School of Economics and Commercial Law
GÖTEBORG UNIVERSITY

Real option Analysis Applied on Product Development

A Case Study of Digital Illusion CE AB (Publ)

Masters Thesis
Industrial and Financial Management

School of Economics And Commercial law
Göteborg University
Spring term 2005

Authors:
Ekelund, Henrik
Johansson, Michael
Mavruk, Taylan

Tutor:
Rosén, Peter

Abstract

Increase in globalization, improvements of capital markets and easier access to financing indicate that the wave of initial public offerings such as IT, consulting and human capital firms is changing the nature of the firm. This change in turn also affects the capital structure, corporate governance, valuation models and accounting techniques, therefore it has become necessary to re-examine much of what is taken for granted within corporate finance. More precisely it leads us to reconsider what entity is being financed, governed and valued. Accordingly, the inefficiency when applying traditional analytical procedures forces decision makers to rely on new valuation methods, in which flexible investment decisions and managerial flexibility are considered as well as risk and uncertainty.

Bearing this in mind we find it interesting to practice the Real Option Analysis on product development through valuing a new type of firm, a web of specific investments. Digital Illusion CE AB a Swedish IT company that is listed on the New Market with focus on game development is therefore chosen for this case study.

Accordingly the main purpose of this thesis is to implement ROA on product development. This study will also lead us to analyse the changes in the overall value of the firm, which is derived from product development. Further an analysis of EA's bid on Dice's shares will also be conducted. We aim to accomplish this by applying company valuation theories into practice, after which we will analyze the advantages and draw backs of the valuation methods, DCF and ROA that are exercised during this report.

The report has led us to conclude that ROA can price the projects within a firm individually and that it in turn completes the value of a firm with option values, considering the uncertainty and flexibility. In contrast to this the DCF is more straightforward to apply on company valuation, but it does however give an overall picture of the firm value without considering the project's flexibility and uncertainty individually.

After our calculations we have come to the conclusion that from a ROA point of view Dice is undervalued on the stock market and with a DCF valuation Dice is priced more reasonably by the market. Thus EA made a well-considered acquisition of 62 percent of Dice shares at a tender offer of SEK 61, but nevertheless we can state that Dice has been valued on the Swedish Stock Market by analysts who were using the DCF valuation, and therefore EA's tender offer was deemed appropriate.

School of Economics and Commercial Law
GÖTEBORG UNIVERSITY

Acknowledgment

Firstly, we would like to thank the Ph.D. Candidates Karl O. Olsson and Daniel Svavarsson, who made this study possible and guided us throughout the research process.

Our profound thanks go to Peter Rosén, tutor of this thesis who was exemplary at his task, and shared invaluable insights with us. We truly appreciated the fact that he always kept his door open for us. Special thanks go to Linda Pettersson and Ph.D. Daniel Pettersen who went above and beyond the line of duty with assistance and advice.

Last but not least, we would like to express our appreciation to our family and close ones who lent their support and encouragement whenever we needed it.

Henrik Ekelund Michael Johansson Taylan Mavruk

Göteborg, May 2005

School of Economics and Commercial Law
GÖTEBORG UNIVERSITY

Table of contents

Appendix

Figures

Formulas

Tables

Abbreviations

APV	Adjusted Present Value
BBUS	Broad Band User Survey
BF	Battle Field, a game concept developed by Dice.
B&S	Black and Scholes
DCF	Discounted Cash flow
Dice	Digital Illusions CE AB (publ)
EBIT	Earnings Before Interest and Tax
eNPV	Expended Net Present Value
ESA	Entertainment Software Association
FCF	Free Cash Flow
IT	Information Technology
MCS	Monte Carlo Simulation
NPV	Net Present Value
PV	Present Value
RO	Real Option
ROA	Real Option Analysis
ROV	Real Option Valuation
sNPV	Static Net Present Value
WACC	Weighted Average Cost of Capital

1 Introduction

In this section an introduction to this thesis and the chosen company for the case study are presented. The problem that arises with the use of traditional valuation methods is discussed. Finally the research questions, the purpose of this thesis and the limitations are stated.

Traditional company valuation methods focus more or less exclusively on considering the physical assets of the company at hand, and this poses a problem today as many companies have their main assets in form of human capital. This very conflict, which occurs when the principle derived on the basis of yesterday's model is being applied on today's reality, is highlighted by Raghuram & Zingales (1999) who have investigated the case of the British advertising agency, Saatchi and Saatchi. In 1994 US fund managers who owned around 20 percent of the company made a valuation mistake by treating Saatchi and Saatchi as a traditional company with clear limitations defined by its assets instead of considering human capital and the future development of the company. Consequently this resulted in damaging the company critically wherefore the authors of this article propose that a company with few physical assets and plenty of human capital should be considered as an exception in order to prevent such conflicts (Zingales, 2000).

Interestingly this mistake of the US fund managers indicates that the wave of initial public offerings such as human capital firms, consulting firms, and especially technological research and development firms (R&D), whose main assets are the key employees and knowledge, is changing the nature of the firm, its relative capital structure, governance, valuation models and accounting techniques. The change in the nature of the firm forces us to re-examine much of what is taken for granted in corporate finance. More precisely it leads us to reconsider what entity is being financed, governed and valued (Zingales, 2000).

However, an analyst should always intend to understand the reason behind these changes when approaching the conflicts and trying to adopt the theory in to deviation in practice. What were the motives behind the change of the very asset incentive and highly vertically integrated prototypical traditional firm, which according to Chandler (1990) emerged the second industrial revolution to utilize economics scope and scale?

Zingales (2000) indicates that three major changes have taken place concerning the balance of power within the firm in the last decade. First of all the physical assets, which used to be major source of rents, have become less common and the rents they are producing are not equally satisfactory. The impact on the improvements of the capital markets has resulted in reduction of the difficulties in financing the expensive assets. This in turn has led to a decrease in communication cost, which reduced the importance of expensive distribution channels that favours the access to the market for newly formed companies. Secondly, we have experienced an increase when it comes to world wide antagonism, which has led the market to reach close to one of the significant assumptions within finance theory: the so called perfect competition. This in turn has increased the demand for process innovation and quality improvement, which can only be generated by talented employees. Thus demand for more innovations has a positive effect on the importance of human capital. Finally, Zingales continues with the implication that easier access to financing has coupled up with starting the world trade and created many employment opportunities and in turn made human capital less specific to their current employer. Mobility of the employees has also increased tremendously parallel to these changes. The increase in competition at the intermediate goods level has also prevented the improvement of vertically integrated firms.

Changes in the nature of firms consequently guide us to abandon the misapprehension that firms' boundaries are clear cut and remain as before when firms' capital structure changes during the time. The traditional approaches to the organizations are very physical asset incentive with its boundaries clearly set in advance and therefore by no means reliable to apply on today's organization, which is mostly human capital incentive (Zingales, 2000).

Once it is recognized that employees, human capital and R&D have become tremendously valuable assets, making the right adjustments in order to solve the conflicts in valuation of these types of companies becomes imperative. Within corporate finance the focus lies after all on the challenges raised by financing the unique combination of physical assets and people within a company, and as Zingales (2000) points out it is important to see "The firm as a web of specific investments". Understanding this unique combination is a significant step, and one that cannot be postponed any longer.

1.1 Research background

In hindsight we find it interesting to practice Real Option Analysis (ROA) through valuing the new type of company by treating it as Zingales suggests as a web of specific investments, which includes the most crucial assets: human capital and R&D. Academic research have previously been carried out in this field, but in the studies however ROA is foremost applied on Pharmaceutical (Banerjee, 2003), Biotechnological (Kellogg & Charnes, 2000), oil (Armstrong, Galli, Bailey & Couet, 2004), natural resources (Colwell, Henker, Ho & Fong 2003), real estate (Greden & Glicksman 2005) and airline industry (Gallego & Phillips 2004) due to similarities between the development of phases in the industries and the nature of ROA when it comes to option valuation. Some research has also been conducted by implementing ROA on IT firms (Buckley, Tse, Rijken & Eijgenhuijsen 2002). This study presents applied the ideas of real options analysis to the valuation of stock market equities where growth potential is significant. In the study advantages of financial options, a comparison between financial options and real options and valuation of Netscape Communications Corp. by implementing real options are also presented.

Bearing this in mind we have separated us from earlier researches in our thesis by choosing a Swedish IT company which focuses on game development. Further the changes in the overall value of the specific firm are additionally analysed derived from the proceedings in the product development. This thesis also differs from the research of Buckley, Tse, Rijken & Eijgenhuijsen (2002) in a way that the drawbacks and limitations of the DCF and ROA methods as well as comparison between these two methods will be conducted instead of analysing the financial option valuation.

Digital Illusion CE AB public (Dice) is a Swedish IT company, listed on the New Market, an unofficial place of trading owned by Stockholm Stock Exchange since 1998.

1.2 Digital Illusion CE AB (publ)

Dice is an IT firm which produces digital illusions in the form of TV and computer games for all leading platforms such as Playstation2, Xbox and PC. The business model of Dice can be defined in terms of games development, which is partly based on Dice's own brand name and on other publishers' brands. Dice receives a fixed production budget from the publisher for the development of a game. The firm also receives royalties from a part of the games sales revenue. The

company follows a production process with defined phases that ensure the quality of products. Dice increases productivity in order to create flexibility in the development of games, and following a development process method is very essential for Dice as it enables the firm to develop further successful games and to create new markets in which the firm owns the rights. Accordingly, the product strategy of Dice is to develop games for a global mass-market, with particular focus on the United States and Europe. In order to increase efficiency and limit costs Dice employ synergies and develops technology that can be spread among production projects (Dice, 2004).

As a final point we find it interesting to note that in mid November, 2004 the American IT company Electronic Arts (EA) gave an offer to purchase total shares of Dice for SEK 61 per share, which was 21 percent higher than the current share price at the time. On the 27th of January in 2005 the tender offer period was over, and EA acquired in total 3 235 053 shares from Bonnier & Bonnier who was one of the major owners in Dice. Thus EA acquired shares from owners with significant holdings in Dice and the total acquired shares increased with another 32 percent as EA purchased 8.9 percent of the total stock of Dice on the open market. Together with the 18.9 percent that EA already had acquired in the beginning of 2004 the company holds total 6 044 720 shares equivalent to 59.8 percent of the votes and capital in Dice.

1.3 Problem and Discussion

As shown in the example of the consulting company, Saatchi and Saatchi, a new definition of a company, as well as new economy provides a challenge for the company analysts. This example furthers us to state that the corporate valuations are no longer depending on traditional fundamentals that reflect on an overall future growth, but rather on flexibility, future expectations and the variables, which in turn have a direct impact on these. Furthermore it leads us to conclude that companies with a large amount of human capital, R&D expenses, patents and other intangible assets are problematic in valuation. Inefficiency when applying traditional analytical methods hence forces decision makers to rely on new valuation methods where flexible investment decisions and managerial flexibility are considered as well as risk and uncertainty (Trigeorgis, 1993). This is due to the direct limitation issues of using traditional methods when valuing companies, which focus on the development of new products.

According to Hemantha, Park & Chan (2001) traditional valuation methods such as the Discounted Cash Flow (DCF) model define the value as single discounted value of possible future cash flows. What contradicts this definition is that the market price of an asset can be different than its value. This is for instance illustrated when the asset is sold under reduction, in which case its price may be lower than its value. One will therefore have to accept that the purchaser has benefited from an essential amount of value. Now, accepting that the idea of a valuation in generating a market value is based on determining the asset's present value, which includes physical aspects of an asset as well as non physical or intangible aspects of an asset, one can argue that applying only traditional methods will not lead to a reasonable result when valuing the projects within Dice. Basically having an all or nothing approach without considering the company's intangible aspects and managerial flexibility can result in a misleading valuation.

Mun (2002) states several problems and limitations with the use of only traditional valuation techniques, and argues that the result from this is an understating of firms with large amounts of human capital and other intangible assets. The difficulties can foremost be noted in the use of a constant weighted average cost of capital (WACC) through time, while estimating an asset's economic life, and while making a point estimation of the expected future cash flows which all in all leads to an inflexibility of final results.

The limitations of DCF assumptions are according to Mun also brought to the surface since it brings forward pre-made decisions and an estimation of permanent future cash flows. Mun continues to argue that projects are observed as mini firms and that they are treated as identical with the nature of the whole firm. Once the valuation is completed projects are furthermore passively managed at the same time as deterministic and predictable point future cash flows are considered, and opportunity cost of capital is used for discounting all the projects. Factors that could have an impact on the outcome of a project are taken into account in the DCF model in the Net Present Value (NPV) and internal rate of return techniques, but still non-physical factors are valued to zero.

The real life business conditions are a lot more complicated than the DCF model proposes, and it is therefore of utmost importance that a market analyst takes a number of additional aspects into account in order to receive a healthier result in valuations. Mun has formed a number of questions that needs to be considered in order to accomplish such a result: When the multiple strategic paths exist, what path should the analyst choose? What options does an analyst have? When the wrong path is chosen how can an analyst get back on the right track? How are the paths valued? What is the optimal timing for further financing? And how are the intangible assets valued?

1.4 Research question

After revising an example of a misleading valuation of a consulting firm (Saatchi and Saatchi) and thus understanding the complexity of valuing companies consisting of non-physical assets, the below stated questions will the main focus in this thesis.

- ✓ How can ROA be applied and implemented on product development?
- ✓ How does the value, which is derived from product development, changes the overall value of the firm?
- ✓ To what extent are the methods, which are used in valuations reliable and what are the drawbacks of the valuation methods that are used in this report?

In addition while answering these questions a number of the above stated analyst concerns that Mun has pointed out in the valuation process are also treated.

1.5 Purpose

The purpose of this thesis is to implement ROA on product development in Dice. Through this we also aim to analyse the changes in the overall value of the firm, which is derived from product development. Further by applying ROA on Dice we will analyse EA's bid on Dice's shares. We aim to accomplish this by applying company valuation theories into practice, after which we will analyze the advantages and draw backs of the valuation methods, DCF and ROA that are exercised during this report.

1.6 Limitations

The information used in order to conduct the analysis in the thesis was pertaining to 2004. Information published 2005 are also used, however the information relating to activities that occurred during 2004 or earlier. Interaction between the different projects in the valuation process is not assumed to take place. However the interaction between different options in one specific project is considered individually. We have not applied Monte Carlo Simulation to sNPV of the projects that are used as inputs in ROA. Hence the sNPV was already based on assumptions, the simulation would in this case simply been a further estimation of done assumptions. We did not consider this sufficient for the result of our valuation. Dividend pay out has not been considered in the calculations due to the uncertainty of future dividends payouts according to the larger investments that Dice is considering.

2 Method

This chapter contains a presentation of the method used throughout the report, our approach to the subject of this thesis, and our overall study methods. During the course of research we found that a number of calculations and qualitative analysis were needed, wherefore we have considered employing both quantitative and qualitative methods as presented below. Furthermore a presentation of data collection techniques and drawing conclusions are illustrated.

2.1 Course of action

The primary intention with this thesis is to value Digital Illusion CE AB (publ) through applying ROA into company valuation. Hence it involves the conducting of a case study that considers Dice's future growth opportunities. According to Patel & Tibelius (1987) the purpose of case studies is to study process and changes, which has lead us to conclude that it is an appropriate approach for this study.

According to Backman (1998) a case study is closely related to qualitative approach in that the gathering of information through interviews and research is fundamental. We have therefore applied qualitative study in order to receive a deeper understanding of Dice. However, since this is a case study of Dice's valuation different phases of a quantitative approach is also applied throughout the study in order to make valuation calculations.

2.1.1 Quantitative method

Quantitative measurement mainly discusses questions such as: How many? and How much? in order to test the hypothesis. According to Lundahl & Skärvad (1999) we encounter three various phases when conducting quantitative investigations in a scientific process. These phases are the Planning phase, the Data collection phase, and the Analytical phase (Figure 1).

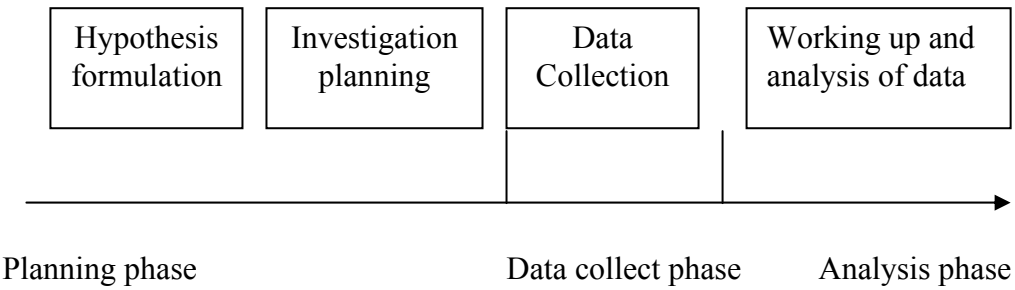


Figure 1: Quantitative investigation process
Source: Lundahl &Skärvad (1999 p.95)

Planning Phase

In the planning phase of our report the strategy used for the valuation of Dice is formulated after discussions in the group and with the tutor Peter Rosén for writing this paper. PhD candidate Karl O. Olsson and Daniel Svavarsson who carry out research in this field at the School of Economics and Commercial Law, Gothenburg University have also contributed with ideas. The planning phase of quantitative investigation process is separated into four parts in order to formulate a well-built hypothesis for the research. We have therefore followed the summary of hypothesis formulation, which is presented below (Figure 2):

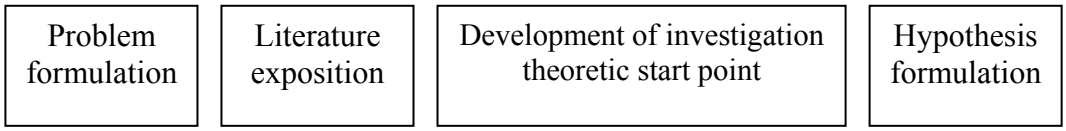


Figure 2: Summary of hypothesis formulation
Source: Lundahl & Skärvad (1999 p.95)

In the problem discussion of this report the limitations of traditional methods in valuation of IT firms, which includes intangible assets such as human capital and future investments, is defined through discussions in our research group based on previous knowledge as well as through a literary study in order to gather information regarding the problem. The development of the investigation, the theoretic start point, the valuation methods, and terms used in the analysis are defined in the theoretical framework in order to make the explanation of the valuation methods and all definitions more recognizable and the relations with the hypothesis formulation more clearly stated.

Data collection phase

In the data collection phase, data is collected through reading articles concerning the Discounted Cash Flow (DCF) model, valuation of IT firms and ROA. Economical report concerning Dice and the gaming industry are also analyzed. A number of e-mail contacts with analyst firms: Redeye, Kaupthing Bank, Remium and United Brokers. A number of interviews with researchers in the field are also conducted. More detailed method of data collection for the report in full is presented under the qualitative method.

Analysis phase

This phase involves making a selection of knowledge and methods before the research process is worked out and the collected material is being analyzed according to the method proposed in by Lundahl & Skärvad (1999).

After conducting the empirical study information concerning Dice, the computer game industry in itself and the partaking of an analysis of Dice conducted by Kaupthing Bank, valuation calculations are carried out. For DCF calculations we have used a software program that can be obtained from Damodaran (2002) and excel sheet programs for ROA which were used in the lectures in Capital Budgeting and ROA courses in spring, 2005.

In order to estimate the future cash flows for DCF calculations, we have applied a growth rate considering Dice's historical progress. This information is taken from Dice annual report (2004). The future growth opportunities are converted into a higher growth rate during the high-growth period for the next five years. The sales growth in the game industry according to Entertainment Software Association (ESA), (2004) is also considered when estimating this growth rate. When estimating future cash flows, we have also considered a growth rate for the stable period. The assumptions for this growth rate are based on our observations of a huge decline in Dice's sales growth during the last five years according to our time series analysis based on the information in Dice annual report (2004).

To be able to estimate future cash flows for sNPV a lower growth rate is applied. This is due to the reason that applying a higher growth rate can lead to a double calculating of the future opportunities since the option values are to be calculated and then added back to firm value. This rate shows the trend of growth rate in year 2005 in view of the growth rate development during the last five years according to our time series analysis based on the information in Dice annual report (2004).

2.1.2 Qualitative method

Qualitative methods are based on interpretations of case studies, observations or text studies and can answer questions like: what, who, when, how and why? In other words this method does not focus on numbers, but on written and verbal expressions, and collections of data and analyses are conducted simultaneously (Lundahl & Skärvad 1999).

Questions such as the value of Dice, how our valuation results of Dice are differing from the results of the analyst firm, and which combination of valuation techniques are applicable in order to value IT firms are considered by the use of a qualitative method in this report and is described in the analysis phase.

2.2 Data collecting

Within this context one makes a distinction between so called primary and secondary data. The primary data is the new data that the researcher collects, while secondary data is already available data that has been collected by other researchers. In this study both types of data will be applied (Arbnor & Bjerke 1994).

Primary data

The use of primary data in this research is primarily based on the interview questions conducted through e-mail correspondence. Open questions are precedence, where free answers are expected. We find it advantageous to receive free answers since this study is based on an analytical approach. It should also be noted that unstructured interview method is chosen in this report in order to have the advantage of adjusting the questions according to experience and knowledge of the interviewed person.

Secondary data

The use of secondary data in this report is implemented through collecting information from scientific papers and course literature, and is mostly used in introduction and theory part. Dice' annual report 2004, the analysis of Dice by Kaupthing Bank, the updated market information concerning Dice, and information on computer game industry collected from Entertainment Software Association (ESA) and a Swedish daily industry newspaper, Dagens Industri, are used as secondary data in the empirical study.

2.3 Depicting conclusions

There are several ways to draw conclusions, but in this paper only the inductive method of conclusion drawing is applied. According to Halvorsen (1992) the inductive way of depicting conclusions means drawing conclusions from empirical data. Halvorsen also mentions the criticism directed towards this method and argues that it is disadvantageous in that it does not reach full security but gives only an extension of probability. The reason for this is that the method is not build on a sum of exclusive outcomes. Within this context it is also important to emphasize that Dice was unable to contribute with such information with the motivation that it could affect their share price. The calculations and conclusions therefore do not reach full security, but is merely a probability of possible out comes. An analytical induction is therefore used in this report where the results of our valuations, interpretations, comparisons of the results and critique against the chosen valuation methods are considered and presented.

