Value-Creating Uncertainty – A Real Options Approach in Venture Capital*

Balázs Fazekas

This article investigates how venture capital is able and willing to enter the scene of innovative startup enterprises as a primary source of finance, despite the significant degree of uncertainty surrounding these firms. The paper explores venture capital's unique risk attitude by proposing a real options approach. The tools and mechanisms applied by venture capitalists enable them to take advantage of the flexibility and uncertainty associated with startups, to exploit the value-enhancing ability stemming from continuous corporate learning, and to profit from the opportunities offered by such firms. As a result, young, innovative enterprises receive a higher rating from venture capital investors who are willing to participate and compete with other sources of finance in the financing of such enterprises. At the same time, the article points out that adapting the valuation applied in the case of financial options to venture capital investments is methodologically problematic; supplementing the real option valuation by decision trees may better capture the value-enhancing effect of the flexibility inherent in startups.

Journal of Economic Literature (JEL) codes: G24, O31, M13

Keywords: venture capital, innovation, startup, real options

1. Valuation problems in the case of venture capital investments

Classical venture capital investments[1] primarily focus on startups; consequently, in order to understand the operational mechanism and unique nature of venture capital, it is essential to define this corporate category and its characteristic features. Startups are institutions based on human capital designed to create a new product or service under conditions of extreme uncertainty (*Ries 2011*). This definition involves four key factors: the key role of human capital, organisational structure, innovation and high uncertainty.

---

* The views expressed in this paper are those of the author(s) and do not necessarily reflect the offical view of the Magyar Nemzeti Bank.

Balázs Fazekas is a PhD student at the University of Debrecen, Faculty of Economics, Institute of Finance and Accounting. E-mail: fazekas.balazs@econ.unideb.hu.

The author would like to thank Patrícia Becsky-Nagy for her invaluable assistance during the writing of this paper.

Our editorial office received the first version of the manuscript on 8 September 2016.

[1] Classical venture capital denotes a group of private equity investments that is specifically aimed at the financing of young, innovative enterprises.

Startups are innovative enterprises that bring new, novel products to the market. This novelty can be fairly diverse: it could be a new scientific discovery, a novel application of existing technologies or methods, a new business model or know-how, or an innovative use of an existing product. Due to the innovative nature of these enterprises, the operation of startups is associated with a significant degree of uncertainty. It is primarily the factor of extreme uncertainty that defines all operating areas of startups, and it accounts for the differences between the management techniques and areas applied in the case of mature companies operating in traditional industries.

Although the definition proposed by Ries (*2011*) does not define the criteria of high growth potential explicitly, it is an important feature of startups stemming from the high degree of uncertainty. Indeed, uncertainty is a double-edged sword that includes the possibility of both unfavourable and favourable outcomes. The high probability of a negative outcome is demonstrated by the high ratio of bankruptcy among startup companies. At the same time, the fact that successful enterprises can increase their business value many fold over the short run is a testimony to their high growth potential.

The valuation of young, innovative enterprises is a peculiar area of business valuation, due to the special features of such companies; for this reason, in their case traditional business valuation methods cannot be applied properly and cannot provide a realistic view. The conditions for the application of DCF methods are not in place in the case of young, innovative firms. Firstly, these firms may not even have assets upon which a prediction of future cash flows could be based, or their operating history is too short to provide a reliable estimate about the assets' cash-generating capability. Another problem is posed by the fact that a significant part of the costs (is expected to yield) returns only in future; therefore, the earnings potential of the enterprise cannot be determined clearly. Determining the growth rate is another key question in the valuation of young enterprises that cannot be answered – supported by adequate valuation methods – satisfactorily. Growth estimates are especially significant in the case of venture capital investments as venture capitalists primary seeking the high growth potential (*Chemmanur et al. 2011*).

As Damodaran (*2009*) pointed out, value creating growth arises only when a firm generates a return on capital greater than its cost of capital. To determine an adequate discount rate, a required rate of return estimated in accordance with the Capital Asset Pricing Model (CAPM) developed by Sharpe (*1964*) can be applied in the case of equity-type sources of finance. Young firms, however, pose estimation challenges as the relative risk ratio that plays a pivotal role in the model (β) can only be estimated on backdata, which are not available for newly established enterprises. Moreover, the CAPM assumes that only undiversifiable market risks

are relevant to the investor, as the model postulates well-diversified investors. If, however, this condition is not in place, as is the case, for example, with the founders of the firm, who typically invest a substantial portion of their wealth in the firm, and unique, company-specific uncertainty will also play an important role. Such idiosyncratic risks play a particularly important role at innovative enterprises, as systemic risk is not the greatest risk such firms need to face: it is the idiosyncratic risk component that plays the most dominant role (*Cochrane 2005, Ewens et al. 2013*). As a result, the CAPM's exclusive focus on systemic risks is disadvantageous for venture capitalists (VC's) as well.

