St. Petersburg University

Graduate School of Management

Master in Corporate Finance

VALUING SYNERGIES IN STRATEGIC ACQUISITIONS USING REAL OPTIONS

Master's Thesis by the 2nd year student

Concentration – Corporate Finance

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АННОТАЦИЯ

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Название магистерской диссертации	Оценка синергий в стратегических приобретениях компаний с помощью методов реальных опционов
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Описание цели, задач и основных результатов	Цель работы – разработка нового метода оценки синергий в долгосрочных слияниях и поглощениях используя современные разработки в теории реальных опционов. Был разработан новый инструмент для первичного анализа компаний-целей приобретателем. При помощи этого метода компания может построить ценовую стратегию приобретения и определить максимальную наценку за компанию-цель. Метод приблизительно базируется на модели оценки реальных опционов Датара-Мэтьюса, потому что эта модель очень гибкая и легка в понимании для пользователей. Метод может быть использован для оценки до 8 наиболее распространённых и важных типов синергий. Для удобного и быстрого использования автором было создано программное обеспечение для метода (VBA приложение “SynergyCalculator”). Пользователю нужно внести финансовые показатели компании-цели, приобретателя и сценарии для неопределённых параметров синергий в окна программы. После определенного числа симуляций приложение предоставляет результаты в виде одного числа, а также в виде гистограммы с распределением исходов. Метод был использован для оценки синергий в нескольких недавних крупных сделках поглощений и продемонстрировал разумные, адекватные результаты. Более того, были идентифицированы недостатки метода и возможные пути его совершенствования.
Ключевые слова	Слияния, поглощения, реальные опционы, синергия, оценка, метод Датара-Мэтьюса

ABSTRACT

Master Student's Name	Andrei I. Vedernikov
Master Thesis Title	Valuing synergies in strategic acquisitions using real options
Faculty	Graduate School of Management
Main field of study	Master in Corporate Finance
Year	2016
Academic Advisor's Name	Anna E. Loukianova
Description of the goal, tasks and main results	The goal of the thesis is development of new synergy valuation method in long tern acquisitions applying modern advances in real options theory. It will be another tool for companies in due diligence process of potential targets and using this tool company can build bidding strategy and define maximum premium it can pay for the target. We have created the method loosely based on Datar-Mathews real option valuation model because it is very flexible and most intuitive for practitioners. It can be applied to valuation up to 8 most common types of synergies. For easy use and smooth implementation we have created software (VBA application "SynergyCalculator"). The user just needs to submit financial data about the target, itself and scenarios for synergy parameters. After the number of simulations software provides results both in singular form and presented as histogram with the distribution of outcomes. The method has been used ex-poste to find synergy values in several recent famous M&A deals and produced sound results. Moreover, we have identified limitations of the method and areas for improvement.
Keywords	M&A, mergers and acquisitions, real options, synergy, valuation, Datar-Mathews method

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INTRODUCTION

In this work we are going to develop new method for synergies valuation in mergers and acquisitions using real options models. The goal is to create and bring new toolbox helping companies not to overpay in M&As. This method can used by companies in different industries valuing both traded and not traded targets either during due diligence process or in later stages before acquisition.

Firstly, we are going to evaluate the actuality of the problem and if the existing methods are already doing job well enough to produce accurate valuations. Then we will explore more about the different types of synergies and their categorizations by different authors.

After analyzing actuality and we will overview main existing real options valuation models in order to determine the most suitable ones for synergies valuation. The most important attribute choosing the model is that it should be easy to use and intuitively understandable for users and practitioners at the same time delivering reliable results.

After establishing the model we will build our method around it adapting it for synergies valuation. We will explain in detail real options logic and all parameters of mathematical model. In order to make the method to be easy to use we will develop software which practitioners will be able to operate to produce quick valuations without any manual work or mathematical solving themselves. We will program all decision making rules and formulas in the code. The user will see clearly interface and after submitting required parameters he or she will see result almost immediately in the separate window.

In the 3rd chapter we will demonstrate our method valuing synergies in 3 recent big M&A deals. We will check the viability of method and soundness of the results. We will try to analyze advantages of the method, its limitations and areas for further research and improvements.

1. LITERATURE REVIEW

1.1 M&A performance perplexity

Over the 20th century M&A activity has been continuously growing and was driven by so called merger waves: “merging for monopoly” (1983 – 1904), “merging for oligopoly” (1916 - 1929), “conglomerate mergers” (1965 – 1969), “hostile takeovers” (1981 – 1989), “cross border mergers” (1990s) and “leveraged mergers” (2003 – 2007) (Vazirani, Nitin, 2015). There is evident characteristic of merger waves that they occur at times of high economic growth and slow down during the recession periods (Gaughan, 1996).