2.4 Validity

According to Eriksson & Wiederscheim (2001) validity of an analysis can be interpreted as to what extent information is needed throughout the research, or alternatively is being constructed in the empirical part of the study.

It is accordingly essential that interviews and e-mail contacts are conducted in a correct manner. To be able to receive a high validity the interviews and e-mail contacts should be carried out in an appropriate way. In view of this the partaking of scientific articles concerning the subject besides group discussions has been considered as very important. The quality of these discussions and the increase of knowledge through the reading of articles enabled us to formulate and ask more relevant questions to Kaupthing Bank.

It was important to find out the name of the analyst firms that analyse Dice and also which persons within the firms to interview in order to obtain as truthful information as possible. We found out from Dice's home page that four companies: Redeye, Kaupthing Bank, Remium and United Brokers have been analyzing Dice. We have tried to reach them through e-mail and telephone contacts, but unfortunately the only information available was an analysis of Dice from Kaupthing Bank. This could be due to the fact that EA's tender offer to Dice's shareholders led the other analyst firms to stop analysing Dice. Receiving information from other analyst firms could have increased the validity of this

report. However, through following of daily financial news papers, additional analysis of Dice was observed and is being used in the report.

2.5 Reliability

Eriksson & Wiederscheim (2001) describes the high reliability as a different and independent means to measure the same phenomenon, and that as such it must give approximately the same result each time. Using reliable methods when gathering and presenting information, is essential for achieving the reliability of a study.

In order to increase the reliability in this paper, the interview questions to Dice's management were considered in an early stage of the report, which made it possible to look them over several times and make relevant changes. An e-mail address was created by the research group in order to collect all the contacts and to organize the information. E-mail replies were available to go through several times in order to reduce the risk of misunderstandings and misinterpretations.

Telephone interviews and contacts via e-mail are means of communication, which is considered to decrease the reliability of a study since the visual aspects are lost by using these methods. However, it should be emphasized that Dice and the analyst firms are located in Stockholm, and EA who offered a bid for Dice is located in the US. Due to the lack of possibility to visit the firms, telephone interviews and e-mail contacts were chosen instead.

The interview questions were sent to Dice via e-mail on Dice's information officer's request. However we have not received any respond to the interview questions due to the reason that Dice considered the questions to have an impact on Dice' share price. Nevertheless the interview questions that were sent to Dice are available in the appendix 2.5.

Despite the fact that we have not received any other information than the annual report from Dice, we have been able to carry out our study. This can be motivated based on the fact that professional market analyst firms use updated market information and annual reports in order to make future assumptions in valuations since they are not able to reach firm specific information from the firms except information that officially published. In view of this fact the outcome of our empirical study based on updated market information, Dice annual report and analysis from Kaupthing Bank is satisfying concerning the reliability.

3 Theoretical framework

This chapter is divided into three parts. In the first part the definition of different types of options is presented in order to give a better understanding of the subject. In the second part the ROA process and valuation of IT investments are studied. The third part focuses on illustrating why criticism is directed towards DCF in order to state why ROA is crucial in valuation of intangible assets. The criticism against ROA and the problems with estimating the parameters are also discussed by comparing a number of theorists' work presented in the articles.

3.1 What is an option?

An option according to Trigeorgis (1993) gives the holder right but not an obligation to sell/buy an underlying asset at a specific price within the future time period. An option puts a price on the risk, possibility and the time that is left to maturity. There are several different types of options such as call, put, European or American options as well as common embedded real options, which include abandonment, expansion, contraction, chooser, compound and sequential compound options.

A brief definition of these options according to Trigeorgis is presented as follows: Call option gives the owner the right but does not obligate the holder to buy an underlying asset at a pre-specified price within some future period, while put option is an option to sell a specified number of securities within some future period at pre-specified prices. European option gives the owner a right but not an obligation to buy or sell an underlying asset at a specific price on the expiration date. While American option gives the owner the possibility but not an obligation to buy or sell an underlying asset at a specific price any time during the yield to maturity.

Trigeorgis also gives an explanation of what common embedded real options are. It is also important to note that Real Options are usually American options. With an option to abandon (put) the holder has an opportunity to terminate the project within the time of maturity as long as the abandonment value exceeds the projects value. Management has a possibility to sell the underlying asset and its knowledge to another firm with which it has a contractual agreement.

Option to expand (call) gives holder a possibility to expand its current operations but not an obligation to do so and will most likely not do so unless market conditions deem it optimal. In short management will choose to expand its operations if the value of an expand option exceeds the value of the project (Trigeorgis, 1993).

With an option to contract (put) Trigeorgis states that management can hedge the firm's current operations. This is done through a legal contractual agreement with one of the firm's suppliers who in turn have agreed to take up the excess capacity and space of the company, and at the same time the firm can lower its existing work force in order to obtain a level of savings. Management will exercise option to contract if its value exceeds the value of the project.

Trigeorgis indicates that a option to choose (put/call) gives possibilities to the holder to choose within a few alternatives for example expand, abandon, continue or defer the project. The firm has an option to choose how it wishes to continue its existing operations through these options. In order for the management to be able to choose a suitable option or combination of real options calculations is needed. Clearly this valuation of combination cannot be treated individually and summing them wildly up will give a misleading result. The reason for this is that it for example is impossible to abandon and expand at the same time. Interaction of option types within the same projects should therefore be considered. Chooser option deems the mutually exclusive and independent nature of these specific options.

What characterizes a compound option (put/call) is that the value of the option depends on the value of another option. For instance if the call is an option on the equity of the firm and equity is an option on the whole value of the firm, it is necessary to first value the equity in order to value call. Therefore the value of the equity becomes the underlying risky asset that is used to value the call option (Trigeorgis, 1993).

Sequential compound option can be used when the project has multiple phases in which latter phases depend on the success of previous phases. If the first stage is successful, the management has at least three options: they can proceed to the next stage, abandon the project or delay the project. It should also be noted that most applications of real options are sequential compound options (Trigeorgis, 1993).

3.2 Real option process and valuation of IT investments

3.2.1 Real option process/Analysis model

The real option process is illustrated below are used as our analysis model when conducting analysis with the help of ROA (Figure 3). This process is followed in the analysis part of this thesis in order to make the calculations and the assumptions when applying ROA on product development.

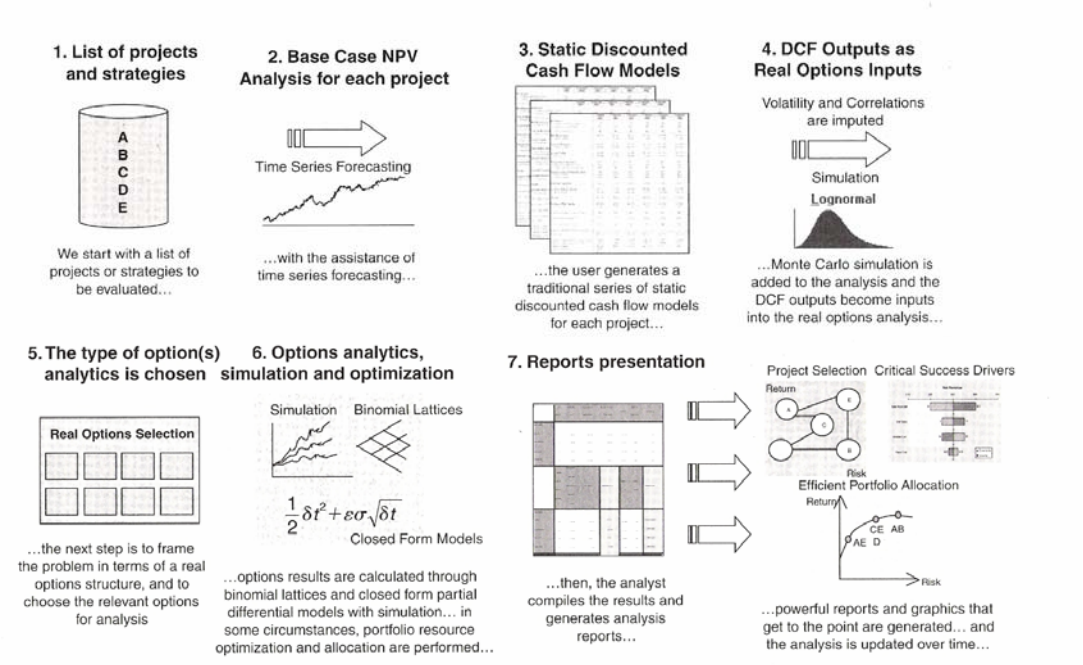


Figure 3: Real Option Process
Source: Mun (2002 p. 322)

1. List of projects and strategies

Listing of projects and strategies is the first step in the real option process. An analyst should decide what projects, assets, initiatives or strategies are reasonable for the analysis matching business mission, vision and goal. The initial list of projects should be qualified in order to meet with the firm's agenda, and the sum of these various projects will lead to an overall value of the company. This phase of the process is very essential since it is at this stage most of the valuable insight is created in order for managers to complete business' missions and solve problems (Mun, 2002).

2. Base case NPV Analysis for each project

In this step DCF of all projects are planned. NPV calculations are applied on each project in order to create a DCF model. NPV calculations are made in accordance with traditional approaches, which are followed by estimating the revenues and

costs of the projects and then discounting them with the appropriate risk adjusted discount rate. The formula for NPV calculations is presented below:

$$NPV = \sum_{t=1}^{T} \frac{FCF_t}{(1+WACC)^t} - Investment\ \ Cost$$

Formula 1: Net Present Value
Source: Mun (2002p.61)

In formula 1, FCF is represented as the after tax free cash flows, while the investment costs present the cost of an investment that the firm invest in order to gain the benefits, T is the time period, t represents the time for the calculation. FCF can be calculated by using management assumptions, historical data, forecasting or simulation.

Formula 2 represents FCF for a levered firm calculation:

FCF = Net Income + α [Depreciation + Amortization] ± α [Change in Net Working Capital] – α [Capital Expenditures] – Principal Repayments + New Debt Proceeds – Preferred Debt Dividends

Formula 2: Levered Free Cash Flow
Source: Mun (2002p.68)

In the formula, α is the equity to total-capital ratio and debt ratio can be calculated as (1- α).

Weighted Average Cost of Capital (WACC) is calculated in formula 3 as:

$$WACC = wdkd*(1-tax) + wcekce + wpskps$$

Formula 3: Weighted Average Cost of Capital
Source: Mun (2002p.61)

In formula 3 w is defined as weights, $_{d}$ for debt, k is cost, $_{ce}$ stands for common equity and $_{ps}$ is preferred stocks.

This basic calculation model of NPV also involves certain difficulties. According to Mun, the estimation of future cash flows and appropriate discount rate is a most

crucial step in the calculations, where either historical data if such exists or otherwise management assumptions may be used.

3. Static Discounted Cash Flow Models

There are a number of traditional models, which are stated by many theorists. However according to Myers (1984) Payback method (PB), Internal Rate of Return (IRR) and Accounting Rate of Return (ARR) are common methods, which are used in order to create DCF models. Accordingly NPV is the most useful among the methods for further calculations within ROA since it is built on NPV.

4. DCF Outputs as Real Options Inputs

Myers mentions the draw backs of DCF i.e. that it generates single point estimate of expected future cash flows, and since forecasting future cash flows is highly uncertain, there is little chance that the single point estimates are accurate. In order to receive a more precise estimate and a more realistic result Monte Carlo Simulation (MCS) may be applied.

Application of sensitivity analysis is usually the first step in this phase. This is done through changing each value driver and noting the change in the resulting NPV. According to Rappaport (1986) there is several value drivers developed and incorporated in the valuation process. The shareholder value approach estimates economic value of an investment by discounting forecasted cash flows by the cost of the capital. In many cases value drivers serve as the foundation for estimating cash flows and thereby also for estimating the future value of a business. The basic valuation parameters or value drivers are defined as turnover growth, operating profit margin, the effective tax rate, working capital change, capital expenditure, cost of capital, and competitive advantage period. According to Jägle (1999) these seven value drivers can assist management in performing sensitivity analysis to determine how a company's shareholder value is affected by changes in its seven value drivers.

One way of illustrating the result of the sensitivity analysis according to Copeland & Antikarov (2001) is to create a tornado diagram, which helps the analyst to build a better view of the most sensitive and crucial variables of the projects. The former variables will be placed on the top of the tornado diagram. The value drivers can also be called critical success drivers, which are prime candidates for MCS. This is due to the fact that some of the critical success drivers may be correlated, for example operating costs may increase in proportion to quantity sold of a particular product and therefore a correlated MCS may be needed. These

correlations can be obtained from historical data. Applying MCS provides a closer estimate to the variables' actual behaviours.

5. The type of option(s) analytics is chosen

The next step in the process is described by Mun (2002) as framing the problem in form of real options. Analysts identify the strategic options for each particular project. These strategic projects can for example include, option to expand, contract, abandon, switch, and choose etc. Analysts can furthermore choose from a list of options to analyze the specific projects in detail based on the nature of each project or each stage of the projects.

6. Option analytics, simulation and optimization

In this step the real option modelling is created. This is according to Trigeorgis (1993) achieved through conducting distribution of discounted cash flow values and an implied volatility of future free cash flows from MCS. The volatility is usually measured as the standard deviation of the logarithmic returns on the free cash flows. Underlying variable in real options is the future probability of the project. This means that the present value of the future cash flows is used as the initial underlying variable in ROA.

7. Principles of valuing Real Options

Real options can be calculated with different methods, path-dependent simulation, closed-form models, partial-differential equations, and multinomial and binomial approaches. In this paper we will be using binomial method in the valuation due to its flexibility and comprehensibility. In the binomial lattice time steps are defined as the number of branching events, starting from time zero. The first time step has two nodes ($S_o u$ and $S_o d$) and the second time step has three nodes ($S_o u^2$, $S_o ud$ and $S_o d^2$) and so on. The nodes on the binomial lattice represent the probability of up and down movements of the underlying asset (Trigeorgis, 1993). How to calculate the movements of the underlying asset is illustrated by the formula below.

$$u = e^{\sigma\sqrt{\delta t}}$$

$$d = e^{-\sigma\sqrt{\delta t}} \qquad d = \frac{1}{u}$$

Formula 4: Calculate up/down movements
Source: Mun (2002 p.144).

In Formula 4 u is presented as the probabilities of an up movement of an underlying asset and d is presented as probabilities of a down movement of the asset, e is the exponential constant. Estimation of u and d is made by the use of the standard deviation σ. In the given formula δt represents the time steps and calculated as T/N, T is the number of years to expiration, N is the number of binomial steps (Mun, 2002 p.144).

Figure 4 below represents a simple two nodes binomial lattice

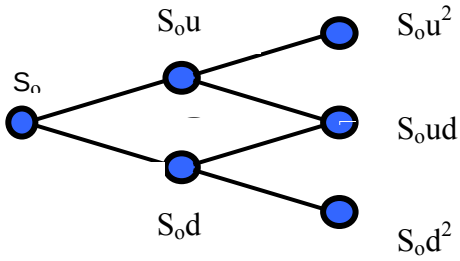


Figure 4: Two nodes binomial lattice
Source: (Mun, 2002 p.142)

Binomial lattices can be solved through risk neutral probabilities. The probabilities of up and down movements are risk adjusted and then discounted with risk free rate of return. It is also important to note that in the binomial lattice the higher the number of the time steps, the higher the level of granularity and accuracy. This in turn leads to a lower level of volatility (Mun, 2002).

The formula 5 is used when calculating the risk neutral probability

$$p = \frac{e^{(rf - b)(\delta t)} - d}{u - d}$$

Formula 5: Risk neutral probability
Source: Mun 2002 p.144

In this formula p represents risk neutral probability, e is the exponential constant, rf is risk free rate, b is continuous dividend out flows in percentage, δt is time steps in the lattice, u is an up movement and d is a down movement of the underlying asset.

The next step in the process is to value the option. According to Jägle (1999) similar techniques are used to value financial options and to price options on

stocks when valuing financial or real options. This is due to the structural similarity between know-how in firms and financial options. Know-how in corporations can be considered as a right, but not an obligation to invest in a project at a likely investment cost as soon as the know-how is available in the firm. This way an analyst is able to take in to consideration the flexibility that a technology intensive firm with high growth prospects has regarding future investment decisions.

Valuation of lattice is done in two steps, starting with the terminal node and then the intermediate nodes. This process according to Trigeorgis (1993) is called backward valuation. The valuation formulas are given below:

1. $V_{uu} = \max [uuS0 - K, 0]$
2. $V_u = \frac{\pi V_{uu} + (1-\pi) V_{ud}}{1+r_f}$
3. $V_d = \frac{\pi V_{ud} + (1-\pi) V_{dd}}{1+r_f}$
4. $V = \frac{\pi V_u + (1-\pi) V_d}{1+r_f}$

Formula 6: Backward Valuation
Source: Trigeorgis (1993)

V_{uu} in the formula represents the value of an up movement of the asset on the second node. V_{ud} stands for value of an up movement on the first node but value of a down movement on the second node of the asset. On the other hand V_u in the formula represents the value of an up movement of the asset on the first node while V_d is the value of a down movement of the asset on the first node. π is the risk neutral probability and r_f is the risk free rate of return.

In the terminal and even intermediate nodes payoffs of the options should be considered. Trigeorgis states that deciding the payoffs of the options depends on the option type. The different payoff functions, which will be used in this report, are described in the formula below:

Payoff for a put option: max [X – ST, 0]
Payoff for a call option: max [ST – X, 0]
Payoff for an abandon option: SV = X
Payoff for an expand option: EF * S – EC
Payoff for a contraction option: CF * S + CG

Formula 7: Payoff functions
Source: Trigeorgis (1993)

Where, X represents the exercise price, ST is strike price, SV is salvage value, EF stands for expansion factor, S is the underlying asset value of the present node EC is expansion cost, CF represents contraction factor and CG is the contraction gain.

8. Reports presentations

Mun (2002) indicates that the analysis should be completed with reporting and presenting the results and the process in it self. The process should not be explained through presenting Black & Scholes (B&S) black-box calculations, which is difficult to understand. Instead a transparent calculation such as binomial model should be used to explain this mathematical process. An update of the analysis is furthermore very important for the real option analysis since it allows the management to make corrections when the uncertainty becomes resolved or risks surfaces. Once risks are identified the analysis should be updated and the input assumptions should be adjusted to the new information.

Finally it is as Balasubramanian, Kulatikala & Storck (2000) points out of a great importance when valuing IT firms it is very vital to estimate the expected future cash flows. In the following section valuing IT investments is therefore clarified.

3.2.2 Valuation of IT investments

Methodology for valuation of IT projects, which is presented in this section includes identification of current and expected business capabilities, design of a contingent investment program to achieve the desired capabilities, estimation of the costs and benefits of realized capabilities in terms of cash flows and evaluation of these cash flows (Balasubramanian et al. 2000).

Identification of current and desired capabilities

The vision of the firm is translated into a set of specific expected business and capabilities in order to plan the effort of the business. It is therefore important for firms to decide what operating drivers are needed to support these business capabilities. Firms achieve this through taking its current operating drivers and determining how to improve, substitute, and build on these drivers in order to deliver the desired business capabilities. Each of the business capabilities has a value, and similarly there is a connected investment for each of the operating drivers. Business capabilities are ensured by making several investments, where investing in the next stage, depends on the success of the previous investment and on business conditions. The management adjusts to the changing conditions by

varying the scope, timing, and scale of the investment in order to eliminate down-side losses and capture the up-side benefits (Balasubramanian et al. 2000).

Figure 5 describes the identification of current and desired capabilities and their impact on future cash flows.

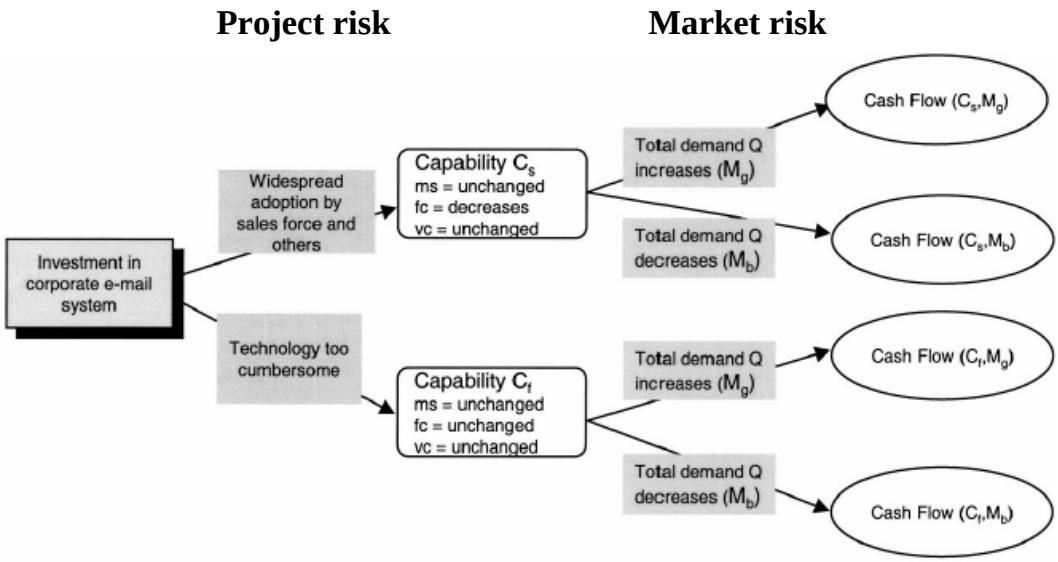


Figure 5: Identification of current and desired capabilities
Source: Balasubramanian et al. (2000 p.45)

As it is shown in figure 5, firms must make changes in technology, process and organisation to be able to move from their current business capabilities to desired capabilities. Firms face project and market related risks when making these changes. Project related risk is determined by how the firm chooses to design, implement and manage the operating drivers. Market related risk depends on market demand, competitors and macroeconomic factors that affect the market demand. It should be stated that even if the projects are clarified, the resulting business capabilities may not be suitable for the market conditions (Balasubramanian et al. 2000).

