REAL OPTIONS IN BUSINESS VALUATION

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Abstract

The corporate value creation and its measurement have been playing a central role in the corporate thinking since the 1990s. More and more people deal with the methodological questions of measuring the value creation. We elaborate a model by which the corporate value can be estimated well. We have combined the traditional financial analysis indicators, the discounted cash flow and free cash flow methods for structuring the model. We have also considered the appropriate management of risk important and, inter alia, output variables of the model have composed the input variables of the real option model connected with the two-dimensional Monte Carlo simulation. Using the two-dimensional Monte Carlo simulation raises a new approach to the management of risk. Developers of the model interpret the risk as a combination of variability and uncertainty therefore we have used it accordingly. Structuring the model, making the intermediate calculations and operating the model by means of the simulation process have been carried out in the Excel spreadsheet programme, connected with the R statistical system. The results have proved that the proper estimation of corporate values can be provided by means of the model and the methods applied.

Key words: *business valuation, free cash flow, uncertainty, real option, two-dimensional Monte Carlo simulation*

JEL Classification: G32, M21, C10

Introduction

The companies in Hungary and throughout Europe faced a whole series of new challenges and underwent numerous changes in the past two decades or so. In the meantime, the corporate structures also grew increasingly complicated and the corporate world became more and more dynamic. In this changed environment, the interest of investors and corporate leaders turned towards the corporate value creation and the increase of property even more. It is necessary for measuring the value creation as well as determining the growth being achieved that we should be able to estimate the current value of a company properly. The investors can judge the usefulness and efficiency of their investments through the corporate value creation which is also acknowledged by the market.

Copeland et al. (1999) write in their book that the clear thinking about the value and the adequate experience for utilizing the evaluation results in the decision-making are preconditions of success in the competitive environment of nowadays.

They think that the managers placing emphasis on increasing the shareholder value can establish and operate much more effective companies, against those who do not do so. And, the companies working more effectively can create a stronger economy, higher standards of living, more career and business opportunities.

It is also to be noted that the valuation may contain subjective elements as well, such as the fact that not every valuation method will lead to the same corporate value. The aim of business valuation can also influence the selection of method and the accomplishment of the whole valuation process. In an inadequately stable economic environment, the differences can be more significant which can be further enhanced by the inadequate knowledge of the persons performing the valuation (Shapiro, 2013).

We have set an aim to elaborate a model by utilization of which the estimation of corporate value can be made more accurate. We have developed the model by combining a variety of methods and we have aimed at creating a model in which we are able to manage the risk appropriately and which applies interval estimation instead of point estimation. In order to comply with these requirements, we have opted to combine the real option valuation with the Monte Carlo simulation. The option pricing models derive the value from the underlying asset therefore, firstly, we need to determine the value of this asset (Mun, 2003) which implies that this way of the valuation can appropriately be applied only by connecting it with another method or other methods. We have chosen the two-stage model of free cash flows in order to produce the input data of the real option model (Damodaran, 2002).

The risk management is indispensable in the financial models therefore the taking into consideration of the risk has a key role in our model as well. We also consider it important to clarify the concept of risk. In his academic inaugural presentation, Iván Bélyácz (2004) said that *"The risk and the uncertainty are some of the most controversial phenomena of the economics. It was never the subject of discussion that both of them have effect on the economic decisions, …"* This quote also evidences the importance of risk management and it also draws attention to the fact that this is not a simple issue.

Innumerable books and articles deal with the risk but it cannot yet be said that everything is accurately clarified about the concept of risk. If we study the literature we find a number of different risk concept. There is no agreed definition of the concept of risk (Aven, 2012). By the risk we mean the possibility that such an adverse event may occur which is unfavourable from the point of view of a particular situation and cannot be predicted fully. We can also say that the risk means the unfavourable occurrence chance of an output.

