P. G., Ofek, E., and Swary, I. (1996). Investor Valuation of the Abandonment Option. *Journal of Financial Economics, 42*(2), 257-287.

Barman, B & Nash, Kathryn, (2007), "A Streamlined Real Options Model for Real Estate Development", 37-42.

Bason, P & Bruun, S, (2001), "Real Options Approaches in Venture Capital Finance", Essay Series, 2-8.

Black F., and Scholes M. (1973). "The Pricing of Options and Corporate Liabilities", The Journal of Political Economy, 81, 3, 637-654

Bhargav, S, (2004), "Impacts of Project Management on Real Option Values", Master's Thesis in Civil Engineering, Texas A&M University, 52-62.

Brandao, L. & Dyer, J. (2003) "Decision Analysis and Real Options: A Discrete-Time Approach to Real Option Valuation", working paper

Brealey, R.A. and Myers S.C. (2000). "Principles of Corporate Finance", 4th ed., McGraw-Hill, New York, NY

Copeland, T and Antikarov,V, (2001). "Real Options: A Practitioner's Guide", Texere, New York, NY, 2001.

Copeland, T.E., Keenan, P.T., „Making Real Options Real", The McKinsey Quarterly, nr. 3, 1998a, pp. 129-141, McKinsey & Company, New York

Copeland, T.E., Keenan, P.T., „How Much Is Flexibility Worth?", The McKinsey Quarterly, nr. 2, 1998b, pp. 38-49, McKinsey & Company, New York

Cox, J., Ross, S. and Rubinstein M (1979). "Option Pricing: A Simplified Approach", Journal of Financial Economics, 7, September, 229-263

Damodaran, (2002) "Application of option pricing models to equity valuation", http://pages.stern.nyu.edu/~adamodar/New_Home_Page/lectures/opt.html (Jan, 2004)

Neufville R, (2001) "Real Options: Dealing with Uncertainty in Systems Planning and Design", revised and accepted for publication in Special Issue, Integrated Assessment Journal, 2003

Dixit, A. K. (1992). Investment and Hysteresis. *Journal of Economic Perspectives, 6*(1), 107-132.

Dixit, A., and Pindyck, R. (1993). "Investment under Uncertainty", Princeton University, Princeton, NJ

Dixit, A. & Pindyck, R. (1995). The Options Approach to Capital Investment. Harvard Business Review, May-June, pp. 105-115.

Fernández, P. (2001) "Valuing Real Options: Frequently Made Errors", IESE Business School, Madrid, Spain

Ford, D. and Ceylan, K. (2004) "Using Options to Manage Dynamic Uncertainty in Acquisition Projects", Acquisition Review Quarterly 9(4): 243-258

Ford, D., Lander, D., and Voyer J. (2002) "A Real Options Approach to Valuing Strategic Flexibility in Uncertain Construction Projects" Construction Management and Economics, 20, 343-351

Gamba, A, (2003). "Real Options: a Monte Carlo Approach", Department of Economics University of Verona, 15-18.

Garvin, M., and Cheah C. (2004) "Valuation Techniques for Infrastructure Investment Decisions" Construction Management and Economics, 22, 373–383

Grafström, C & Lundquist, L,"Real Option Valuation vs. DCF Valuation", Master's Thesis in Financial Economics, Stockholm University, 20-32.

Gutierrez, O & Aliseda, F, (2006), "Real Options with Unknown-Date Events", Universitat Autonoma de Barcelona, 78-85.

Helmchen, T, (2002), "How do real options come into existence", Bureau d'Economie Theorique et Applique University Louis Pasteur, 21-26.

Ho, S. and Liang, Y. (2002) "An Option Pricing-Based Model for Evaluating the Financial Viability of Privatized Infrastructure Projects", Construction Management and Economics, 20(2), 143–56

Joglekar, N. and Ford, D. (2002) "Product Development Resource Allocation Policies with Foresight", Sixteenth Triennial Conference of the International Federation of Operational Research Societies (IFORS), Edinburgh, UK, July, 2002

Joglekar, N. and Ford, D. (2004) "Product Development Resource Allocation with Foresight", in press at the European Journal of Operational Research

Keefer, D. L., Smith F. B. Jr., Back H. B. (1991) "Development and Use of a Modeling System to Aid a Major Oil Company in Allocating Bidding Capital" Operations Research 39 28-41

Kogut, B., and Kulatilaka, N. (1994). Operating Flexibility, Global Manufacturing, and the Option Value of a Multinational Network. *Management Science, 40*(1), 123-139.

Kumar, R. (1995), "An Options View of Investments in Expansion-Flexible Manufacturing Systems.", The International Journal of Production Economics, 38, pp. 281-291

Lander, D. M., and Pinches, G. E. (1998)" Challenges to the Practical Implementation of Modeling and Valuing Real Options", Quarterly Review of Economics and Finance, 38, 537–567

Lander, D & Shenoy, P, (1999), "Modeling and Valuing Real Options Using Influence Diagrams" School of Business Working Paper No 283, 20-29.

Luehrman, T. (1997). "What's it Worth? A General Manager's Guide to Valuation", Harvard Business Review, May-June, 132-142

Mahnovski, S, (2002). "An Application of Real Options to Public and Private Investment in Hydrogen and Fuel Cell Technologies", Pardee RAND Graduate School, 45-51.

Merton R., (1973) "Theory of Rational Option Pricing" Bell Journal of Economics and Management Science, 4 (1), 141-183

Mikael, C, (2004). “Modellinf the Valuation of Very Large Industrial Real Investment”, Institute for Advanced Management Systems Research, November 2004, 32-38.

Myers, S. (1984). “Finance Theory and Financial Strategy”, Interfaces, 14, January-February, 126-137

Ogunlana, S., Heng Li and Sukhera, F. (2003) “System Dynamics Approach to Exploring Performance Enhancement in a Construction Organization” Journal of Construction Engineering and Management, ASCE, 129, 5, 528-536

Pape, U & Schmidt, S, (2004). “Valuing Joint Ventures Using Real Options” ESCP-EAP Working Paper, 1-2.

Perdue, R. K., McAllister W. J., King P. V., Berkey B. G. (1999) “Valuation of R and D Projects Using Options Pricing and Decision Analysis Models” Interfaces 29(6) 57-74

Rodrigues A. and Bowers J., (1996) “The Role of System Dynamics in Project Management” International Journal of Project Management, 14, 4, pp. 213-220

Sharfman M. and Dean J. Jr., (1997) “Flexibility in Strategic Decision Making: Informational and Ideological Perspectives”, Journal of Management Studies 34:2

Sterman, J.S., (2000). Business Dynamics: Systems Thinking and Modeling for a Complex World, Irwin McGraw-Hill, New York

Stulz, R & Han Shin, H, (2000), “Firm Value, Risk, and Growth Opportunities” NBER Working Paper, 20-30.

Trejo, C, (2000), “Real Options: Understanding the Basics Concept”, Assistantship project for MABM degree, Mississippi State University, 9-13.

Triegeorgis, L, (1996). “Real Options, Managerial Flexibility and Strategy in Resource Allocation” Financial Management, 22, 202-224

Trigeorgis, L., (1995). “Real Options in Capital Investment: Models, Strategies and Applications”, Praeger, Westport, CT

Trigeorgis, L. (1993). The Nature of Option Interactions and the Valuation of Investments with Multiple Real Options. *Journal of Financial and Quantitative Analysis, 28*(1), 1-20.