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Framework for Start-up Valuation

The paper aims to develop a model to value companies in their initial phases of development. The premise of the paper is that start-up companies are perplexing to value. Each of the standard approaches to valuation, such as income, asset or market-based method, reveals its infirmity or significant limitations when confronted with the challenge of valuing start-ups. As a result, many valuation methods yield unrealistic numbers.

We are presenting a framework that creates a coherent environment for successful start-up valuation. It emphasizes the following components: fundamentals of DCF valuation, intellectual capital contributions, embedded real options, calibrated capital structure, sensitivity and scenario analysis, coherent model with iterative financial functionalities. The model is fully operational and has been used for the valuation of several start-up companies.

Keywords: Start-ups valuation, equity financing, discounted cash flows, real options, iterative models.

Introduction

Start-up companies are difficult to value. Each of the standard approaches to valuation reveals its infirmity or significant limitations when confronted with the challenge of valuing start-ups. Income-based methods are difficult to use since young businesses typically have a short history with little or no revenues. For the same reason, the estimation of the cost of capital component that is to capture the project risk poses a huge challenge too. Asset-based methods are of little use since the start-up value usually lies in their future potential and not in the existing assets whose value at this stage is often negligible. Market-based methods rely on ratios that refer to certain benchmarks (earnings, EBITDA, sales), many of which are likely to be negative and consequently would generate negative valuations. Other methods such as Venture Capital Method, Pre-money and Post-money Valuation or First Chicago Method can only be called “crude or dirty” since they are typically simplified versions or combinations of the standard three approaches and as such share all the shortcomings when deployed to value young companies.

For all the above reasons, many standard valuation methods applied to young companies yield highly volatile numbers and the models that are used are very sensitive to any change in the parameters. According to Damodaran (2009), “there are four pieces that make up the intrinsic valuation of start-ups a puzzle: the cash flows from existing assets, the expected growth from both new investments and improved efficiency on existing assets, the discount rates that emerge from our

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assessments of risk in both the business and its equity, and the assessment of when the firm will become a stable growth firm". We also share Damodaran's view (1998) that "the value of a firm is the present value of expected cash flows generated by it, discounted back at a composite cost of capital that reflects both the sources and costs of financing used by it. This general statement applies no matter what kind of firm we look at, but the ease with which cash flows and discount rates can be estimated can vary widely across firms". Admittedly, the estimation of cash flows and discount rates in the case of young companies is challenging, but the fundamentals of valuation continue to apply.

In this paper, we aim to portray a framework that is a complex platform providing scope for determining inputs relevant to valuing companies in their initial phases of development and necessary tools for the integration of the inputs. Especially now during the fourth industrial revolution era, when knowledge-based high-tech firms may soon dominate over established firms in the "old economy", valuation models need to incorporate the young companies' characteristics in the pursuit of developing an effective modeling framework for the valuation of start-up firms. Our framework reflects the complexity of start-ups valuation and emphasizes a range of components (fundamentals of DCF valuation, intellectual capital contributions, embedded real options, calibrated capital structure, sensitivity and scenario analysis, coherent models with iterative financial functionalities), some of which are highlighted in the literature review below. The components provide a scaffolding needed for a start-up valuation, which enables cohesion, rounds of calibration, captures flexibilities and growth potential, quantifies risk. The unique characteristic of the framework is that it integrates all the components and deploys an iterative approach to the equity valuation as well as financial forecasting. Consequently, the iterations are ubiquitous across all the modules and contribute significantly to the valuation precision. The model bridges the gap between theory and industry contemporary practice and needs. It is fully operational and was used for the valuation of several start-up companies to be financed by the European Regional Development Fund.