Further Figure 5 indicates that considering the project risk, when the firm has a high quality technology and the investment is adopted by the sales force extensively, the firm will have advanced capability. Accordingly firm's market share of total demand and the variable costs will be unchanged but the fixed costs will be decreased. On the other hand when the technology is too cumbersome, the firm will have a lower capability. Firm's market share of total demand, fixed costs and the variable costs will remain the same. Further considering the market

related risk, cash flow will be higher or lower depending on the total demand Q. In figure 5 Mg implies good and Mb implies bad outcome of the market demand.

Accordingly net cash flow in order to estimate firm's future growth opportunities and capabilities is calculated as:

$$\text{Net cash flow} = ms^* Q^* \text{price} - fc - vc^* ms^* Q$$

Formula 8: Net cash flow
Source: Balasubramanian et al. (2000 p.45)

Where, ms represents the firm's market share, Q is the total demand, fc is the fixed operating costs, and vc stands for the variable costs per sales.

Design of an investment program

As Balasubramanian et al. (2000) mentions, definition of current capabilities and businesses appear to be quite traditional in the ROA process. In contrast to this the consideration of the events in the future is highly uncertain. When identifying desired capabilities two sources of uncertainties are recognized, market-related (price and demand) and project related uncertainty, which may lead the firm to achieve different capabilities than the current ones.

Identifying the desired capabilities according to Balasubramanian et al. (2000) is done through building a decision tree by determining the menu of choices at each decision node, based on outcomes of previous states and then identifying internal and external sources of uncertainty. Figure 5 shows an example of a decision tree for an IT firm, which can include the firm's future growth opportunities, weaknesses and capabilities.

Estimation of cash flows

The third step is to determine the cash flows generated by each business capability. Balasubramanian et al. (2000) refers to the following cost-benefit model, which can be applied at each time period when calculating the cash flows of an IT investment.

$$\text{Net Cash Flow} = (ms * Q) - fc - (vc * Q)$$

Formula 9: Net Cash Flow
Source: Balasubramanian et al. (2000)

In formula 9, ms represents market share, Q is the total industry demand, fc stands for fixed costs and vc is the variable costs per unit.

Market share, fixed costs and per unit variable cost are influenced by investments. The values of variables depend on the success or failure reached at the investment stage, and on the nature of the investment. The total market demand is based on the market. The next step is the valuation of these cash flows, and as mentioned previously this is where ROA can be applied.

Additionally Luehrman (1997) states that companies with new technologies, product development ideas defensible positions in the fast growing markets or access to potential new markets have valuable opportunities. It should be stated that for some firms opportunities are the most valuable things they own. When valuing such companies a normal DCF model is applied, however strategic projects are evaluated with special rules. A lower hurdle rate rather than the routine investments can be used when applying DCF calculations in order to compensate DCF's tendency to undervalue strategic options. On the other hand using a lower growth rate than usual growth rate will prevent to overvalue the firm considering the strategic options. Accordingly a special rule when valuing such companies is to evaluate strategic opportunities off-line, outside the DCF calculations. Additionally an option is valuable and its value depends on the underlying asset, the stock. Since owning the option is not the same as owning the stock, one must be valued differently than the other. Accordingly two types of cash flows matter in valuation. Cash from the business and cash that is required for further investments. Time also matters in two ways, timing of the eventual cash flows and how long the decision to invest might be deferred. Risk of the investment and the risk that the circumstances will change should also be considered in valuation of such companies.

Luehrman mentions also about the principle of value additivity as it is acceptable to split the projects in to pieces, value each piece and add them back up as well as it is okay to value each project individually and add them back up. This approach most often leads to an adjusted present value (APV). Because the basic idea behind the APV is value additivity, management can use it to break a problem down into pieces that make a managerial sense. By this way the management will be in charge of realizing individual pieces of value.

3.3 Criticism of DCF and ROA

3.3.1 Criticism of DCF valuation

After having a better knowledge of different types of options, it is important to realize why it is an advantage to apply ROA into company valuation, and it is also assumed that criticism towards traditional methods will assist this understanding.

Jägle (1999) states that peer group analysis and market multiples cannot be applied if the company's products and services are considered unique as it is in many cases within technology intensive industries. This statement leads to the critique against DCF valuation. The forecasts are often difficult to estimate and fail to include risk and valuable flexibility.

Jägle (1999) refers to Hayes & Garwin who argue that DCF alone has abstract weaknesses when it comes to the theoretical assumption within the model, and that this in turn leads to an underestimating of projects in a short term perspective and making investments less desirable. Accordingly, Hodder & Riggs (1982) argues that DCF analysis assumptions counteract long term investments. Hodder suggest that the implementation of DCF analysis ignores the different levels of risks that occur in different phases of a project and that the NPV calculation understates the value in situations where the management by its actions either can improve profits or limit losses. Jägle also refers to one of Myers (1984) main points where the NPV criterion is deemed inappropriate. Myers main point is that early investments e.g. major expansion in existing market, entry into a new market, acquisition or strategic alliances, R&D programs, or investment in an IT network/infrastructure are all early links in a chain of interrelated projects. Considered this way the value of these investments develop mainly not from expected cash flows, but from the fact that they unlock future growth opportunities e.g. second generation products or processes, access to a new market, or strengthen the core capabilities of a company.

With this criticism in mind Jägle differentiates between two basic components of a company value. Firstly the value of the company's existing business is considered, and secondly the value of growth opportunities and their evolution over the company's life cycle i.e. the value from potential new projects and businesses. Both values from existing business and value from future growth opportunities are based on the company's physical, human, and market demand.

Hence valuation of a company with growth opportunities is illustrated in the formula below:

$$MV = VE + VGO$$

Formula 10: Market valuation of company
Source: Jägle (1999)

Where MV = Market valuation of company, VE = Value from existing business, VGO = Value of future growth opportunities. Interestingly enough this formula is similar to the expended NPV of the ROA formula that is described by Mun (2002), and in which the expended NPV equals to static NPV (market value) of a firm plus the option value (growth opportunities).

Hodder & Riggs (1982) argues further that the DCF valuation ignores three critical issues: the effect of inflation, the different levels of uncertainty in different phases of a project, and the management's own ability to diminish risk. Accordingly Jägle indicates that in comparison to simple DCF valuation the option based approach for technology intensive companies is less dependent on FCFs which are significantly difficult for fast growing companies to estimate. Instead the option based valuation is more dependent on risk, which will be exposed in the success probabilities of the option tree. In his paper Jägle refers to Newton who argues that risk is easier to estimate than cash flows and that an estimation of risk thereby will generate a more defensible and accurate measure. However, even if the real option valuation of a firm is suggested draw backs of ROA should also be considered. Criticism against ROA is therefore discussed in the next section.

3.3.2 Criticism of ROA

According to Wörner, Racheva-Iotova & Stoyanova (2002) applying real option thinking to company valuation seems theoretical and intuitively appealing. Further Wörner et al. argues that unlike capital budgeting the real option process of a single European option according to B&S terminology as well as compound option proxy perform poorly when applied to company valuation. Wörner et al. therefore also suggests that by reworking the blocks of real options a more accurate estimation should be achieved. Wörner et al. further state that real option valuation is based on the idea to find or create an asset that is traded on the financial market, and that it should illustrate the same risk profile as the underlying one of the real option. This process is also known as duplication, and in accordance with this the option on the traded asset is then valued using

common option pricing theory (Wörner & Grupp 2003). The duplication risk profiles are moreover according to Wörner & Grupp a straight forward approach for traditional applications or real option theory, but are more difficult to imply when the underlying assets are innovations due to the fact that innovations expand the space of possible investment alternatives by introducing novel sources of risk. If the sources of risk is unparalleled or the market is incomplete, it might be impossible to hedge this risk by constructing a portfolio of assets that shows the same payoff structure like the option's payoff and selling it because such a hedge portfolio is just not available. This will directly affect the risk neutral approach of pricing a known underlying asset in incomplete markets. In order to acknowledge detailed difficulties of estimating the parameters in ROA the problem with estimations is accordingly presented in the next section.

Problems with estimating the parameters

Miller & Park (2002) states a number of interesting points concerning real option analysis. Among other things that a number of draw backs exist in the valuation and implementation of ROA due to the fact that real options are benchmarked from financial option pricing. The authors indicate that in general six parameters impact the option value. These parameters are stated and explained as follows:

The underlying asset

Miller & Park discuss the stochastic process and the underlying asset tradability through the following statements: The stochastic process can be defined as one of the key assumptions of B&S, the asset price movements follows Geometric Brownian Motion in which the terminal distribution is the lognormal distribution. This assumption is valid when valuing financial options where stock prices cannot be negative, but it possesses a problem when valuing real options. The underlying asset price can be negative and lognormal distribution does not account for that. The position jumps and mean reversion are the other stochastic processes, which describe the price movements of the underlying asset. Position jumps are used to capture sudden and sharp movements of the asset price, which may occur when the underlying asset is real. An impact of sudden technological change on the underlying asset price is a good example for the position jumps. These will increase the option value. The main reversion indicates that the asset price tends to turn to some long term average price which may increase or decrease the option value. The mentioned stochastic processes are often used in combination when generating a terminal distribution, which differs from the lognormal one. Using these three processes in combination can to some extent limit the problem, which occurs when using only Geometric Brownian Motion.

Miller & Park discuss the underlying asset tradability and refers to Trigeorgis for a twin security approach. The approach is hard to implement in practice because it is almost impossible to find a twin security, which is perfectly correlated with the real asset if the asset is not traded. However, Trigeorgis indicates also that the use of a twin security could be possible when the real asset is traded in future markets, but also when there exists a company, which specializes on projects that are valued. Then the company's stock price can be used and the investment contributes to the firms' market value. In this case the own company's stock price can be used.

In addition to this two more approaches are discussed. Firstly the real asset can be treated as traded in the sense that since the asset is publicly traded it contributes to the company's market value. Thus it can be assumed that the real asset's twin is the security itself. Secondly the market asset disclaimer assumes that real assets are perfectly correlated with each other and form the best unbiased estimate of their value if they are traded, in which case real assets should be treated as they were traded (Mun, 2002).

Volatility

A key parameter which affects the option value is the estimation of an accurate volatility, which is a logarithmic distribution of cash flows. The problem with estimating the volatility is that many real assets do not have historical return information, and the traded option price is neither available in all cases. Three approaches are suggested for estimation of volatility: twin security information, Monte Carlo simulation (MCS) and closed form, B&S expression. In short this means that volatility is estimated either through finding a twin security, running a multiple simulation or by using a sensitivity analysis. Volatility can in addition be dependent on multiple uncertainty sources, be stochastic or depending on time. Therefore correlations between the varying uncertainties should be considered. Positive correlations can lead to an increase in option value, meanwhile independent and negative correlations might lower the option value (Miller & Park, 2002).

Exercise Price

According to Mun the exercise price when valuing ROA is not unique and differs depending on the type of option being is valued. A good example of this can be that the salvage value is the exercise price of the next option in an abandonment option. Meanwhile the investment cost of undertaking the next investment is the exercise price in the other type of options. The exercise price could also be lumpy,

meaning that it might be discretionary cost/expense at one specific point or it might be a series of payments spread over a long period of time. These segregated payments should be combined into one exercise price in RO valuation.

Expiration Date

Financial options have a fixed maturity, which is relatively short. In contrast real options might have a very long duration and it is often unknown when valuing the option. Further execution of the real option requires a certain time period for development. This time period can be considered when determining the expiration date (Miller & Park, 2002).

Dividends

An increase or decrease on the underlying asset value during the real options life could have an essential impact on the option value. In contrast dividend payments such as pay outs, insurance fees, licensing royalties has to be accounted for and considered as a leakage in the value. The amount and the timing of the dividend might be unknown or dependent on the market/private exogenous factors for real options (Miller & Park, 2002).

Risk and the appropriate discount rate

Mun discusses the difficulties with estimating these parameters in ROA as portfolio investment gives the possibility for diversification of private risk, which in turn leads to the acceptance of using risk free rate in the valuation of options. If underlying tradability assumptions hold, it is then understood that the real option can be valued as a financial option. Hence risk free rate can be used for all discounting. Risk adjusted discount rate and standard utility functions are other approaches, which can be used as an appropriate discount rate when valuing real options. The problem with using the utility approach is that it has a tendency to undervalue the option since it likely would overstate the risks that could be traded and hedged away. The problem with financial option approach is that the use of risk free rate leads to an inflated project value because it assumes that all risk is market risk and can be alleviated through replicating a portfolio. This will understate the uncertainty since the entire project can be discounted at the risk free rate. Therefore the private risk portion should be discounted at a higher rate. Even though average risk adjusted discount rate can be found to equate those two approaches, no single discount rate approach is correct because of the asymmetric payoff of the option.

4 Empirical study

Company facts as well as information concerning Dice's game projects are presented in the first part of the empirical study. In the second part information about the game industry and facts concerning entertainment market is given. In the last part of this section valuation results, which are obtained from Kaupthing Bank, are presented.

4.1 Company facts

This section states Dice's vision and concept as well as lists different projects and strategies that match and correlate with Dice's business model.

> **Vision:** *Digital Illusions shall be one of the leading game developers in the world by continuously creating innovative quality products for a global mass-market* (Dice, 2004).

> **Business concept:** *Digital Illusions develops TV and computer games for selected game segments where it has a competitive advantage. The company shall gradually increase the proportion of own brand names, and reach the global mass-market by providing excellent quality and working with the sector's leading publishers* (Dice, 2004).

> **Business model:** *Digital Illusions' business model is to develop games based on its own brand names. The games are then marketed, distributed and sold by a publisher. Digital Illusions receives a fixed production budget from the publisher for the development of a game. Digital Illusions also receives a part of the games sales revenues in the form of royalties provided the game reaches a certain sales level. Royalties are calculated on a percentage of the price per sold unit and are received first after the already paid production budget has been recovered and deducted. Should a game be a success, such as Digital Illusions Battlefield 1942, the Company may develop a so-called expansion pack, like Battlefield Road to Rome. The Company may also develop complete follow-ups to the game, like Battlefield 2. An internally developed brand name is a platform where expansions and new versions of the game enable a good return for many years* (Dice, 2004).

Short-term goals (two years)

- ✓ *Create at least one product based on a completely new own brand name.*
- ✓ *Launch at least three games each year.*

Long-term goals (five years)

- ✓ *Hold a dominating position in the games market with internally developed products where the Company owns the brand name and other intellectual rights.*
- ✓ *Launch at least three games each year.*
- ✓ *Maintain growth that exceeds that of the games sector.*

(Dice, 2004).

4.1.1 Facts concerning Dice

In 2003 Dice entered into a cooperate agreement with EA. The cooperation agreement includes that EA is responsible for marketing, distribution, and sales of games based on Dice own developed trademarks. The agreement was renewed in 2003 and it stretches over 15 years. In January, 2005 EA purchased 59.8 percent of Dice shares. The purchase makes it harder for Dice to cooperate with other publishers than EA. The royalty revenues will also be lower due to the stronger relation with EA (Dice, 2004).

Today Dice possesses strong trademarks and is one of the leading developers in first person shooter/action and racing games. Dice receives strong royalty revenues from own developed trademarks. The company has a good and proven production process for game development based on phases, which focus on greater quality through the whole process. The process is flexible in order to maintain a high productivity (Dice, 2004).

Dice's strategy is based on development of bestseller games and trademarks with strong possibilities of follow up games and supplementary products in order to create greater profit margins. During 2004 Dice launched five games. The quality of the game is the most differential factor when creating a bestseller game. In order to lower the risk that correlates to game development, Dice uses a risk management that is based on fixed budgets in the development genres that Dice govern. These genres are first person shooter/action and racing. The fixed development budgets are adjusted for different phases in the development process,

and Dice's games are also adjusted to customer demands by conducting different market researches (Dice, 2004).

One of Dice's most valuable assets is their employees and especially the once who develop the games. It is therefore important for Dice to maintain a low employee turnover, which can be illustrated by the employee turnover from 2004 at 2 percent. The synergy effects are now recognized by consolidating Gothenburg and Stockholm production offices. The head production office is since 2004 located in Stockholm, and since then new structures has been implemented. Larger and more flexible teams with focus on centralized technology development exist in the game development process. The currency fluctuations in the USD will affect Dice project revenues due to the fact that budgets and capital are received in USD, whereas most of the costs for projects are conducted in SEK (Dice, 2004).

4.1.2 Dice's game projects

Sales for the Battlefield (BF) concept totalled to 4.6m units in 2004. The sales are expected to become greater for the follow ups in the BF concept. Additionally the trademark positions itself as one of the best online games in the world. Dice has received great rewards for proven quality of their game development. The average rating for a game developed by Dice totalled 90 percent. 100 percent in rating means a perfect game (Dice, 2004).

In June 2005, BF 2 will be launched for PC. BF Modern Combat will be launched during the autumn of 2005 for video gamers. This is the first BF game that will be released for Playstation 2 and Xbox. Two more projects are under development and will be launched for the next generation of platforms (Playstation and Xbox) in 2006/2007 (Dice, 2004).

In September 2004, Dice bought Trauma Studios production in New York. The total purchase price was 500 000 USD, in the purchase a trademark Desert Combat was included. Dice's development process makes it possible to move knowledge and capacity between different projects (Dice, 2004).

In the end of September 2004, Dice sold a development license for the BF 2 technology platform to Aerotech Telub who is a subsidiary to SAAB. The price for the technology platform was SEK 4m and included a minor support function.

The agreement states the rights for Aerotech Telub to develop education simulations for the Swedish Armed Forces (Dice, 2004).

4.2 The game industry

Dice takes advantage of the large entrance barriers that exist in the gaming industry by the technology altitude. Developers in the game industry stand before new technology investments due to the next generation of platforms, and the next generation of platforms is expected to be launched during 2005/2006. This change is expected to increase the focus on video gaming, but the large investments will probably decrease Dice's revenues during the following years (Dice, 2004).

The trend in the industry is mounting to create larger games than before, which will make the projects bind more capital. Significant for this is that delays become more and more expensive in the industry. It is hard and difficult to estimate future growth in the industry of interactive entertainment, but there are large opportunities on new and expanding markets such as Eastern Europe and China. The most comprehensive competition for Dice is other entertainment forms such as movies, games, and records. There is also a certain loss of revenues due to the illegal downloading of games over the Internet. Competition with other successful game developers such as the British Lionhead and the American BioWare is also recognized (Dice, 2004).

4.2.1 Facts concerning interactive entertainment market

The market for games in numbers, interactive entertainment had a continuing growth during 2004. A further expansion of the market is expected under the following years. According to ESA (2004) the total sales of software games in the US for 2004, amounted to 7.3 billion dollars. This is a new record and can be compared to the total sum for 2003 which were 7 billion dollars (Figure 6 and 7).

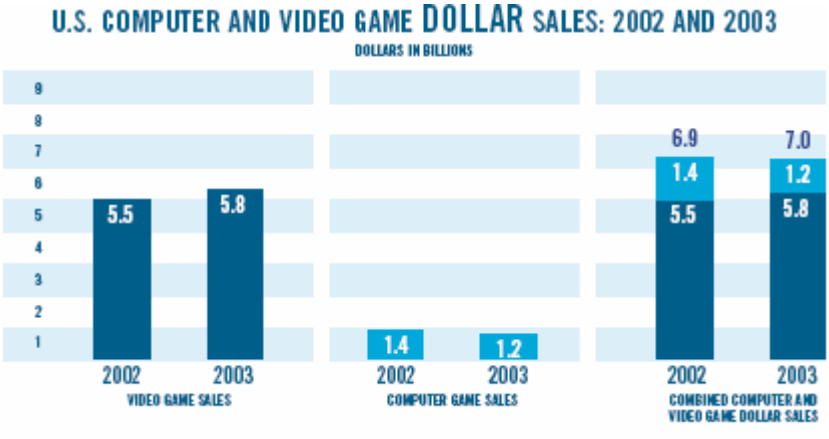


Figure 6: U.S. computer and video game sales 2002 – 2003
Source: ESA (2004)

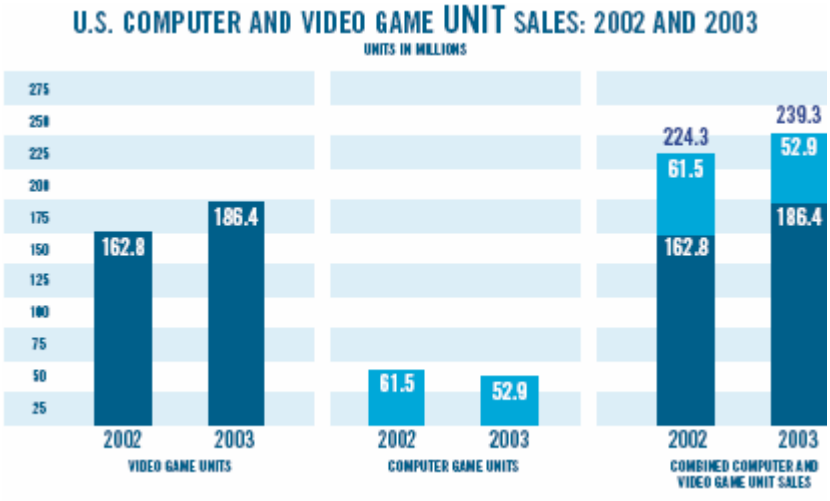


Figure 7: U.S. computer and video game unit sales 2002 – 2003
Source: ESA (2004)

Sales for total games on the American market are increased by 11 percent. The most successful genre for video games (2003) was action which represented 27.1 percent of the total sales. Sports represent 17.6 percent of the total sales, racing stood for 11.3 percent meanwhile first person shooter games stood for 8.6 percent and of the total sales (Figure 8 and 9).

