A logisztikai IT beruházások reálopció megközelítése

Real Option Approach of Logistic IT Investments

FERENC ERDŐS[1]

Absztrakt
Az előzetes beruházásgazdaságossági elemzések során gyakorta alkalmazott DCF-alapú tőkeérték eljárások egy beruházási projektet megbonthatatlan egészként kezelnek. Ezzel szemben a reálopciók alkalmazásával a menedzsment döntési rugalmassága és az innovációkból adódó lehetőségek beépíthetőek a modellbe, amely a különböző üzleti folyamatokat támogató informatikai rendszerekbe való invesztíció esetében jelentős potenciált hordozhat magában.
A tanulmány fő célja, hogy a logisztikai területére fókuszáló üzleti szoftverberuházások bizonytalan környezetéhez illeszkedően egy olyan projektértékelési módszert javasoljon, amely a reálopciók figyelembevételén alapul.
A tanulmány elemzi a különböző reálopciós típusoknak a logisztikai üzleti szoftverek ex-ante jellegű gazdasági elemzése során való alkalmazhatóságát, valamint a különböző opcióárazási eljárásokat.

Kulcsszavak: reálopciók, logisztikai IT-beruházások

Abstract
An investment project is handled as an indivisible whole by DCF-based capital value methods frequently used in ex-ante investment efficiency analyzes. In contrast, using real options, the flexibility of management decision-making and the opportunities come from possible innovations can be incorporated into the model, which may therefore provides significant potential in the case of investments for IT systems supporting different business processes.
The main purpose of the study is to propose a project evaluation method, which is based on the consideration of real options, in line with the uncertain environment of business software investments focusing on its logistics area.
This study analyses the applicability of different real option types in an ex-ante based investment analysis of logistics business software, as well as the different option pricing methods.

Keywords: real options, logistic IT investments

INTRODUCTION

In the last few decades, business applications used in the company have become a fundamental factor in success in most markets. These software are entitled to satisfy special needs of a company or an activity. Among these, accounting applications are parts of our everyday life, but enterprise resource planning (ERP) systems and their separately installed and used modules and subsystems are also included here, just like the increasingly widespread business intelligence applications. IT solutions focusing on logistics and supply chains are of particular importance among them, which can provide a great business value for the company. In many cases, they are available as parts of an ERP system, but separate integrated solutions can also be found on the market.

Against the fact that the different business information systems are widely used in business life since the eighties and the nineties (Ehie–Madsen, 2005; Kamhawi, 2008), from a long period of time – and even nowadays – many researches reveal that during the implementation

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of these systems, there are numerous projects, which are below expectations or completely failed (Bingi et al 1999, Ram and Corkindale, 2014; Ram et al., 2013; Matende–Ogao, 2013). One reason for failure is that in many cases, these projects are still tried to be accomplished without any preliminary economic impact analysis – or only the quantification of costs are considered and utility value based qualitative analyses are applied at most in relation to expected software functions.

In the last decades, in ex ante investment economic evaluation analyzes, the determination of methods (Graham–Harvey, 2001) based on DCF (discounted cash flow) – such as NPV (net present value) – had been widespread in corporate practice. One of the main deficiencies of these DCF-based capital value methods is that they handle an investment project as an indivisible whole. In contrast, using real options, the flexibility of management decision-making and the opportunities come from possible innovations can be incorporated into the model, which may therefore provides significant potential in the case of different business applications. A real option is the investment into such physical assets, human resources or organizational capability that provides the opportunity to respond to possible future events (Kogut–Kulatilaka, 2001). The company's management can modify its previous decisions based on new information in relation to the change of the market environment, so this respond ability can create new opportunities to increase the capital value of the investment. (Rózsa, 2004). The application of these real options entails serious opportunities, particularly in the evaluation of strategic investments (Rózsa, 2007).

As the disregard of future flexibility also can be considered as a conceptual problem in the case of DCF-based procedures, and the strategic significance of IT investments supporting logistics business processes is indisputable, so this new distribution approach may be relevant in the ex-ante economic analysis of these investments.

1. THEORETICAL BACKGROUND OF EVALUATING OPTIONS

The real option extension of financial options related to investments was applied for the first time in the eighties (Trigeoris, 1996), and it became relatively widespread among large corporations in some industries. In the case of the USA's large corporations, the integration of real options into the investment analysis calculations had already been nearly 30 percent, as stated in the survey published by Graham and Harvey in 2001 (Graham–Harvey, 2001).