Frank H. Knight was one of the famous economists of the early 20th century. His book - Risk, Uncertainty and Profit - is credited with introducing the distinction between "*risk*" and "*uncertainty*" (Rakow, 2010). In the work which was published in 1921, Knight (2009) makes a distinction between the risk and the uncertainty about which serious discussions are still ongoing; there are people who dispute the findings of Knight and there are ones who accept it. In our opinion, the uncertainty is a component of the risk, accepting the view spreading increasingly and applied in the ecological modelling relatively widely (Molak, 1997; Cullen - Frey, 1999) that the risk has two components: uncertainty and variability. According to Wilson and Shlyakhter (Molak, 1997), this type of using the risk significantly spreads and becomes more and more accepted. Different authors write that the uncertainty can be linked to the lack of information, knowledge and skill and, consequently, it can be reduced by obtaining information, knowledge and skill. The variability means the heterogeneity of values which is temporal, spatial and related to the organization and, consequently, it cannot be reduced by obtaining further information, knowledge and skill. According to Wilson and Shlyakhter (Molak, 1997), the uncertainty can be specified by probability distributions while the variability can be specified by frequency distributions. According to Vose (2008), the risk can be divided into the same two parts but he considers the variability as a special case of uncertainty and he names both together total uncertainty. We think that it is not needed to make a distinction between the risk and uncertainty from the point of view of measurability but the risk itself can or cannot be measured. Such division of the risk is important because it may require different managerial approach from a decision making point of view.

The question may also arise how the variability, which seems clear in the ecological systems, can appear in the economic systems. If we accept the findings of system theory that the abilities of a system is determined by its structure (Mella, 2012) – which is the modes, forms of the arrangement or connection of the system elements as well as the relations between these ones - and this makes the system an entity having the appropriate identity then, consequently, the organizations (systems) performing the same or similar activities may have different structures and, for this reason, they may have different abilities as well. This means that the identity of organization (system) will also change by modifying the organizational structure. We could also say that the organizations are determined by their structures (Espejo – Reyes, 2011). The foregoing gives the answer to the question asked i.e. the variability can be interpreted in case of the economic organizations as well.

In our business valuation model, the proper management of risk is ensured by the real option method and the Monte Carlo simulation. The real option is such a system-based and integrated solution which uses the model of financial option pricing for the valuation of physical (real) assets in dynamic and uncertain business environment. The quantitative risk analysis is very important in determining the risk of decision-making problems. The Monte Carlo simulation is widely used and it is a suitably effective and flexible tool of the quantitative risk analysis which allows us to assign probability distributions to certain variables of the mathematical model of the problem and, by random sampling from these distributions, we can determine the distribution of output variables (Mun, 2006; Jäckel, 2002). The Monte Carlo simulation often faces criticism over the fact that this is a technique ensuring the determination of an approximate value. At the same time, if we set the number of iterations of the simulation high appropriately and we structure the model at an acceptable level then the required accuracy can be reached (Thomopoulos, 2013).

Material and method

In order to solve the business valuation model, we have chosen such softwares that are available in any enterprise and can easily be connected with other softwares which make it possible to operate that from a single interface. This objective could be ensured by connecting the Microsoft Excel spreadsheet with the R statistical system. The R statistical system (Venables - Smith, 2008) is a free open source software which has a very wide range of opportunities for statistical application by reason of its modular structure thus it complements the statistical deficiencies of the widely used Excel spreadsheet programme very well (Heiberger–Neuwirth, 2009; Baier–Neuwirth, 2003).

R statistical system provides several kinds of simulation opportunities. From the opportunities, we have chosen the ‘two-dimensional Monte Carlo simulation’ module (mc2d) that gives opportunity to discern the variable and uncertain factors

(Pouillot et al., 2015). The module is object-oriented therefore it is relatively easy to pass results to other R modules and perform further calculation by means of those. The module ′mc2d′ uses the simulation ′bootstrap′ and the extension of ′maximum likelihood estimation′ for solution of the model. For more than 30 years, the simulation ′bootstrap′ has already been used for estimating the confidence interval of a particular statistical characteristic in case of applying the numerical methods. The significance of simulation ′bootstrap′ is that it can also give an appropriate estimation in the case when analytical mathematical solution does not exist (Mun, 2006).