During the 90s US M&A activity has risen dramatically from 2074 transactions to almost 10000 in the beginning of 21th century (Weston, Fred, Johnson, 1999).

These days more than 20 thousands M&A deals are conducted in the world every year. The number of deals increased by 17% to 31,427 in and combined valued jumped by 57% from 1.87$ trillion to 2.94$ trillion indicating revival of big M&A deals in 2014 (Wilmerhale, 2015).

However, recent studies and authors from major business publishers contend that most of deals do not result in increased value for shareholders of acquirer. Some indicate the unsuccessful rate of 50% (Weber, Tarba, 2014) others even higher to 70%-90% (Christensen, Alton, 2011). In this paragraph we will try review previous studies from different time periods and try to infer come conclusions about the success rates of M&As and reasons of their failure.

A. Agrawal and J.F. Gaffe (1999) analyzed a number of previous researches which were conducted before 1990s and after 1990s. They have made this distinction because before 90s methods were less statistically sophisticated and precise, and it could affect the significance of results.

Generally they found that before 1990s in the short term acquirers made small or close to zero returns and targets had strong positive returns (Roll 1986). In the long term Jensen and Ruback (1983) found strong negative abnormal returns, which they tried to explain by market inefficiency and overestimation of movement of price.

Other authors suggested the following results for long term M&As: Mandelker (1974) and Bradly & Jarrell (1988) found negative but statistically insignificant returns. The results from Asquith (1983) and Magenheim & Muller (1988) and were more conclusive and showed statistically significant negative abnormal returns. On the other hand Malatest (1983), Asquith, Bruner and Mullins (1983) obtained statistically significant abnormal positive returns. Thus we can conclude that results tend to be negative for acquirers especially in the long term.

Results obtained after 1990s are considered by Agrawal and Gaffe as more trustful due to better developed methodology. Agrawal, Jaffe and Mandelker (1992) and Mandelker,

Anderson later in 1993 used size and book-to-market adjustments to obtain negative statistically significant results for 5 years period. Later Rau & Vermalen (1998) and Gregory (1997) without using adjustments confirmed negative abnormal returns for 3 and 5 year interval respectively.

In other independent study Bruner (2004b) have analyzed previous works on this topic and have established following conclusions.

1) In the short term (several months after M&A) 25 studies confirmed abnormal positive returns for shareholders of the target. And statistically significant results showed the following distribution of results for acquirer:

- Negative 26%
- Zero 31%
- Positive 46%

Another number of mixed results were statistically insignificant.

Generally, companies 24 out of 25 showed positive returns with 14 of them strongly positive.

2) In the long term after announcement results were different: 11 out of 16 studies showed negative and significant negative returns

Summarizing our analysis we can see that for acquirers results in short term are very mixed and in the long term most studies confirm that acquirers tend to have negative abnormal returns

Explanation of M&A performance puzzle

Strong connection has been found between the methods of payment and M&A performance by a number or scholars: Franks, Harris and Mayer (1988), Franks, Harris and Titman (1991), Gregory (1997). They found that all-stock acquisitions had stronger negative performance in comparison to all-cash acquisitions.

Another possible reason has been proposed by Rau &Vermalen (1998). They found the "glamour" acquirers (those with better financial performance and higher market-to-book value ratios) earn significant negative return in mergers (-17%) regardless of method of payment.

The practitioners Kristin Ficery, Tom Herd and Bill Pursche (2007) from Accenture are defining two groups mistakes in the acquisition process:

1) Measurement and valuation mistakes
2) Integration and synergy extraction mistakes

They note that managers are getting better at identifying and even measuring potential synergies but contend that the synergic value is not "sure thing". They contend that after

acquiring this opportunity the most difficult part is how to realize them. They say that the acquirer always incurs the costs during the integration and the synergy extraction process.

C. M. Christensen, R. Alton, C. Rising (2011) pinpoint significance of both problems but underline the main fallacy of managers in post-merger integration process. They evidence that discrepancy between the goals of M&A and subsequent integration process destroys the value of synergies.

74% of CEOs in Deloitte's survey answered that they consider integration as a serious part of the deal and that they had formal integration strategy before going to merger (Deloitte, 2015). Academic scholars also contend that post-merger integration is pivotal point in value creation of the deal: Agrawal & Jaffe (2000), Epstein (2004); Hitt, King, Krishnan (2009).

Bruner (2004a) in his turn claims that the valuation should be a central part of M&A analysis due to several reasons. Firstly, only through the synergy assessment managers can somehow reasonably come up to the projected premium size, and secondly only knowing specific sources of synergy and their potential size managers can start planning corresponding integration strategy.