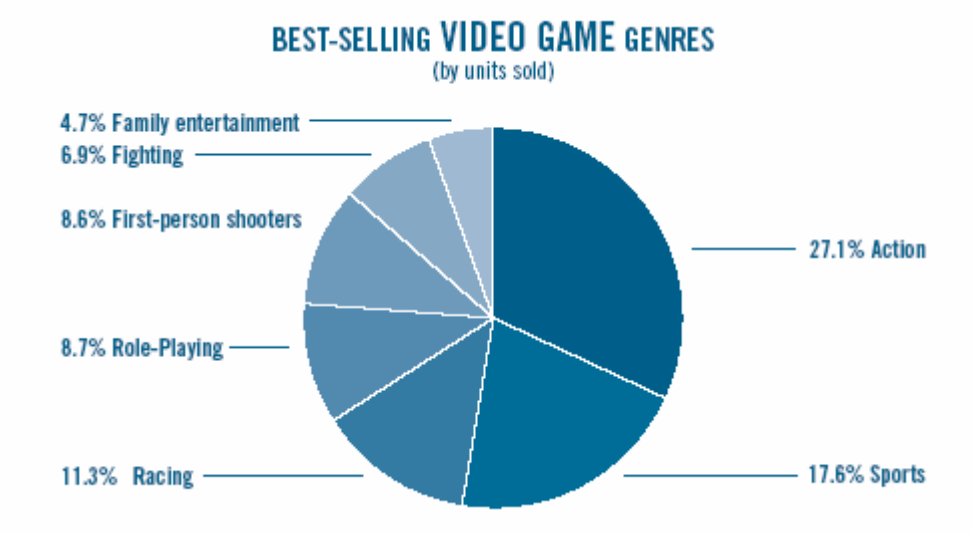


Figure 8: Best selling video games genres
Source: ESA (2004)

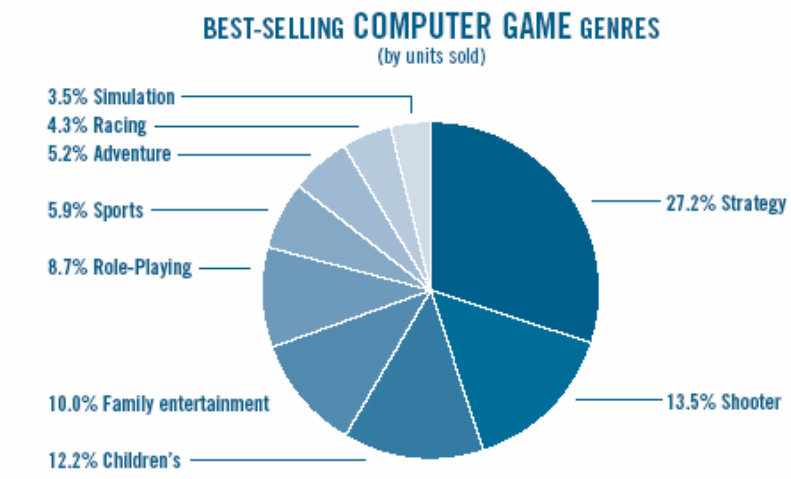


Figure 9: Best selling computer games genres
Source: ESA (2004)

According to Broad Band User Survey (2005) there are more than 150m households with broadband in the world today and the amounts are expected to increase further. The online gaming is correlated due to this increase. Sales for PC games decreased with 12 percent on the American market. The video gaming sales in the American market increased with 11 percent in 2004 compared to 2003. The game industry is growing based on cycles due to the generation shift in the new platforms this information is according to ESA (2004) for historical sales information se Appendix 4.2.1.

4.3 Analysis of Dice by Kaupthing Bank

In Kaupthing Bank's (2004) analysis of Dice presents three arguments behind EA's claim that Dice will find it hard to operate alone on the market. These arguments include a shift in technology, conversion of BF for multiple platforms and increased competition from global titles.

Kaupthing Bank points that Playstation 3 will probably reach the market in mid-2006 and will be built on IBM's new 64-bit processor CELL, and it will be possible for game developers to develop games for this platform in spring 2005. Xbox 360 will reach the market in time for the holidays 2005 and will have performance in line with Playstation 3, but instead it will be built on the Power PC chip. Accordingly there is a new Nintendo handheld called DS, and also the new handled platform called PSP from Sony. It is also important to mention that these two have just started to reach the market. All of these factors will have impact on the shift in technology.

Consequently Kaupthing Bank argues how this platform shift will affect Dice. BF was the first game that EA confirmed for the next generation of video games, which is evidence of the importance of trademark. This game will be launched in late 2006 or early 2007. It is therefore in EA's best interest to support Dice with the appropriate developing tools and resources.

Another interesting detail according to Kaupthing Bank is that 70 percent of the code that was developed for the postponed 2005 spring Playstation 2 and Xbox title "the Contractor" can be reused for the next generation platforms. This information was provided from Dice's CEO Patrik Söderlund. In addition Kaupthing Bank continues to argue that if this information is true, the platform change cannot be as expensive as Dice's board and EA claim.

Accordingly BF Modern Combat will be launched on Playstation 2 and Xbox in autumn 2005. Kaupthing Bank states that Dice has a considerable potential for both of these platforms, as this game has been converted to fit single player mode as well.

Accordingly Kaupthing Bank expects BF for PC to be a huge winner with at least two millions sold copies for 2005. This technology shift may lead to a slowdown concerning newly sold video games as consumers are probably waiting on the new platforms, but Kaupthing Bank believes that it may on the other hand increase the number of sold PC games. The technology shift might also force publishers like EA to invest more in marketing until the new platform is launched. Finally EA argues according to Kaupthing Bank that Vivendi and Microsoft are competitors to Dice. However, Kaupthing Bank states that this is wrong since they are old customers to Dice and competitors to EA, and points out that Dice's trademarks are worth much more to EA than the SEK 61 EA offers.

Kaupthing Bank estimates that 2005 will be a good year for Dice as they release three own titles and one or two expansion packs for BF 2. In their previous valuations Kaupthing Bank has used classic business ratio and proxy valuation but now they also use DCF method and sensitivity analysis in order to estimate worst/best case scenario. In addition to this a number of estimations are made by Kaupthing Bank in order to estimate the value of Dice. These assumptions are presented in Table 1. Beta and market risk are used to estimate WACC, which in turn is used to discount the revenues, while the risk free rate is used to discount the costs and the cost of debt is used to discount the debts.

Valuation assumptions and sensitivity

Assumptions			**Phase 1**	**Phase 2**	**Phase 3**
Market risk		4.0%	2004-06E	2007-16E	2017-
Risk free rate		4.5%	16.0%	33.4%	50.7%
Cost of debt a tax		4.0%			
Req. return on eq.		10.1%	**DCF Value (SEK)**		**EBITA marg.**
Beta		1.4	**Ph.2G**	18.0%	19.0%	20.0%	21.0%	22.0%
WACC		10.1%	6.0%	52	53	55	57	59
			8.0%	55	57	59	60	62
Cont. value	**Ph.2**	**Ph.3**	10.0%	58	60	**62**	65	67
NOPLAT growth	10.0%	n.m.	12.0%	62	64	67	69	72
ROIC	35.0%	WACC	14.0%	66	69	72	75	78

Table 1: Valuation assumptions and sensitivity
Source: Kaupthing Bank (2005)

In addition Kaupthing Bank's estimates of Dice have arrived at a value that sets the share price to SEK 77 as a best case scenario for early 2005 and SEK 62 as a worst case scenario for late 2005. The worst scenario assumes lower royalties, decreasing the total revenues with 40percent. All in all Kaupthing Bank expects a higher bid from EA and sets their target price at SEK 72.

Consequently Kaupthing Bank estimates a value of Dice according to best/worst case scenario and the estimated target price are shown in Table 2.

Scenario	Shares	Price SEK	Company Value
Best	10 110 060	77	778 474 620
Target	10 110 060	72	727 924 320
Worst	10 110 060	62	626 823 720

Table 2: Value of Dice according to best/worst case scenario
Source: Kaupthing Bank (2005)

5 Analysis

The assumptions and calculations are structured according to the theoretical framework and the empirical study. In this part the real option process is considered and applied from a company valuation point of view, which emphasis that the value of a firm is completed with the option values of the projects.

5.1 List of projects and strategies

The analysis of Dice's annual report from 2004 led to the identification of possible future projects.

- ✓ The launch of BF 2 for PC during the summer of 2005.
- ✓ The launch of BF Modern Combat for Playstation 2 and Xboxduring the autumn of 2005.
- ✓ The launch of two more unnamed titles for the next generation platforms during 2006 and 2007.
- ✓ DCF valuation of Dice as one project.

In the projects described above, expansion packs and follow ups to bestseller games and trademarks are included. Additionally Dice's strategy is to launch three new titles each year and one new trademark every two years. However, there are only four projects today that Dice has decided to launch. These four projects, which are described above, are the most significant projects of the company, and are under development at present (Appendix 5.1).

According to Mun (2002) a list of projects and strategies are the first step in the real option process. This step of the process is applied on Dice when valuing different projects in order to find the project that will be the most profitable. Applying ROA can then result in new values such as future growth opportunities to a project. These values are usually not recognized when doing a DCF valuation. When we applied ROA on Dice, the valuation forecasts were based upon information about the company in form of annual, quartile, and market reports. In this stage information and research were vital. It should be stated that the option values of the projects will not be better than the accuracy of the information that the analyst is in command of. Therefore deep insights about the firm and the industry must be collected. Once this was achieved a list of different projects and strategies that should be derived from Dice DCF value was made. Dice was also listed as one project in order to create a base value for the firm in the next stage.

5.2 Base case NPV analysis for each project and firm

In this step the DCF of the projects are calculated. Static NPV (sNPV) calculations are applied concerning the firm and each project in order to create a DCF model according to Arnold & Hatzopoulos (2000).

The assumptions for the calculations are made from the information and research collected in the earlier stage. In this stage we had an option to value every single project within Dice, and in this case a growth rate that equals zero should be applied to Dice's sNPV. We could also choose to value only the defined projects within Dice and estimate a reduced growth rate for Dice's sNPV. This choice should basically be considered as correlated to the size of the firm. In Dice's case it is important to note that it could be difficult to manage a valuation of every single project within the firm, concerning the royalty revenues that are received from previous projects, and therefore we were better of estimating a reduced growth rate for the firm and by making a calculation of the sNPV only for the defined projects.

5.2.1 DCF and sNPV for the firm

The future cash flow is calculated in order to find out the sNPV of the firm. Related information is taken from the annual report of Dice 2004 and a number of assumptions are made in order to make the calculations.

Accordingly current revenues, current operating income, depreciation, current debt outstanding, cash and marketable securities, and the number of shares outstanding are taken from the annual report. Capital expenditure is calculated as total acquisition plus physical assets. Change in working capital is calculated as current assets minus current liabilities for the year 2003 and 2004. Value of equity options issued by Dice is defined to SEK 4.50 and the totalled number of options is defined as 2 329 002 options.

A traditional DCF calculation, which includes future growth opportunities, is calculated. The future growth opportunities are converted into a higher growth rate during the high-growth period for the next five years. This growth rate is assumed to be 8.10 percent. According to the information based on the sales in the game industry has increased with an average of 7.00 percent per year for the last five years. We know from our empirical study that Dice's aim is to maintain growth that exceeds that of the game sector and according to the company's annual report the growth rate for the year 2004 was 8.10 percent. We assume that

Dice will follow this trend in high growth period for the next five years. The growth rate for the stable growth period is supposed to be 4.05 percent. This result arises from the assumption that we observe a huge decline in Dice's sales growth during the last five years.

In order to estimate the sales growth for the next five years a time series analysis (Appendix 5.2.1 A) is applied to Dice's historical sales growth. The outcome from the analysis was that Dice's sales growth declines approximately 50 percent per period. This result leads to state that 4.05 percent of sales growth for the stable growth period is reasonable.

For the sNPV calculations growth rate for the high growth period for the next five years is calculated to 2.19 percent according to the time series analysis. This rate indicates the trend of growth rate in year 2005 in view of the growth rate development during the last five years. For the stable growth period the average growth rate of the last five years according to the time series analysis is calculated to 1.20 percent. This growth rate does not include the development that arises from Dice's four projects that are under development. The growth rate concerning these projects is considered in the option values.

Pre-tax operating margin is calculated through dividing the operating income by the net sales before tax, which equals to 12.30 percent. The net sale is expected to increase correlated to the market growth, however there are large investments that have to be done in order to achieve this growth. In addition to this the royalty revenue will decrease due to the stronger relations to EA. We assume therefore that the operating income in SEK will be in a status quo state in the next five years, which will affect the operating margin to decrease to 8.40 percent.

We assume that Dice will use 24.06 percent debt for financing their future investments. The figure is based on average historical debt (last 5years) used for financing new investments. The growth rate for capital expenditure and depreciation is based on historical information. Dice's capital expenditure has increased 10.00 percent during the past years. Working capital is divided by the revenues in order to define it in percent, and equals to 88.60 percent. Corporate tax rate is taken as 28.00 percent. Beta for Dice is taken from market estimation of IT companies, 1.20 this figure is compared to another computer game company Daydream, which is a higher risk company with a beta of 1.51. Accordingly we assume that a beta of 1.20 is relevant for Dice (Dagens Industri, 2005).

Long term (five years) bond rate is 2.67 percent. The information is taken from Stockholm Stock Exchange group (OMX, 2005).

According to Kaupthing (2005) Risk free rate is estimated to 4.50 percent. The information on the market risk premium estimated to 4.00 percent according to the Central Bank of Sweden (2005).

Pre-tax operating margin in perpetuity is assumed to 15.03 percent. The figure is based on the historical data, the average pre-tax operating margin for the last 3 years. We assume that stable stage period operating growth will reach to this level after the expansion phase due to the technical development and the investments made after this period.

Return on capital in perpetuity (8.15 percent) is calculated as EBIT/ Total Assets-Current Liabilities. The inputs for the calculation are taken from the Dice annual report 2004. This is due to the assumption that the ratio will remain unchanged in perpetuity in the stable growth stage. Since the change in sales growth declines dramatically, we believe that Dice's main aim is to try to maintain figures, which Dice has in the annual report (2004). We believe that it is therefore appropriate to use these figures in the stable growth stage.

Capital expenditures dived by depreciation is defined in percentage (108.00 percent) in the calculation. Dice's annual report is used as a source. 24.06 percent of debt is applied during the stable growth period. This is based on the historical information. During past years Dice has applied 24.06 percent of debt on their investments. Interest rate of debt in the stable period is assumed to be the same as risk free rate. Beta in the stable growth calculations is the same as the Beta used in high growth period. This is based on the assumption that stable growth will not affect the risk of the company (Appendix 5.2.1 B-C-D).

5.2.2 sNPV for the projects

Free cash flow for each project is estimated through first dividing the average operating profit from units sold between years 2002-2004. In this way historical average operating profit per unit sold between the actual years is estimated to SEK 12.52. In order to estimate the operating profit and the units sold in the future, both PC game and video game development in the game industry are first calculated based on the historical information according to the ESA (2004). The starting point to estimate the units sold for a PC game in the future is that Dice

has launched the PC game, BF 1, in 2003 and the total unit sales for this game was 4.6m. From the analysis of the market it is found that the unit sales for the PC game industry have declined around 5.00 percent between the years 2002 and 2003. The unit sales for BF 2, which is also a PC game, would then be assumed as 4.36m considering the decline in the PC game industry. For the unit sales estimation of a video game, we know from the historical information based on the ESA (2004) that the market sales for a bestseller game including expansion packs and follow ups is around 19.72m units. Since 22.10 percent of the total market is represented by PC games, then the unit sales for a bestseller video game also including expansion packs and follow ups can be calculated to approximately 15.36m because the video game unit sales represent 78.00 percent of the total units sold. The next step is to estimate the operating profit per project. This can now be calculated through multiplying average operating profit per unit sold by the estimated unit sales per project. Accordingly estimated operating profit for BF 2 is calculated to SEK 54.53m and the other three video game projects' operating profit is SEK 192.34m per project. In order to calculate the sNPV of the projects the operating profit per project is divided by the WACC of the company for the respective year (Appendix 5.2.2).

5.3 Static Discounted Cash Flow Models

In this stage different DCF models are considered according to Myers (1984). The results of DCF calculations for the firm and sNPV calculations for the firm and each project are presented in Table 3 (SEK).

Dice (2005)	**Firm**	**BF 2**	**BFMC**	**UNX 1**	**UNX 2**
sNPV (m)	364 503 616	51.23	180.69	169.73	159.45
NPV (m)	584 878 635				
Share price	38.58				
Share price	58.28				

Table 3: Static Discounted Cash Flow Models

According to our calculations, DCF models shows a NPV of SEK 584 078 635 and a price per share SEK 58.28 in 2005. This value is very close to the market value of Dice today. Static NPV calculations with a lower growth rate result in SEK 364 503 616 and price per share SEK 38.58. The option values of the projects are to be added in order to find the expended NPV. Consequently sNPV

of BF 2 is calculated to SEK 51.23m, BF Modern Combat to SEK 180.69m, Unnamed project X1 SEK 169.73m and Unnamed project X2 SEK 159.45m.
The traditional DCF models complete the NPV that generates a broader picture of the specific project in ROA. However, the NPV was the most important method for us due to fact that the NPV outputs of the projects were used as the RO inputs.

5.4 DCF Outputs as Real Options inputs

It is important to state that the sNPV, which is obtained for the whole firm, is not used as the inputs for the RO valuation in order to value the projects that are under development. This is due to fact that sNPV includes royalty revenues, which arises from sales of previously launched projects. It could be wrong to consider royalty revenues when calculating sNPV for new projects. Each project's sNPV is therefore calculated independently from the royalty revenues through calculating the revenues and costs that are related only to the projects and are used as inputs for ROA. Since this calculation is based on the mentioned assumption it is problematic to apply a MCS to these input values. It should also be underlined that the volatility for each project could be higher than the volatility for whole the firm, however the volatility in our calculations for the projects does not have a large impact on the option value due to the high expansion factor. According to our calculations, which are aligning with Dice's estimation, 40 percent volatility is applied on ROA for the projects. We also assume that there are no interactions within the different projects, but we have however considered the interaction within each project separately in order to make the calculations less complicated and more comprehendible.

5.5 The type of options that is chosen

In this section the option strategy is framed in terms of real options structure according to Mun (2002). Expansion, Contraction and Abandonment options are chosen in order to apply on to each project. The relevant assumptions and calculations for the variables that affect the ROA for each project are also presented. Assumptions for the expansion, contraction and abandonment options are based on the information concerning Dice's future possibilities.

5.5.1 Inputs for the ROA

Static NPV for respective project is taken as the underlying asset for respective projects in ROA. Volatility is estimated through calculating the logarithmic

returns of monthly historical cash flows during 2002-2004 and then annualising the volatility of the period. Through this calculation volatility is estimated to be 40.00 percent. This calculation matches, Dice's own assumption of volatility (40.00 percent), which is based on the historical data according to Dice's annual report 2004 (Appendix 5.5.1 A) Kaupthing Bank's estimation of the risk free rate of return is considered to be 4.50 percent, and the time to maturity is estimated to 3 years since the aim of the valuation period is between 2005 and 2007. However steps in the Binomial tree are calculated quarterly in order to receive a higher level of granularity and accuracy which means that binomial steps (Δt) is 0.25.

According to Dice's annual report 2004 the dividend payout was SEK 0.90 per share. Dividing the dividend payout by the share price resulted in dividend yield of 1.53 percent. However the dividend payout has not been considered in the calculations due to the uncertainty of future dividends payouts according to the larger investments that Dice is considering.

Expansion Option

When estimating the expansion factor, development of new trademark, or development of expansion packs and follow ups for bestseller games with possibilities to collect royalty revenues are considered.

According to Dice's annual report the total sales for BF 1 amounted to 4.6m units to PC gamers. The PC games stand for 22.00 percent of the total market of the computer and video game industry. Video games stand for 78.00 percent of the total market according to ESA's report (2004). This report states that the video game industry's sales units are increasing in comparison to the computer game industry with the percentage of approximately 5.30 percent. We believe that this will affect the units sales of BF 2 concept aimed for PC gamers to amount to a total sale of 4.36m units.

The video game market is increasing and Dice are about to launch a BF Modern Combat for video gamers. If the sales will be developing in the same proportion as it is in the video game industry, Dice sales in the video game industry will be 15.36m units. If these assumptions are accurate the total sales within the BF 2 concept will be 4.36m units considering the 5.30 percent decrease of the PC game sales in the industry. According to these calculations Dice will gain an expansion factor for the BF 2 of 1.97. If then the same assumptions are made for the video game projects the expansion factor can be calculated to 3.08 considering that the sales units of video games for each project will reach to 15.36m units within Dice.

It is also significant to mention that the calculated sales for each project stretches over the respective project's lifetime, including expansion packs and follow ups.
The starting point on estimation of the expansion cost for each project is that according to Dice's annual report from 2004, Dice has fixed costs in order to develop a computer game, and in 2004 Dice developed three games. This is also the amount of games that the company plans to launch every year according to its strategy. In order to estimate the expansion cost for a project for the year 2004 we have therefore divided the annual cost by three projects. For year 2005 to 2007 cost of debt is considered in the estimation. Consequently expansion cost for BF 2 and BF Modern Combat is calculated to SEK 64.54m each, for Unnamed project X1 SEK 66.62m and for Unnamed project X2 SEK 68.77m (Appendix 5.5.1 B).

