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# Bachelor's Thesis

## Venture Capital and Valuation Models

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# 1. INTRODUCTION

Startup companies are companies in early stage with unique characteristics. A startup company often has a new innovative idea, a product or a service that has market potential. A startup is often run by their entrepreneurial founders who try to capitalize the innovation, product or service. These early stage companies usually need additional funding from venture capitalist because of limited revenue or high costs and most of all lack of capital of the owners. Startup entrepreneurs can seek funding from commercial banks, angel investors or venture capital firms. Investing in a startup has high risk but also high reward if the startup succeeds. Venture capitalists face serious adverse selection risk while they try to make big profits by investing in an early stage companies with high growth potential but the difficulty is to invest in the right projects. After investing in a company venture capital investors take an equity stake in the startup and shares both, upside and downside risk.

Valuing is an important part of investing process but valuing early stage hi-tech companies is a demanding task. This study examines different valuation models that venture capitalist use when valuing startup companies. The goal is to find the differences of different valuation models and see how reliable is the information models can provide for decision-making.

## 1.1 Background

In venture capital (VC) investors invest in startup companies that show long-term growth potential. Venture capital market plays a significant role in providing capital to wide range of companies because startups do not have alternative access to capital markets. Typical characters for venture capital are high risk and returns that are higher than average. The venture capital markets are relatively new in the world except in the US and UK. In Finland and in rest of the Europe startups have been traditionally funded through commercial banks and state finance institutions. Nowadays the venture capital markets are one of the most used capital markets for startups also in Europe. The

growth of venture capital markets in Europe started in the early 1990s (Luukkonen, 2006). The backgrounds of modern venture capital financing can be tracked to early 20th century when wealthy families like Rockefeller, Bessemer and Whitney hired professional managers to seek out potential companies to invest in (Gompers, 1994).

Venture capital markets in Europe haven't been as efficient as in the US mainly because the US is stock market centered and can offer easier exits through IPOs as Europe is still developing its stock markets (Black & Gilson, 1998). IPOs are seen as the common route out from startups however exits can be made through mergers and acquisitions as well. Corporate ventures are rising because of the globally weaker IPO market. Dow Jones database shows that Google Ventures was the most acquisitive company in the US venture market between 2003 and 2012.

The trend for the past 6 years has been that VCs invest in more mature companies that are already having revenues. Ernst & Young (2013) reports, that the share of investment directed to the generating revenue stage has increased from 56% to 69% between years 2006 and 2012. This means that VCs are less likely to take risk and they prefer companies that have business and get paid for it. As companies start to have revenues, the valuation process gets easier because forecasts can be made based on the current information. This means that the information asymmetry is much lower than in early stage cases.

Ernst & Young (2013) report shows current trends of VC markets. It shows that investment activity has declined from 2011 to 2012 but overall the activity and invested capital seems to be on normal level in the US, Europe and China. However the median valuation of companies has declined more than the investment activity. The decrease in Europe is from $41.6 million to $28.4 million and in the US from 61.1$ million to $54.0 million. Considering that the investment decisions have shifted to later stages the valuations should be higher. The uncertainty of global economy can explain a part of the lower valuations.

Terry et al. (2002) list characteristics of early stage companies. The main character they list is that early stage companies have products or services that have not reached

technical or economic feasibility and may still need additional research and development before going to market. Early stage companies usually have potential market for these products and therefore investors are interested in them. Technology startups usually need to go through many steps before large-scale revenue generation can take place. Therefore companies face frontloaded costs and losses in the beginning. Early stage startups need to secure sufficient capital to achieve success. Even though a startup may have received initial financing early in its development, there is a risk of failure until the company is self-sustaining the generation of cash flows. Investors must keep these characters in mind when evaluating businesses and making projections about the future.

## 1.2 Research Problem, Objectives and Limitations

Company valuation is one of the most important factors of modern corporate finance theory. Understanding the special characters of early stage company valuation and the usefulness of different models is very important in the investing process. Venture capitalists that have high abilities to discriminate between good and bad investments should have higher return on their portfolio *ex post.* The discrimination is mainly done by good evaluation of projects and the valuation process plays big role in that. Venture capital markets have been increasing rapidly on the 21$^{st}$ century and for example in Finland startups are seen as a growth engine for economy. Startup valuation is a rather new topic and there haven't been many studies about usefulness and differences of different models. For the investors information about valuation models for startup valuing is important because some models may be better than others. This study focuses on the use of three different valuation models that have been chosen based on literature and previous studies (Dittmann, et al., 2004; Hsu, 2007; Sanders & Boivie, 2004; Terry, et al., 2002). Startups are a very heterogeneous group with specific characteristics. That is the reason why this study is limited to high technology startups only. Hi-tech companies need big investments and hi-tech developed projects are

characterized by high uncertainty regarding the results and this makes the valuation more important.

In this study the research problem is to find out how good is the information different valuation models can offer about early stage hi-tech startups. This study also tries to answer questions about why some models work better than others and if there are possibilities to improve the valuation models.

## 1.3 State of the Art

The purpose of state of the art is to find out the current situation of the international study field of venture capital valuation methods. This study is based on valuation techniques that venture capitalists use on evaluating process so it is important to find out what are the findings on recent studies on this topic. The chosen 11 articles can be seen in Appendix 1.

The review revealed that there haven't been many studies about usefulness of different valuation techniques in empirical researches. Wright et al. (2004) suggest that fine-graded analysis about valuation techniques and VC process should be done by case studies because of the heterogeneous characteristics of startups.

Dittmann, Maug & Kemper (2004) studied how German venture capitalists value their investments and how the use of different techniques affects investment performance. Wright, Lockett and Sapienza (2002) studied the use of valuation methods and information sources in different VC markets. Wright et al. (2004) continued the study and added more VC markets to study. All the studies showed that discounted cash flow (DCF) method is the most used among venture capitalists although it relies strongly on growth assumptions.

Dittmann, Maug & Kemper (2004) found that venture capitalists usually use three different methods and that the DCF users don't perform better than other technique users. However, the companies that use DCF and provide some evidence that they

subject themselves to the methodological constraints imposed by DCF outperform VCs that either don't use DCF at all or use it with significant subjective adjustment.

Wright, Lockett and Sapienza (2002) found that option based models and other alternative valuation techniques are used more often in developed VC markets like in the US. In emerging markets human capital becomes more important as investors need to know more about local markets. Legal system of different countries and its implication for capital markets is more important in explaining the source of information used than it is for the valuation methods used. The human capital and entrepreneurs' reputation has impact on startup valuation. Entrepreneurs with previous experience on industry and startups tend to get higher valuations (Davila, et al. 2002).

As DCF is the most used valuation method, researchers have provided other models for startup valuation. Miloud, Aspelund and Cabrol (2012) examined valuation method that values the company's input instead of traditional output valuation. They also found that there is a linkage between strategic management theories and new alternative venture valuation practices.

Black (2002) studied usefulness of different financial statement components when valuing early stage companies. The findings were that earnings do not provide significant valuation relevant information for startups. The book value of equity and investing cash flows were more value-relevant.

Messica (2008) argued that to determine the exit value is important for VCs. Messica created a quantitative financial method for valuing VCs. He argues that he is the first one to use this model however other authors' studies didn't recognize this model at all. Sammut (2011) and Goldenberg and Goldenberg (2009) discussed about venture capital method. Sammut argued that venture capital method is good when valuating first and second round funding and investors should use high enough discount rate. Goldenbergs argued that instead of venture capital method investors should use real option based methods.

Some of the articles revealed the problems and strategic components of the valuation process. Sanders and Boivie (2004) discussed about adverse selection and moral

hazard problems that investors face. When information asymmetry is high, prices are typically discounted and high-potential firms may leave significant capital on the table until information asymmetry is lower. In startup cases the sources of competitive advantage are more in intangible assets than in tangible assets. Because of this investors find significant difficulty in valuing potential downstream economic benefits. Hsu (2007) studied also the strategic components and found out that successful managers get higher valuation and prior experience is positively related to VC valuation.

The findings from the 11 articles show that the study field of venture capital valuation is divided into strategic factors and into use of valuation methods. The findings show that human capital of the startup has effect on how big valuation a company gets and this explains why there are many studies about strategic components that affect valuation.

Articles show that VCs use valuation methods even though the information the methods provide aren't the most important factor when investing in startups. DCF seems to be the most often used method but researchers have provided several alternative models just for the startup companies. The state of art confirms the suggestion that currently investors use valuation methods but there haven't been many studies that focus on the use of accounting information.

## 1.4 Structure of the Study

The study proceeds as it is shown in Figure 1.