Literature review

In this section, we review selected models and procedures of start-up valuation. Equity valuation models have continued to advance since the works of J. B. Williams (1938) who created the first model of DCF valuation and then M. Gordon, E. Shapiro (1956), who further developed a concept of the required rate of return. Since then, research related to common equity valuation has grown tremendously and is one of the most researched topics in the finance literature. The research is followed by thousands of practitioners conducting business appraisals for mergers and acquisitions, privatization, liquidations, divorce cases, most of which require from them the unique quality of bringing together the art and the science of financial markets. A review of current practice advocates that consistency and cohesion between the diverse concepts that are used can add value to start-up valuation practice.

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The emergence of high technology, shared economy or social media industries at the beginning of the XXI century, characterized by new transformative business models and negative earnings that persist for several years, has presented a challenge to traditional valuation methodology. Damodaran's paper (2009) was one of the first approaches to tackle the problem. He admits that "valuing companies early in the life cycle is difficult, partly because of the absence of operating history and partly because most young firms do not make it through these early stages to success." The companies are characterized by the following factors: no history, small or no revenue and operating losses, dependence on private equity and the fact that many do not survive. Then, he lists the challenges that are typically faced when valuing young companies: existing assets, growth assets, discount rates, terminal value and value of equity claims. His main conclusion is that although valuing a young company poses a myriad of uncertainties, such companies still should be valued systematically after an appropriate valuation model has been chosen, no matter if this is a discounted cash flow, relative or real options valuation.

Many recent articles have attempted to address the valuation problems of high growth firms (Isaksson 2020, Mirzanti 2019, Wessendorf 2019). They often discuss the problem of valuating intellectual property (Uzma 2016, Kijek 2014) or applying the real-option theory (Cola 2016). Methods based on options theory have a strong scientific background but are not commonly used in practice. The assumption is that that many events in a firm have the same characteristics as options, and their payoffs mimic the payoffs of financial options. In general, it applies to equity too. Shareholders are in fact in possession of a call option: max (V–D, 0) – they will obtain the difference between the company's value (V) and its liabilities (D), or nothing, which is exactly the payoff of a call option. Thus, a firm can be seen as a portfolio of such real options. Their sum makes the company's value (Capinski 2008).

Estimating the cost of capital is one of the problems faced when valuing young companies. The iterative approach to equity valuation eliminates deficiency in the capital asset pricing model (CAPM) which is commonly used by appraisers to calculate discount rates. The main assumption behind the iterative model is that the costs of equity should capture the risk immanent in the capital structure (Capinski 2005). It should track the structure and change whenever the debt-to-equity ratio alters. After several iterations, the model eventually obtains a unique solution for equity that is independent of the initial choice of equity (Larkin 2011).

Matthias and Wimber (2012) begin their paper with an observation that "start-up firms typically produce negative cash flows in the first years after their foundation. As a consequence, standard discounted cash flow methods are not applicable (…)". Then, they are trying to prove that the real options approach is especially advantageous in the realm of start-up firms. Those investing in start-ups finance growth opportunities and thereby acquire real asset options. Option valuation models,

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as opposed to DCF models, can adequately account for the option-like feature of start-up investment. In the paper, they combine the valuation techniques of real options pricing and optimal capital structure models. The model tries to capture the fact that many start-ups typically exhibit only a limited number of projects that have already been materialized, but at the same time hold potentially valuable additional investment options. Their model also allows for the derivation of optimal conditions for exercising the waiting option to invest in a start-up as well as its optimal capital structure upon establishment. They also show how unexercised additional options to invest (growth options) - even if producing negative cash flows at the time of investment - may significantly contribute to the start-up firm's value.

Framework and procedure

The framework presented in the paper is a fully integrated valuation procedure primarily based on the DCF model which is thoroughly augmented by embedding a few concepts and modules that create a coherent, conducive to start-up valuation, environment.

- Interactive financial forecasting system.
- Iterated DCF valuation model.
- Concepts of real options valuation.
- Intellectual capital valuation.
- Sensitivity and scenario analysis.