By distinguishing between the variability and the uncertainty, Frey and Zheng have developed a two-dimensional simulation programme (Auvtool), however, its opportunities are much more confined than the ones provided by the R system. Simulation module ′mc2d′ developed by Pouillot and his colleagues (2015) is totally based on the same principles as Auvtool which allows to examine the fitment of probability distributions as well. This latter one can also be solved in the R by means of module ′fitdistrplus′ which was also made by Pouillot and his colleagues.

One important preparation task of the simulation calculations is to choose the probability distribution of the random variables being in the model. The ′mc2d′ allows to use 17 kinds of distributions, among which there are discrete and continuous distributions. In the present model, we have used three kinds of distributions: the normal, Weibull and triangular distributions. The triangular distribution can also be used in the framework of simulation programmes mentioned before. Wickman (1999) mentions the triangular distribution as a special beta distribution, its more detailed presentation can be found in the book of (Kotz - van Dorp, 2004). One part of the programmes allows to use the symmetrical triangular distribution only but ′mc2d′ allows to use both the symmetrical and non-symmetrical forms as well. We have used the symmetrical form for operating our model.

The currently used model is the further development of a previous version. In the previous model, the corporate asset value has appeared as a point estimation, we could say that it has been utilized as a deterministic model, as an input data of the option pricing model. At present, determination of the corporate asset value is also performed by means of the simulation model. Real option method is a valuation technique that enables to take advantage of market opportunities preventing or mitigating losses if future conditions are unfavorable (Rózsa, 2010). Applying this method to determine corporate value is often the cash flows are affected by a number of uncertain variables (Pringles et al., 2015) The real options approach rules the situation out where the researchers are unsure about the likelihoods of states of the analyzed unit. It usually uses strong assumptions about researchers' beliefs (Miao Wang, 2011; Rózsa, 2004).

For testing the model, we have utilized the data of firms listed in the Budapest Stock Exchange and other data of stock exchange and central bank. The model has been compiled by using the data of Linamar Nyrt.

We have carried out the sensitivity analyses of option and corporate value by calculating the so-called 'Greeks', by means of module ′fOptions′ of the R statistical system. (Würtz, 2004) We have calculated the values of the 'Greeks' by utilizing the averages of each parameter.

Results and debate

For testing the model, we have used the company's data series of 10-years (2005-2014) by utilizing the data of annual reports that can be found on website of the Budapest Stock Exchange. A shorter time frame would be sufficient to perform the calculations but at least 8 data are required for some trials of module 'fitdistrplus'. In the model, those balance sheet and income statement items are required which serve as input data of the model. Figure 1 shows the main architecture for solution of the model and the initial data being necessary for the model.

In order to determine the predicted values, it is necessary to determine the changes in sales revenues by means of which we generate random numbers for the further calculations. We have chosen the appropriate distribution type by means of the module 'fitdistrplus'. For the analysis of distribution, we have also utilized the procedure 'bootstrap' provided by the module. The result obtained can be seen on Figure 2 where the values are illustrated in the function of square of skewness and kurtosis. It can be seen on the figure that the original values are rather closer to the gamma and lognormal distribution while the values produced by procedure 'bootstrap' are concentrated around the uniform distribution.