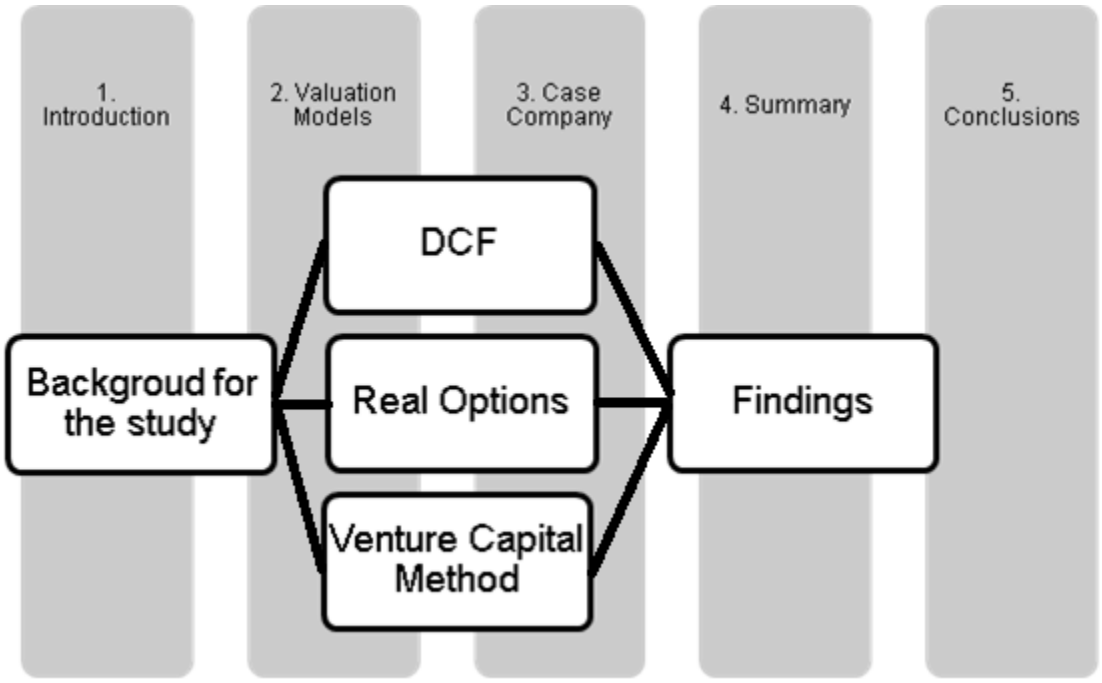


*Figure 1. Structure of the study*

The first chapter describes the background for the study by explaining shortly the current situation of venture capital markets. The background is followed by research problems and limitations. The final part of the first chapter is the state of the art part which gives compact overview of the recent international studies. In second chapter three different valuation models are examined. In chapter three the valuation models introduced in the second chapter are tested in a case company. Chapter four summarizes the findings of these three models. The conclusions are shown in chapter five.

# 2. VALUATION MODELS

The most commonly used valuation techniques taught in the finance textbooks are discounted cash flow analysis and internal rate of return model (Brealey,Myers & Allen, 2011) (Ross & Westerfield, 2001). Cornell (1993) and Damodaran (2001) offer alternative valuation methods such as book values, comparable methods and real options valuation. Sipp and Carayannis (2013) introduce deeper analysis on real options on management decision making. Damodaran (2001) focuses on valuation of technology startups and points out the problems of most common used valuation methods. Valuation models developed in mainstream corporate finance can be used in venture capital also, but the lack of certain information can constitute a problem. Early stage companies require valuation models that can handle the uncertainty. According to Damodaran (2001) even companies with negative earnings, no historical data or comparable firms can be valued. This study aims to the valuation of these early-stage companies.

Festel, Wuermseher, and Cattaeneo (2013) introduced the way of dividing the valuation methods. Originally the classification was done by Achleitner and Nathusius in 2003 in the article “Bewertung von Unternehmen bei Venture-Capital-Finanzierungen”. The valuations methods are categorically based on previous studies and findings. The classification can be seen in Figure 2.

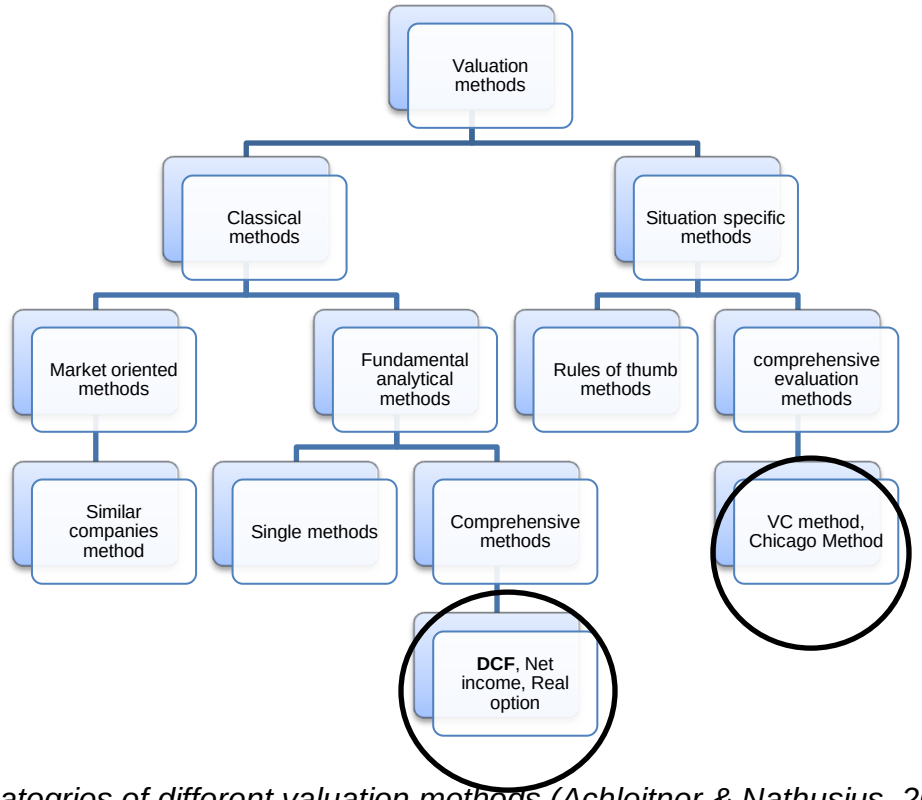


*Figure 2. Catogries of different valuation methods (Achleitner & Nathusius, 2003)*

In this chapter three different valuation methods and their theory are introduced. The advantages and problems of different valuation methods are discussed from a startup point of view. The models are chosen based on literature and can be seen circled in Figure 2. All three valuation methods are comprehensive models. Two of the models, DCF and Real option model are catogorized as classical fundamental methods and the venture capital method is categorized as a situation specific model. Discounted cash flow method is the most used method among venture capitalists and it is the first model examined. In chapter 2.2 real option based model is examined. Real option model was chosen because it is only used in the US where the most developed VC markets are located. The third model that is used is venture capital method that is developed for early stage companies and therefore it is part of this study.

## 2.1 Discounted Cash Flow

Discounted cash flow method (DCF) has been the most used valuation technique among venture capitals all over the world. Wright et al. (2002, 2004) country studies show that venture capitalists use DCF as a primary method in the USA, India, UK, France, Hong Kong, and Singapore. Dittmann et al. (2004) also argue that DCF is the most used method in Germany. Magnigart et al. (2000) study shows that VCs use DCF as primary also in Belgium. All this suggest that DCF is very effective valuation method and should make good predictions. However, DCF has many disadvantages especially when valuing early-stage companies that yet do not have stable cash flows.

Irving Fisher (1930) was the first one to introduce discounted cash flow method in a publication. Since the first appearance in publication DCF model has been the most commonly used and known valuation method. Among venture capitalists the DCF is the most used method even though it has many disadvantages when valuing early stage enterprises. Discounted cash flows give value for the firm and this value determines how big of a share will venture capitalists gain through their investment.