The approach and technique applied in the quantifying of real options are the same as the option pricing procedures applied in the financial field, and among these, primarily the binomial and the Black-Scholes models are used for the evaluation. The original Black-Scholes formula specifies the value of the non-distributing European-style purchase option, where the option can only be exercised at the end of its life, at its maturity:

$$c = S \cdot N(d_1) - K \cdot e^{-rT} \cdot N(d_2) \tag{1}$$

$$d_1 = \frac{ln\left(\frac{S}{K}\right) + \left(r + \frac{\sigma^2}{2}\right)T}{\sigma\sqrt{T}} \tag{2}$$

$$d_2 = d_1 - \sigma\sqrt{T} \tag{3}$$

where:
S: the current exchange rate of the underlying asset;
K: the strike price of the option;
T: the time remaining until the option expires;
r: risk-free interest rate for the option's duration;
σ: the relative standard deviation of the underlying asset's yield (volatility)

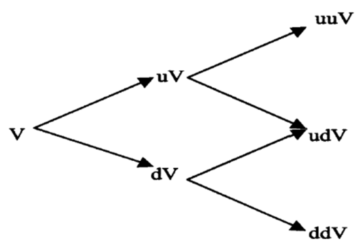
The binomial model can be used for the evaluation of the options was originally created by Cox, Ross and Rubinstein (Cox et al, 1979), with the underlying purpose to help the understanding of the Black-Scholes model for those who have no deeper mathematical knowledge. However, this model became the commonly used numeric procedure of the pricing of derived products (Bóta, 2006). The binomial model had been widespread, because it is capable of handling such regularities which are not manageable or difficult to be managed by other models. It is mainly because of the fact that it evaluates the investment at certain points of its lifetime. For example the model is also capable of evaluating American-style (where the evaluation can be performed in any time of the duration) and Bermudian-style (where the evaluation can be performed at certain points only) options.

The binomial model uses 'discreet-time frame' in order to measure the key variable of the option via a binary tree, going through a given number of steps from evaluation to the option's depletion. The figure illustrates a possible price for the device in every node for a certain time. These price estimation classes give the basis of the option's evaluation. The evaluating process is iterative, it is moving from the last node to the first (which is the time of evaluation). Following this method, the option evaluation consists of three steps:

1. generating the 'pricing tree';
2. calculating the option value for each endpoint;
3. variable assignment for each previous node, the value of the first node become the value of the option.

The binomial tree is created from the evaluation and it is valid to the expiry date. At each step, we assume that the given investment's value will be increased or decreased because of specific factors (u: increasing, d: decreasing, $u \geq 1$ and $0 < d \leq 1$).

Figure 1. Two-steps binomial tree



If S is the current value, then in the next time the value can be Su = S * u and Sd = S * d. These value increasing and decreasing factors are determined by the volatility of the device (σ) and the time interval between the two steps (t). If we suppose that the price is σ2t, we can state that

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

and

$$d = e^{-\sigma\sqrt{t}} = 1/u\,.$$

The binomial tree ensures that the tree can be reconverted, i.e. if the value of the device is shifted upwards or downwards, then the value of the option will react similarly. This attribute decreases the number of nodes in the tree, so it accelerates the calculation of the option's value and it provides the opportunity to calculate the value of the investment for every node based on the formula. This is important, because in that case, it is not necessary to start with the building of the tree. So the value of the node is:

$$S_n = S_0 \times u^{N_u - N_d}\,,$$

where N_u is the number of positive factors and N_d is the number of negative factors.

At every endpoints of the tree – which is the expiry of the option – the option's value is simple its inner value, so: MAX [(S – K), 0] for the buying option and MAX [(K – S), 0] for the selling option – where K is the strike price of the asset and S is the spot exchange. The evaluation of the intermediate nodes starts with the penultimate step in time and it moves to the first node (which is the time of evaluation). The binomial value can be found at every points with the presumption of risk neutrality. If this can be applied, then the model assigns the greater value to the node from the binomial and validation values.

The Black-Scholes and the binomial models are also confirmed by the same theories, but the continuous calculating method of the Black-Scholes model is opposed to the discreet-time calculating method of the binomial model. In the case of European options, as it is increasing, the number of steps are also increasing, so the binomial model is approaching to the Black-Scholes model. The binomial model assumes that the change in relation to prize follows a binomial dispersion; after many attempts we can notice that this type of binomial dispersion approaches a normal dispersion based on the Black-Scholes presumption.

2. THE FUZZY APPROACH

Fuzzy logic is one of the several polyvalent logical semantics used in many fields of sciences, such as automation, information technology or economics.

In recent years, there have been many attempts when fuzzy logic was used for the option evaluation of different real investments. In contrast with traditional sets, where an element is whether a member of the set or not, in the case of fuzzy sets, an element can be partially belongs to the set. The degree of inherency is determined by the inherency function (membership function or fuzzy function) μ, which assigns a real number between 0 and 1 to the elements of the fuzzy set.