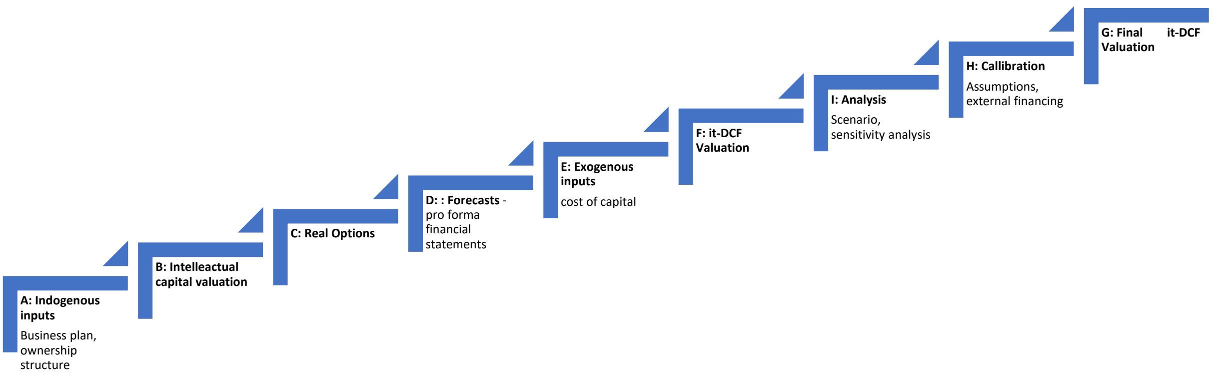

Figure 1. Iterative DCF valuation

All these concepts, once integrated into one coherent procedure, allow for the successful valuation of start-up companies. The models, mostly due to its unique characteristics such as integration via iterations and permanent calibration, helps to avoid pitfalls of traditional or dirty valuation methods when applied to young companies. Figure 1 shows the phases in the valuation process.

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Financial forecasting system

Pro forma financial statements are a starting point for calculating free cash flows and then the company's value in any DCF model. They are an immanent part of the valuation model (it-DCF) which also includes free cash flow, cost of capital and valuation engine modules. The precision of the forecasts is determined to a large extent by how coherent the *pro forma* financial statements and the other modules are. An Interactive Financial Forecasting System (IFF) consists of all *pro forma* documents: balance sheets, income statements, cash flow statements, ratio analysis and can be built in standard spreadsheets.

Calculations in *pro forma* documents are interlinked. A change in one cell will trigger changes in many other cells (and finally in the valuation cell). First, the system needs two plugs that would balance the assets and liabilities. Typically, cash and short-term debt are the plugs. The short-term debt being a plug automatically adjust whenever the assets exceed liabilities. Otherwise, cash (the plug in the assets section) takes over and adjusts the cash level if there is a surplus of equity and liabilities over assets. Cash is kept on the operationally justified level, irrespective. Koller (2010) coined the "reorganizing of balance sheets and income statements" phrase to explain the process.

Technically, for the sake of such calculations, the spreadsheet needs to be switched into a manual calculation mode. The solution is provided through iterations enabled in MS Excel (preferences, calculation options, manual and iterative calculations). The model has dozens of such interlinked cells. For example, an increased cash level will impact the net income via the interest on deposits (which are related to cash levels). However, the higher net income will translate into even more cash in the next year, on the assumption of a certain pay-out ratio. Besides, the model is based on a set of assumptions (revenue growth, costs structure, plow back ratio, profit margin, interest on deposits and loans, etc.), that are predefined, but then can and should be redefined in the calibration phase.

The IFF system creates a coherent and fully integrated environment for financial planning and building *pro forma* financial statements. The impact of change in a single parameter may be easily tracked. Integrating IFF into the it-DCF valuation model allows creating hypothetical scenarios, conducting sensitivity analysis and simulations for various sets of inputs.