Figure 1: Process and basic data of the model calculation

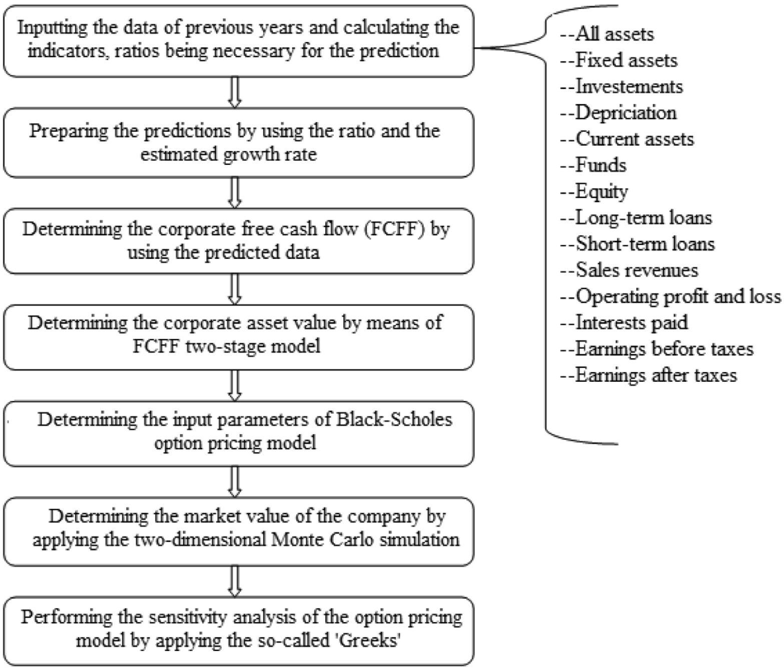

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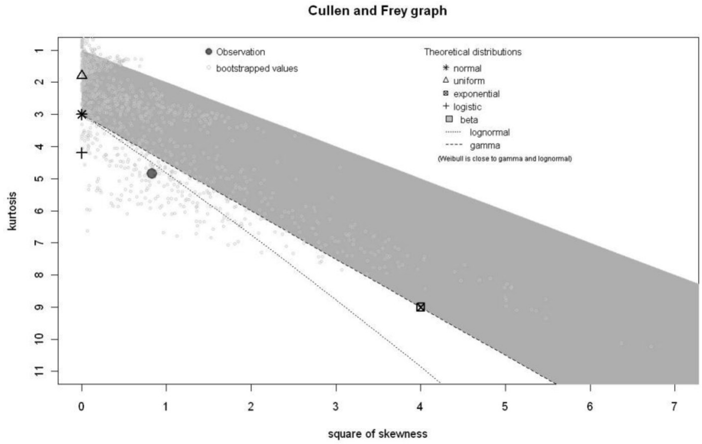
Figure 2: Distribution analysis (fitdistrplus)



Source: own calculation

For a more accurate determination of the distribution, we have performed the Kolgomorov-Smirnov and the Anderson-Darling tests, the results of which are shown by Table 1.

It can be seen on the table that the exponential distribution is the best based on the Kolgomorov-Smirnov test but, at the same time, this is the worst based on the Anderson-Darling test. The logistic distribution is the best based on the Anderson-Darling test and the second best based on the Kolgomorov-Smirnov test, at the same time, the logistic distribution cannot be fitted based on the original data. In the light of the above, we have chosen the third best distribution, namely the Weibull distribution, which fits to the original data at an acceptable level (Figure 3). The programme has estimated the values 8.2601 and 1.1563 as parameters of the Weibull distribution. Accordingly, we have performed the tests for the other random variables and the random number generations have been carried out based on the results of those.