In different DCF-based economic analyzes, the definition of parameters – such as estimating cash flows or defining the discount rate – is an extremely difficult task in the case of IT investments. This is especially true for software projects that support logistic business processes, for which – due to their innovative and complex nature – the estimation of these parameter's values relies heavily on the highly subjective judgment of decision makers. In conventional approach, due to the uncertainty surrounding such investments, probability distributions may be assigned to each cash flow.

In the economic analyzes with the using of the fuzzy set theory, the different parameters can be described by possibility distributions instead of probability distributions. (Zadeh, L. A. 2008) This approach can be used in the binomial and also in the Black-Scholes option evaluating model. Estimating investment-related volatility in this approach is also a complex task.

In the case of logistics IT investments, the degree of inherence can be characterized by fuzzy sets, since a possible distribution can be given instead of the binary possible and non-possible outputs.

3. BUSINESS SOFTWARE INVESTMENTS AS OPTIONS

The real option types can be adopted by option categories interpreted to financial area, which can be the following (Yeo–Qiu, 2003):

- exit option;
- waiting option;
- growth option;
- staging option;
- different modifying options.

In the following, I will examine whether the different options can represent any value in the case of applications supporting different logistic business processes.

3.1. EXIT OPTION

Rejecting some parts of a business IT system or the whole concept can be a valuable option only if the technologies and assets used in the investment can be utilized in the future. In this regard, the logistic IT investments can be considered as irreversible, because an already customized business IT system cannot be utilized for another corporation, so in that case, this option is practically worthless.

3.2. WAITING OPTION

By the implementation of an investment, the decision makers resign from the shifting of the investment, i.e. from its possible implementation at a later date. The value of the waiting option is resulted by that as time goes on, there will be more information in relation to the investment and its alternatives, so a more adequate decision can be made. In the case of business IT systems, their temporal shift occurs frequently, which provides serious basis for the consideration of this option.

To determine the waiting option value of a business application's introduction, we can determine the required parameters by Table 1 using the Black-Scholes model.

Table 1. The input parameters of the waiting option value of a logistics application's introduction

Financial purchase option	***Variable***	***ERP-investment waiting option***
Spot price of the underlying asset	S	NPV – waiting cost
Strike price	K	Total cost of the project
Maturity date	T	Deferring interval
Risk-free interest rate	R	The same
Volatility of returns of the underlying asset	σ	The risk of the project's cash flows

Source: own work

The spot price of the underlying asset can be calculated as the passively calculated NPV value reduced by waiting costs. In that case, the cost of the waiting is the loss of the possible profit due to the shifting of the business application's introduction. The strike price actually means the costs of the investment. The risk of the project's cash flows can be estimated the best with using a simulation risk analysis (for example Monte Carlo simulation).

3.3. GROWTH OPTION

In the case of logistic IT systems, the growth option can means their possible scalability in the future. In the case of an on-premises software system, scalability means that as the load is growing, the performance of the system can be progressively increased by the addition of new hardware resources, without modifying the software. So the growth option has a value, if the investment provides the possibility of growth in the future. It is usually a significant value in the case of a logistic IT system, so it should be incorporated into investment efficiency calculations.