Iterative DCF Valuation, capital structure and the cost of capital

The premise underlying DCF valuation is as follows: a company value is the present value of all the cash flows the company will generate in the future. The model presented below has three components: cash flows, costs of capital and discounting process.

$$V_0 = \frac{CF_1}{(1+k)^1} + \frac{CF_2}{(1+k)^2} + ...,$$

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Let us focus on two aspects of calculating the company's cost of capital. One is relating to linking the cost of equity with the changing capital structure. Relying on a fixed cost of capital over the life of a project (company) is not a good option. Instead, we are assuming that the k_u cost of capital does not depend (by definition) on the level of debt. Thus, it is also assumed that it is not related to any changes in the capital structure either. Debt, cost of equity, and equity will change in a way that the left side of the formula is unaffected.

$$k_u = k_D \frac{D(1-T)}{V_u} + k_E \frac{E}{V_u}.$$

It is worth noting that the cost of debt, equity, and the value of equity and debt will change, whenever the capital structure changes. Then, the formula may be rewritten concerning the cost of equity and it is essential to the valuation framework:

$$k_E = k_U + \frac{D(1-T)}{E}(k_U - k_D).$$

However, applying the formula to real-life calculations poses a challenge. E (equity value) affects the cost of equity, but simultaneously, the very cost of capital is needed to determine the value of equity. A numerical solution seems to be the only feasible approach to solve such logical loops. Obviously, k_E become later a part of WACC calculations. For example, to find the value V (defined as E+D, for a given year t), one needs to know the values of WACC, next E, and then k_E. It is impossible to calculate WACC without V (the one we look for), and E without k_E. There appear to be many logical loops in the formulae. It is a chain of formulae that become so integrated that the cost of capital "tracks" the capital structure and changes accordingly. Technically, the solution is provided through iterations enabled in MS Excel. The details can be found in Capinski (2005). The iterative method of company valuation overcomes a fundamental problem that is often ignored by many standard DCF valuations: the fact that the cost of capital depends on the financial structure.

Another problem with valuing young companies is the cost of capital. The standard approach to use the CAPM (the Capital Asset Pricing Model is a common model the appraisers use to calculate discount rates) model is difficult because such young companies are not traded. The regression analysis cannot be used to obtain β. The use of sector data (β) does not solve the problem since it bears the assumption that we are experiencing diversifiable risk only. However, investors into young companies are typically idea or venture capital providers. Using estimated β, would assume that market risk only matters, and other risks are insignificant. According to Damodaran (2009) in the case of young companies or start-ups, it is difficult to assume that the investors are adequately diversified. For that reason, he suggests using scaled β values, so-called total betas. Market beta in the equation below is a β value obtained for public companies listed in a stock exchange. Correlation between the companies used to find the β and the market is a scaling factor. For example, the biotechnology sector β is 2.57, whereas the correlation with the market is 29.42%, hence total beta is

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4.33. In cases where investors are slightly better diversified, their correlation with the market is higher, and as a result, the total beta will be lower. If the company goes public (allowing full diversification), the original value of β (2.33) could be used again.

$$\beta_{Total} = \frac{Market\ Beta}{Correlation\ with\ market}$$

Typically, the costs of capital applied to start-up companies are very high. They have to reflect business risk, but also the probability that a company will not survive until its IPO. According to Damodaran's research (Damodaran 2009, p. 15), the rates of return required by venture capital range, depending on a company's development stage, from 25 to 70%.

Real options

Various flexibilities, which are immanent to any business project, are rarely captured by traditional methods of valuation. During the life of a project, the cash flows may be significantly lower or higher than the expected ones. When the cash flows are lower e.g. due to diminished demand or advert exogenous conditions, the project should be abandoned. In the case of favorable circumstances, we might be able to capitalize on success. Both decisions, to withdraw after failure or expand after success, depend on future events that are highly uncertain. The similarity with options theory seems obvious. A buyer of a "put" may exercise the option if the price of the underlying asset goes down, likewise, a buyer of a "call" may benefit from a situation when the price of an underlying instrument goes up. Hence, the expression "real options" is often used whenever referring to an option whose underlying assets are not financial instruments. Real options capture certain characteristics of projects that are ignored by the standard DCF approach: reversibility (projects can be abandoned or postponed), uncertainty (cash flow variability risk is taken into account) and flexibility (decisions concerning launching projects can be optimized). Real options categorization reflects (Copeland 2000) the above characteristics: deferral options, abandon options, contract options, and growth options.