We can conclude that both measurement and integration processes are critical for the success of M&A and in our paper we will try reduce the mistakes coming from the Valuation stage. In the next paragraph we will proceed examining the main sources of synergies in M&A as have been defined by scholars and practitioners.

1.2 Where do synergies come from?

Damodaran (2005) and Bruner (2004a) generally distinguish similar groups of synergies in M&A. Damodaran (2005) divides them in two broad categories:

1. Operating synergies. This synergies arise from the fact that combined firm is now bigger and can exert economies of scale, exercise greater pricing power and provide new opportunities for growth in new or existing markets. Moreover, he adds that right combination of functional capabilities of the two companies can result in operating synergies.
2. Financial synergies. Merged firm can bring better debt capacity, tax benefits from operating losses from the targets, asset revaluations. Combination of two entities one of which owns a lot of cash and another many profitable projects will be exercise higher NPV together.

Bruner provides more detailed systematic classification dividing synergies in functional groups. He adds those coming from revenues through cross selling and branding and cost reduction synergies from greater purchasing power, elimination of subsidiaries and improvements in supply chain and distribution. Bruner (2004a) excludes from the category of

financial synergies asset reduction and tax benefits synergies leaving only borrowing advantages. Both authors describe synergies as benefits which could be realized in a combination of acquirer and a target above their stand-alone value.

The main difference between two classifications is that Bruner (2004a) also introduces the category of real options (ROs) as synergies which are not explicitly declared to be embedded in Damodaran's classification.

He proposes the following categorization of potential real options in acquisition:

- Growth options
- Exit options
- Options to postpone investment
- Flexibility option (to change operating scale)
- Switch option (to change operation processes)

We can assume that Damodaran (2005) may have considered growth options as a part of operating synergies, however other types were certainly not considered by him. Damodaran (2005) also adds the control premium and defines the value of a target for the acquirer as:

$$Value_{target} = Value_{target\ stand-alone} + Value_{synergies} + Control\ Premium \quad (1)$$

Bruner divides synergies as synergies in place and real options synergies:

$$Value_{target} = Value_{target\ stand-alone} + Value_{synergies}^{In\ place} + Value_{synergies}^{Real\ options} \quad (2)$$

The area has also been extensively researched by other scholars: operating synergies Anslinger & Copeland (1996); Khrishnamurti and Vishwanath (2008); growth options: Myers (1977), Kogut (1991), Smith & Triantis (1995), option to postpone investment McDonald (1986).

Collan & Cinnunen (2009) consider also categorization of synergies during different stages of the acquisition process where they demonstrate how real options appear. (Figure 1)

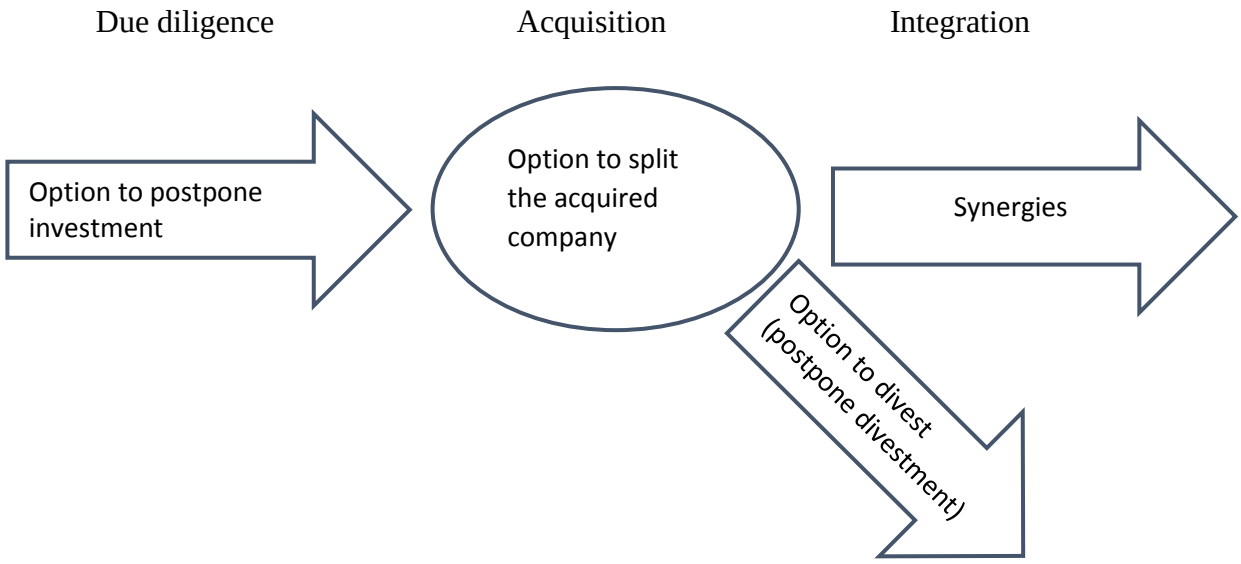


Figure 1.1 Real options and stages of acquisition (Collan 2009)