The first step when valuing with DCF is to calculate the free cash flows (FCF) of a company and make forecasts for the future cash flows. The free cash flow is the amount of cash that a firm can pay out to investors after paying for all investments.

$$FCF_t = OCB_t - I_t \tag{1}$$

Where $OCB_t$ is the company's net operating profit after taxes during period t and $I_t$ is the company's investment during period t including variation of working capital. Pignataro (2013) shows the exact way of calculating the free cash flow of a company. This can be seen in Figure 3.

| **Unlevered Free Cash Flow** |
|---|
| Net income |
| + Depreciation & amortization |
| + Deferred taxes |
| + Other non-cash items |
| + Working capital changes<br>- Capital expenditures<br>+ A/T Net interest expense |
| **= Total unlevered free cash flow** |

*Figure 3. Unlevered Free Cash Flow (Pignataro, 2013)*

After calculating the free cash flows of a company and making the forecasts for the future, the next step is to discount the values to a valuation horizon (H) and the forecasted value of the business at the horizon also discounted back to present value (PV). This can be seen in Equation 2.

$$PV = \frac{FCF_1}{1+r} + \frac{FCF_2}{(1+r)^2} + \cdots + \frac{FCF_t}{(1+r)^t} + \frac{PV_t}{(1+r)^t} \quad (2)$$

Where FCF terms stand for cash flows for forecasted periods and $PV_H$ stands for free cash flow in periods *t+1, t+2*, etc. r stands for discount rate. It is not practical to forecast free cash flow year by year to infinity and that is why there is the horizon value. Horizon value is chosen arbitrarily.

The horizon value can be estimated in many ways. Brealey, Myers and Allen (2011) estimate the value by choosing first the free cash flow of the last forecasted year, then the long-run growth rate *g* has to be determined and a discount rate *r* chosen. By adding these factors to Equation 3 we get:

$$PV\ (horizon) = \frac{1}{(1+r)^t}\left(\frac{FCF_t}{r-g}\right) \quad (3)$$

So, therefore, the present value of a company is PV (free cash flow) +PV (horizon value). If the horizon value is calculated as in equation 3, it may be over 100% of the value of the company because PV of cash flows can be negative. Alternative way of

calculating the present value for horizon is to multiple the last FCF value with P/E ratio or market-book value. These rations work relatively well with mature companies. (Brealey, et al., 2011).

Venture Capitalists have some kind of exit strategy so they are interested in net present values when investing in companies. The net present value must be higher than zero or otherwise investment is not profitable. Net present value can be calculated by discounting the estimated cash, summarize those and subtract the invested money from summarized cash flows. This can be seen in Equation 4.

$$NPV = \left(\sum_{t=1}^{n} \frac{FCF_t}{(1+r)^t}\right) - I_0 \quad (4)$$

Where $FCF_t$ is the free cash flow on year $t$, $I_0$is the investment in year 0 and *r* is the discount rate.

Young companies have high failure rates and companies might not make it to stable growth and the terminal value will not provide the large windfall to value. Other problem with terminal value is that some firms reach the steady state in a couple of years as others have much longer stretch of high growth, before settling into mature growth. The growth rate isn't the only thing that determines the magnitude of the terminal value. The concurrent assumptions about risk and excess returns during the stable phase are also important factors. (Damodaran, 2009)

The problem with DCF model is how to determine the discount rate r and growth rate g. These ratios have huge impact on company valuation. The discount rate tells how big risk is involved in the investment. The discount rate is usually determined based on a company's cost of capital which is the expected return on a portfolio of all the company's existing securities – debt and equity. However, today most of the companies use the cost of capital only as a benchmark for new investment. Just a slight change in a discount rate can change the valuation crucially. (Brealey, et al., 2011)

Dittmann et al. (2004) study shows that venture capital use most often DCF valuations but the use of DCF is different among VCs because they determine the discount rate

differently. Only a few of the German venture capitalists use DCF in a way that relates discount rates to the cost of capital. Venture capitals don't want to use CAPM and WACC concepts and they prefer to choose the interest rate 'internally'. The problem with determining the discount rate for early stage companies is that investors can't use CAPM and WACC in traditional way because VCs portfolios aren't well diversified, startups are high illiquidity, and startups information is incomplete compared to publicly traded firms. (Kerins et al. 2004; Merton, 1987)

Ditmann et al. (2004) study shows that VCs use either opportunity cost of capital or factor models to estimate the discount rate. Usually the rates are between 30-70%, which implicates high risk (Damodaran, 2009; Metrick, 2007; Smith & Smith, 2004). Bhagat (2014) explains why VCs use different discount rates and why those rates are so high. Bhagat argues that the high rates reflect to that not all startup projects succeed. Adjusting for the probability of success of the project provides estimates of discount rates comparable to rates of return on common stocks and other financial assets. These discount rates can be used to incorporate the risk of marketing success, regulatory rulings, competitors' response on market, and political risk.

There are some fundamental problems when valuing hi-tech startups with DCF. Schootbrugge and Wong (2013) point out these problems. First problem comes with timing, hi-tech projects often have long time horizons and when discounting cash flows over 10 years with high discount rate these projects will never receive positive NPV. The discount rate itself is problem as discussed earlier. In high-tech cases the discount rate estimation has one more shortcoming; high technology projects usually have different stage of risk at different stage of life cycle. Once the technology is proved the risk becomes much lower. Therefore, the DCF doesn't value the different options that the hi-tech startups have. This strongly suggest that real option based valuation would fit this purpose better because it involves the stop and change scenarios.

Damodaran (2007) studied the problems of DCF and points out that the model works when there are cash flows from existing assets, the expected growth comes from both new investments and improved efficiency. The discount rate must emerge from

assessments of risk in both the business and its equity. Startup companies have estimation challenges on each of these measures. The growth of the assets is a puzzling problem because most of the value in high-tech companies comes from the growth. Usually the lack of history and high variation on future cash flows makes the estimation of the growth uncertain.

Young businesses can be valued systematically with DCF model if there is enough data available. The first step is to estimate the future cash flows market oriented, either with top down approach or with bottom up approach. These approaches consider the whole market where the company is operating. In top down approach the cash flow estimation begins with estimating the total market for product and work down to the revenues and earnings of the firm. In bottom up approach the capacity of the firm is the first estimation factor and after that the units that will be sold are estimated and the revenues those units provide. (Damodaran, 2001)

To solve the problem that the discount rate has, venture capitalists often use arbitrary target rates. Damodaran (2001) provides an alternative way to solve the right discount rate. The process begins with determining the sector average beta and un-levering the beta to arrive at the beta of the business. This can be seen in Equation 5.

After determining the beta investors must adjust for diversification. To account for the absence of diversification the regression that gave the market betas also tells how much of the risk in the sector comes from the market. Dividing the market beta by the correlation of the publicly listed companies gives the scaled up version of beta that captures all of the risk of being in a specific business. This total beta tells how much risk an investor who has completely invested in one business has. When VCs invest in the company the beta lowers because of the diversification. This is because VCs have other companies in their portfolios. The total beta for VC is calculated by dividing the market beta by VC's portfolio correlation

$$Unlevered\ Beta\ for\ sector = \frac{AVG\ Beta\ for\ publicly\ traded\ firms}{\left(1+(1-Tax\ rate)Avg\ Market\frac{D}{E}ratio\right)} \quad (5)$$

In this study the bottom up approach is used in case section and the estimation is done by company executives. In this study WACC is used for discount rate and it is calculated by using CAPM. The beta used is the levered beta of the sector. The beta for sector is collected from Stern University's data base. The reason for using levered betas of certain sector is because we assume that an investor hasn't diversified his portfolio and therefore the beta must be higher than the regular beta of the sector.

Levered betas give higher cost of equity which is good. By using levered betas our discount rate gets closer to the discount rate that VCs typically use. The problem with case companies is that they operate on very specific industry with a few competitors only. So the sector beta is calculated from the returns of companies all over the world. We could have also done risk adjustments to CAPM but by choosing unlevered betas we don't have to make any other adjustments to the model.

## 2.2 Real Option Based Valuation

Traditional methods fail to estimate the uncertainty that hi-tech startups and startups in general have. DCF method assumes that investors follow the original investment plan and do not make any corrections. Copeland and Antikarov (2001) argue that DCF systematically undervalues all projects because DCF doesn't consider the value that flexibility has in an investing process. In real life the uncertainty and changes in the markets force venture capitalists to make new strategies and change plans.

The real option analyses are based on idea that investors can control uncertainty and flexibility which other valuation techniques fail to deal with. Real option analyses approach investing in multi-stage point of view. The basic idea is to transfer the financial option pricing models in capital market theory to the valuation of risky and uncertain projects (Roll, 1994).

Real options goal is to minimize downside risk and maximize upside potential of investments (Sipp & Carayannis, 2013). Unlike financial options, real options analyses deal with investments in real assets.

Real options are getting popular on developed venture capital markets like in the USA (Wright, et al., 2004). But still real options appear more on research papers than in real life investment process. The main reason for this might be that real option analysis requires complex calculations that average business investors aren't familiar with.

### 2.2.1 Financial Options

Real option analysis relies strongly on financial options theory. Financial options have been known for many centuries but academic interest increased in 1972 when the Black-Scholes pricing theory was first published. Sipp and Carayannis (2013) define financial options as contracts between buyers and sellers that give the buyers the right, but not the obligation to buy or sell the underlying asset at a later date for a predetermined price. The buy option is called a call option and the sell option is called a put option.