Here is a brief presentation of the basic ideas demonstrating the concept of a real option. If a company drills an oil well, it actually buys an option: if the drilling is fruitful, the company will launch the product. The expenses incurred during the exploration phase represent the option premium, and the cost of further investment incurred in the future T is the exercise price. The payoff depends on the success of the well and it is the difference between the value of the future expected cash flows (discounted to time T) and the investment. The payoff is then given by the following formula: max(0, R(T)-K), where K is the value of the investment and R (T) is the value of the generated cash flows at time T (a situation known in the world of finance under the name "call option"). It is zero when the result of the drilling is negative, and the company does not invest. However, such options have features

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that distinguish them sharply from financial options: they can be rarely written or sold, we cannot hedge, nor can we replicate them using the underlying assets and bonds.

The example below illustrates the benefits of having an option to expand. When starting a business, we can build a bigger warehouse or buy more efficient (than necessary) machines, which may allow a business to increase production in case of larger demand without having to incur additional investments later on.

A project (garage gates business) requires an investment of 100 and will bear cash flows of 50 (success), or 40 (flop) for three years. The probability of success scenario materializing is 60%. Sales in years 2 and 3 may grow significantly (by 30) if an investment of 20 is made at the end of year 1. The cost of capital is 20%.

NPV of the project (without the option to expand) is negative (–3.1). Exercising the option to expand generates cash flows (in the optimistic scenario) of 30, 80, 80 in the three subsequent years. NPV of the project becomes 9.8 and the option is worth 12.9. However, the option was valued with a decision tree analysis (DTA), which raises some doubt: physical probabilities are arbitrary, adding more options will transform a decision tree into a chaotic bush-like structure.

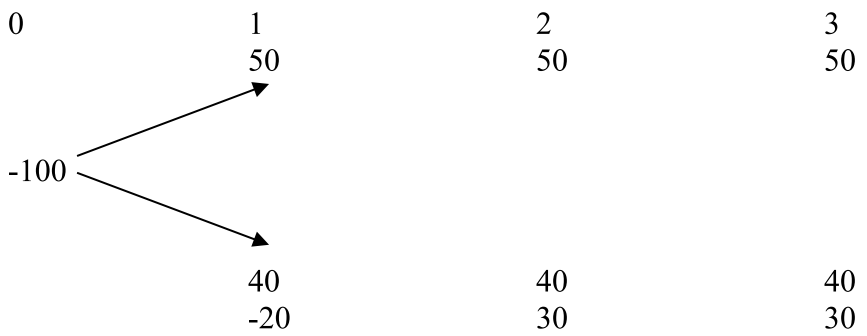

Figure 2. Option to expand - DTA

Let us then take another approach to value the option, this time taken from a world of financial options. The technique relies on replication. First of all, let us simplify the cash flows and consider only two (both in year 1 – year 2 and 3 cash flows are discounted to year 1 value). With this interpretation, the payoffs of the option are 25.83 (high demand), or 0. Now, we need to find a stock (or tradable asset), whose value depends on the demand for garage gates It costs 5 and pays off 6 (if demand is high) or 4 if low. Let us also consider a risk-free asset that costs 10 and pays off 11 after one year. The portfolio composed of the stock (64.58 is invested) and bond (46.97 is borrowed) generate the same payoffs as the real option. If the demand is high, the portfolio value is:

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$$64.58 \times \frac{6}{5} - 46.97 \times \frac{11}{10} = 25.83$$

Otherwise, it becomes:

$$64.58 \times \frac{4}{5} - 46.97 \times \frac{11}{10} = 0$$

The payoffs are the same, hence the present values must equal too. The option value is then the same as the original value of the portfolio: $64.58 - 46.97 = 17.61$. The result is different than the one obtained by DTA since instead of subjective probabilities, the market ones were used.