The conditions for the application of traditional DCF-based valuation are not in place in the case of venture capital investment valuations; this method fails to estimate the value of these companies adequately and yields unrealistic results. Relative valuation applies various indicators to assess the firms compared to other companies, but even these relative valuation techniques are exposed to the problems specific to young companies, due to the unique characteristics of such firms, which impedes the application of DCF-based valuation methods.

First of all, it is difficult to identify both the indicator which might be an adequate point of reference and the company or companies that could be the basis for comparison. Only a company similar to the company to be evaluated can serve as a benchmark. This, however, gives rise to a Catch-22 situation: if we manage to identify a similar firm, we will face exactly the same problems in determining the indicators as the ones encountered in the case of the company to be assessed. Moreover, since these similar companies are presumably not listed on the stock exchange, their market value is not available explicitly. In selecting the benchmark, the most expedient choice (the lesser evil) is to select a listed company operating in a similar sector which, however, has completely different risk, return and growth features. Controlling for the low survival rate of the companies and risk measurement are other challenging areas of relative valuation.

2. Appearance of real options in venture capital investments

As we have seen above, traditional valuation techniques do not provide an accurate estimation of the value of startup companies, primarily because these valuation methods fail to properly address the uncertainty and flexibility inherent in startups (*Abrams 2010*). The innovation processes of startups imply continuous uncertainty as the environmental effects and the learning process induce changes in the activity of the enterprises. The key question in valuation is how to compute and address the uncertainty and flexibility inherent in startups. This can be accomplished by applying the real options method. Using the real options reasoning, analysts can present the increase in business value generated by the learning curve of startups on the one hand, and on the other hand, they can explore why venture capital is able and willing to appear as a primary source of finance in this particular corporate category.

The wave model developed by Szerb (*2006*) demonstrates the changes in the enterprise's need for and access to external funds during the different lifecycle stages of the enterprise, with regards to the different financing types. The model is based on the fact that different amounts and different types of financing are available to the enterprise in its individual lifecycles, and the firm's demand for funds is also not linear: at certain stages demand increases sharply, followed by stagnation within the cycle. According to Szerb's (*2006*) conclusions, young, newly established companies may face funding gaps when enterprises with significant growth potential are unable to obtain sufficient funds due to the insufficient supply of financing sources. The primary reason behind the emergence of funding gaps is the high information asymmetry associated with this particular corporate category (*Becsky – Nagy 2014*). Moreover, few investors are willing to put up with the high degree of uncertainty characterising these firms (*Karsai 2010*). Venture capital plays an important role in the narrowing of this funding gap (*Nagy 2004*).

According to the literature, VC's may participate in the financing of young, innovative firms leveraging their special expertise.[2] This expertise allows for the efficient selection of investment-worthy companies and hence, it assists in resolving the problem of adverse selection; furthermore, through the cooperation following the investment the investors are able to create added value for their portfolio companies (*Chemmanur et al. 2011*).

Real options can be viewed as a decision-making method, valuation technique or a tool for strategic planning (*Driouchi – Bennett 2012*). A real option is an investment in organisational capabilities, physical and human assets that provides the opportunity to respond to potential future events (*Kogut – Kulatilaka 2001*). The real options approach underpins that, in addition to the explanation presented above, it is venture capital's special attitude to uncertainty that prompts it to finance young, innovative firms. The real options valuation of venture capital is rooted in the fact that the tools and mechanisms of this financing form enable investors to take advantage of the flexibility of startups and to exploit the value-enhancing ability stemming from continuous corporate learning. Accordingly, it can profit from the options offered by the enterprises while also creating new options. In this sense, the flexibility and uncertainty inherent in the enterprises are factors enhancing business value (*Rózsa 2004*), which can be leveraged with the assistance of the knowledge and resources offered by VC's. The institution of classical venture capital financing emerged as an answer to the financing difficulties of young, innovative enterprises; its evolution process shaped those characteristic features and instruments of venture capital that allow VC's to take advantage of the potential behind these enterprises.

[2] See, for example: *MacMillan et al.* (*1998*), *Fried, V. H. – Hisrich, R. D.* (*1994*), *Harding* (*2002*), *Karsai* (*1997*).

The real options approach not only builds on the expertise of VC's as emphasised in the literature, but also supplements it. It should be noted that uncertainty in itself does not create options; management's ability to recognise and leverage options is a crucial component as well (*Copeland – Keenan 1998, Miller 2002*). Profits can only be realised from the options offered by the enterprises if the required knowledge, tools and resources are available (*Rangan 1998*). Consequently, the potential value-generating effect of uncertainty will only arise if the conditions required for recognising, shaping and implementing the options are in place.