Damodaran (2008) describes a call option as an option where the buyer of the option has the right to buy the underlying asset at a fixed price (strike price) at any time prior to the expiration date of the option (American-style option). The buyer has to pay a price for this right, a premium. At expiration if the value of the underlying asset is less than the fixed price, the option is not exercised and buyer's loss is the premium paid. If the value of the asset is greater than the fixed price, the option is exercised and the buyer wins the difference between market price and fixed price. A payoff Figure 4. illustrates the cash payoff on an option at expiration.

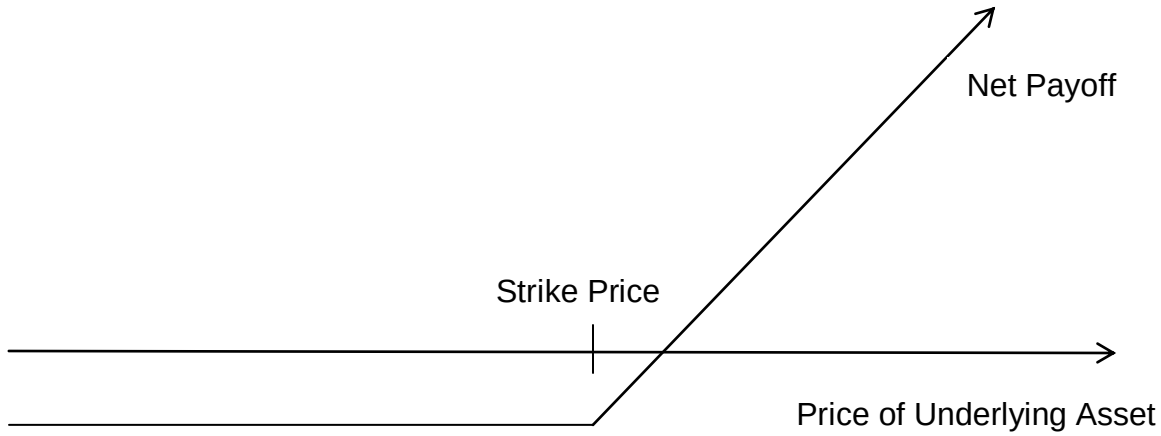


*Figure 4. Payoff on Call Option*

A put option is option that gives the buyer of the option the right to sell the underlying asset at a fixed price at any time prior to the expiration date of the option. Again the buyer has to pay a premium for this. If the price of the underlying asset is greater than the strike price, the option will not be exercised, and on the other hand if the price of the underlying asset is less than fixed price the buyer will exercise the option. So the put option has a negative net payoff if the value of the underlying asset exceeds the strike price. The put has a gross payoff equal to the difference between the strike price and the value of the underlying asset if the asset value is less than the strike price. This payoff can be seen in Figure 5. (Damodaran, 2008)

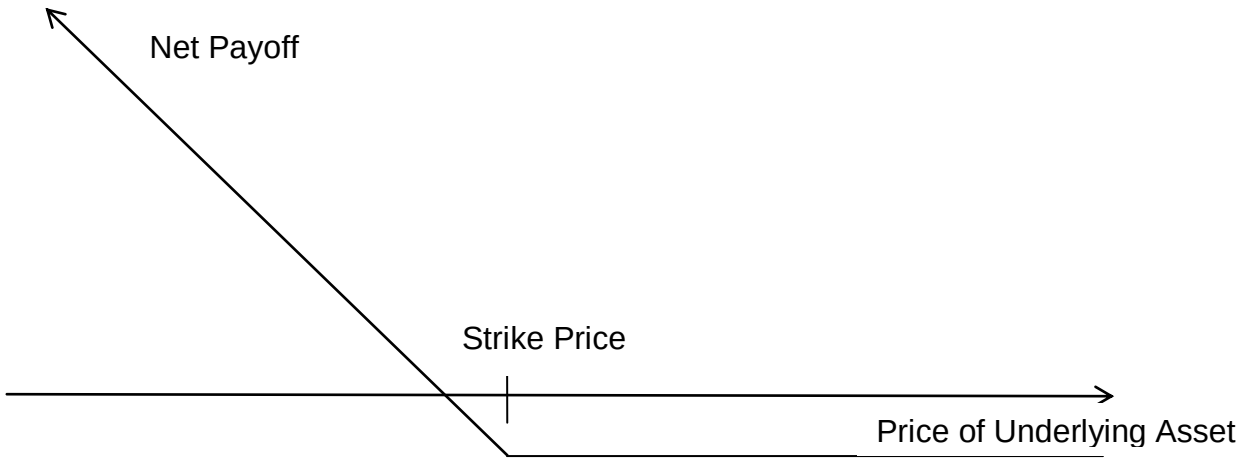


*Figure 5. Payoff on Put Option*

The value of an option is determined by a number of variables relating to the underlying asset and financial markets. Park and Herath (2000) listed variables that have effect on option pricing. In Table 1. are listed the five most important factors in this study's point of view.

Table 1. Variables that affect option pricing

| Variable | Call option | Put option |
|---|---|---|
| **Increase in current asset price** | Increases the payoff of the call and the call price | Reduces the payoff of the put and the value of the put |
| **Increase in strike price** | Reduces the payoff and value | Increase the payoff and value |
| **Greater the time to maturity** | Increases the call value due to greater chance of the asset reaching high values | Increases the put value because of greater chance of the asset reaching low values |
| **Greater volatility of the stock** | Increase the value due to greater chance of the asset reaching high values | Increases the put value because of greater chance of the asset reaching low values |
| **Higher interest rate** | High interest rates low the PV of the strike price and hence increases the call value | High interest rates low the PV of the strike price and hence decreases the put value |

Amram and Kulatilaka (1999) list three common solution methods for option valuation. First are the partial differential equations (PDE) that usually are analytical models in which the most common valuation method is Black-Scholes model. Other commonly used methods are dynamic, numerical simulations like binomial analyses. A third solution method consist simulations like Monte Carlo model.

Option pricing analysis takes in to consideration the uncertainty which is the most crucial factor in venture capital investing. Seppä and Laamanen (2001) argue that Black-Scholes model is designed to price monthly periods that are based on historical data. In hi-tech startups the investing horizon is often many years so the Black-Scholes model can't make precise valuations. In the study of Seppä and Laamanen the key finding was that option pricing analyses are useful in venture capital investing and that

binomial model predicts the future better than other traditional methods. According to Lehtonen (2000) the binomial model makes good predictions on long horizon because it considers the changes happening on option maturity.

In 1979, Cox, Ross, and Rubinstein introduced the binomial tree pricing model in Financial Economics “Option pricing: a simplified approach” article. The basic idea of the binomial tree is that the greater the number of time steps in the tree, the closer the convergence toward the valuation of the Black-Scholes model. The tree might be burdensome but it can be considered more accurate than the Black-Scholes model because it accommodates dividend-paying underlying assets as well as American-style options (Sipp & Carayannis, 2013).

In binomial model the option price development is examined at the end of each period. At the end of each period there are two possible outcomes and possibilities for those outcomes. The assumption is that the current price of underlying asset is S and at the end of period the price can be uS or dS. The discount rate r is same as risk free interest rate because in binomial model is risk neutral. If r is same as risk free rate then u > d > r or otherwise there is arbitrage opportunity on the market. If the call options price is now C and the price increases uS during the period then the value of the option at the end of period is Cu. Otherwise, if the price decreases dS the value of the option at the end of the period is Cd. Therefore, Cu= max [0, uS – K] and Cd= max [0, dS - K], where the K is the options strike price. (Cox & Rubinstein, 1985)

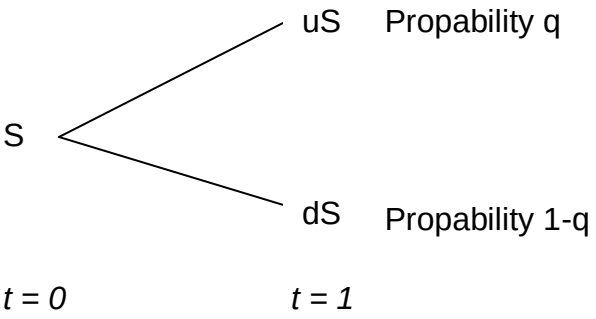


*Figure 6. Possible outcomes of call option at the end of period 1.(Cox & Rubinstein, 1985)*

The equation of multi period binomial model can be seen in Equation 6. (Lehtonen, 2000).

$$C_{T-n} = \frac{1}{(1+r)^n} \sum_{j=a}^{n} \binom{n}{j} p^j (1-p)^{n-j} \left[(1+u)^j (1+d)^{n-j} S_{T-n} - K\right] \quad (6)$$

Where $C_{T-n}$ is the value of Call option after period n, *n* is the number of periods, *j* is the number of increases on value of underlying asset, *r* is the discount rate which is the same as risk free rate, *u* is the increased value of underlying asset, *d* is the decreased value of underlying asset, *a* is the minimum number of increases on value that equals to option value >0, *K* is the strike price, and $S_{T-n}$ is the value of underlying asset in the beginning of the period. If the binomial model is used for valuing startup companies there have to be made some modification to equation.