Table 1: Testing the different distribution types

Test	**Type of Distribution**					
	normal	**logistic**	**lognormal**	**gamma**	**Weibull**	**exponential**
Kolmogorov-Smirnov test	0.1644	0.1273	0.1996	0.1876	0.1455	0.4865
Anderson-Darling test	0.3150	0.2340	0.4707	0.4118	0.2461	3.0501

Source: own calculation

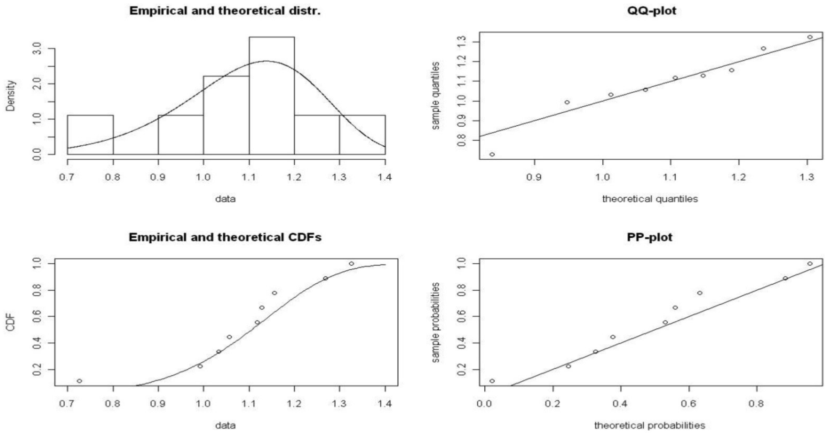
For the prediction, we have utilized the averages of the balance sheet and income statement items from the last five years.

As described above, we have produced the predicted values that we have calculated for 9 years according to the number of past values. We have utilized the first year (2000) just as a preceding year to form certain indicators (e.g. changes in sales revenues, changes in current assets.

By utilizing the values predicted, we have calculated the corporate free cash flow (FCFF) for each of the 9 years based on the following formula:

*FCFF = Operating profit and loss * (1 – corporate tax rate) + Depreciation – Investments – Changes in the working capital*

Figure 3: Characteristics of the Weibull distribution



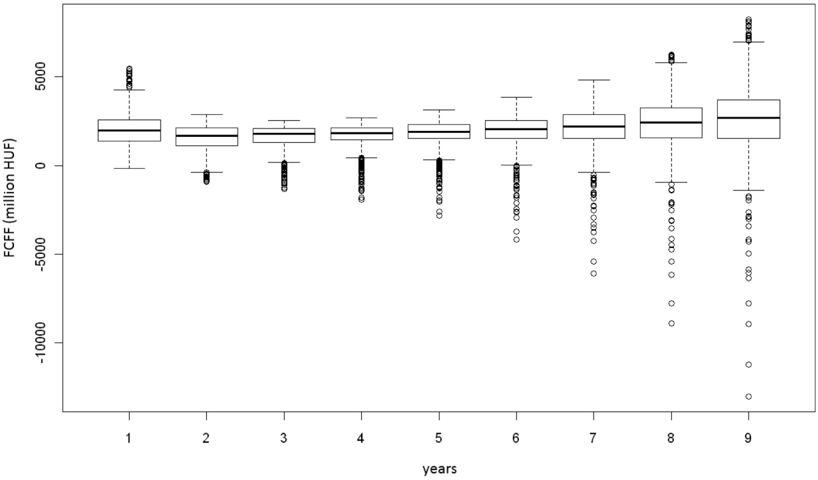
Source: own calculation

Figure 4 presents the main characteristics obtained for the corporate free cash flow by means of boxplot diagrams.

It can be seen on Figure 4 that there are more and more outliers and the range is also increasing as the years go by. It can also be seen on Figure that the value of median is becoming increasingly larger and the interquartile (upper quartile – lower quartile) range is increasing as well.

After that, we determined the asset value of the company by utilizing the present values of the corporate free cash flows. Determination of the asset value was carried out similarly to Gordon's dividend model but there is the corporate free cash flow in the numerator, instead of the dividend.

Figure 4: Main characteristics of the corporate free cash flow



Source: own calculation

As a discount rate, we have chosen the corporate average weighted cost of capital that we have determined considering the costs of external capital predicted estimated for the future.