By being actively involved in the enterprise, VC's can influence the operation of the company and the future of their investment. In addition, they are in possession of the human capital, business and management skills (*Carvalho et al. 2005*) required for the recognition of the options. The financing mechanisms of venture capital, such as multi-stage financing, monitoring, the application of convertible securities, are tools applied by investors that allow them to benefit from the real options available at the enterprise.

The application of multi-stage financing enables VC's to provide the total capital requirement of the investment in several instalments, after the enterprise has achieved certain pre-defined milestones. Consequently, VC's can test the performance of the firm with relatively small funds invested; they can gather information on its operation and, based on the information obtained, they can reject the possibility of further financing if the firm proves to be non-viable or continue to provide funding in the case of positive market feedbacks. Thanks to the information gleaned from the operation of the firm, the potential markets of the startup can be explored and a modification of the basic idea may even attract new markets, giving rise to growth options. Financing via convertible bonds is of key significance for VC backed enterprises (*Kaplan – Strömberg 2003*). Such securities can reduce losses in the event of the enterprise's failure, because, retaining its credit nature, it precedes equity during the liquidation of the company, giving the investor a senior claim and at the same time, in the case of conversion it guarantees the benefits from any increase in the business's value for the investor (*Hellmann 2006*).

Through the real options approach it is easy to see why venture capital is willing to participate in the financing of startups despite the uncertainty involved. In the case of options, the volatility of the underlying product has a positive impact on the value of the options; in the case of high uncertainty, the existence of real options lowers the semi-variance of the investment, but because of the extreme deviations from the expected value, the investor has a possibility to obtain extremely high returns.

Since there are no other financing forms where, as is the case with venture capital, a toolset is available to take advantage of the options offered by the firms, in the case of all other financing sources an increase in uncertainty will reduce the value

of the investment. If, however, the investment is viewed as a real option, this uncertainty will become a value-enhancing factor (*Yeo – Qiu 2003*). This increase in value, in turn, may influence investment decisions; indeed, if the upside potential of real options is ignored in the valuation of startup companies, the firms will be underestimated, which might lead to the rejection of investment opportunities. By contrast, when the value-enhancing effect of real options is factored in, VC's may attach a higher value to such firms, increasing the odds of potential venture capital financing.

3. Real options valuation methods and their limitations

Real options, therefore, are clearly present in the case of venture capital investments, and the real options reasoning demonstrates their value-enhancing effect on portfolio companies. In order to define this added value, in addition to the real options argument, the toolkit of real options valuation should also be checked against venture capital investments. Ever since *Myers* (*1984*) proposed the application of option pricing in the case of real instruments with underlying flexibility and introduced the concept of real options, real options valuation has become a widely discussed topic and has gone through a great degree of development. The questions about the proper application of the method, however, remained open. After the initial enthusiasm, the limitations of transposing the procedures applicable in the case of financial options have increasingly come to the foreground and the focus shifted to the methodological problems affecting the application of real options valuation primarily for the following reason. Even though the functioning of financial markets tends to converge to the assumptions on which the methods used for the valuation of financial options are based (although they do not fully hold even there), corporate investments may still be far from satisfying these assumptions.

The pricing of financial derivatives is based on replicability (*Medvegyev 2011*); in other words, with the combination of a risk-free instrument and the underlying instrument, it assumes the creation of portfolios whose future payment corresponds to the payment of the derivative. This is because the derivative's source of risk is the underlying instrument itself, and since they are in perfect correlation, by taking the appropriate positions consistency between the payment of the two portfolios can be ensured. A risk free portfolio can be created by adjusting the weight of the underlying instrument and the derivative in the portfolio properly, where the rate of return on the portfolio should be identical with the risk-free interest rate (*Black – Scholes 1973*). This argument allows for no-arbitrage pricing and risk neutral valuation (*Dömötör 2011*), which renders the estimation of the risk premium – which might be subjective and hence, may bias the results – unnecessary. Instead,

risk neutral valuation allows for the objective and consistent application of the risk-free interest rate for option pricing.

Real options valuation was conceived in response to the problem that, in the case of flexible real asset investments, no discount rate can be defined that properly reflects the uncertainty of the investment and the reactions of decision-makers to various outcomes. As *Trigeorgis* (*1996*) pointed out, no-arbitrage pricing and risk neutral valuation can be achieved – similar to financial options – even in the case of real assets, by using comparable replicating securities of similar risk; consequently, the tools of options valuation can be used in the case of investments in real assets with inherent flexibility. However, while the risk source is identical for both the underlying instrument and the related derivative in the case of financial options and the investor can construct a replicating portfolio generating the return of a risk-free security, similar financial products are not available in the case of real assets; therefore, the conditions for risk neutral valuation are not in place.