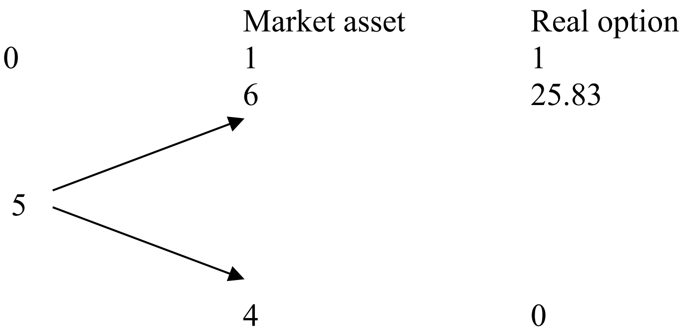

Figure 3. Option to expand – binomial tree

When applying financial option methodology, the Black-Scholes model is more often used as compared to the binomial trees approach. The model assumes certain price dynamics and does not involves scenarios. The valuation boils down to identifying a few parameters: the option pay-off, the underlying asset variability, and the risk-free rate. Calculating the price of a derivative involves calculating an integral, but for certain options such as call or put, the price may also be found analytically. Here is the formula for a call option.

$$c_t = S_t N(d_1) - K e^{-r_f (T-t)} N(d_2),$$

where: $$d_1(S_t, T) = \frac{\ln(\frac{S_T}{K}) + (r_f + \frac{\sigma^2}{2}((T-t)}{\sigma\sqrt{T-t}},$$

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$$d_2(S_t, T) = d_1 - \sigma\sqrt{T-t}.$$

The value of the call option can be now calculated with the following parameters: K = 20 (strike), S = 30, variability = 30%, risk free rate = 10% and T = 1 (decision to expand will be taken in one-year time). Its value is 12.03.

Various flexibilities, immanent to any start-up project, can be easily captured by real options valuation. Hence, it is tempting to add real option to the start-up valuation framework and apply financial options valuation techniques to real options. It is also possible, providing there is a financial asset that is perfectly correlated with the underlying asset of the real option. Otherwise, the imperfect correlation may lead to a substantial lack of precision in the valuations.

Calibration including intellectual capital

At the point of conducting their valuation, start-up companies often do not have any assets other than intellectual capital, and the intangible assets they do possess typically are not formally evidenced in a form of patents or licenses. However, the companies may present a coherent business model and the founders may have outstanding expertise in the field. In some cases, they have already incurred certain costs when preparing to launch the project. All these values can be described and adequately valued. There are many ways of how to present intellectual capital.

- Intellectual capital statements (reports consisting of know-how description, managerial challenges, initiatives, metrics).
- Intangible assets tracker (a set of metrics to assess the current company's performance and identify key factors for its future performance.
- Value creation index (a list of factors that predominantly contribute to value creation in various industries), the index may significantly improve the efficiency of the decision-making process.
- Total value creation (a tool that captures the value created by all stakeholders of a company).

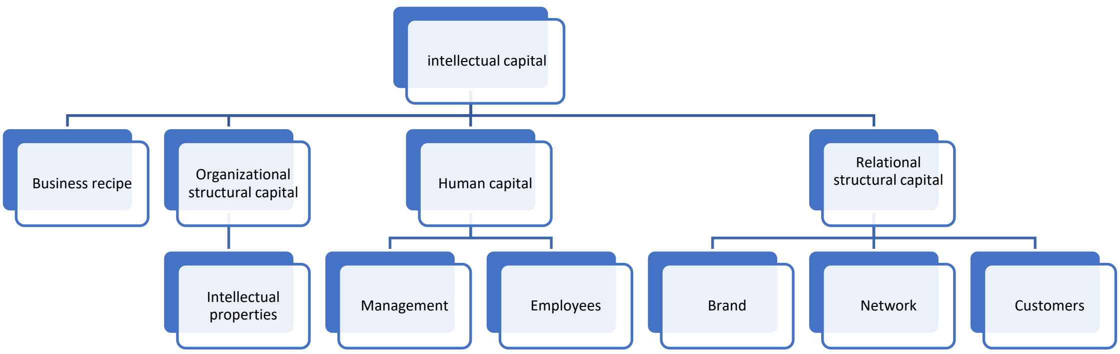

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Figure 4. Intellectual capital model
Source: www.intellectualcapital.se