Contraction option

When estimating the contraction factor for the developing of games for a specific publisher the possibilities to collect royalty revenues from the already launched projects is considered. This is accomplished by renting out some percentage of Dice's capacity. The contraction factor is estimated through calculating the capacity for each project. Dice developed three projects in 2004 and we assume that each project represents 33.00 percent of Dice's capacity. This assumption is based on the fact that Dice's strategy is to develop three projects per year, and therefore we assume that the resources for the projects are equal. Consequently the contraction factor for each project can be calculated to 67.00 percent (1-0.33). Only the revenue that is received from the projects is considered in calculation of contraction gain. The reason why we have limited us from considering royalty revenues in this calculation is that project revenues are received from the publishers unlike the royalty revenues that are received from own developed games. Accordingly project revenues are divided by three considering that three projects were developed in 2004. Then the time value of money is taken into consideration with a 5.00 percent of interest rate when calculating the contraction gain for each project. Consequently contraction gain for BF2 and BF Modern Combat are calculated to SEK 42.07m, for Unnamed project X1 SEK 43.96m and for Unnamed project X2 SEK 45.94m (Appendix 5.5.1 B).

Abandonment options

The starting point for our assumptions concerning the salvage value is the possibilities for Dice to sell a development license. Dice sold a development licence for a platform from their BF 2 project to SAAB, Aerotech Telub. This sale amounted to SEK 4m. This licence gives SAAB a possibility to use the technique to develop education simulations for Swedish army. Accordingly SEK 4m is

taken as a salvage value for the projects in our calculations. Interest rate of 5.00 percent is considered in order to calculate respective projects salvage value.
Finally the salvage value for BF 2 and BF Modern Combat are determined as SEK 4.18m each, Unnamed project X1 SEK 4.37m, and Unnamed project X2 SEK 4.56m. We have considered the different options that might be within Dice's projects for construction of the options. The following questions were considered when framing the option strategy for Dice. What are the firms' options with the project? Which paths are possible to choose for the firm when its surroundings are changing? How flexible are the firm in terms of expansion, contraction, abandonment, and switching capacity?

There are a lot of different opportunities that can be included in an option, and at this stage it is essential to base the construction of options on known information and estimates due to the high scale influence on the option value of several variables. It should also be stated that Dice's whole structure might have to be changed in order to collect these option values. Hence if it was recognized that the management of Dice was unable to deal with flexibility, the specific option values could have been difficult to truthfully rely on. When applying real option analysis on Dice we therefore had to make a structure analysis based on historical data concerning Dice's goal achievement as a complement to the ROA in order to define if Dice was able to collect flexibility values or not. An extension of the structure analysis was to determine which specific flexibility values that Dice were able to capture (Appendix 5.5.1 B).

5.6 Option analytics simulation and optimization

In this step the RO model according to Trigeorgis (1993) is created. Hence the options results are calculated by using binomial lattices and the sensitivity as well as best/worst case scenario is applied onto results in order to identify the critical success drivers and different scenarios of the outcomes. However the optimal values, which are obtained from our original calculations, are presented in this report as our target values. It is important to note that the firm value that is calculated with ROA is perishable, meaning that the analysis has to be updated correlated to the releases of new information in order to show an accurate value of the firm.

According to our ROA through binomial lattices option value for BF 2 is SEK 32.01m, for BF Modern Combat SEK 320.04m, for Unnamed project X1 SEK 295.63m and for Unnamed project X2 is SEK 272.59m. In order to state the

interactions of different options that are exercised in this report, we have made an option to choose calculations for each project, and in the Appendix 5.6 A-B-C-D it becomes clear on which node of the binomial tree to expand, contract, abandon or keep the option going.

According to our sensitivity analysis volatility, expansion factor and the contraction factor are the most critical variables for the projects. On the other hand risk free rate and the salvage value of the projects are the least important variables for the option value. We should also mention that the expansion factor is relatively high in our calculations due to consideration that the unit sales of projects include the project's lifetime. BF 2 has the lowest expansion factor within the projects. When the sensitivity analysis is applied to the projects with a higher expansion factor, we experience that the expansion factor interestingly enough has a larger impact than the volatility on the option value. The reason behind this can be that the higher expansion factor sets a limit on the down side of the option value variation in the volatility (Appendix 5.6 E-F-G-H).

Our best/worst case scenario analysis starts by forming the assumption that all the variables that affect the option value will decrease or increase by 50.00 percent. The figure estimated through adding the 10.00 percent extra risks due to entrance of new markets, China and Eastern Europe onto 40.00 percent of volatility. We refer to the (Appendix 5.6 I) for Best/Worst case scenarios concerning the option values.

5.7 Reports presentation

Finally the results are presented in this stage according to Balasubramanian et al. (2000). The option values of the projects are added to the sNPV of Dice and the expended NPV is calculated. The value that is obtained from the DCF calculations is presented in this stage in order to make a comparison of the results with those of the ROA. Dice's values that are received from the best/worst case scenario are also reported at this stage. The values are calculated for the next three years, 2005-2007.

In order to obtain expected value of Dice through ROA we have first calculated the discounted option values of each project for respective year by taking the WACC into consideration. The discounted option values are added to sNPV, and the obtained result, eNPV, is then divided by the share outstanding for respective year in order to find the share price. The value of Dice according to our ROA for

the year 2005 then equals to SEK 1 235 034 418 and the price per share is SEK 110.82.
By following the same process Dice's value considering the best case scenario can be calculated to SEK 1 869 538 473 and the price per share is SEK 167.75 for the year 2005. When the worst case scenario is considered a value of Dice decreases to SEK 638 579 641 and the price per share to SEK 57.30 for the same year.

Dice value with DCF, with high growth period growth rate 8.10 percent and stable period growth rate 4.05 percent is also calculated. This calculation does not consider the option values of the projects, and the growth rate is therefore higher than what is applied for the sNPV calculations. Accordingly the value of Dice for the year 2005 can be calculated to SEK 584 078 635. Cash and marketable securities, value of debt, net value of equity and the share outstanding are considered in calculation of the price per share, and equals to SEK 58.28 (Appendix 5.7).

Figure 10 is presented in order to be able to compare our results with the results of Kaupthing Bank and the market as well as EA's tender offer for Dice in SEK.

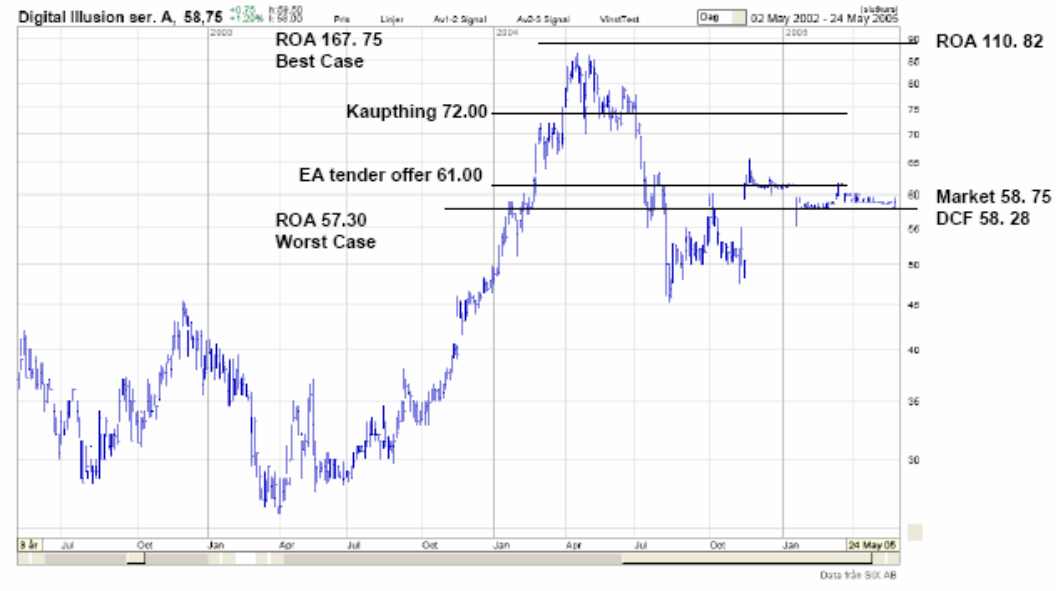


Figure 10: Chart over Dice's stock price
Source: OMX (24-05-2005)

According to traditional analysis we have estimated a firm value for Dice at SEK 58.28, which is approximately in line with the market value of one share that is SEK 58.75. EA put a tender offer at SEK 61.00 per share, and through this they acquired 59.80 percent of Dice. The tender considering traditional DCF valuation is, however, slightly higher than our estimations and than the market value paid at that point in time. When considering ROA the tender offer seems lower than acceptable. Our estimated value for Dice using ROA has led to a target price at SEK 110.82. This means that Dice has a large number of embedded growth opportunities in view of Dice's video game development and the increase in the video game industry. The expected future value of Dice will therefore be higher than what is estimated by the market at present. However Dice might decrease in value since EA owns a major part of the firm at present and EA is in total charge of the company and can if they prefer sell Dice's assets to another subsidiary within the EA concern. This makes the firm value significantly depending on EA's business decisions, and the situation can therefore culminate in a majority/minority ownership conflict. Such a conflict might cause the external investors of Dice to reconsider their placements. Hence when analysing the Dice's historical sales growth one can assume that it will be difficult for Dice to cope with the market and competitors.

According to our time series analysis Dice's sales growth has declined tremendously during the last five years. This could mean that the tender offer of EA could be the right opportunity for Dice to work up its figures. Considering the projects that are under development Dice has large future growth opportunities. However the overall performance of Dice has according to our analysis declined, which in extension will affect Dice in the sense that the company might be unable to operate their activities according to their strategy.

6 Conclusions

The purpose of this thesis and the research questions are re- presented in this section. It is followed by our conclusions.

The implementation of ROA on product development was conducted through out this thesis. The purpose of the implementation of ROA on product development in Dice was to analyse the changes in the overall value of the firm. Hence the advantages and draw backs of the valuation methods that are exercised during this report were also analysed. EA's bid on Dice's shares was further studied through the DCF and ROA perspectives.

Accordingly the research questions of this thesis were:

- ✓ How can ROA be applied and implemented on product development?
- ✓ How does the value, which is derived from product development, changes the overall value of the firm?
- ✓ To what extent are the methods, which are used in valuations reliable and what are the drawbacks of the valuation methods that are used in this report?

Based on ROA we have come to the conclusion that Dice's estimated value including future growth opportunities equals to SEK 1 234 034 418 for the year 2005 and that the price per share would be SEK 110.82. This result can be compared to the market value of Dice, which equals to SEK 654 767 223 and the price per share at SEK 58.75 (24-05-2005). According to our DCF analysis the estimated market value for Dice was SEK 584 878 635 and the adjusted share price amounted to SEK 58.28. It can be concluded that the price per share conducting a DCF valuation are similar to the market value of Dice. This value can also be compared to the estimated price per share obtained from Kaupthing Bank. Their target price per share was SEK 72 for year 2005 using a DCF model. One difference between our calculations and those of Kaupthing Bank's arises from the fact that Kaupthing Bank has applied a higher growth rate in their calculations.

However, the differences occur when taking ROA into consideration. This is due to the fact that intangible assets, future growth opportunities, and flexibility are priced. According to our analysis the high value derived from the ROA compared to the value derived from the DCF analysis depends mainly on a high expansion factor, hence the expansion factor is the most sensitive variable. This high expansion factor is due to the fact that Dice is entering a new market by

converting PC based games into videogames. According to our empirical study the game development proceeds from PC based games towards a stronger development in the videogame sector, which also has the largest share of the total market (78.00 percent). Hence a high expansion factor occurs which leads to a higher overall value of the firm, which is derived from the product development.

Accordingly from a RO point of view Dice is undervalued on the market, but from a DCF valuation Dice is priced more reasonably by the market. From this statement we can conclude that EA from a ROA point of view made a well-considered acquisition of 59.80 percent of Dice shares at a price of SEK 61.00. Nevertheless we can state that Dice have been valued on the Swedish Stock Market by analysts through using the DCF valuation, and therefore EA's tender offer was appropriate.

We can also conclude that there are several drawbacks and limitations that have to be considered when applying ROA on product development. The ROA can price the projects within a firm individually and in turn completes the value of a firm with option values, considering the uncertainty and flexibility. It is important to note that a common mistake when applying ROA is to double calculate the option values, this will lead to a incorrect option value. In order to prevent this miscalculation the growth opportunities should be valued in the option valuation, which will lead us to state that a reduced or zero growth rate should be applied in the sNPV calculations. However in our case it should be considered that Dice has royalty revenues that are received from previously launched projects. Hence applying a zero growth rate will ignore this royalty revenues, we have therefore estimated a reduced growth rate according to our time series analysis based on information from Dice annual report.

In contrast DCF is more straightforward to apply on company valuation: however it gives an overall picture of the firm through considering a general growth rate. This growth rate does not include intangible assets, future growth opportunities, and flexibility, which means that the DCF method does not price the projects that are under development accurately.

Further we have experienced through our valuation analysis that a high expansion factor sets a downside limit on the volatility. This will lead us to define that a high expansion factor in Dice's case is the most sensitive variable, which will have an impact on the option value.

On the other hand when using ROA the factors that will have strong influence on the valuation can be difficult to estimate, therefore it is significant that the assumptions made for the analysis is based on precise information and research about the respective company and their surrounding. The analysts with updated information and accurate assumption will be in position of the most reasonable estimation of the company value, hence different target prices will occur due to the differences in the assumptions. Further the range for creating the analytics consensus for one stock will be broader in ROA compared to DCF due to ROA's higher requirement of assumptions.

Another important factor that should be emphasised is the time value of the analysis. Hence the company values derived from the ROA appear to be similar regarding the years 2005-2007. This is due to the fact that the calculated projects merely can be realised i.e. expanded, contracted, or abandon only at one time during this period. This in turn leads us to state that the ROA applied on company valuation is in highest grade an object for constant updates correlated to releases of new information that changes these variables in order to expose a more accurate value.

The structure of a firm is essential when it comes to determining a value of a firm in ROA. Hence if the management of the firm is unable to deal with flexibility and is not creditable for making decisions, the specific option values could be invalid. Therefore a complement to the ROA could be a structure analysis that will define if the company is able to collect flexibility values or not.

6.1 Final Comments

Further we would like to state that there are risks in valuing a company by considering their future growth opportunities, which can lead to an overestimation since the values are accordingly intangible and might just occur in the future. ROA applied on company valuation should therefore be used as a complement to the traditional DCF when valuing firms with human capital and intangible assets. Accordingly we believe that a condition to be able to apply ROA into company valuation is that the management of the specific firm recognises and uses RO thinking in the firm's projects and strategies.

6.2 Criticism

The type of criticism that this essay is most vulnerable to is the fact that we were not able to receive information from Dice. Hence when making the calculations we have been force to make large amount of assumptions based on the historical data. Dice argued correctly that the information that we needed was considered to influence the stock price and therefore Dice was unable to grant permission for us to take part of this information. A critic to our thesis is that we hadn't considered these difficulties when constructing the framework for the thesis. Therefore the assumption were in some cases considered based on the information given as economical and market reports from corporation bodies with special interest in the computer and video game industry.

7 Further research

Under this section some thoughts concerning further research that appeared during the progress of the thesis work are stated.

Alphabetic check list for applying real option analysis to company valuation

This is an adjusted version of Mun's (2002) real option process for company valuation which is constructed through our experience when conducting this thesis. The adjusted real option process can be considered as a starting point for further research, when a theoretical framework for applying ROA onto company valuation is constructed.

a. Information and research studies.
b. List of projects and strategies.
c. Estimate the sNPV for the projects that can be defined within the firm's strategy.
d. Estimate the sNPV for the firm as one project with a reduced growth rate.
e. Estimate a series of static DCF models for each project.
f. Conduct a sensitivity analysis on the sNPV that is going to be used as an input in the ROA for the projects.
g. Conduct a Monte Carlo simulation.
h. Perform a company structure analysis.
i. Construct options for the projects.
j. Choose which real option method that should be applied.
k. Define option values of the projects.
l. Add eNPV for each project with the sNPV for the firm to get the total value of firm.
m. Report and present the result.
n. Constant updates of the analysis correlated to releases of new information in order to expose an updated and accurate value of the company.

Further we have experienced through our valuation analysis that a high expansion factor sets a downside limit on the volatility. Another suggestion for further research is therefore to look closer on how these two different factors stated in the valuation process will have an impact on each other.

8 References

Articles

Armstrong, M., Galli, A., Bailey. W., Couët, B. (2004). Incorporating technical uncertainty in real option valuation of oil projects. *Journal of Petroleum Science and Engineering*, 44, 1-2, 67-82.

Arnold, G., Hatzopoulos, P. (2000). The Theory-Practice Gap in Capital Budgeting: Evidence from the United Kingdom. *Journal of Finance & Accounting*, 27, 5/6, 603-627.

Balasubramanian, P., Kulatilaka, N., Storck, J. (2000). Managing information technology investments using a real-options approach. *Journal of Strategic Information Systems*, 9, 39-62.

Banerjee, A. (2003). Real Option Valuation of a Pharmaceutical Company. *The Journal for Decision Makers*, 28, 2, 61-74.

Buckley, A., Tse, K., Rijken, H., Eijgenhuijsen, H. (2002). Stock Market Valuation with Real Options: Lessons from Netscape. *European Management Journal,* 20, 5, 512-526.

Chandler Jr., Alfred D. (1990). Response to the Contributors to the Review Colloquium on Scale and Scope. *Business History Review*, 64, 4, 736-759.

Colwell, D., Henker, T., Ho, J. Fong, K. (2003). Real Options Valuation of Australian Gold Mines and Mining Companies. *Journal of Alternative Investments,* 6, 1, 23-39.

Gallego, G., Phillips, R. (2004). Revenue Management of Flexible Products: Manufacturing & Service. *Operations Management*, 6, 4, 321-338.

Greden, L., Glicksman, L. (2005). A real options model for valuing flexible space. *Journal of Corporate Real Estate*, 7, 1, 34-49.

Hemantha, H., Park, S.B., Chan, S. (2001). Real Options Valuation and its Relationship to Bayesian Decision-Making Methods. *Engineering Economist*, 46, 1-32.

Hodder, J.E., Riggs, H.E. (1982). Pitfalls in evaluating risky projects. *Harvard business review*, 63, 1, 128 – 135.

Jägle, A. (1999). Shareholder value, real options, and innovations in technology intensive companies. *R&D Management*, 29,3.
Kellogg, D., Charnes, J. (2000). Real-Options Valuation for a Biotechnology Company. *Financial Analysts Journal*. 56, 3, 76-85.

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

Miller, L., Park, C., (2002). Decision Making Under Uncertainty – Real Options to the Rescue? *The Engineering Economist*, 47, 2.

Myers, S. (1984). Finance theory and financial strategy. *Interfaces*, Jan/Feb, 14, 1, 126.

Raghuram, R., Servaes, H., Zingales, L. (1999). The Cost of Diversity: Diversification Discount and Inefficient Investment. *Working Papers – Yale School of Management's Economic Research Network, 1, 79.*

Roussel, P.A. (1983). Cutting down the guesswork in R&D. *Harvard Business Review*. 61, 5, 154-161.

Trigeorgis, L. (1993). Real Options and Interactions with Financial Flexibility. *Financial Management*, 22, 3, 202-225.

Wörner, S., Grupp, H. (2003). The derivation of R&D return indicators within real options framework. *R & D Management*, 33, 3, 313-326.

Wörner, S., Racheva-Iotova, B., Stoyanov, S. (2002). Calibration of a basket option model applied to company valuation. *Mathematical Methods of Operations Research*, 55, 2, 247-264.

Zingales, L. (2000). In Search of New Foundations. *Journal of Finance,* 55, 4, 1623-1654.

Books

Arbnor, I., Bjerke, B., (1994). *Företagsekonomisk metodlära.* Lund: Studentlitteratur.

Backman, J. (1998). *Rapporter och Uppsatser*. Lund: Studentlitteratur.

Copeland, T., Antikarov, V. (2001). V. *Real Options: a practitioner's guide*. London. Texere cop.

Eriksson, L.T., Wiederscheim, P.F. (2001). *Att utreda, forska och rapportera*. Malmö: Liber ekonomi.

Halvorsen, K. (1992). *Samhällsvetenskapligmetod*. Lund: Studentlitteratur.

Lundahl, U., Skärvad, P-H. (1999). *Utredningsmetodik för Samhällsvetare och Ekonomer*. Lund: Studentlitteratur.

Mun, J. (2002). *Real Options Analysis – Tools and Techniques for Valuing Strategic Investment Decisions*. New Jersey, Wiley Finance.

Patel R., Tibelius U. (1987). *Grundbok i forskningsmetodik: kvalitativt och kvantitativt*, Lund: Studentlitteratur.

Rappaport, A. (1986). *Creating Shareholder Value: The New Standard for Business Performance.* New York: The Free Press.

Web sources

Central Bank of Sweden, 2005. *Economical statistics*. Available from: http://www.riksbank.com/templates/SectionStart.aspx?id=10604 [Accessed 19 May 2005]

Dagens Industri, 2005. *Trader - historical share price information*. Available from: http://www.di.se [Accessed 6 May 2005]

Damodaran Online, 2005. *Spread sheet programs*. Available from: http://pages.stern.nyu.edu/~adamodar/ [Accessed 6 May 2005]

Digital Illusions CE AB (publ), 2005. *Interim report, January – March 2005*. Available from: http://global.dice.se [Accessed 10 May 2005]

OMX - Stockholm Stock exchange, 2005. *Market information*. Available from: http://www.omxgroup.com/stockholmsborsen/fixedincome [Accessed 6 May 2005]

Point Topic, 2005. *Broad Band User Survey 2005*. Available from: http://www.point-topic.com [Accessed 19 May 2005].

Publication from a corporate body

Digital Illusions CE AB (publ), (2005). *Digital Illusions - Annual Report 2004*.

Entertainment Software Association (ESA), (2004). *Essential facts about the computer and video game industry: sales, demographics, and usage data*. ESA.

Kaupthing Bank Sverige AB. (2004). *Digital Illusions: 3Q04 results – software and computer services, Sweden*. Kaupthing Bank & Research.

Kaupthing Bank Sverige AB. (2005). *Digital Illusions: Bid process – software and computer services, Sweden*. Kaupthing Bank & Research.