### 2.2.2 Real Options

In real option model the investment is divided in different stages and the first stage is executed to have more information. After the first stage the investment is re-evaluated and decisions for possible second round investments are made. Hi-tech startups can be seen as a group that holds opportunities in new technology, high R&D investments, and big market potential. These opportunities might be the only valuable asset that a company has. It is difficult to value these assets and therefore investors often wait until they see if the company has potential. This scenario often leads to under- or over-investing. (Luehrman, 1997)

Amram and Kulatilaka (1999) describe real options characteristics similar to financial options. The call option gives the buyer right to buy and the real option gives the investor the right to invest at a predetermined price. The underlying real option asset in this case is the startup company. The more uncertainty the startups have on revenues and profits, the more is the value of option and, the more the investors will have to wait

for the investment. Trigeorgis (1998) showed the similarity between financial and real options. This comparison can be seen in Table 2.

Table 2. Similarity between financial and real options (Trigeorgis, 1998)

| **Financial option** | **Real option** |
|---|---|
| Value of the underlying asset | Present value of expected cash flows |
| Option strike price | The investment cost |
| Time to maturity | Time to expiration date of investment |
| The uncertainty in the value of underlying asset | The uncertainty in the value of the startup |
| Risk free rate | Risk free rate |

The valuing of option is based on objective factors listed above. With these factors real options help to recognize factors that create uncertainty and with real options investors can examine different outcomes.

Amram and Kulatilaka (1999) argue that investors should use real options when 1) investment decision has a lot of uncertainty about the future so that it is better to wait and get more information. 2) There is a lot of uncertainty about the future so that investors can advance from flexibility because investments value comes from growth opportunities not from cash flows. 3) Investors know that they have to change the strategy or investment in the future. These factors strongly argue that real options are the best valuing method when investing in early stage companies. Trigeorgis (1996) categorized the different types of real options.

Table 3. Common Real Options (Trigeorgis, 1996)

| **Category** | **Description** | **Important in:** |
|---|---|---|
| Option to Defer | Management holds an option to buy valuable resources. It can wait x years to see if output prices justify constructing a | All natural resource extraction industries; real estate development; farming; paper products |

| | | |
|---|---|---|
| | building or plant. | |
| Time to Build Option | Staging investment as a series of outlays creates the option to abandon the company in midstream if new information is unfavorable. Each stage is an option on the value of subsequent stages and valued as a compound option | All R&D intensive industries; long development capital-intensive projects |
| Option to Alter Operating Scale | If market conditions favorable than expected, the firm can expand the scale of production. If conditions are less favorable than expected, the scale of operations can be reduced. | Natural resource industries; facilities planning and construction in cyclical industries; fashion apparel; consumer goods; commercial real estate |
| Option to Abandon | If market conditions decline severely, management can abandon current operations permanently and realize the resale value of capital equipment and other assets in second-hand markets | Capital intensive industries; financial services; new product introductions |
| Option to Switch | If prices or demand change, management can change the output mix of the facility or the same outputs can be produced using different types of inputs | Output shifts: Any goods sought in small batches or volatile demand. Consumer electronics; toys; specialty paper Input shifts: All feedstock-dependent facilities |
| Growth Options | An early investment is prerequisite or link an a chain of interrelated projects opening up future growth opportunities | All infrastructure-based or strategic industries, especially high-tech, R&D, industries with multiple product generations |
| Multiple Interacting Options | Projects often involve a collection of various options, both upward-potential enhancing calls and downward-protection put options. Combined option value may differ from the sum of separate | Real-life projects in most industries |

From the table above it can be seen that for early stage hi-tech companies the time to build option or the growth option are the best ones to use because they consider most the changing and uncertain market environment. In this study the growth option is chosen because of the strategic characteristics it has. In high-tech startups the early investments create basis for the future investments and market expansion is often made through pilot projects. Investors don't expect profits from the first investments but from the opportunities those investments create.

Damodaran (2001) points out that real option approach has its limitations. As pointed out before the Black-Scholes option pricing model is based on assumptions that may hinder when valuing hi-tech startups.

Firstly, hi-tech startups are not publicly traded. The option pricing theory is built on the assumption that a replicating portfolio can be created on the underlying asset and on the premise of riskless lending or borrowing. Secondly, the value of a hi-tech startup doesn't follow a continuous process as it is the assumption in the Black-Scholes model. The third limiting assumption is that the variance of an option has to be known and it shouldn't change over the maturity.

Hi-tech startups often have long investment horizon and the variance of the project cannot be considered to be constant so the assumption doesn't hold. The final limiting assumption is in the Black-Scholes model is, that the exercise in instantaneous may be difficult to justify in the cases of real options and hi-tech startups.

Lander and Pinches point out that binomial models are more intuitive than continuous-time models and they require less mathematical background and skills to use so it should be more popular than other real option calculation models. The binomial model describes the changes of the value of the underlying asset. In venture capital this is underlying asset is a startup company. The whole idea of the binomial model is that investors build a decision tree from the possible outcomes. These outcomes develop alternative values for the underlying asset. Amram and Kulatilaka (1999) point out the advantages of the binomial model. First the model can contain a large number of real option applications. Secondly it is as said before the most comfortable model for users

and the uncertainty and the consequences of contingent decisions are described with good visual images.

Luehrman (1997) suggest that the real option method shouldn't be the only method to use in valuation. Wright et al. (2004) studies show that real options are more used in the US but VCs typically use couple of methods at the same time. Dittmann et al. (2004) study shows that German VCs typically use 2 or 3 different methods and always other method if real option method is used. These findings suggest that real options don't give enough information and it needs other model for precise valuations.

The real option models aren't widely used among venture capitalists which raise a question: Why not?

Lander and Pinches (1998) studied the use of real options and the challenges that real options have in practice. They argue that use of the binomial model creates some problems. First the binomial models are trees and real option valuation can quickly grow burdensome large as the number of time periods increases. Secondly the binomial model works well only when there is just one fundamental source of uncertainty. Lander and Pinches suggest that the investors primarily don't use real options because models are not well known or understood, investors don't have the required mathematical skills, many of the required modeling assumptions are often violated in a real option application, and the necessary additional assumptions required for mathematical tractability limit the scope of applicability.

## 2.3 The Venture Capital Method

The venture capital method was first introduced by William Sahlman in 1987 in Harvard Business School Press. Sahlman based his approach on an assumption that value to the investor is the present value of the early-stage company calculated at a successful exit event. The venture capital method consists both market and income approach (Pellegrino, 2007).

Basic idea of the method is to combine DCF analysis with multiples. The venture capital method is created for startup valuation. The rationale in the model is that at a certain point in time, an early stage investor will want to exit the project. It also focuses on the percentage of shares investor wants to buy. (Schootbrugge & Wong, 2013)

According to Caselli (2010) the venture capital method is used when the price setting is dominant and also during seed or startup deals with still negative cash flows and earnings. On other words with high uncertainty but still potential future rewards. The model is based on the question: "What amount of shares does the investor buy based on the amount of money needed to invest?"

Pellegrino (2007) argued that it is important to know how much ownership investor should receive. The company wants to provide proportion which is equitable for the risk and size of the investment. In the other hand the investor wants to receive an equitable proportion for the risk it bears in making the investment and no less.