The transposition of options valuation to the environment of real asset investments may offer a seemingly elegant solution for the valuation of the flexibility behind the investments, and enables analysts to circumvent the estimation of expected returns, which – as *Száz* (*2011*) pointed out – may be arbitrary and elusive. At the same time, when the formulas created for the valuation of financial options are applied in situations where the required conditions are not in place, we may receive biased results.[3]

Table 1 summarises the approaches aimed at the valuation of investments with the methods of option pricing.[4] The classical approach suggested by *Amram – Kulatilaka* (*1999*) applies the models used for the valuation of financial options to the valuation of real options, taking the conditions existing for financial options as a given. As we can see, the classical approach proved to be the only purely option-based evaluation attempt. It is, however, indicative of the limitations of the model's applicability that the authors were subsequently forced to revise and modify the classical approach, recognising that – due to the unique, project-specific uncertainty involved in the case of real assets – it is impossible to create a portfolio that is a perfect copy of derivative payments; consequently, risk neutral evaluation is also impossible.

[3] Think of a watch whose condition for use is that it is not water-resistant. It will show completely different times outside of the water than under the water.
[4] For a detailed methodological description of individual valuation procedures, see Borison (2005).

Table 1
Real options valuation methods and their applicability

	Assumption	Valuation model	Applicability:
The classic approach (Amram – Kulatilaka 1999)	Replicating portfolios can be constructed from traded products; i.e. the existence of a replication security is assumed that correlates perfectly with the investment and moves closely together with a geometric Brownian motion; consequently the no-arbitrage argument is sound.	A method applied for the valuation of financial options such as the BS or the CRR model based on the market data of the replication security.	Conditions for the classic approach are rarely given. It can be applied if an adequate traded replicating security exists. In the lack of such instrument, however, if project-specific idiosyncratic risks are determinant, the method cannot be applied.
Subjective approach (Luehrman 1998)	It assumes the existence of a replicating portfolio and therefore the applicability of no-arbitrage arguments. It also assumes the portfolio's co-movement with a geometric Brownian motion.	A method applied for the valuation of financial options such as the BS or the CRR model based on the 'price' derived from the DCF-based valuation of the project and estimated volatility.	While the data of the replicating portfolio do not play a key role in the valuation, the reliability of subjective data is questionable. For lack of a replicating portfolio, the application of a valuation method founded on the no-arbitrage argument is inconsistent.
Marketed asset disclaimer (MAD) approach (Copeland – Antikarov 2001)	The replicating security is the project's NPV itself, without flexibility; therefore, the assumptions are the same as those applicable to the use of NPV: the computation of expected returns is based on the existence of (replicating) securities of similar risk. Asset price movements can be described by geometric Brownian motion.	Valuation with a binomial tree method. A CAPM-based discount rate is applied for the calculation of the project's NPV. A subjective estimate of cash flows and volatility.	There is no need for a replicating portfolio. Owing to the subjectivity of the data, assets and options might be mispriced. Estimating subjective data is problematic. A security of similar risk is required for proper NPV calculation.
Revised classic approach (Amram – Kulatilaka 2000)	The model supplements the classic approach, given that the classic approach is based on fairly restricting assumptions. It cancels the assumptions of the former.	Application of decision trees. Allocation of subjective odds to individual outcomes. Subjective estimate of cash flows. NPV calculation by using the appropriate WACC discount rate.	Its application is justified when project-specific risks dominate instead of the risk priced in by the market. Due to the subjectivity of data, mispricing can occur.
The integrated approach (Smith – Nau 1995)	Partially complete market: complete market in terms of market risks, but incomplete market in terms of project-specific (private) risks.	The option pricing model is applied to risks that can be hedged by traded securities and decision trees are applied to project-specific risks.	Due to the integration of the decision tree and the option pricing methods, this approach can be universally applied. Market risks and project-specific risks need to be separated. The perception of project-specific risks is subjective.

Source: Own compilation based on Borison (2005).

With respect to the different valuation approaches it was an important recognition that only a part of the uncertainties surrounding real assets can be considered market-priced risk,[5] while the remainder of the uncertainties can only be assessed by subjective methods. As a result, however tempting it may be, some estimation of the expected return cannot be circumvented in real options pricing. Similarly, as we have seen in the summary of the valuation models, classic option pricing methods are supplemented or replaced by simulation, NPV-based or decision-tree valuation components. Selecting between the models outlined in *Table 1* primarily depends on the risk profile of the given investment and on the extent to which the decisions made during the life of the investment are surrounded by project-specific uncertainties versus risks that can be objectively assessed with the assistance of a benchmark investment or security.