There is also a range of tools that might be used to analyze intellectual capital. One of them is ICRating, a concept developed by Leif Edvinsson at Intellectual Capital Sweden AB (Figure 4). The rating is used to "measure and describe non-financial assets that are not reported or described in traditional financial statements" (www.intellectualcapital.se), but that might be of critical importance to the long-term success of an organization in terms of its growth and profitability in particular. In the case of idea companies, their valuation is especially difficult since the companies are not operational. The procedure below provides a way to link the IC valuation with required equity financing and optimal capital structure.

1. Valuing their intellectual capital is a good starting point since this is the only "tangible" asset such companies possess. Scrutinizing a business plan (if well prepared) may help to decide what is the value of the intellectual capital (technology, clients' database, etc.) contributed by the founders into a balance sheet (under goodwill). The goodwill is subject to amortization but does not impact the tax shield since it is written off from the taxable income. It is expected the founders will also contribute some cash.
2. Then, the external financing can be pre-determined. This follows several rounds of negotiations when the company's capital structure, including ownership structure, is decided. For example, the founders contribute 310 000 EUR as intellectual capital (goodwill) and 200 000 EUR in cash (51% share). The remaining 49% is provided by external investors.
3. At the next phase (after the ownership structure has been agreed upon) a post-money valuation phase follows. The DCF valuation is conducted in several rounds, which are a process of a constant calibration of the model. The calibration is based on certain boundary conditions: is the assumed financing sufficient to carry out the main investments and cover the costs, what is the minimum/optimal financing that would not jeopardize the company's liquidity? The calibration (validated by a scenario analysis) gives a final answer to a few questions concerning the company value, the optimal ownership structure and the required level of external financing.

Valuing start-ups' intellectual capital is crucial to determine the company's capital structure and the required external financing.

Scenario and sensitivity analysis

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In the DCF valuation the risk is mostly captured via a cost of capital. However, in the case of young companies, the standard approach is that scenario analysis is also used to additionally capture the risk. Typically, three scenarios are being considered.

1. Success – the company reaches the IPO stage within 4-5 years (based on the business plan).
2. Realistic – the company is successful and able to pay dividends but will never reach the IPO stage (based on business plan verified by analysts).
3. Liquidation – the company is a failure and the investors are trying to recover the investments by liquidating the assets. The revenues are lower than assumed and the net profits are negative in the years 1-5.

Table 1. Scenario analysis – profitability

Scenarios	Values	Weights	IRR	kE	NPV
Optimistic	9 057 936	0.4	52.20%	17.23%	7 833 446
Realistic	1 683 754	0.5	18.60%	17.23%	440 999
Liquidation	269 433	0.1	8.51%	17.23%	-955 057
Weighted average	4 491 995		31.03%		3 637 633

Table 1 shows the outcomes of the scenario analysis for a company. The profitability and the rates of return were based on NPV and IRR (for a 5-year investment). The approach helps to mitigate the risk involved in start-up valuations.

As shown in the chapters above, DCF valuation models have become very complex and less transparent at the same time (Hitchner 2006). They rely on numerous assumptions (typically 30-40) and complicated iterated computations. There is no shortage of valuation models, what is often missing is a proper understanding of the valuation mechanisms. For this reason, the valuation model should be subjected to the sensitivity analysis, where the impact of every single assumption made on the final company value is quantified. The analysis first points out the set of critical assumptions, which may have a major impact on the calculated company's value. Apart from quantifying the impact of the assumptions, the analysis runs qualitative checks on the assumptions assessing the robustness of the arguments standing behind the critical factors for valuation. Consequently, the sensitivity analysis improves the objectivity of the model and mitigates the exposure to the manipulation of the results. The sensitivity analysis reveals its critical role in the valuation process and proves that it should be considered as the standard step in every DCF valuation.