Damodaran (2001) shows how the valuation process goes when valuing with the venture capital method. The first step is to estimate the earnings to future: two to five years is what investors usually estimate. In most of the cases the forecast period in set to the exit point so the four year estimation is better in this case. Second step is to multiple the value at the end of the forecast period (*n* in the Equation 6.) by the P/E ratio that publicly traded firms in the industry trade at. The multiple can be also based on other companies in the industry that have been sold or gone public recently. This can be seen in Equation 7.

$$Value\ of\ Equity_n = Earnings_n * P/E \tag{7}$$

As in the other models, we have to consider the time value of the money. So the third step is to discount the estimated equity value back at a target rate of return. The target rate of return is generally set high enough to capture the perceived risk in the business and the likelihood that the firm won't survive. As discussed earlier in this study VCs usually use discount rate between 30-70%. The present value calculation can be seen in Equation 8. where *r* is the target rate of return.

$$PV_{equity} = \frac{Value\ of\ equity_n}{(1+r)^n} \quad (8)$$

The fourth step in the valuation is to calculate the proportion that investors get in the company. The calculation is done by adding the new capital brought in into estimated PV of equity. The PV of equity calculated in step three is called pre-money value and the value after adding the new capital is called post-money value. So Post money valuation = Pre money valuation ($PV_{equity}$) + New capital. The proportion of equity that the venture capitalist is entitled to is computed by dividing the capital added by the post-money valuation. This can be seen in Equation 9.

$$Proportion\ of\ equity\ to\ investor = \frac{Capital\ provided}{Post\ Money\ Valuation} \quad (9)$$

Although the venture capital method is developed just for startups, it still has some drawbacks. Schootbrugge and Wong (2013) point out some of the problems. If investors use P/E ratio of a comparable company or project, it might be hard to find these projects. The discount rate is not rational because it is only based on investors' assumptions. Damodaran (2001) argues that the focus on revenues and earnings ignores the factors that happen after the exit horizon. The exit horizon way of thinking also ignores the challenges of estimating operating details for the long term. Damodaran is also concerned about the issues that the P/E multiple and discount rate has. He points out that the high discount rate incorporates the likelihood that the business will fail. The discount rate that VCs determine is an equity value because VCs invest in equity only. So the future values discounted have to be equity values also. Investors can't use revenues and enterprise value multiples in the VC method.

# 3. CASE COMPANY

In this chapter of the study the three models introduced earlier are tested with real life hi-tech startup. The case startup company operates on industry where the market potential for new innovations is huge. The goal is to see if some of the models perform better and is it possible to improve the models. The case company is called company X because the management of the company doesn't want the company to be identifiable. The NPV for investment might not be positive in every model. Company X is looking for a 1 million euro investment. The startup examined in this paper is at early-stage and the valuations are strongly based on future expectations. The case company is currently looking for first round of external investing. The investment is used to start the commercial operations. The company operates on a niche market whit a few competitors which makes the market expansion easier. Company's innovation that is patent protected has a huge market potential worldwide.

## 3.1 Discounted Cash Flow

The discounted cash flow method is the most used among VCs. In this chapter DCF analyses are made for the case company. First part of the analysis is the estimation of the future income statement and especially the revenue, cost of goods sold (COGS), EBITDA and EBIT. The tax rate used in the tax calculation is the Finnish corporate tax rate 20%. The losses of the first years are tax deductible so taxes are paid only from sixth year onward. Second step is to calculate the free cash flows for the forecast period. The forecast period is eight years. The additional re-investments are noticed in FCF calculations. The calculations of the income statement, free cash flows, cost of capital, and the assumptions made can be seen in appendices 2, 3, 4, 5, and 6. The free cash flows are discounted with weighted average cost of capital (WACC). The cost of debt is the interest rate on bank loan and the cost of equity is calculated using CAPM. The beta used in CAPM is the sector levered beta that describes the best an undiversified investor's risk. The betas are calculated for two different industries because company X's competitors are categorized in the two different industries. Risk

free rate is the Finnish government 10 year bond with the interest rate of 1.92% and the market premium is 5%. According to Modigliani-Miller theory VCs must consider the debt-to-equity ratio and its effect on the cost of equity because the company is not fully financed with equity. The equity amount is corrected with capital loan that is considered to be equity. The debt and equity amount and the whole WACC calculation for company X can be seen in Appendix 5. The perpetuity growth rate is a little bit smaller than in textbooks usually. This is because the risk free rates and economy growth rates are generally on a low level. Table 5. shows the net present value calculation for company X.

Table 5. Net Present Value of Company X

| **NPV Calculations Company X** | | |
|---|---|---|
| 1000 € | *Industry 1.* | *Industry 2.* |
| Beta | 2.73 | 3.08 |
| Perpetuity growth rate | 2 % | 2 % |
| PV FCF | 1612.02 | 1420.37 |
| Terminal Value PV | 1765.62 | 1229.66 |
| Terminal % total | 52.1 % | 46.4 % |
| PV total | 3386.63 | 2650.04 |
| NPV total | 2386.63 | 1650.04 |
| Profit | 239 % | 165 % |

From the Table 5. can be seen that even with low growth rate and high beta that describes the business beta, the NPV is over two million. Even in the industry 2 where the levered beta is higher than industry 1 the NPV is still over 1.5 million. The forecast period is relatively long for startups but in the case of hi-tech companies forecasts can be made further to the future because markets aren't changing as fast as in other industries. The terminal value in the valuation is about 50% in both of the cases. If the forecast period was shorter, the terminal value would be higher. Often when startups are valued and especially hi-tech startups the terminal value is nearly 100% of the present value because the mature growth and most of the profits come after the forecast period. In this study the forecast period is high and the profits start running after

three years and that is why the terminal value is lower than usually. With company X the high NPV and profits can be explained through the market potential. Competitors do not have similar kind of technology or cost benefits that company X has. The markets are huge for this kind of innovation and the revenues and profits can be collected in a short time because of the efficiency that innovation has.

## 3.2 Real Option Based Valuation

In this study the real options are used to support the other models and more as a strategic tool. There won't be any exact mathematical values but the goal is to give other perspectives and create discussion. As Luehrman (1998) argued the real option shouldn't be the only method used so the aim is to see how good the real option models work as a 'secondary' valuation method. Different real option types will be examined in a hi-tech startup point of view and we try to see what kind effects these options could have.

Valuation of hi-tech startup companies is mainly based on the valuation of opportunities and therefore the real option is a good tool for valuing these companies. The question is often which and in what kind of situation can real option be used. Different real option types are listed in Table 3. Those same types and their adaptability to hi-tech startups are discussed next.

**Option to defer:** This option doesn't have much value for VCs because the option is based on decreasing the uncertainty by waiting for the price of resource to go down. Company X has ideal market conditions and waiting only makes room for competitors and company X doesn't have operational cash flows so there isn't any value for waiting.

**Time to build option:** This call option can be valuable for VCs because of staging the investment and having the possibility to abandon project. Although, in this case the option is nearly expanded because most of the R&D is done there is a possibility to use this option in future when expanding to new markets. Sure the VCs have a staging option here also because the market expansion goes step-by-step to new market area.

The current investment in company X is used for setting up a facility so there aren't many possibilities for staging the one million investment but after the first investment VCs could help company X find strategic partners for further expansions and finance those expansions.

**Option to alter operating scale:** For VCs investing in the case company this option is an option to expand scale of the investment if the conditions are more favorable than expected. This option is a call option. Investment costs for X and Y aren't volatile so that shouldn't have effect on this option value but again VCs can benefit from the volatility that the startups have. If market prices and market potential increase, the value of the option increases because investments can be done in faster phase.

**Option to abandon a project:** This is a put option for VCs. If the investment is a failure, the stocks of a company can be sold. The strike price of this option is the value of the VCs share of company's stock, if it is sold or shifted to a more valuable use. In the case company this option can be realized for example by claim to resale value of the machinery which can be relatively high. The option value is of course increased if the cash flows decrease, investment costs rise, time to expiration date is short or the volatility of startup is small. In case company X this option has some value because invested money goes to facility and machinery building. Investors could claim the seniority to tangible assets in case of failure.

**Option to switch outputs or inputs:** This option can be seen as a managerial option. Option requires the product and process flexibility. Case company's output can't be changed but the most important thing is that the innovation can be used in different industries. Option to switch in this case isn't really an option for VCs but it can be used in co-operation with the management.

**Growth option:** This option is almost similar to the time to build option. This option can be seen as the most important option for our case company. Almost all early stage investments in hi-tech companies can be seen as investments in growth. Investment in company X creates the background for future facilities through pilot project. The market potential is worldwide. First investors can see one facility working and after that make

further investments to new facilities in new countries. This call option is truly valuable for VC investors because the cash flows increase after first investments and VCs can benefit from the volatility that hi-techs generally have.

The best combination of real options to VCs that invest in company X would be time-to-build option, option to abandon and growth option.

## 3.3 The Venture Capital Method

This tool is made for valuing long-term high-risk early stage companies. When valuing the case company, we assume that there is only one financing round during the exit period. When there is only one financing round we don't have to worry about the dilution of the shares. The process begins with estimating the future returns and the same predictions that were made in the DCF analyses are used here. The exit period is chosen to be 5 years. The discount rate used in this method is the anticipated return on the investment. Previous studies that have been discussed in this paper suggest that VCs usually demand 30-70% profits. In the case company the required return is chosen to be 30% which is a relatively low discount rate for this method. The discount rate is set low because case company has a management team with previous experience on the industry, intellectual property, identified customers, pending patents, and the innovations are carefully studied and they represent a new technology. Considered all the expertise and competitive advantage that the company X has, the discount rate could be even smaller. When calculating the exit value we use equity based numbers: the net income is multiplied by sector P/E ratio. After these calculations three different scenarios were made. The base scenario assumes that everything goes as planned. The downside case is based on assumption that the start of the project is delayed by one year. In the upside case the project proceeds one year faster than expected. The results of the VC method can be seen in Table 6.