4. Application of the real options valuation in venture capital investments

While option pricing assumes complete markets, it is specifically the market imperfections characterising their portfolio companies that provide the niche exploited by venture capital investors (*Becsky-Nagy – Fazekas 2015*). If real options valuation is to be used for the purposes of venture capital investments, first we need to examine the risk profile of such investments. This investment form is typically aimed at enterprises and manifested in projects which, due to their previously discussed innovative nature, can be viewed as unique in the market. Accordingly, these investments tend to be dominated by a high degree of risk and uncertainty that are typically project-specific, idiosyncratic risks. The unique uncertainties surrounding venture capital investments, however, fundamentally define and at the same time, restrict the valuation procedures applied to the options written for traded financial products, as the replicating security constituting the basis of these methods cannot be found. Consequently, it is not possible to define the weights that are to be allocated to specific outcomes and that are required for options valuation to ensure reliable risk neutral valuation.

As a result, it is not enough to simply use the pricing techniques applied in the case of purely financial options for the valuation of venture capital investments; these techniques should be supplemented by additional methods. The integration of decision trees and options valuation – as described by *Smith – McCardle* (*1998*) and *Smith – Nau* (1995) – may offer a solution for capturing flexibility.

[5] For the purposes of discussing the topic, it is important to distinguish between risk and uncertainty. According to *Bélyácz* (*2011*), the concept of risk denotes known possible outcomes with known probabilities assigned to them, while in the case of uncertainty the probabilities associated with specific outcomes are unknown, and even possible outcomes are not necessarily unambiguous.

The basis of the valuation is the decision tree that represents the decision alternatives arising during the life of the investment. In the case of venture capital investments, decision alternatives are typically related to product development, market entry and exit, although they may be fairly broad-ranging depending on the sector and on the focus of the investment. Alternatives arising at the product development stage could be the continuation or the rejection of the project. The option of rejecting the project is typically stipulated in investment contracts in the form of multi-stage financing, where each stage is subject to certain conditions. As a result, depending on the capital requirement of the given period or the capital required for achieving a pre-defined milestone, partial disbursements are made from the funds required for the financing of the project. In addition, modification options may arise at the product development stage due to the innovative nature of the firms and continuous corporate learning. As regards market entry, the greatest source of uncertainty is the level of demand, in relation to which growth options may occur in the investments.

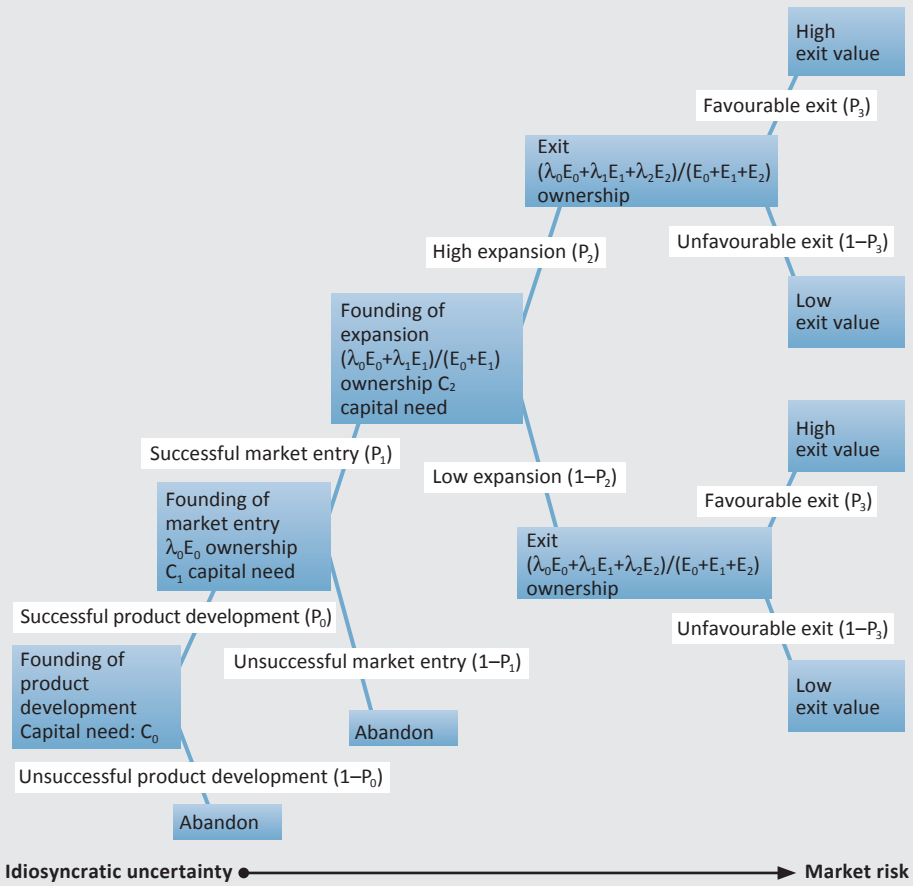
Essentially, based on risk features, the integrated approach classifies individual decision alternatives into two categories, distinguishing between market risks that can be hedged by trading securities and private uncertainties, where similar hedging is not an option. In the case of decision alternatives, therefore, it is important to assess whether the source of risk for the given alternative is a market factor or a company-specific private factor. While in the case of the former, copycat portfolios may be constructed and thus risk-neutral weights can be defined and applied for valuation purposes, in the case of the latter, subjectively estimated odds are allocated to individual outcomes in order to evaluate each available possibility, also in consideration of investors' risk preferences.