Table 2 illustrates the sensitivity analysis performed for one parameter: marketing costs to revenues ratio. The original assumption was that the ratio is 22% in the forecast for year 1-2 and then

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26% in years 3-5 forecasts (justified by stronger competition and more efforts needed towards clients' retention). The sensitivity analysis implies that for years 1-2, one percentage point change translates into a 0.87% change in the company's value, whereas, for the years of 3-5, the one percentage point change translates into a 19% change. Undeniably, the analysis raises doubts about the effectiveness of marketing in the years 3-5 or the credibility of the forecasts.

Table 2. Sensitivity analysis - marketing costs to sales ratio and its impact on the company's value.

Marketing costs as % of sales in years 1–2 (column 1) and 3–5 (line 1)									
	22	23	24	25	26	27	28	29	30
19	79.23	60.07	40.90	21.74	2.57	–16.59	–35.76	–54.92	–74.06
20	78.36	59.20	40.03	20.87	1.74	–17.43	–36.59	–55.76	–74.92
21	77.53	58.36	39.20	20.03	0.87	–18.30	–37.46	–56.63	–75.79
22	76.66	57.50	38.33	19.17	0.00	–19.17	–38.30	–57.46	–76.63
23	75.79	56.63	37.50	18.33	–0.83	–20.00	–39.17	–58.33	–77.50
24	74.96	55.79	36.63	17.46	–1.70	–20.87	–40.03	–59.20	–78.33
25	74.09	54.92	35.76	16.59	–2.54	–21.70	–40.87	–60.03	–79.20

Conclusions

In this paper, we analyzed a range of components typically used in company valuation to elaborate a systematic approach to valuing young companies. We suggest that the use of the set of components (interactive financial forecasting system, iterated DCF valuation model, real options, intellectual capital valuation, sensitivity analysis) may be augmented by integrating them into a coherent system and interlinking by deploying an iterative approach.

The integration works on a few different levels. First, the standard DCF valuation model is significantly enhanced by introducing the iterative approach: linking all the in the valuation processes steps (pro forma financial statements, free cash flows calculations, cost of capital estimation, discounting process) into a coherent whole. Second, certain components, such as intellectual capital, real options need to be considered a must in any valuation of start-up firms. Finally, the consistency of the model is also achieved by embedding a precise, based on spreadsheets functionalities, sensitivity

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analysis. In the environment of a complex valuation model (numerous assumptions and complicated iterated computations), it will improve the objectivity of the model and will mitigate the exposure to the manipulation of the results. The role of sensitivity analysis is critical in the valuation process and should be considered as the standard step in every DCF valuation.

The components provide a solid scaffolding needed for a start-up valuation. Integrating them with the use of iterative techniques constitutes a decent framework for start-up valuation with the characteristics listed below.

1. Interactive financial forecasting system – *creates a coherent and fully integrated environment and enables rounds of calibration.*
2. Iterated DCF valuation model – *the value of a firm is the present value of expected cash flows, the cost of capital "tracks" the capital structure and changes accordingly.*
3. Real options – *capture various flexibilities immanent to any start-up project.*
4. Intellectual capital valuation – *provides inputs to required equity financing and optimal capital structure.*
5. Sensitivity and scenario analysis – *improve the objectivity of the model and mitigates the exposure to the manipulation of the results.*

Achieving a coherent start-up valuation process that is systematic and sustainable is a challenging endeavor. The approach proposed in the paper is believed to be efficient as it integrates relevant practices into a coherent, iterations-based process. Entities that are involved in a start valuation process such as venture capital, private equity or government assistance programs will greatly benefit from the enhanced process and more accurate valuation results.

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