Appendix 2.5
Type: Interview Questions to Dice for ROA

Interview Questions to Dice for ROA

Net present value

1.1 What is the expected total revenue, costs and the sales volume for following projects, Battlefield 2, Battlefield Modern Combat, Unnamed project X1 and Unnamed project X2?

1.2 In average, how many percent of the revenue for each game presents the royalty incomes for Dice?

1.3 What is the average revenue in SEK per sold game?

1.4 What are the expected revenues, costs and investments for the new generation of platforms?

1.5 What is the expected result from the purchase of Trauma Studios?

1.6 What is the estimated weighted average cost of capital for Dice?

Sequential option

2.1 How is the development process planned for a game?

2.2 Is the game development process divided into different phases?

2.3 In that case what is the characteristic of each phase in the process?

Abandonment option

3.1 Do you have the possibility to abandon a project during the development process?

3.2 In that case how much is the expected salvage value for a project?

Contraction option

4.1 Does Dice have a possibility to let out some parts of its capacity to external publishers?

4.2 In that case how much is the expected revenue for this deal?

4.3 In that case how much is the estimated reduction of Dice's capacity?

Expansion option

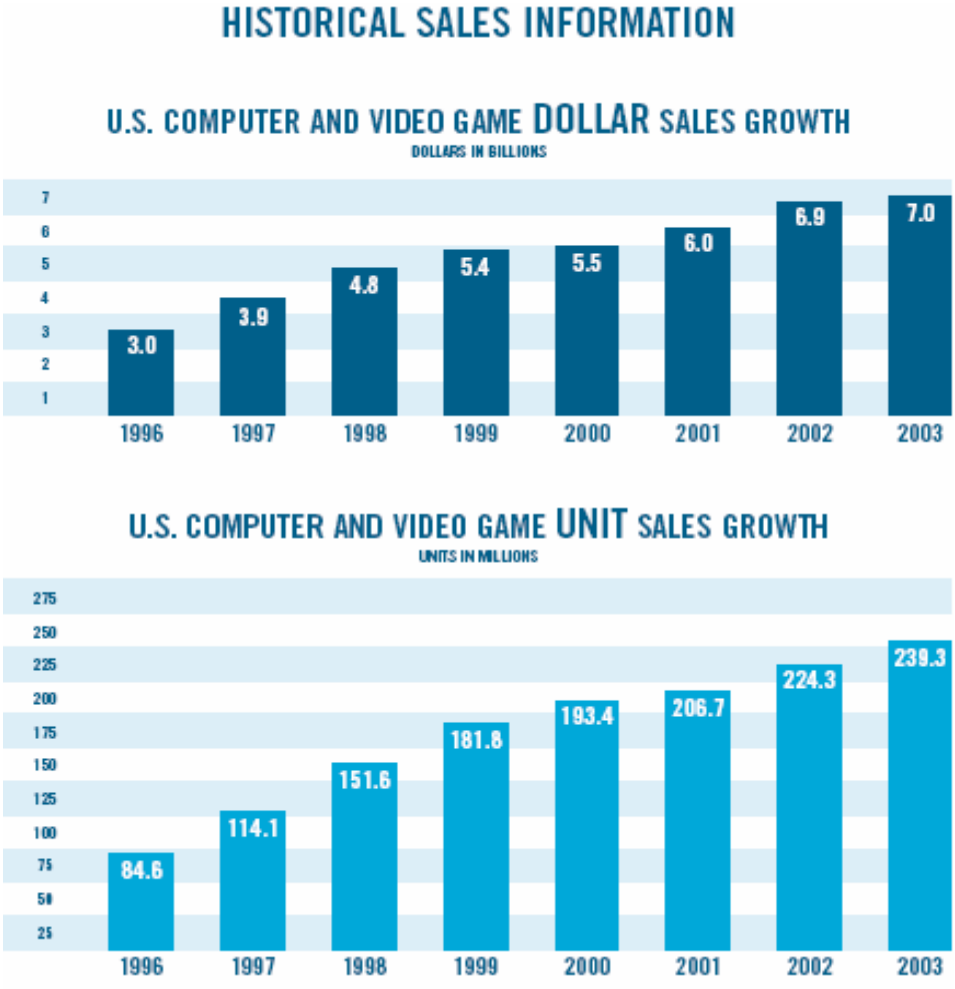
5.1 What are the expansion possibilities for a specific project?

5.2 Do the projects have multiple expansion possibilities?

5.3 In that case how can these expansion possibilities be defined in percent?

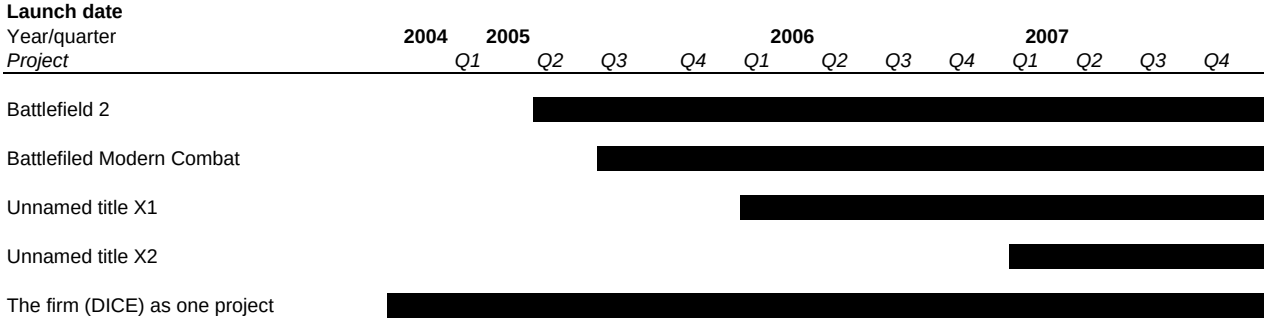
5.4 What are the expected expansion costs for each named project?

Appendix 4.2.1
Type: Sales growth in the U.S. game industry
Source: Entertainment Software Association



Appendix 5.1
Type: *DICE list of projects and strategies*

Launch date



Appendix 5.2.1 A
Type: *Time series analysis, Option Strategy*
Source: *Annual report Dice 2004*

Year		Growth (y)	Time (t)	y * t	t^2	Year	Time (t)
	2000	2,46	1	2,46	1	2005	6
	2001	1,33	2	2,66	4	2006	7
	2002	0,41	3	1,23	9	2007	8
	2003	0,39	4	1,56	16		
	2004	0,081	5	0,405	25		
		4,671	**15**	**8,315**	**55**		

b	**Annual decrease of sales growth**	**Time serie equation**
-0,5698	**0,5698**	**y = a + b * t**

Constant (a)	**Effective change rate**
0,9342	**0,4302**

Trend (y)
2,1864

Sales growth considering annual change

2005	2006	2007	2008	2009
3,48%	1,50%	0,64%	0,28%	0,12%

Appendix 5.2.1 B

Type: *Base case NPV analysis for each project and firm*

Source: *Annual report Dice 2004*

The firm (DICE) as one project

Number of shares	11 114 974
Price per share (2005-04-21)	59,25 kr
Dividend per share	0,90 kr
Total dividend	10 003 476,60 kr

Key factors for firm	
Total Market value (MV)	658 562 209,50 kr
Total book value (BV)	266 373 000,00 kr
Book to Market ratio	40,45%
Market to Book ratio	247,23%
Amount of debt	61 143 000,00 kr
MV of debt	151 165 730,67 kr
Amount of equity	205 230 000,00 kr
MV of equity	507 396 478,83 kr
Debt/equity ratio (MV)	29,79%
Current assets 2003	213 795 000,00 kr
Current Liabilties 2003	41 838 000,00 kr
Working capital 2003	171 957 000,00 kr
Current assets 2004	244 795 000,00 kr
Current Liabilities 2004	55 518 000,00 kr
Working capital 2004	189 277 000,00 kr
Change in working capital	10,07%
Change in working capital	17 320 000,00 kr
Total tangible assets	7 588 000,00 kr
Investment operations	8 290 000,00 kr
Capital expenditure (CAPEX)	15 878 000,00 kr
Cash and bank	130 764 000,00 kr
Current investments	688 000,00 kr
Cash and marketable securities	131 452 000,00 kr

Amount of oustanding options	2 329 002
Option value	4,50 kr
Vale of equity options issued by Dice	10 480 509,00 kr
Operating income	26 249 000,00 kr
Netsale	213 721 000,00 kr
Operating margin 2004	12,28%
Market growth	7,84%
Effective change	107,84%
E market growth during 5 years	45,83%
Effective E market growth during 5 years	145,83%
Working capital 2004	189 277 000,00 kr
Sales 2004	213 721 000,00 kr
Working capital as percentage of revenues	88,56%
Dept grade	24,06%
Equity grade	75,94%
EBIT	26 249 000,00 kr
Total Assets - Current Liabilities	321 891 000,00 kr
Return on capital in perpertuity	8,15%
Capital expenditure (CAPEX)	15 878 000,00 kr
Depreciation	17 162 000,00 kr
CAPEX of depreciation	108,09%

Appendix 5.2.1 C
Type: *DCF for the firm*
Source: *Annual report Dice 2004*

INPUTS FOR VALUATION

Current Inputs

Enter the current revenues of the firm =	$ 213 721 000
Enterr the current operating income of the firm =	$ 26 249 000
Enter the current capital expenditures =	$ 15 878 000
Enter the current dollar depreciation for the firm =	$ 17 162 000
Enter the change in Working Capital in last year =	$ 17 320 000
Enter the value of current debt outstanding =	$ 55 518 000
Cash and Marketable Securities at the firm =	$ 131 452 000
Value of equity options issued by the firm =	$ 10 480 509
Enter the number of shares outstanding =	11 144 974,00

High Growth Period	*Inputs*
Enter the growth rate in revenues for the next 5 years =	8,10%
Your current pre-tax operating margin is	12,30%
Enter the pre-tax operating margin you expect your firm to have in year 5 =	8,40%
How much debt do you plan to use in financing investments?	24,06%
Enter the growth rate in capital expenditures & depreciation	10,00%
Enter working capital as a percent of revenues	88,60%
Enter the tax rate that you have on corporate income	28,00%
What beta do you want to use to calculate cost of equity =	1,20
Enter the current long term bond rate =	2,67%
Enter the market risk premium you want to use =	4,00%
Enter your cost of borrowing money =	4,50%

Stable Period	*Inputs*
Enter the growth rate in revenues =	4,05%
Enter the pre-tax operating margin in perpetuity =	15,03%
Do you want to compute reinvestment from fundamentals?	Yes
Return on capital in perpetuity for the firm =	8,15%
Enter capital expenditures as a percent of depreciation in this period	108,00%
How much debt do you plan to use in financing investments?	25,00%
Enter interest rate of debt in stable period =	4,50%
What beta do you want to use in the stable period =	1,20

ESTIMATED CASHFLOWS

	Base	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*
Growth in Revenue		8,10%	8,10%	8,10%	8,10%	8,10%	7,29%	6,48%	5,67%	4,86%	4,05%
Growth in Deprec'n		10,00%	10,00%	10,00%	10,00%	10,00%	8,81%	7,62%	6,43%	5,24%	4,05%
Revenues	$ 213 721 000	$ 231 032 401	$ 249 746 025	$ 269 975 454	$ 291 843 465	$ 315 482 786	$ 338 481 481	$ 360 415 081	$ 380 850 616	$ 399 359 956	$ 415 534 034
COGS											
% of Revenues	87,72%	88,49%	89,27%	90,05%	90,82%	91,60%	90,27%	88,95%	87,62%	86,30%	84,97%
- $ COGS	$ 187 472 000	$ 204 450 921	$ 222 950 424	$ 243 105 444	$ 265 062 800	$ 288 982 232	$ 305 560 772	$ 320 582 006	$ 333 708 927	$ 344 631 668	$ 353 079 269
EBIT	$ 26 249 000	$ 26 581 480	$ 26 795 601	$ 26 870 009	$ 26 780 666	$ 26 500 554	$ 32 920 709	$ 39 833 075	$ 47 141 689	$ 54 728 288	$ 62 454 765
Tax Rate	28,00%	28,00%	28,00%	28,00%	28,00%	28,00%	28,00%	28,00%	28,00%	28,00%	28,00%
EBIT (1-t)	$ 18 899 280	$ 19 138 665	$ 19 292 833	$ 19 346 407	$ 19 282 079	$ 19 080 399	$ 23 702 910	$ 28 679 814	$ 33 942 016	$ 39 404 368	$ 44 967 431
+ Depreciation	$ 17 162 000	$ 18 878 200	$ 20 766 020	$ 22 842 622	$ 25 126 884	$ 27 639 573	$ 30 074 619	$ 32 366 305	$ 34 447 458	$ 36 252 505	$ 37 720 732
- Capital Expenditures	$ 15 878 000	$ 17 465 800	$ 19 212 380	$ 21 133 618	$ 23 246 980	$ 25 571 678	$ 29 604 598	$ 33 637 517	$ 37 670 437	$ 41 703 357	$ 45 736 277
- Change in WC	$ 17 320 000	$ 15 337 901	$ 16 580 271	$ 17 923 273	$ 19 375 058	$ 20 944 438	$ 20 376 844	$ 19 433 170	$ 18 105 884	$ 16 399 275	$ 14 330 233
= FCFF	$ 2 863 280	$ 5 213 164	$ 4 266 201	$ 3 132 137	$ 1 786 925	$ 203 856	$ 3 796 088	$ 7 975 432	$ 12 613 153	$ 17 554 240	$ 22 621 652
Terminal Value (in '05)											$ 996 310 237

COSTS OF EQUITY AND CAPITAL

	2004	*2005*	*2006*	*2007*	*2008*	*2009*	*2010*	*2011*	*2012*	*2013*	*2014*
Cost of Equity		7,47%	7,47%	7,47%	7,47%	7,47%	7,47%	7,47%	7,47%	7,47%	7,47%
Proportion of Equity		75,94%	75,94%	75,94%	75,94%	75,94%	75,75%	75,56%	75,38%	75,19%	75,00%
After-tax Cost of Debt		3,24%	3,24%	3,24%	3,24%	3,24%	3,24%	3,24%	3,24%	3,24%	3,24%
Proportion of Debt		24,06%	24,06%	24,06%	24,06%	24,06%	24,25%	24,44%	24,62%	24,81%	25,00%
Cost of Capital		6,45%	6,45%	6,45%	6,45%	6,45%	6,44%	6,44%	6,43%	6,42%	6,41%
Cumulative WACC		106,45%	113,32%	120,63%	128,42%	136,70%	145,51%	154,88%	164,83%	175,42%	186,66%
Present Value		$ 4 897 185	$ 3 764 710	$ 2 596 427	$ 1 391 511	$ 149 124	$ 2 608 791	$ 5 149 526	$ 7 652 075	$ 10 007 197	$ 545 862 088

FIRM VALUATION

Value of Firm	**$ 584 078 635**
+ Cash and marketable securities =	**$ 131 452 000**
- Value of Debt	**$ 55 518 000**
Value of Equity	**$ 660 012 635**
- Value of Equity options issued by firm	**$ 10 480 509**
Value of Equity per Share	**$ 58,28**

	2004	*2005*	*2006*	*2007*	*2008*	*2009*	*2010*	*2011*	*2012*	*2013*	*2014*
Value of firm by year		$ 584 078 635	$ 616 551 755	$ 652 067 088	$ 691 008 028	$ 733 806 751	$ 780 950 030	$ 827 480 780	$ 872 764 967	$ 916 256 678	$ 957 530 262
$ Value of Debt		140 529 319,66 kr	$ 148 342 352	$ 156 887 341	$ 166 256 532	$ 176 553 904	$ 189 364 763	$ 202 203 203	$ 214 909 645	$ 227 341 607	$ 239 382 565

Appendix 5.2.1 D
Type: *sNPV for the firm*
Source: *Annual report Dice 2004*

INPUTS FOR VALUATION

Current Inputs

Enter the current revenues of the firm =	$ 213 721 000
Enterr the current operating income of the firm =	$ 26 249 000
Enter the current capital expenditures =	$ 15 878 000
Enter the current dollar depreciation for the firm =	$ 17 162 000
Enter the change in Working Capital in last year =	$ 17 320 000
Enter the value of current debt outstanding =	$ 55 518 000
Cash and Marketable Securities at the firm =	$ 131 452 000
Value of equity options issued by the firm =	$ 10 480 509
Enter the number of shares outstanding =	11 144 974,00

High Growth Period	*Inputs*
Enter the growth rate in revenues for the next 5 years =	2,19%
Your current pre-tax operating margin is	12,30%
Enter the pre-tax operating margin you expect your firm to have in year 5 =	8,40%
How much debt do you plan to use in financing investments?	24,06%
Enter the growth rate in capital expenditures & depreciation	10,00%
Enter working capital as a percent of revenues	88,60%
Enter the tax rate that you have on corporate income	28,00%
What beta do you want to use to calculate cost of equity =	1,20
Enter the current long term bond rate =	2,67%
Enter the market risk premium you want to use =	4,00%
Enter your cost of borrowing money =	4,50%

Stable Period	*Inputs*
Enter the growth rate in revenues =	1,20%
Enter the pre-tax operating margin in perpetuity =	15,03%
Do you want to compute reinvestment from fundamentals?	Yes
Return on capital in perpetuity for the firm =	8,15%
Enter capital expenditures as a percent of depreciation in this period	108,00%
How much debt do you plan to use in financing investments?	25,00%
Enter interest rate of debt in stable period =	4,50%
What beta do you want to use in the stable period =	1,20

ESTIMATED CASHFLOWS

	Base	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*
Growth in Revenue		2,19%	2,19%	2,19%	2,19%	2,19%	1,99%	1,79%	1,60%	1,40%	1,20%
Growth in Deprec'n		10,00%	10,00%	10,00%	10,00%	10,00%	8,24%	6,48%	4,72%	2,96%	1,20%
Revenues	$ 213 721 000	$ 218 401 490	$ 223 184 483	$ 228 072 223	$ 233 067 004	$ 238 171 172	$ 242 915 542	$ 247 273 446	$ 251 219 931	$ 254 731 985	$ 257 788 769
COGS											
% of Revenues	87,72%	88,49%	89,27%	90,05%	90,82%	91,60%	90,27%	88,95%	87,62%	86,30%	84,97%
- $ COGS	$ 187 472 000	$ 193 273 262	$ 199 238 707	$ 205 372 742	$ 211 679 890	$ 218 164 793	$ 219 289 576	$ 219 944 785	$ 220 123 928	$ 219 823 514	$ 219 043 117
EBIT	$ 26 249 000	$ 25 128 228	$ 23 945 776	$ 22 699 481	$ 21 387 114	$ 20 006 378	$ 23 625 966	$ 27 328 661	$ 31 096 003	$ 34 908 471	$ 38 745 652
Tax Rate	28,00%	28,00%	28,00%	28,00%	28,00%	28,00%	28,00%	28,00%	28,00%	28,00%	28,00%
EBIT (1-t)	$ 18 899 280	$ 18 092 324	$ 17 240 959	$ 16 343 626	$ 15 398 722	$ 14 404 592	$ 17 010 695	$ 19 676 636	$ 22 389 122	$ 25 134 099	$ 27 896 869
+ Depreciation	$ 17 162 000	$ 18 878 200	$ 20 766 020	$ 22 842 622	$ 25 126 884	$ 27 639 573	$ 29 917 073	$ 31 855 700	$ 33 359 289	$ 34 346 724	$ 34 758 884
- Capital Expenditures	$ 15 878 000	$ 17 465 800	$ 19 212 380	$ 21 133 618	$ 23 246 980	$ 25 571 678	$ 27 688 960	$ 29 806 242	$ 31 923 524	$ 34 040 806	$ 36 158 088
- Change in WC	$ 17 320 000	$ 4 146 914	$ 4 237 731	$ 4 330 538	$ 4 425 377	$ 4 522 292	$ 4 203 512	$ 3 861 104	$ 3 496 585	$ 3 111 680	$ 2 708 310
= FCFF	$ 2 863 280	$ 15 357 810	$ 14 556 867	$ 13 722 093	$ 12 853 250	$ 11 950 195	$ 15 035 297	$ 17 864 990	$ 20 328 302	$ 22 328 336	$ 23 789 355
Terminal Value (in '05)											$ 461 867 188

COSTS OF EQUITY AND CAPITAL

	2004	*2005*	*2006*	*2007*	*2008*	*2009*	*2010*	*2011*	*2012*	*2013*	*2014*
Cost of Equity		7,47%	7,47%	7,47%	7,47%	7,47%	7,47%	7,47%	7,47%	7,47%	7,47%
Proportion of Equity		75,94%	75,94%	75,94%	75,94%	75,94%	75,75%	75,56%	75,38%	75,19%	75,00%
After-tax Cost of Debt		3,24%	3,24%	3,24%	3,24%	3,24%	3,24%	3,24%	3,24%	3,24%	3,24%
Proportion of Debt		24,06%	24,06%	24,06%	24,06%	24,06%	24,25%	24,44%	24,62%	24,81%	25,00%
Cost of Capital		6,45%	6,45%	6,45%	6,45%	6,45%	6,44%	6,44%	6,43%	6,42%	6,41%
Cumulative WACC		106,45%	113,32%	120,63%	128,42%	136,70%	145,51%	154,88%	164,83%	175,42%	186,66%
Present Value		$ 14 426 945	$ 12 845 711	$ 11 375 112	$ 10 009 062	$ 8 741 793	$ 10 332 730	$ 11 534 954	$ 12 332 656	$ 12 728 780	$ 260 175 873

FIRM VALUATION

Value of Firm	**$ 364 503 616**
+ Cash and marketable securities =	**$ 131 452 000**
- Value of Debt	**$ 55 518 000**
Value of Equity	**$ 440 437 616**
- Value of Equity options issued by firm	**$ 10 480 509**
Value of Equity per Share	**$ 38,58**