We have used the Black-Scholes option pricing model as a real option model, the input parameters of which are the following:

S – values of assets of the company (value of the underlying asset)

K – nominal value of the outstanding loan (the validation price)

t – weighted average duration of the loan (endurance of the option)

σ^2 – variance of shares (values) of the company (variance of value of the underlying asset)

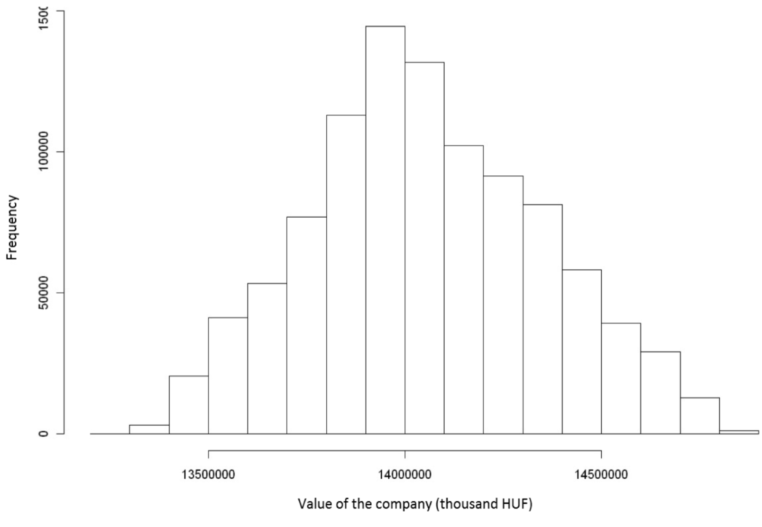
r – rate of return of treasury bonds being in line with endurance of the option (risk-free rate)

We have determined the corporate asset value (S) as described above. We have calculated the variance of underlying asset (σ2) of shares of the company based on the market values regarding the particular period, by using the logarithm of each exchange value. We have considered the average duration of loans as weighted average duration of the loan (t) that we have estimated by means of the balance sheet and the notes on the accounts. We have determined the risk-free rate by utilizing the Treasury bond yields of a duration of 5 years, considering the values expected in the future as well. Taking the corporate data into consideration, we have generated random data with triangular distribution for the loans while we have generated random data with normal distribution for the risk-free rate and the variance of shares of the company.

By utilizing the input data listed above, we have completed the two-dimensional simulation i.e. we have determined the market value of the company (Figure 5). During the two-dimensional simulation, the result vector originated by the combination of uncertain and variable factors is a product of pieces of random numbers generated for the two factor types (1 million pieces in our model because we have produced 1000-1000 random numbers for both risk types). In case of the two-dimensional simulation, the production of a larger number of random numbers would significantly increase the size of result vector and would become more and more time-consuming as well as the size of memory would also be a limit. The two-dimensional simulation essentially contains two Monte Carlo simulation cycles, an internal and an external one. The internal one deals with the variable variables while the external one deals with the uncertain variables.

Table 2 contains the main statistical characteristics of the corporate value determined by the simulation. We can see on Table 2 that the corporate value obtained as a result is spreading in a relatively narrow interval around the mean, its relative standard deviation is 1.54% which is reckoned as a very low value. The 95-percent confidence interval of the value is 13 522 387 – 14 661 811 thousand HUF i.e. we can say that value of the company is in this interval with a 95-percent probability based on our calculation. The total range of the result obtained is not too big either, it is 1 182 281 thousand HUF which is 11.5% of the mean. The stock exchange capitalization of the company was 14 929 200 thousand HUF on 31 December 2009 which means that we have underestimated the actual value by the simulation and this is not in the given interval but above it. At the same time, the deviation compared to the mean determined by us is 872 510 thousand HUF which is not significant compared with the mean or the median. We think that the model can be used well for estimating the corporate value despite the deviations.