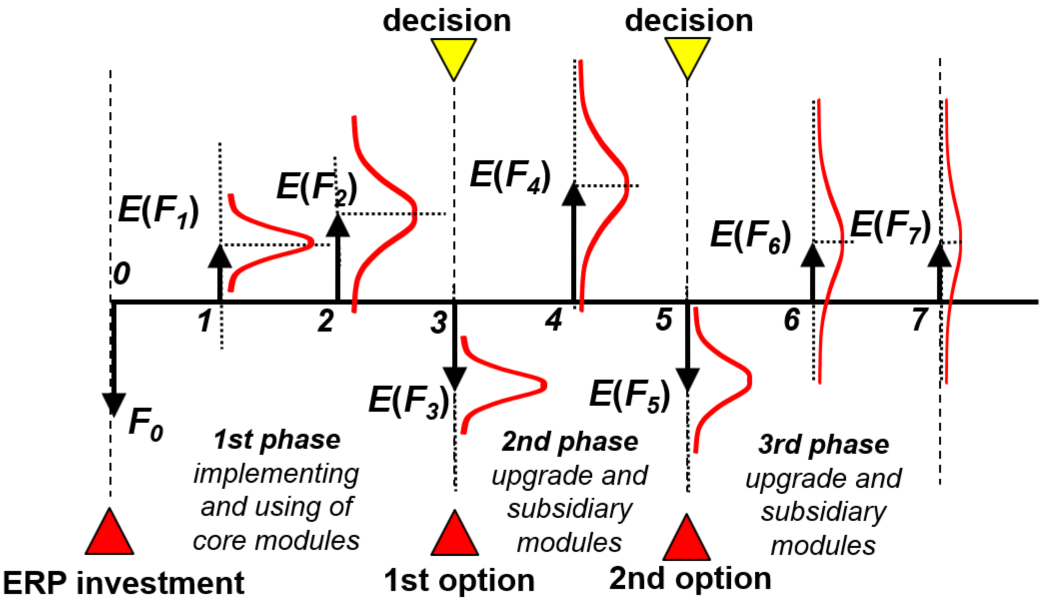
3.4. MODIFYING OPTION

Modifying options are specifying the value of market environment changes related to the given project during the lifetime of the investment project by the management. Using modifying options, some parts of the uncertainties around productive investments can be handled well, but during the operation of an on-premises application, only a narrow margin of possible actions are available for the management. While the operation of a production equipment has an option to shut down in order to minimize loss, if market conditions become temporarily unfavorable, and it has an option to restart, in the case of business applications, these options are practically worthless. However, there are some modifying options, which should be also considered before the introduction of the applications supporting different logistic processes. This can be, for instance, the software's option to extend lifetime, which helps to handle the uncertainty of the hypothetical lifetime applied in the case of DCF methods, such as in the case of commonly used NPV determination.

3.5. STAGING COMPLEX OPTION

The business IT investments are realized in stages in many cases, so after the realization of each stage in possession of the new information, the management will have the opportunity for realizing, shifting or rejecting the further stages. The introduction of an ERP system including a logistic module can be a typical example, which is frequently performed more than one step, because usually each module also can be introduced in a time-shifted way. Accordingly, such an investment can be evaluated as a complex option consists of growth, waiting and exit options, where every stage can be considered as an option concerning to the estimated value of the following steps.

Figure 2. An ERP investment as staging complex option



Source: You et al, 2012

Figure 2 illustrates an investment, where only a narrower range of modules (e.g. financial and accounting modules) are introduced in the first round, and later there will be opportunities for introducing new submodules (e.g. logistics) or changing version. Moreover, the structure of ERP systems allows continual patches and upgrades, which can be implemented as new decision points. The Black-Scholes model can be applied for evaluating the staging and complex options, because it contains several discreet decision points, and it also can handle multi-option situations. We can determine the required parameters by Table 2 using the Black-Scholes model.

Table 2. The input parameters of the staging complex option value of an ERP investment

Financial purchase option	***Variable***	***ERP investment waiting option***
Spot price of the underlying asset	S	NPV – waiting cost
Strike price	K	Total cost of the ERP project's phase
Maturity date	T	Deferring interval
Risk-free interest rate	R	The same
Volatility of returns of the underlying asset	σ	The risk of the cash flows of the project's phase

Source: own work

Each phase of the ERP investment project is a real option for the management to select (without commitment), and the whole project is modeled as a complex option.

4. CONCLUSION

The different market environment of financial investments based on the foundations of stock exchange trading and real investments are one of the main disadvantages of the real option procedure. To determine an option's value correctly in the time of the actual decision and also concerning to future periods, we need the rigorous market value of the investment's subject. While in the case of financial options, these mean the obviously available spot price and the future, so-called equity prize of the stocks, in the case of real investments – for example in logistic applications – these are based on different rough estimates only. Therefore, some authors judge this procedure as a dead end in their works (Kruschwitz, 2005). Furthermore, the search of a specific option analogy and the alignment of a specific evaluation procedure may be necessary for each specific logistic IT investment situation, which also basically makes the practical application more difficult.

Despite the fact that this practical application of real options in the case of IT systems supporting business processes is severely hampered, the integration of real options into the calculations using the Black-Scholes model is already proposed by the business value justification related methodologies (for example TEI: Total Economic Impact, REJ: Rapid Economic Justification, TVO: Total Value of Opportunity) developed for complex IT projects around the millennium, although the logic of the binomial model with the discreet decision points is closer to the decision-revision process related to the introduction stages of IT projects. Volatility, as the determination of input parameter, is another weakness of the real option approach, which can be observed only from the evolution of past data series even in the case of financial underlying assets, therefore in the case of real investments it is an enormously complex task.

Certainly, information technology alone does not solves any logistic business problems. The investment decision-making team has to be familiar with the newly developed business processes, which are associated with the term SCM (supply chain management), and they must be familiar with the application requirements and any implementation barriers that exist, in order to sustainably increase the company's success through the use of modern software and hardware solutions.

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