	2004	*2005*	*2006*	*2007*	*2008*	*2009*	*2010*	*2011*	*2012*	*2013*	*2014*
Value of firm by year		$ 364 503 616	$ 372 664 535	$ 382 152 960	$ 393 088 378	$ 405 598 220	$ 419 818 284	$ 431 837 377	$ 441 766 983	$ 449 837 252	$ 456 390 502
$ Value of Debt		87 699 570,12 kr	$ 89 663 087	$ 91 946 002	$ 94 577 064	$ 97 586 932	$ 101 797 538	$ 105 523 782	$ 108 780 702	$ 111 613 619	$ 114 097 625

Appendix 5.2.2
Type: *sNPV For The Projects*
Source: *Annual report Dice 2004*

NPV (project based)	Operating profit in SEK	Unit sold (million)	Operating profit per units sold
2002	15892000,00	2890000,00	5,50
2003	41116000,00	2030000,00	20,25
2004	26249000,00	1730000,00	15,17
Total 2002-2004	83257000,00	6650000,00	
Average 2002-2004	27752333,33	2216666,67	12,52

Introduction Project	E operating profit per project	E unit sales (million)	1 + WACC	sNPV
2005 Battlefield 2	54,53	4,36	1,0645	51,23
2005 Battlefield Modern Combat	192,34	15,36	1,0645	180,69
2006 Unnamed procet X1	192,34	15,36	1,1332	169,73
2006 Unnamed procet X2	192,34	15,36	1,2063	159,45

Appendix 5.5.1 B
Type: *The type of options that is chosen*

Project name	Launch date	E units sales (millions)	*Expansion factor*	*Expanion costs*
Battlefield 1	2003	4,60		
Expansion				
Battlefield 2	2005	4,36	1,97	64,53
Battlefield Modern Combat	2005	15,36	3,08	64,53
Unnamed procet X1	2006	15,36	3,08	66,62
Unnamed procet X2	2007	15,36	3,08	68,77
Contraction			*Contraction factor*	*Contraction gain*
Battlefield 2	2005		0,67	42,07
Battlefield Modern Combat	2005		0,67	42,07
Unnamed procet X1	2006		0,67	43,96
Unnamed procet X2	2007		0,67	45,94
Abandonment			*Salvage value*	
Battlefield 2	2005		4,18	
Battlefield Modern Combat	2005		4,18	
Unnamed procet X1	2006		4,37	
Unnamed procet X2	2007		4,56	

sNPV (project based)	Introduction year	sNPV in millions
Battlefield 2 (PC)	2005	51,23
Battlefield Modern Combat (Console)	2005	180,69
Unnamed procet X1 (Console)	2006	169,73
Unnamed procet X2 (Console)	2007	159,45

The software entertainment market
Source: Entertinment Software Assocciation, Report 2004
Total sales for PC game (millions)

Year	Units sold PC	Total market sales PC + Video game (millions)	PC in % of total industry
2002	61,50	224,30	0,27
2003	52,90	239,30	0,22
Decrease in sold units, PC (millions)		Increase in total market (millions)	Decrease in % of sold units, PC (considering the increase of the total market).
	8,60	15,00	0,05

Estimated units sales for Battlefield 2

4,36	(1-0,05313*4,6)

Total sales for video game (millions)

Year	Units sold Console	Total market sales PC + Console game (millions)	ole game in % of total industry
2002	162,80	224,30	0,73
2003	186,40	239,30	0,78

Market information		
22% of the maket (PC Game)	4,36	
78% of the market (Console game)	15,36	
100% of the total market	**19,72**	(100% * 4,36 / 0,22106)

Expansion costs	Millions SEK (2004)	2005	2006	2007
Total costs 2004	187,50	193,58	199,85	206,32
Number of projects during	3,00	3,00	3,00	3,00
Costs for one project	62,50	64,53	66,62	68,77

Cost of debt	0,03
Effective factor	1,03

Contraction factor	
Full capacity	1,00
Number of projects	3,00
Capacity for each project	0,33
Contraction factor each project	0,67

Contraction gain	SEK in millions (2004)	SEK in millions (2005)	SEK in millions (2006)	SEK in millions (2007)
Project revenue	120,77	126,20	131,88	137,82
Revenue per project	40,26	42,07	43,96	45,94
Interest rate	0,05			
Effective rate	1,05			

Abondonment	SEK in millions (2004)	SEK in millions (2005)	SEK in millions (2006)	SEK in millions (2007)
Salvage for value (one project)	4,00	4,18	4,37	4,56
Interest rate	0,05			
Effective rate	1,05			

Dividend	
Dividend per share	0,90
Price per share 2005-05-11	59,00
Dividend yield	0,02

Other factors	
Volatility	0,40
sNPV (MSEK)	552,22
Time to maturity	3 years

NPV (project based)	Revenue (millions)	Unit sold (million)	Revenues per units sold
2002	139814000,00	2890000,00	48,38
2003	193659000,00	2030000,00	95,40
2004	213721000,00	1730000,00	123,54
Total 2002-2004	547194000,00	6650000,00	
Average 2002-2004			82,28

Appendix 5.5.1 A

Type: *Estimated Volatility for Dice during 2002-2004*

Source: *www.di.se*

Time Period	Date	Cash Flow Close	Cash Flow Relative Returns	Natural Logarithm of Cash Flow Returns
0	01-dec-04	60,5		
1	01-nov-04	61	1,008264463	0,008230499
2	1-Oct-04	53	0,868852459	-0,140581951
3	01-sep-04	55	1,037735849	0,037041272
4	02-aug-04	51	0,927272727	-0,075507553
5	01-jul-04	62,75	1,230392157	0,207332945
6	01-jun-04	75	1,195219124	0,178329536
7	3-May-04	76,25	1,016666667	0,016529302
8	01-apr-04	75	0,983606557	-0,016529302
9	01-mar-04	69	0,92	-0,083381609
10	02-feb-04	69	1	0
11	02-jan-04	57	0,826086957	-0,191055237
12	01-dec-03	47,9	0,840350877	-0,173935763
13	03-nov-03	46,3	0,966597077	-0,033973543
14	1-Oct-03	37,6	0,812095032	-0,208137911
15	01-sep-03	33,2	0,882978723	-0,124454174
16	01-aug-03	32	0,963855422	-0,036813973
17	01-jul-03	32	1	0
18	02-jun-03	28,5	0,890625	-0,115831816
19	2-May-03	29,5	1,035087719	0,034486176
20	01-apr-03	33	1,118644068	0,112117298
21	03-mar-03	26,5	0,803030303	-0,219362828
22	03-feb-03	30,2	1,139622642	0,130697191
23	02-jan-03	35	1,158940397	0,147506137
24	02-dec-02	38,2	1,091428571	0,087487454
25	01-nov-02	43,3	1,133507853	0,125317119
26	1-Oct-02	37,4	0,863741339	-0,146481931
27	02-sep-02	34	0,909090909	-0,09531018
28	01-aug-02	31	0,911764706	-0,09237332
29	01-jul-02	29	0,935483871	-0,066691374
30	03-jun-02	33	1,137931034	0,129211731
31	2-May-02	36,5	1,106060606	0,100804699
32	02-apr-02	39	1,068493151	0,066249386
33	01-mar-02	42,5	1,08974359	0,08594243
34	01-feb-02	41,5	0,976470588	-0,023810649
35	02-jan-02	41,7	1,004819277	0,004807702
			Volatility of the Period	**11,55%**
			Annualizing Volatility	**40,01%**

Appendix 5.6 A
Type: *Option to Choose, Battlefield 2 E*

Multiple interaction Options

Inputs		**Output**	
Underlying Asset Value Now (S0)	51,23	Growth Rate (R)	1,0113
Standard Dev - Annual (Std)	40,01%	Up Movment /Period (u)	1,2215
Riskfree Rate - Annual (rf)	4,50%	Down Movement /Period (d)	0,8187
Exercise Price (X)	0	Risk-neutral Probability (q)	0,4782
Time to Maturity - Years (t)	3	1-p	0,5218
Binomial steps - Years (dt)	0,25		
Expansion Factor	1,97	Option Premium	32,01
Expansion Costs	64,53		
Contraction factor	0,67		
Contraction Savings	42,1		
Salvage value	4,2		

	2004		2005				2006				2007				
Time	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4			
Lattice Evolution of the underlying	51,23	62,58	76,43	93,36	114,04	139,29	170,14	207,82	253,85	310,06	378,73	462,61	565,06		
		41,94	51,23	62,58	76,43	93,36	114,04	139,29	170,14	207,82	253,85	310,06	378,73		
			34,34	41,94	51,23	62,58	76,43	93,36	114,04	139,29	170,14	207,82	253,85		
				28,11	34,34	41,94	51,23	62,58	76,43	93,36	114,04	139,29	170,14		
					23,01	28,11	34,34	41,94	51,23	62,58	76,43	93,36	114,04		
						18,84	23,01	28,11	34,34	41,94	51,23	62,58	76,43		
							15,43	18,84	23,01	28,11	34,34	41,94	51,23		
								12,63	15,43	18,84	23,01	28,11	34,34		
									10,34	12,63	15,43	18,84	23,01		
										8,46	10,34	12,63	15,43		
											6,93	8,46	10,34		
												5,67	6,93		
													4,64		

	2 004		2 005				2 006				2 007				
Time Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4			
Option Valuation	83,24	97,00	115,75	141,06	174,82	219,18	276,38	348,67	438,38	548,44	683,01	847,53	1 048,63		
		72,44	81,92	95,06	113,16	137,96	171,50	216,11	274,00	347,02	436,98	547,02	681,57		
			65,31	71,66	80,53	92,89	110,20	134,33	167,74	213,01	272,08	345,60	435,55		
				60,90	65,08	70,95	79,04	90,47	106,62	129,88	163,49	210,60	270,65		
					57,49	60,90	65,08	70,28	77,63	87,60	101,90	123,85	160,12		
						54,69	57,49	60,90	65,08	70,17	76,39	84,00	93,28		
							52,41	54,69	57,49	60,90	65,08	70,17	76,39		
								50,53	52,41	54,69	57,49	60,90	65,08		
									49,00	50,53	52,41	54,69	57,49		
										47,74	49,00	50,53	52,41		
											46,71	47,74	49,00		
												45,87	46,71		
													45,18		

	2004		2005				2006				2007				
Time Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4			
Optimal Decision Lattice	Open	Open	Open	Open	Open	Open	Open	Open	Open	Open	Open	Open	**Expand**		
		Open	Open	Open	Open	Open	Open	Open	Open	Open	Open	Open	**Expand**		
			Open	Open	Open	Open	Open	Open	Open	Open	Open	Open	**Expand**		
				Contract	***Contract***	Open	Open	Open	Open	Open	Open	Open	**Expand**		
					Contract	***Contract***	Open	Open	Open	Open	Open	Open	**Expand**		
						Contract	***Contract***	***Contract***	***Contract***	***Contract***	***Contract***	***Contract***	***Contract***		
							Contract	***Contract***	***Contract***	***Contract***	***Contract***	***Contract***	***Contract***		
								Contract	***Contract***	***Contract***	***Contract***	***Contract***	***Contract***		
									Contract	***Contract***	***Contract***	***Contract***	***Contract***		
										Contract	***Contract***	***Contract***	***Contract***		
											Contract	***Contract***	***Contract***		
												Contract	***Contract***		
													Contract		

Appendix 5.6 B
Type: *Option to Choose, Battlefield Modern Combat E*

Multiple interaction Options

Inputs		**Output**	
Underlying Asset Value Now (S0)	180,69	Growth Rate (R)	1,0113
Standard Dev - Annual (Std)	40,01%	Up Movment /Period (u)	1,2215
Riskfree Rate - Annual (rf)	4,50%	Down Movement /Period (d)	0,8187
Exercise Price (X)	0	Risk-neutral Probability (q)	0,4782
Time to Maturity - Years (t)	3	1-p	0,5218
Binomial steps - Quarter (dt)	0,25		
Expansion Factor	3,08	Option Premium	320,04
Expansion Costs	64,53		
Contraction factor	0,67		
Contraction Savings	42,07		
Salvage value	4,18		

	2004	2005			2006				2007				
Time	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	
Lattice Evolution of the underlying	180,69	220,71	269,58	329,29	402,21	491,29	600,09	732,99	895,32	1 093,60	1 335,80	1 631,63	1 992,97
		147,93	180,69	220,71	269,58	329,29	402,21	491,29	600,09	732,99	895,32	1 093,60	1 335,80
			121,11	147,93	180,69	220,71	269,58	329,29	402,21	491,29	600,09	732,99	895,32
				99,15	121,11	147,93	180,69	220,71	269,58	329,29	402,21	491,29	600,09
					81,17	99,15	121,11	147,93	180,69	220,71	269,58	329,29	402,21
						66,46	81,17	99,15	121,11	147,93	180,69	220,71	269,58
							54,41	66,46	81,17	99,15	121,11	147,93	180,69
								44,54	54,41	66,46	81,17	99,15	121,11
									36,47	44,54	54,41	66,46	81,17
										29,85	36,47	44,54	54,41
											24,44	29,85	36,47
												20,01	24,44
													16,38

	2 004	2 005			2 006				2 007				
Time Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	
Option Valuation	500,73	622,92	772,68	955,89	1 179,84	1 453,53	1 787,97	2 196,61	2 695,90	3 305,91	4 051,16	4 961,60	6 073,83
		399,58	499,16	621,51	771,35	954,56	1 178,50	1 452,17	1 786,59	2 195,22	2 694,50	3 304,49	4 049,72
			316,98	397,83	497,64	620,13	770,00	953,21	1 177,13	1 450,78	1 785,19	2 193,80	2 693,06
				249,75	314,97	396,16	496,21	618,78	768,63	951,82	1 175,72	1 449,36	1 783,75
					195,38	247,38	313,05	394,62	494,83	617,39	767,23	950,40	1 174,29
						151,96	192,55	245,07	311,32	393,23	493,43	615,97	765,79
							118,04	148,59	189,65	242,99	309,92	391,81	492,00
								92,60	114,19	144,86	186,92	241,57	308,48
									74,82	88,54	109,46	140,87	185,48
										63,87	71,29	83,04	103,04
											58,45	62,07	66,50
												55,48	58,45
													53,05

	2004	2005			2006				2007				
Time Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	
Optimal Decision Lattice	Open	Open	Open	Open	Open	Open	Open	Open	Open	Open	Open	Open	**Expand**
		Open	Open	Open	Open	Open	Open	Open	Open	Open	Open	Open	**Expand**
			Open	Open	Open	Open	Open	Open	Open	Open	Open	Open	**Expand**
				Open	Open	Open	Open	Open	Open	Open	Open	Open	**Expand**
					Open	Open	Open	Open	Open	Open	Open	Open	**Expand**
						Open	Open	Open	Open	Open	Open	Open	**Expand**
							Open	Open	Open	Open	Open	Open	**Expand**
								Open	Open	Open	Open	Open	**Expand**
									Open	Open	Open	Open	**Expand**
										Open	Open	Open	**Expand**
											Contract	***Contract***	***Contract***
												Contract	***Contract***
													Contract

Appendix 5.6 C
Type: *Option to Choose, Unnamed project X1 E*

Multiple interaction Options

Inputs		**Output**	
Underlying Asset Value Now (S0)	169,73	Growth Rate (R)	1,0113
Standard Dev - Annual (Std)	40,01%	Up Movment /Period (u)	1,2215
Riskfree Rate - Annual (rf)	4,50%	Down Movement /Period (d)	0,8187
Exercise Price (X)	0	Risk-neutral Probability (q)	0,4782
Time to Maturity - Years (t)	3	1-p	0,5218
Binomial steps - Years (dt)	0,25		
Expansion Factor	3,08	Option Premium	295,63
Expansion Costs	66,62		
Contraction factor	0,67		
Contraction Savings	43,96		
Salvage value	4,37		

	2004		2005				2006				2007				
Time	Q1		Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4		
Lattice Evolution of the underlying	169,73		207,32	253,23	309,31	377,82	461,49	563,69	688,53	841,01	1 027,27	1 254,77	1 532,66	1 872,09	
			138,96	169,73	207,32	253,23	309,31	377,82	461,49	563,69	688,53	841,01	1 027,27	1 254,77	
				113,76	138,96	169,73	207,32	253,23	309,31	377,82	461,49	563,69	688,53	841,01	
					93,14	113,76	138,96	169,73	207,32	253,23	309,31	377,82	461,49	563,69	
						76,25	93,14	113,76	138,96	169,73	207,32	253,23	309,31	377,82	
							62,42	76,25	93,14	113,76	138,96	169,73	207,32	253,23	
								51,11	62,42	76,25	93,14	113,76	138,96	169,73	
									41,84	51,11	62,42	76,25	93,14	113,76	
										34,25	41,84	51,11	62,42	76,25	
											28,04	34,25	41,84	51,11	
												22,96	28,04	34,25	
													18,80	22,96	
														15,39	

	2 004		2 005				2 006				2 007				
Time Q4	Q1		Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4		
Option Valuation	465,36		579,91	720,46	892,48	1 102,79	1 359,81	1 673,90	2 057,70	2 526,64	3 099,58	3 799,56	4 654,71	5 699,41	
			370,45	463,66	578,41	719,07	891,11	1 101,40	1 358,41	1 672,48	2 056,26	2 525,19	3 098,11	3 798,08	
				293,06	368,52	462,02	576,97	717,69	889,71	1 099,99	1 356,98	1 671,04	2 054,80	2 523,70	
					230,24	290,81	366,68	460,50	575,57	716,27	888,28	1 098,54	1 355,51	1 669,55	
						179,72	227,58	288,64	365,01	459,08	574,13	714,82	886,81	1 097,06	
							139,75	176,54	224,91	286,70	363,58	457,63	572,67	713,34	
								109,05	136,04	173,15	222,45	285,25	362,11	456,15	
									86,67	104,98	131,71	169,71	220,98	283,77	
										71,77	82,76	99,73	126,39	168,23	
											63,25	69,00	77,45	90,79	
												59,34	62,75	66,91	
													56,55	59,34	
														54,27	

	2004		2005				2006				2007				
Time Q4	Q1		Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4		
Optimal Decision Lattice	Open		Open	Open	Open	Open	Open	Open	Open	Open	Open	Open	Open	**Expand**	
			Open	Open	Open	Open	Open	Open	Open	Open	Open	Open	Open	**Expand**	
				Open	Open	Open	Open	Open	Open	Open	Open	Open	Open	**Expand**	
					Open	Open	Open	Open	Open	Open	Open	Open	Open	**Expand**	
						Open	Open	Open	Open	Open	Open	Open	Open	**Expand**	
							Open	Open	Open	Open	Open	Open	Open	**Expand**	
								Open	Open	Open	Open	Open	Open	**Expand**	
									Open	Open	Open	Open	Open	**Expand**	
										Open	Open	Open	Open	**Expand**	
											Open	Open	Open	**Expand**	
												Contract	***Contract***	***Contract***	
													Contract	***Contract***	
														Contract	

Appendix 5.6 D
Type: *Option to Choose, Unnamed project X2 E*

Multiple interaction Options

Inputs		**Output**	
Underlying Asset Value Now (S0)	159,45	Growth Rate (R)	1,0113
Standard Dev - Annual (Std)	40,01%	Up Movment /Period (u)	1,2215
Riskfree Rate - Annual (rf)	4,50%	Down Movement /Period (d)	0,8187
Exercise Price (X)	0	Risk-neutral Probability (q)	0,4782
Time to Maturity - Years (t)	3	1-p	0,5218
Binomial steps - Years (dt)	0,25		
Expansion Factor	3,08	Option Premium	272,59
Expansion Costs	68,77		
Contraction factor	0,67		
Contraction Savings	45,94		
Salvage value	4,18		

	2004	2005			2006				2007			
Time	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Lattice Evolution of the underlying	159,45	194,76	237,90	290,58	354,93	433,54	529,55	646,83	790,08	965,05	1 178,77	1 439,83	1 758,70
		130,54	159,45	194,76	237,90	290,58	354,93	433,54	529,55	646,83	790,08	965,05	1 178,77
			106,87	130,54	159,45	194,76	237,90	290,58	354,93	433,54	529,55	646,83	790,08
				87,49	106,87	130,54	159,45	194,76	237,90	290,58	354,93	433,54	529,55
					71,63	87,49	106,87	130,54	159,45	194,76	237,90	290,58	354,93
						58,64	71,63	87,49	106,87	130,54	159,45	194,76	237,90
							48,01	58,64	71,63	87,49	106,87	130,54	159,45
								39,31	48,01	58,64	71,63	87,49	106,87
									32,18	39,31	48,01	58,64	71,63
										26,35	32,18	39,31	48,01
											21,57	26,35	32,18
												17,66	21,57
													14,46

	2 004	2 005			2 006				2 007			
Time Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Option Valuation	432,04	539,41	671,31	832,84	1 030,34	1 271,74	1 566,74	1 927,22	2 367,69	2 905,87	3 563,38	4 366,68	5 348,03
		343,00	430,20	537,82	669,87	831,43	1 028,91	1 270,29	1 565,27	1 925,74	2 366,20	2 904,35	3 561,85
			270,51	340,88	428,44	536,31	668,44	829,98	1 027,45	1 268,81	1 563,78	1 924,23	2 364,67
				211,87	268,01	338,86	426,82	534,86	666,97	828,50	1 025,96	1 267,30	1 562,25
					165,00	208,88	265,59	337,06	425,36	533,38	665,48	826,99	1 024,43
						128,35	161,44	205,84	263,42	335,58	423,87	531,87	663,95
							100,79	124,25	157,52	203,00	261,93	334,06	422,34
								81,48	96,45	119,25	153,38	201,48	260,40
									69,53	77,64	90,55	112,62	151,85
										63,59	67,50	72,28	79,10
											60,39	63,59	67,50
												57,77	60,39
													55,63