In the case of venture capital investments, the different stages of the company's lifecycle and the risk sources determining the decision alternatives are not independent of each other. The risks surrounding the decisions made during the seed stage of the investment are typically company-specific uncertainties and can be estimated by subjective methods. By contrast, with the decisions arising during subsequent stages, following market entry, the focus shifts to market risks. This stage opens up the possibility of the application of financial option pricing.

Figure 1 illustrates the basic decision-making possibilities arising during the life of venture capital investments aimed at young, innovative firms.[6] By investing into a particular firm, the investor acquires a stake in the company and at the same time, he also acquires an option to keep financing the firm if the company proves to be valuable. This further increases the investor's stake, which can be subsequently sold

[6] Since individual decision alternatives are company-specific, there is no universal model to describe the real options valuation of venture capital investments based on the integrated approach; at the same time, however, the individual steps of the valuation can be generalised for evaluating the investments.

Figure 1
Decision tree to illustrate the options arising during the life of venture capital investments



Note: 'λ_t' means the new stake acquired after the investments, and 'E_t' means the increment in the firm's equity at date 't'. Pt means the odds and weights allocated to the outcomes of individual decisions.
Source: Authors' compilation.

at a favourable price during the investor's exit if the firm's value has increased.[7] If the firm's value has declined, however, the option of further financing is rejected, which protects the investor from sustaining further losses in addition to the initial, typically smaller-scale, investment.

[7] For example, in the case of the first investment, by making investment C_0, the investor obtains the option to acquire, if he opts for continuing to finance the firm, an additional stake in the company through capital investment C_1. Financing will continue if the expected cash flows of the investment exceed the capital requirement of the investment.

In order to define the expected values linked to the individual points of the tree, individual outcomes should be weighted. The seed stage is clearly dominated by unique uncertainties; therefore, only subjective estimates are available to define the odds of each individual outcome. By contrast, market risks become increasingly prominent as the exit draws near (*Korteweg – Nagel 2016*). At this stage, by using a similar security and constructing risk neutral weights, the methods used for the pricing of financial options also become applicable. As to how much investors can rely on market data versus subjective estimates for decisions arising between these two points in time depends on how unique the company's activity is and the extent to which it is comparable to the securities of similar enterprises.

The optimal decision strategy and the estimated value can be defined by 'rolling back' the decision tree. VC's can realise the returns on their investments by selling their stake and exiting the company; consequently, their objective is to maximise the exit value of the stake acquired (*Becsky-Nagy 2006*). The value of the investment can be defined by rolling back the cash flow expected upon exit; in other words, the investor needs to define the discounted value of the cash flows expected upon exit for each individual outcome (i.e. cash flows reduced by the amount of the investments) in such a manner that only the value of the decision representing the highest value is considered.

Integrated with options valuation, a similar use of decision trees will enable analysts to model the flexibility in individual investments and to present the decision alternatives underlying the investments. At the same time, since the valuation procedure is itself a combination of various methods, interpreting the result might be ambiguous. While options valuation would show the market value of a given investment objectively, the value derived from the application of decision trees and subjective valuation methods and from the integration of investors' risk preferences in the discounting of cash flows cannot be considered to be the market value of the given investment. This integrated valuation approach can be primarily used as a tool of an optimal investment strategy, supporting investors in making their decisions.

5. Summary

This article attempted to investigate how venture capital can and is willing to enter the field of innovative startup enterprises as a primary source of finance, despite the significant degree of uncertainty surrounding these firms. The conclusion of the article is that the answer to this question should be sought in the unique attitude of venture capital to uncertainty, which can be best described by the real options approach to venture capital investments. Venture capitalists rely primarily on their professional experience to efficiently select the investment-worthy companies, thereby reducing the efficiency losses caused by adverse selection in the market.

On the other hand, they can contribute to the increase of firm's value during the cooperation following the initial investment. This article supplemented this explanation that is prevailing in the literature.

The description of startup companies showed that the innovation processes of these firms generate a great deal of uncertainty, but with the assistance of organisational learning and sufficient flexibility, these processes provide the possibility of a significant, sharp increase in the firm's value. Through the use of various tools and mechanisms – such as personal involvement, monitoring, multi-stage financing, the application of convertible bonds – VC's can take advantage of the real options offered by the investments and leverage their toolkit to shape these options. Real options are designed to impose a lower limit on the risks of individual investments (in order to mitigate losses), while the odds of upside uncertainties (the possibility of high returns) are retained.