Table 6. The Venture Capital Method results for Company X

| VC method Company X | | | |
|---|---|---|---|
| 1000 € | Base Case | Downside | Upside |
| Exit value | 11775.92 | 9337.12 | 25816.44 |
| P/E ratio | 17.42 | 17.42 | 17,42 |
| Time to exit | 5 | 5 | 5 |
| Discount rate | 30.0 % | 30.0 % | 30.0 % |
| Investment amount | 1000 | 1000 | 1000 |
| Equity value post money | 3171.60 | 2514.76 | 6953.12 |
| Equity value pre money | 2171.60 | 1514.76 | 5953.12 |
| Proportion of equity to VC | 31.53 % | 39.77 % | 14.38 % |
| Number of shares pre money | 605 | 605 | 605 |
| Number of new shares | 279 | 399 | 102 |
| Number of shares post money | 884 | 1004 | 707 |
| Price per share | 3.59 | 2.50 | 9.84 |

From the results can be seen that the VCs will acquire 14-39% of the company depending on the scenario. The best case for the VCs is that the company goes public at the time when the VCs exit and the shares acquired can be sold through the IPO. In the downside case VCs will have the biggest proportion of the company but the scenario isn't hoped for entrepreneurs or VCs because the profits and cash flows come at the later stage and with higher uncertainty.

The valuation in the base case is pretty similar as in DCF model even though the venture capital method is more situation based method. It is very important for the entrepreneurs to have as big proportion of the company as possible. The entrepreneurs will have 85 to 60% share of the company. The real life scenario will be something between these three scenarios so the amount that VCs gain for their investment is more a matter of negotiation than mathematics. The venture capital method sure helps the negotiations but it can't solve the valuation problem.

# 4. SUMMARY

The findings of the three models introduced in this study are compared in this chapter. In this study the research problem was to find out how good is the information different valuation models can offer about early stage hi-tech startups and finding answers to questions why some models work better and are there possibilities to improve the valuation models. The main finding is that the models provide many variations and there is no “exact way” for using the models.

DCF is the most used model among VCs but the DCF model is strongly based on assumptions depending on the company under the valuation. The most abstract assumptions have to be made when calculating the cost of capital that is used for discount rate. When valuing hi-tech startups that do not trade publicly or have a big peer group of comparable companies, there is no right way for the cost of capital determination. The biggest challenge is to find high enough cost for equity. One way of calculating the cost of equity is with adjusted CAPM. In this study the risk adjustment for CAPM was made through the beta ratio. The free cash flows are also strongly based on entrepreneurs’ and investors’ predictions but there are good methods for FCF calculations if the cost structure and gross profits of the startups are calculated carefully. The DCF is widely used and popular among VCs because it is easy to use and different scenarios can be done with it. When valuing startups best way to use DCF is to do sensitivity analyses and see what kind of effects does the changes in beta, cash flows, and growth rate have to the net present value. By doing this, investors can consider better the changing environment and volatility of startups.

Real options are similar kind of tools as financial options and they can provide mathematical values for companies but the use of real options as a mathematical way isn’t easy in real life cases and that is why real options are not widely used. However, real options can be used as an analytical tools for support other models. For example DCF doesn’t consider the changing environment but when real options are used with DCF, investors can make what if situations and different strategies for the investments.

If the real options are considered in a mathematical way, the NPV they make is Strategic NPV = Static NPV + Option Value (Amram & Kulatilaka, 1999).

For example when investors make assumptions to the DCF model, they can validate the assumptions and different what if situations with real option analyses. Real options are very effective “mind tools” especially when investment horizon is long and you can’t trust the DCF model 100%.

Compared to DCF and real option models the venture capital method has some advantages and disadvantages. The venture capital method doesn’t consider free cash flows that might be hard to estimate in young businesses but in many cases the slightest estimations of operating expenses and investments are better than no estimations at all. The discount rate that the VC method uses describes the risk of VCs but in many cases the high discount rate makes the investment look unprofitable. The venture capital method and the real option method pay attention to changing environment better than DCF model. The problem that the venture capital method has is that in the end investors and entrepreneurs have to negotiate the proportion.

DCF provides best numerical measures for young companies if the risk adjustments are made correctly and not too many assumptions are made because DCF is easy to manipulate. Real options are the best for analytical thinking but hard to use if investors want exact numbers out from the analysis. The venture capital method is good tool for VCs but has little help for the entrepreneur. VCs can see from the venture capital method that how much they should get proportion for their investment. The proportion owned in a company is very important when VCs make their exit and especially in the case of IPO. Entrepreneurs are often “losers” when the VC method is used because VCs want as high proportion to themselves as possible and they have stronger negotiation power. The post money valuation is often negotiated with the entrepreneur and investors and that is why the scenarios are more like suggestive values than fundamental values.

# 5. CONCLUSIONS

This study examines the usefulness of valuation models in venture capital. The goal was to find how good information can different models provide and is it possible to improve the models. Study was limited to high-technology startups because of the unique characteristics those have. Analyses were made by examining the literature and previous studies about the topic. After that three different models were chosen based on literature and their characteristics. Finally models were tested with real life hi-tech startup.

Considered how popular topic the venture capital and startups are nowadays, only a few studies are made about their valuation. Most of the studies made consider strategic management which in many cases is the most important part. However, some kinds of valuations are always made in the investment cases and that is why this study was made. Because of the heterogeneity of startups, study was made with only a one startup company.

Basically any of the models chosen can't be used in a "textbook way" but with modifications they are very helpful. In DCF the risk adjustments are made by adjusting discount rate with correcting the CAPM. Many researchers have provided risk adjusted CAPMs but there aren't one CAPM that works with every company. Different kinds of adjustments have to be made for example in cases of a liquidity problem, information asymmetry, and undiversification of the portfolio. Real options should be used only with other models and to support decision making. Mathematical solutions for real options are quite complicated when they are used in real life situations. In theoretical framework calculations can be done but in the real life for example if Black and Scholes model is used, estimating the volatility can be a demanding task. The VC method is best when different scenarios are made.

Further studies could be made about risk adjusted CAPMs for startups and see what kind of effects the risk adjustment has on valuation. This study was strongly based on financial numbers so further studies should consider more the strategic point of view but based on the financial valuation.

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# APPENDICES

## APPENDIX 1: State of the Art Articles

| Author | Year | Title | Topics |
|---|---|---|---|
| Hsu, D. | 2007 | Experienced entrepreneurial founders, organizational capital, and venture capital funding | Entrepreneual experience and valuation relation |
| Dittmann, I., Maug, E., Kemper, J. | 2004 | How Fundamental are Fundamental Values? Valuation Methods and their Impact on the Performance of German Venture Capitalists | Use of valuation methodologies in Germany |
| Sanders, G., Boivie, S. | 2004 | Sorting things out: Valuation of New Firms in Uncertain Markets | Information assymmetry and moral hazard |
| Miloud,T., Aspelund, A., Cabrol, M. | 2012 | Startup valuation by venture capitalist: an empirical study | Linkage between strategic management and new valuation models |
| Black, E. | 2002 | Usefulness of financial statement components in valuation: an examination of start-up and growth firms | Financial statement components in early stage valuation |
| Messica, A. | 2008 | The Valuation of Cash-Flowless High-Risk Ventures | Methods that venture capitalists use. Exit value and venture capital model |
| Sammut, S. | 2011 | Valuation methods in early-stage biotechnology enterprises the venture capital method at work | Venture capital method using |
| Davila, Foster, Gupta | 2002 | Venture capital financing and the growth of startup firms | Role of VC funding in explaining the growth |
| Wright, et. al | 2004 | Venture Capital Investors, Capital Markets, Valuation and Information | Differences in valuation methods used in different regions |
| Lockett, A., Wright, M., Sapienza H. | 2002 | Venture capital investors, valuation and information | Differences in valuation methods used in different regions |
| Goldenberg, D.H., Goldenberg, M.D. | 2009 | Why entrepreneurs and VCs disagree in valuing start-up firms | DCF vs. Option-based approaches and VC method |