Figure 5: Result of simulation: histogram of corporate values

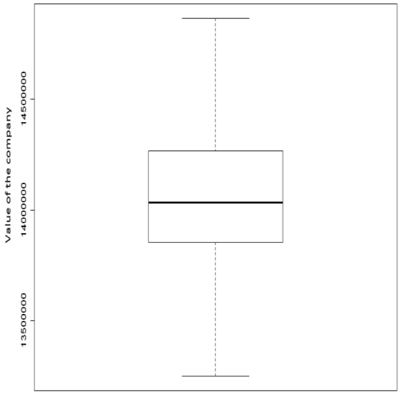


Source: own calculation

In the following, we have carried out the sensitivity analysis of the model by utilizing the so-called *"Greeks"*. In the Black-Scholes model, it is relatively simple to calculate with the Greeks which should be an expected attribute of the financial models. We have determined the values of Delta, Gamma and Lambda in our model.

Table 2: Main statistical characteristics of corporate value determined by the simulation

Statistical characteristic	Value
Minimum	13 247 537
Lower quartile	13 855 805
Median	14 032 584
Mean	14 056 690
Upper quartile	14 263 940
Maximum	14 867 262
Interquartile range	408 135
Standard deviation	217 066
Relative standard deviation	1.54%
95-percent confidence band	13 522 387
	14 661 811
Kurtosis	-0.4796



Source: own calculation

In case of the current model, the Delta indicator measures the change ratio of the corporate value taking the value of assets of the company into consideration. We can also say that Delta shows how the value of company moves together with the value of assets i.e. how well the asset value is described by the corporate value. The closer the **Delta** is to one, the better the asset value is described by the corporate value. Value of 0.7345 obtained as a result indicates that the model can determine the corporate value pretty well. We can say that the corporate value moves together with the asset value of company to such an extent.

Gamma measures the ratio of change of the Delta having regard to the changes of corporate asset value. Gamma is essentially the sensitivity of Delta to the small displacement of the corporate asset value. We have obtained 0 as value of Gamma which indicates that Delta is sensitive only to bigger displacements of the corporate value, the small displacements do not cause real changes in its value.

Lambda is a quotient of the percentage change in the corporate value and the percentage change in the asset value. Lambda gives how many percent the displacement is in the corporate value in case of a 1-percent displacement of the asset value. We have obtained 1 as a result of Lambda which indicates that the corporate value and the asset value move completely together.

The overall conclusion is that the value of company can be described well by the buying option used in the model and the change in the value of option moves together with the underlying value (i.e. the corporate value) pretty well.

Conclusion

In the article, taking account of the specialized literature sources as well, we have presented a different kind of interpretation of risk. Although there are still serious discussions about the concept and interpretation of the risk today but the appropriate management of risks is unavoidable in the financial modelling. We think that the new approach concerning the risk can be used in the financial modelling well. We are also aware of that there are further issues to be clarified. For example, it is not easy to decide which factors we should rank among the variable factors and among the uncertain ones. Specifying the architecture of the model is an additional task as well. Beyond the foregoing, by continuing the research, we would also like to solve that the model can also be applied for the non-public companies in which case the determination of risk means the biggest problem. Later, we would also like to enlarge the range of outputs and sensitivity analysis, making better use of opportunities provided by the R statistical system, possibly combining the module 'mc2d' with other simulation methods existing in the R.

In reference to the model presented, we can conclude that the model can be well-applied for determining the corporate value in spite of those smaller problems that still exist. This model is also an evidence of that we have a stronger chance to reach a better result by combining the methods. Several methods are combined in the model: the corporate free cash flow calculation, Gordon's dividend model, the net present value calculation, Black-Scholes option pricing model and the two-dimensional Monte Carlo simulation.

Based on the model calculations presented, we can state that the developed business valuation model operates with a reliable result. The inaccuracies arise from the fact that we needed to rely on external data and related estimations in the course of determining parameters of the model. By making the data more accurate, the result could most likely be further improved.

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