The question is how to determine this added value. The market of corporate investments and the market of products traded in financial markets are very different; therefore, the methods designed to valuate financial options cannot be fully transposed to real options valuation. The source of the high degree of uncertainty characterising the initial stages of enterprises can be typically attributed to company-specific factors and decisions which, due to their unique nature and in the absence of an adequate benchmark, can only be estimated by subjective methods. With the progress of the company's lifecycle market risks become increasingly prominent, which allows for the application of the methods designed for the valuation of financial options during these stages. Consequently, the flexibility of the investments and the decision alternatives can be best captured by a combination of options valuation and the decision tree approach, also in consideration of the special features of venture capital.

Since there are no other financing forms where, as is the case with venture capital, a toolset is available to take advantage of the options offered by the firms, in the case of all other financing sources an increase in uncertainty will reduce the value of the investment. By contrast, using the options valuation, uncertainty becomes a value-enhancing factor, which boosts the value of the startups with inherent real options, allowing VC's to evaluate these businesses higher, and thereby increasing the odds of startup companies obtaining capital via this funding form. Accordingly, VC's may attach a higher value to certain portfolio companies than other financiers, and are willing to participate in the financing of startups despite the higher degree of uncertainty.

References

Abrams, J.B. (2010): *Quantitative Business Valuation – A Mathematical Approach for Today's Professionals.* Second edition. Hoboken, Wiley.

Amram, M. – Kulatilaka, N. (1999): *Real Options: Managing Strategic Investment in an Uncertain World*, Harvard Business School Press, Boston.

Amram, M. – Kulatilaka, N. (2000): Strategy and Shareholder Value Creation: The Real Options Frontier. *Journal of Applied Corporate Finance,* Vol. 15(2) pp. 15–28.

Becsky-Nagy, P. (2006): Kilépések politikája – Hogyan válnak meg a kockázati tőkések a befektetéseiktől? *(*Exit policies – How do Venture Capitalists Leave Their Investments Behind?*). Competitio,* Vol. 5(2) pp. 83–98.

Becsky-Nagy, P. (2014): Growth and Venture Capital Investment in Technology-based Small Firms. *Annals of the Oradea of Economic Science,* Vol. 2(2) pp. 828–836.

Becsky-Nagy, P. – Fazekas, B. (2015): Speciális kockázatok és kockázatkezelés a kockázatitőke-finanszírozásban (The Special Risks and Risk Management of Venture Capital). *Vezetéstudomány (Budapest Management Review),* Vol. 46(3) pp. 57–69.

Bélyácz, I. (2011): Kockázat, bizonytalanság, valószínűség (Risk, Uncertainty, Probability). *Financial and Economic Review,* Vol. 10(4), pp. 289–313.

Black, F. – Scholes, M. (1973): The Pricing of Options and Corporate Liabilities. *Journal of Political Economy,* Vol. 81(3) pp. 637–654.

Borison, A. (2005): Real Options Analysis: Where Are the Emperor's Clothes? *Journal of Applied Corporate Finance,* Vol. 17(2) pp. 17–31.

Carvalho, A.G. – Calomiris, C. – Matos, J.A. (2005): Venture Capital as Human Resource Management. *NBER Working Paper Series,* National Bureau of Economic Research, Cambridge, May 2005.

Chemmanur, T.J. – Krishnan, K. – Nandy, D.K. (2011): How does Venture Capital Financing Improves Efficiency in Private Firms? A Look Beneath the Surface. *Review of Financial Studies,* Vol. 24(12) pp. 4037–4090.

Cochrane, J.H. (2005): The Risk and Return of Venture Capital. *Journal of Financial Economics,* Vol. 75(1) pp. 3–52.

Copeland, T.E. – Antikarov, V. (2001): *Real Options: A Practitioner's Guide.* Texere, New York.

Copeland, T.E. – Keenan, T.E. (1998): How Much Is Flexibility Worth? *McKinsey Quarterly,* No. 2, pp. 38–49.

Damodaran, A. (2009): *Valuing Young, Start-Up and Growth Companies: Estimation Issues and Valuation Challenges.* Online: http://dx.doi.org/10.2139/ssrn.1418687. Downloaded: 24 June 2015.

Dömötör, B. (2011): A kockázat megjelenése a származtatott pénzügyi termékekben (Appearance of Risk in Financial Derivatives). *Financial and Economic Review,* Vol. 10(4) pp. 360–369.

Driouchi, T. – Bennett, D.J. (2012): Real Options in Management and Organisational Strategy: A Review of Decision-making and Performance Implications. *International Journal of Management Reviews,* Vol. 14(1) pp. 39–62.