## APPENDIX 2: Income Statement Predictions

**DCF Analyses Company X**

Financial year end in December

1000 €

| | *t* | *t+1* | *t+2* | *t+3* | *t+4* | *t+5* | *t+6* | *t+7* |
|---|---|---|---|---|---|---|---|---|
| Sales | 0 | 325 | 800 | 4000 | 5500 | 9900 | 15000 | 22000 |
| Work performed by its own purpose | 179 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Purchases | 1 | 223 | 289 | 958 | 1251 | 2970 | 4500 | 6600 |
| External services | 0 | 334 | 416 | 1341 | 1752 | 3960 | 6000 | 8800 |
| Variation in stocks | 0 | 307 | 91 | -101 | -297 | 0 | 0 | 0 |
| Gross Profit | 178 | 75 | 186 | 1600 | 2200 | 2970 | 4500 | 6600 |
| - Staff expenses | 185 | 450 | 525 | 600 | 1000 | 1250 | 2000 | 2750 |
| - Rents & Real estate | 44 | 60 | 60 | 112 | 112 | 160 | 220 | 270 |
| - Cargo and car expenses | 3 | 5 | 10 | 20 | 30 | 50 | 70 | 100 |
| - Maintenance | 5 | 10 | 20 | 20 | 30 | 40 | 50 | 70 |
| - Marketing | 43 | 40 | 60 | 80 | 100 | 120 | 150 | 200 |
| - G&A | 30 | 40 | 50 | 50 | 70 | 100 | 140 | 180 |
| Total operating expenses | -310 | -605 | -725 | -882 | -1342 | -1720 | -2630 | -3570 |
| **= EBITDA** | -132 | -530 | -539 | 718 | 858 | 1250 | 1870 | 3030 |
| - Depreciation | 5 | 168 | 172 | 175 | 177 | 186 | 17 | 13 |
| **= EBIT** | -137 | -698 | -711 | 543 | 681 | 1064 | 1853 | 3017 |
| - Financial expenses | 6 | 11 | 10 | 7 | 5 | 2 | 0 | 0 |
| Profit before taxes | -143 | -709 | -721 | 536 | 676 | 1062 | 1853 | 3017 |
| - Tax | 0 | 0 | 0 | 0 | 0 | -212 | -371 | -603 |
| **= Net Income** | **-143** | **-709** | **-721** | **536** | **676** | **850** | **1482** | **2414** |

## APPENDIX 3: DCF Assumptions Company X

**DCF Assumptions Company X**

| 1000 € | *t* | *t+1* | *t+2* | *t+3* | *t+4* | *t+5* | *t+6* | *t+7* |
|---|---|---|---|---|---|---|---|---|
| Tax rate | 20 % | 20 % | 20 % | 20 % | 20 % | 20 % | 20 % | 20 % |
| Net Working Capital | -26.0 | 171.2 | -237.6 | 61.0 | -236.0 | -236.0 | -236.0 | -236.0 |
| Change in Working Capital | 26.0 | -197.2 | 408.8 | -298.6 | 297.0 | 0.0 | 0.0 | 0.0 |
| CAPEX | 0 | 0 | -20 | -20 | -20 | -50 | 0 | 0 |
| Depreciation | 5 | 168 | 172 | 175 | 177 | 186 | 17 | 13 |

## APPENDIX 4: FCF Company X Industry 1.

**Free Cash Flow Company X Industry 1.**

1000 €

| | *t* | *t+1* | *t+2* | *t+3* | *t+4* | *t+5* | *t+6* | *t+7* |
|---|---|---|---|---|---|---|---|---|
| EBIT | -137 | -698 | -711 | 543 | 681 | 1064 | 1853 | 3017 |
| + Depreciation | 5 | 168 | 172 | 175 | 177 | 186 | 17 | 13 |
| + Working Capital changes | 26.0 | -197.2 | 408.8 | -298.6 | 297.0 | 0.0 | 0.0 | 0.0 |
| - Capital expenditures | 0 | 0 | -20 | -20 | -20 | -50 | 0 | 0 |
| - Taxes on EBIT | 0 | 0 | 0 | -108.6 | -136.2 | -212.8 | -370.6 | -603.4 |
| **= Total** | -106.0 | -727.2 | -150.2 | 290.8 | 998.8 | 987.2 | 1499.4 | 2426.6 |
| PV of FCF | -106 | -544.457 | -97.3049 | 163.0099 | 484.4545 | 414.3186 | 544.5048 | 762.4955 |

## APPENDIX 5: FCF Company X Industry 2.

**Free Cash Flow Company X Industry 2.**

1000 €

| | *t* | *t+1* | *t+2* | *t+3* | *t+4* | *t+5* | *t+6* | *t+7* |
|---|---|---|---|---|---|---|---|---|
| EBIT | -137 | -698 | -711 | 543 | 681 | 1064 | 1853 | 3017 |
| + Depreciation | 5 | 168 | 172 | 175 | 177 | 186 | 17 | 13 |
| + Working Capital changes | 26.0 | -197.2 | 408.8 | -298.6 | 297.0 | 0.0 | 0.0 | 0.0 |
| - Capital expenditures | 0 | 0 | -20 | -20 | -20 | -50 | 0 | 0 |
| - Taxes on EBIT | 0 | 0 | 0 | -108.6 | -136.2 | -212.8 | -370.6 | -603.4 |
| **= Total** | -106.0 | -727.2 | -150.2 | 290.8 | 998.8 | 987.2 | 1499.4 | 2426.6 |
| PV of FCF | -106 | -528.335 | -93.0152 | 153.4992 | 449.3847 | 378.5932 | 490.1321 | 676.1168 |

## APPENDIX 6: Cost of Equity and Capital Company X Industry 1.

| Cost of Equity and Capital Company X Industry 1. | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 1000 € | ***t*** | ***t+1*** | ***t+2*** | ***t+3*** | ***t+4*** | ***t+5*** | ***t+6*** | ***t+7*** |
| Sector Beta | 2.73 | 2.73 | 2.73 | 2.73 | 2.73 | 2.73 | 2.73 | 2.73 |
| Cost of equity without debt | 15.57 % | 15.57 % | 15.57 % | 15.57 % | 15.57 % | 15.57 % | 15.57 % | 15.57 % |
| Cost of equity levered | 20.24 % | 19.90 % | 18.71 % | 17.52 % | 16.33 % | 15.57 % | 15.57 % | 15.57 % |
| Amount of debt | 275 | 255 | 185 | 115 | 45 | 0 | 0 | 0 |
| Amount of equity | 587 | 587 | 587 | 587 | 587 | 587 | 587 | 587 |
| Debt to Equity ratio | 47 % | 43 % | 32 % | 20 % | 8 % | 0 % | 0 % | 0 % |
| Cost of debt (after-tax) | 5.60 % | 5.60 % | 5.60 % | 5.60 % | 5.60 % | 0.00 % | 0.00 % | 0.00 % |
| Cost of capital | 25.84 % | 25.50 % | 24.31 % | 23.12 % | 21.93 % | 15.57 % | 15.57 % | 15.57 % |
| *WACC* | *15.57 %* | *15.57 %* | *15.57 %* | *15.57 %* | *15.57 %* | *15.57 %* | *15.57 %* | *15.57 %* |

## APPENDIX 7: Cost of Equity and Capital Company X Industry 2.

| Cost of Equity and Capital Company X Industry 2. | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 1000 € | ***t*** | ***t+1*** | ***t+2*** | ***t+3*** | ***t+4*** | ***t+5*** | ***t+6*** | ***t+7*** |
| Sector Beta | 3.08 | 3.08 | 3.08 | 3.08 | 3.08 | 3.08 | 3.08 | 3.08 |
| Cost of equity without debt | 17.32 % | 17.32 % | 17.32 % | 17.32 % | 17.32 % | 17.32 % | 17.32 % | 17.32 % |
| Cost of equity levered | 22.81 % | 22.41 % | 21.01 % | 19.62 % | 18.22 % | 17.32 % | 17.32 % | 17.32 % |
| Amount of debt | 275 | 255 | 185 | 115 | 45 | 0 | 0 | 0 |
| Amount of equity | 587 | 587 | 587 | 587 | 587 | 587 | 587 | 587 |
| Debt to Equity ratio | 47 % | 43 % | 32 % | 20 % | 8 % | 0 % | 0 % | 0 % |
| Cost of debt (after-tax) | 5.60 % | 5.60 % | 5.60 % | 5.60 % | 5.60 % | 0.00 % | 0.00 % | 0.00 % |
| Cost of capital | 28.41 % | 28.01 % | 26.61 % | 25.22 % | 23.82 % | 17.32 % | 17.32 % | 17.32 % |
| *WACC* | *17.32 %* | *17.32 %* | *17.32 %* | *17.32 %* | *17.32 %* | *17.32 %* | *17.32 %* | *17.32 %* |