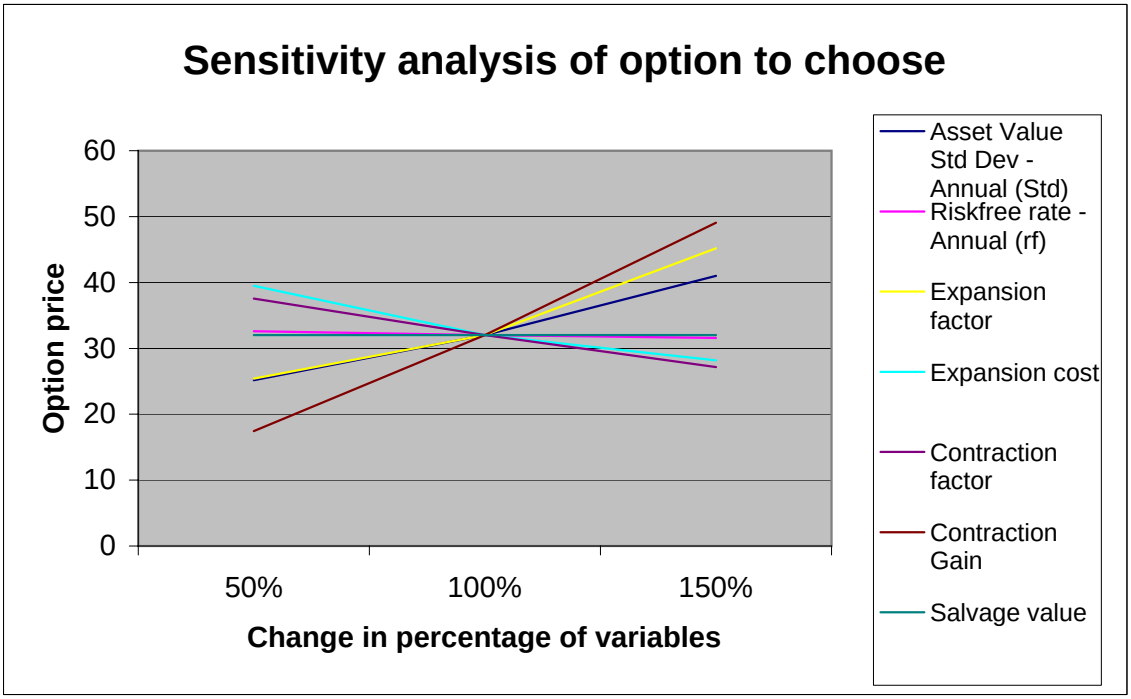
	2004	2005			2006				2007			
Time Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Optimal Decision Lattice	Open	Open	Open	Open	Open	Open	Open	Open	Open	Open	Open	Open	**Expand**
		Open	Open	Open	Open	Open	Open	Open	Open	Open	Open	Open	**Expand**
			Open	Open	Open	Open	Open	Open	Open	Open	Open	Open	**Expand**
				Open	Open	Open	Open	Open	Open	Open	Open	Open	**Expand**
					Open	Open	Open	Open	Open	Open	Open	Open	**Expand**
						Open	Open	Open	Open	Open	Open	Open	**Expand**
							Open	Open	Open	Open	Open	Open	**Expand**
								Open	Open	Open	Open	Open	**Expand**
									Open	Open	Open	Open	**Expand**
										Contract	***Contract***	***Contract***	**Expand**
											Contract	***Contract***	***Contract***
												Contract	***Contract***
													Contract

Appendix 5.6 E
Type: *Sensitvity analysis Battlefield 2*

Battlefield 2

	50%	100%	150%
Asset Value Std Dev - Annual (Std)	20,005%	40,01%	60,015%
Option price	**25,16**	**32,01**	**41,00**
Riskfree rate - Annual (rf)	2,250%	4,50%	6,750%
Option price	**32,62**	**32,01**	**31,6**
Expansion factor	1,485	1,97	2,455
Option price	**25,41**	**32,01**	**45,18**
Expansion cost	32,265	64,53	96,795
Option price	**39,49**	**32,01**	**28,19**
Contraction factor	0,835	0,67	0,505
Option price	**37,54**	**32,01**	**27,17**
Contraction Gain	21,035	42,07	63,105
Option price	**17,46**	**32,01**	**49,08**
Salvage value	2,09	4,18	6,27
Option price	**32,01**	**32,01**	**32,01**

	Option value
Best case	82,61
Worst case	3,4
Volatility	0,4
Additional risk (new markets)	0,1
Total	0,5



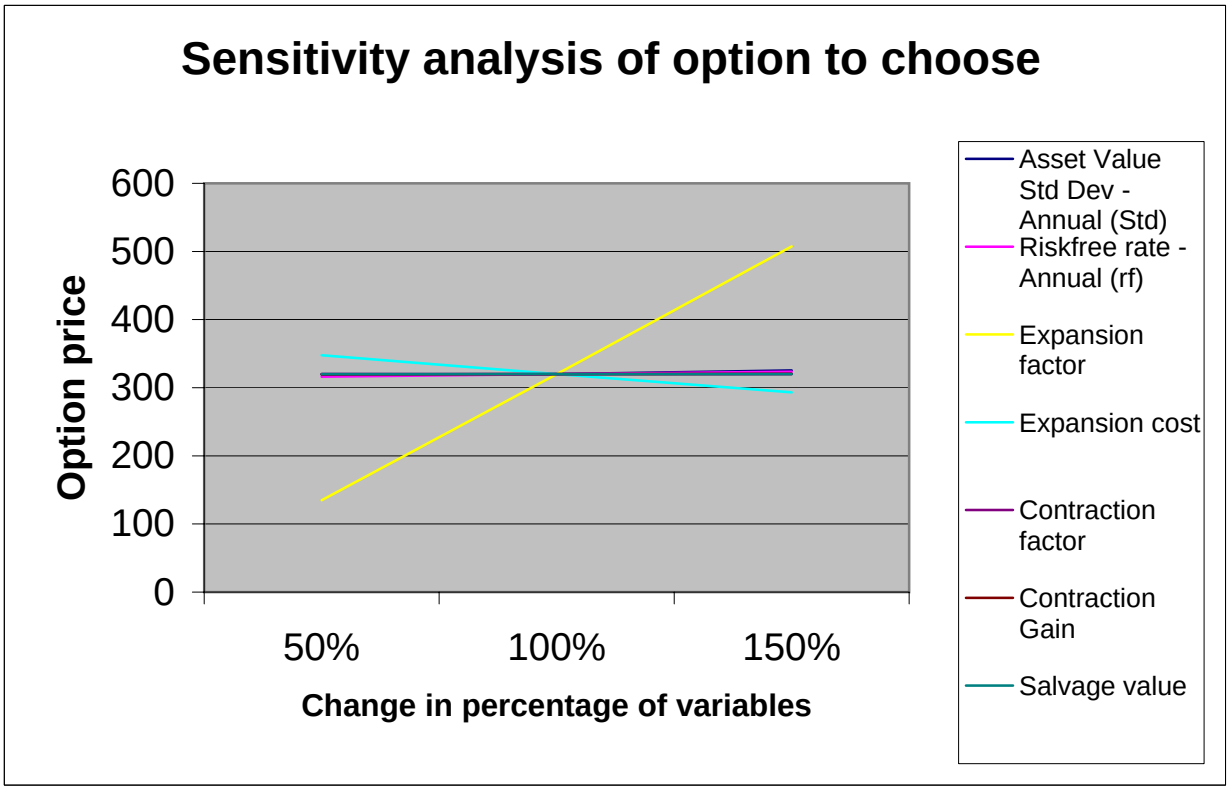
Appendix 5.6 F

Type: *Sensitvity analysis Battlefield Modern Combat*

Battlefield Modern Combat

	50%	100%	150%
Asset Value Std Dev - Annual (Std)	20,005%	40,01%	60,015%
Option price	**319,45**	**320,04**	**325,30**
Riskfree rate - Annual (rf)	2,250%	4,50%	6,750%
Option price	**316,3**	**320,04**	**323,57**
Expansion factor	2,04	3,08	4,12
Option price	**134,94**	**320,04**	**507,48**
Expansion cost	32,265	64,53	96,795
Option price	**347,72**	**320,04**	**293,11**
Contraction factor	0,835	0,67	0,505
Option price	**320,17**	**320,04**	**319,9**
Contraction Gain	21,035	42,07	63,105
Option price	**319,58**	**320,04**	**320,55**
Salvage value	2,09	4,18	6,27
Option price	**320,04**	**320,04**	**320,04**

Option value	MSEK
Best case	535,9
Worst case	108,94



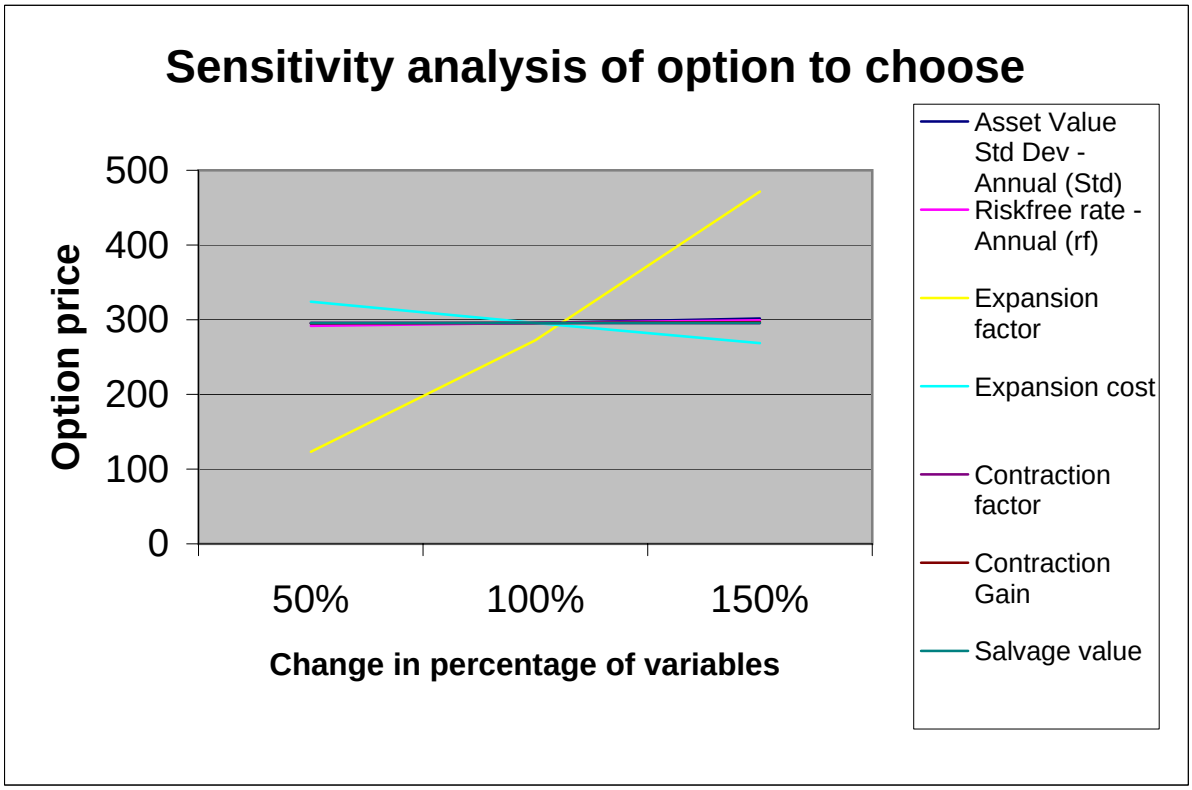
Appendix 5.6 G

Type: *Sensitvity analysis Unnamed project X1*

Unnamed project X1

	50%	100%	150%
Asset Value Std Dev - Annual (Std)	20,005%	40,01%	60,015%
Option price	**294,83**	**295,63**	**301,64**
Riskfree rate - Annual (rf)	2,250%	4,50%	6,750%
Option price	**291,84**	**295,63**	**299,22**
Expansion factor	2,04	3,08	4,12
Option price	**123,22**	**272,59**	**471,49**
Expansion cost	33,31	66,62	99,93
Option price	**324,04**	**295,63**	**268,6**
Contraction factor	0,835	0,67	0,505
Option price	**295,76**	**295,63**	**295,5**
Contraction Gain	21,98	43,96	65,94
Option price	**295,10**	**295,63**	**296,76**
Salvage value	2,185	4,37	6,555
Option price	**295,63**	**295,63**	**295,63**

Option value	MSEK
Best case	501,8
Worst case	95,09

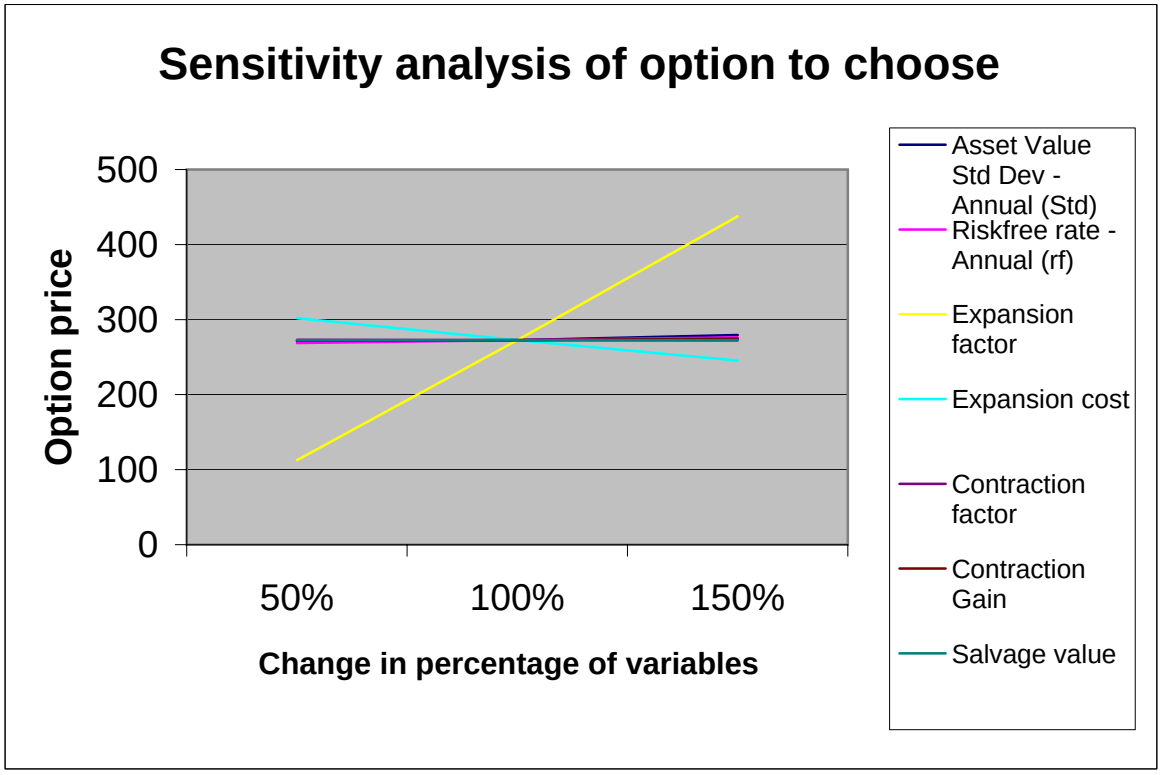


Appendix 5.6 H
Type: *Sensitvity analysis Unnamed Project X2*

Unnamed project X2

	50%	100%	150%
Asset Value Std Dev - Annual (Std)	20,005%	40%	60,015%
Option price	**271,57**	**272,59**	**279,39**
Riskfree rate - Annual (rf)	2,250%	4,50%	6,750%
Option price	**268,73**	**272,59**	**276,26**
Expansion factor	2,04	3,08	4,12
Option price	**112,63**	**272,59**	**437,66**
Expansion cost	34,385	68,77	103,155
Option price	**301,8**	**272,59**	**245,4**
Contraction factor	0,835	0,67	0,505
Option price	**273,14**	**272,59**	**272,46**
Contraction Gain	22,97	45,94	68,91
Option price	**272,03**	**272,59**	**274,49**
Salvage value	2,09	4,18	6,27
Option price	**272,59**	**272,59**	**272,59**

Option value	MSEK
Best case	470,01
Worst case	81,98



Appendix 5.6 I

Type: *Best Case - Worst Case Scenario*

Battlefiled 2	**Option value SKr m**
Best case	82,61
Expected	32,01
Worst case	3,4

Battlefield Modern Combat	**Option value SKr m**
Best case	535,9
Expected	325,29
Worst case	108,94

Unnamed title X1	**Option value SKr m**
Best case	501,8
Expected	295,63
Worst case	95,09

Unnamed title X2	**Option value SKr m**
Best case	470,01
Expected	272,59
Worst case	81,98

Appendix 5.7
Type: *Company Value*

Company Value with ROA expected scenario (high-growth period growth rate 2,19%, stable period, growth rate 1,20%)

Year 2005	Year	Option Value	1 + WACC	Disc. Optionvalue 2005
Battlefield 2	2005	32,01	1,0000	32,01
Battlefield Modern Combat	2005	320,04	1,0000	320,04
Unnamed project X1	2006	295,63	1,0645	277,72
Unnamed Project X2	2007	272,59	1,1322	240,76
				870,53

Year 2006	Year	Disc. Optionvalue 2005	1 + WACC	Disc. Optionvalue 2006
Battlefield 2	2005	32,01	1,0645	34,08
Battlefield Modern Combat	2005	320,04	1,0645	340,68
Unnamed project X1	2006	277,72	1,0000	277,72
Unnamed Project X2	2007	240,76	1,0645	226,17
				878,65

Year 2007	Year	Disc. Optionvalue 2006	1 + WACC	Disc. Optionvalue 2007
Battlefield 2	2005	34,08	1,1322	38,58
Battlefield Modern Combat	2005	340,68	1,1322	385,72
Unnamed project X1	2006	277,72	1,0645	295,63
Unnamed Project X2	2007	226,17	1,0000	226,17
				946,11

Company Value expected case	sNPV	Option value	e NPV	Share outstanding	Price per share
2005	364 503 616,00 kr	870530801,81	1 235 034 417,81 kr	11144974	110,82 kr
2006	372 664 535,00 kr	878649878,69	1 251 314 413,69 kr	11144974	112,28 kr
2007	382 152 960,00 kr	946105718,58	1 328 258 678,58 kr	11144974	119,18 kr

Company Value with ROA best case scenario (high-growth period growth rate 2,19%, stable period, growth rate 1,20%)

Year 2005	Year	Option Value	1 + WACC	Disc. Optionvalue 2005
Battlefield 2	2005	82,61	1,00	82,61
Battlefield Modern Combat	2005	535,90	1,00	535,90
Unnamed project X1	2006	501,80	1,06	471,40
Unnamed Project X2	2007	470,01	1,13	415,13
				1505,03

Year 2006	Year	Disc. Optionvalue 2005	1 + WACC	Disc. Optionvalue 2006
Battlefield 2	2005	82,61	1,06	87,94
Battlefield Modern Combat	2005	535,90	1,06	570,47
Unnamed project X1	2006	471,40	1,00	471,40
Unnamed Project X2	2007	415,13	1,06	389,98
				1519,78

Year 2007	Year	Disc. Optionvalue 2006	1 + WACC	Disc. Optionvalue 2007
Battlefield 2	2005	87,94	1,13	99,56
Battlefield Modern Combat	2005	570,47	1,13	645,88
Unnamed project X1	2006	471,40	1,06	501,80
Unnamed Project X2	2007	389,98	1,00	389,98
				1637,22

Company Value best case	sNPV	2005 Option value	e NPV	Share outstanding	Price per share
2005	364 503 616,00 kr	1505034856,85	1 869 538 472,85 kr	11144974	167,75 kr
2006	372 664 535,00 kr	1519775276,60	1 892 439 811,60 kr	11144974	169,80 kr
2007	382 152 960,00 kr	1637221250,39	2 019 374 210,39 kr	11144974	181,19 kr

Company Value with ROA worst case scenario (high-growth period growth rate 2,19%, stable period, growth rate 1,20%)

Year 2005	Year	Option Value	1 + WACC	Disc. Optionvalue 2005
Battlefield 2	2005	3,40	1,00	3,40
Battlefield Modern Combat	2005	108,94	1,00	108,94
Unnamed project X1	2006	95,09	1,06	89,33
Unnamed Project X2	2007	81,98	1,13	72,41
				274,08

Year 2006	Year	Disc. Optionvalue 2005	1 + WACC	Disc. Optionvalue 2006
Battlefield 2	2005	3,40	1,06	3,62
Battlefield Modern Combat	2005	108,94	1,06	115,97
Unnamed project X1	2006	89,33	1,00	89,33
Unnamed Project X2	2007	72,41	1,06	68,02
				276,93

Year 2007	Year	Disc. Optionvalue 2006	1 + WACC	Disc. Optionvalue 2007
Battlefield 2	2005	3,62	1,13	4,10
Battlefield Modern Combat	2005	115,97	1,13	131,30
Unnamed project X1	2006	89,33	1,06	95,09
Unnamed Project X2	2007	68,02	1,00	68,02
				298,51

Company Value worst case	sNPV	2005 Option value	e NPV	Share outstanding	Price per share
2005	364 503 616,00 kr	274076024,98	638 579 640,98 kr	11144974	57,30 kr
2006	372 664 535,00 kr	276934640,02	649 599 175,02 kr	11144974	58,29 kr
2007	382 152 960,00 kr	298505576,81	680 658 536,81 kr	11144974	61,07 kr

Company Value with DCF (high-growth period growth rate 8,10%, stable period, growth rate 4,05%)

Company Value DCF	Year 2005	Year 2006	Year 2007
Value of firm	584 078 635,00 kr	616 551 755,00 kr	652 067 088,00 kr
Cash and marketable securities	131 452 000,00 kr	131 452 000,00 kr	131 452 000,00 kr
Value of debt	55 518 000,00 kr	55 518 000,00 kr	55 518 000,00 kr
Value of equity	660 012 635,00 kr	692 485 755,00 kr	728 001 088,00 kr
Value of equity options issued by firm	10 480 509,00 kr	10 480 509,00 kr	10 480 509,00 kr
Net value of equity	649 532 126,00 kr	702 966 264,00 kr	738 481 597,00 kr
Shares outstanding	11 144 974	11 144 974	11 144 974
Value per share	**58,28 kr**	**63,07 kr**	**66,26 kr**