Ewens, M. – Jones, C.M. – Rhodes-Kropf, M. (2013): *The Price of Diversifiable Risk in Venture Capital and Private Equity*. AFA 2013 Washington, DC Meetings.

Fried, V.H. – Hisrich, R.D. (1994): Towards a Model of Venture Capital Decision Making. *Financial Management,* Vol. 23(3) pp. 28–37.

Harding, R. (2002): Plugging the Knowledge Gap: An International Comparison of the Role for Policy in the Venture Capital Market. *Venture Capital: An International Journal of Entrepreneurial Finance,* Vol. 4(1) pp. 59–76.

Hellmann, T. (2006): IPOs, Acquisitions and the Use of Convertible Securities in Venture Capital. *Journal of Financial Economics,* Vol. 81(3) pp. 649–679.

Kaplan, S.N. – Strömberg, P. (2003): Financial Contracting Theory Meets the Real World: An Empirical Analysis of Venture Capital Contracts. *Review of Economic Studies,* Vol. 70(2) pp. 281–315.

Karsai, J. (1997): The Possibilities of Venture Capital in the Financing of Small and Medium-Size Firms. *Economic Review,* Vol. 44(2) pp. 165–174.

Karsai, J. (2010): A Blessing or a Curse? The Impact of Private Equity Investments on the Economy. *Vezetéstudomány (Budapest Management Review),* Vol. 41(3) pp. 14–25.

Kogut, B. – Kulatilaka, N. (2001): Capabilities as Real Options. *Organisation Science,* Vol. 12(6) pp. 744–758.

Korteweg, A. – Nagel, S. (2016): Risk-Adjusting the Returns to Venture Capital. *The Journal of Finance.* Accepted Author Manuscript. doi: 10.1111/jofi.12390.

Luehrman, T.A. (1998): Investment Opportunities as Real Options: Getting Started on the Numbers. *Harvard Business Review,* Vol. 76(7–8) pp. 3–15.

MacMillan, I.C. – Kulow, D.M. – Khoyilian, R. (1988): Venture capitalists' involvement in their investments: extent and performance. *Journal of Business Venturing,* Vol. 4(1) pp. 27–47.

Miller, K.D. (2002*):* Knowledge Inventories and Managerial Myopia. *Strategic Management Journal,* Vol. 23, pp. 689–706.

Myers, S.C. (1984): Finance Theory and Financial Strategy. *Interfaces,* Vol. 14(1), pp. 126–137.

Nagy, P. (2004): *Az informális kockázati tőke szerepe a finanszírozási rések feloldásában (The Role of Informal Venture Capital in Plugging the Financing Gaps)*. VIII. Industrial and Corporate Economics Conference, University of Pécs, October 21–22 2004.

Rangan, S. (1998): Earnings Management and the Performance of Seasoned Equity Offerings. *Journal of Financial Economics,* Vol. 50. pp. 101–122.

Ries, E. (2011): *The Lean Startup: How Today's Entrepreneurs Use Continuous Innovation to Create Radically Successful Businesses*. Crown Business.

Rózsa, A. (2004): Stratégiai beruházások reálopciós megközelítése (The Real Option Approach to Strategic Investment). *Vezetéstudomány (Budapest Management Review),* Vol. 35(2) pp. 53–61.

Sharpe, W.F. (1964): *Capital Asset Prices:* A Theory of Market Equilibrium under Conditions of Risk. *The Journal of Finance,* Vol. 19(3) pp. 425–442.

Smith, J.E. – McCardle, K.F. (1998): Valuing Oil Properties: Integrating Option Pricing and Decision Analysis Approaches. *Operations Research,* Vol. 46(2) pp. 198–217.

Smith, J.E. – Nau, R.F. (1995): Valuing Risky Projects: Option Pricing Theory and Decision Analysis. *Management Science,* Vol. 41(5) pp. 795–816.

Száz, J. (2011): Valószínűség, esély, relatív súlyok (Probability, Chance, Relative Weights). *Financial and Economic Review,* Vol. 10(4), pp. 336–348.

Szerb, L. (2006): Az informális tőkebefektetés és a kockázati tőke szerepe a vállalatok finanszírozásában (The Role of Informal Direct Investment and Venture Capital in Corporate Financing). In: Zsolt Makra (ed.): *A kockázati tőke világa (The world of Venture Capital).* Aula Kiadó.

Trigeorgis, F. (1996): *Real Options: Management Flexibility and Strategy in Resource Allocation*. Cambridge MA, MIT Press.

Yeo, K.T. – Qiu, F. (2003): The Value of Management Flexibility – A Real Option Approach to Investment Evaluation. *International Journal of Project Management,* Vol. 21(4) pp. 243–250.