Collan & Cinnunen (2009) add also option to split the target and partially divest it in the acquisition process. They claim that synergies also can be presented as real options as there are highly uncertain and require significant efforts to be realized. So they were among the first to discuss synergy and option to split in the real options framework and offered do develop this topic in further research.

We have applied Bruner's (2004a) criteria on real option definition to check the viability of such assumption.

1) Identifiable underlying asset. In the case of operating synergies it is present a value of potential benefits. It could be present value of incremental cash flows resulting from growth options, synergetic increase in sales, tax or cost reductions, depending on a type of synergy. *Confirmed.*

2) Exclusive. We consider the strategic acquisition where the acquirer has control power of the firm. Thus options grant special rights only to the management of the acquirer and its shareholder. *Confirmed.*

3) *Contingent.* It has been confirmed in the paragraph above that the value of synergies is highly uncertain and depends first of all on management effort and other factors depending on source of synergy. *Confirmed.*

4) *Costly to acquire.* According to EY Merger Integration survey (EY, 2014) on average 14% of the size of deal is subsequently also spent in the integration process. *Confirmed.*

5) Time constrained. In general synergy-generating action can be started long after acquisition itself. However there are certain limits caused by the nature of synergies and board decisions, which put certain limits on timeframes of implementation. *Confirmed.*

We can see that operating and other types of synergies can be considered real options as they follow the criteria of option definition.

Summarizing paragraph we inform that in our work we will use definition of synergy given by Bruner: synergy represents benefits coming from the target to the combined company which otherwise would not be available for target stand-alone. In real option frameworks these are out-of-money real options for the target.

In the Bruner's formula (2004a) below we will consider $Value_{synergies}^{In\ place}$ (operating and financial synergies) also as real options as they have been confirmed to be as such and proposed for further research by Collan and Kinnunen (2009). In addition we checked above that they comply with classical definition of option ourselves. As result in our work we propose the following categorization of synergies for valuation purpose:

I. Synergies depending on how effectively will be organized integration

1) Operational synergies
   - Revenue enhancing synergies through cross selling, cross branding and so on
   - Cost reduction synergies through greater purchasing power, capacity utilization, reducing overlapping management
2) Growth synergies
   - Synergetic effect giving opportunities for higher growth in one of the segments
3) Financial synergies
   - Tax benefits
     - Loss carryforward
     - Asset write-up
     - Tax rate decrease
   - Increased borrowing capacity / Decreased borrowing rate
   - Decreased cost of capital
4) Other options, company and industry specific

II. Synergies depending on how effectively will be organized divestment

Synergies to be valued using proposed Real Options valuation model

Options to divest, split and sell in parts on favorable conditions for acquirer (KONE acquisition of Partek) (Collan 2009)

As explained above the purpose of this work – valuation of 8 types synergies which are most frequently expected in M&As.

In the next paragraphs we will make an overview of the real option valuation methods based on which we will build our methodology.

1.3 Classic models

As we have identified the synergies can be considered as real options and in the next paragraphs we will try understand existing methods, how they work, their advantages and disadvantages.

But before that we will compare the real options valuations methods with classic methods such as DCF. Generally, RO valuation takes roots from the works on financial options valuation (Black and Scholes, 1973). However, the biggest difference is that financial options are usually standardized and real options are vice versa are although could be similar in classification but usually unique in their characteristics for every project or M&A. Thus it requires more sophisticated and flexible methods for their valuation. Generally, for reasons why ROs are very important for investments valuation we can again refer to the Bruner (2004a).

Firstly, DCF and other classic valuation methods just cannot capture the potential value of strategic options which are included in the nature. NPV methods are trying to mimic precisely the underlying market process and due to the nature of their banking origin are more conservative and suitable for annuity like payments (Mathews, Datar, 2007).

Secondly, ROs are very important for the companies with high growth potential or with some unique capabilities for example in pharmaceutical, hi tech or aerospace industry where ROs share in the total value in the valuation could be higher than 50%.

Thirdly, effective identification and valuation or strategic real options in the M&A is crucial for building subsequent integration strategy.

Fourthly, real are options are pervasive and inherently embedded in managerial decision making process, and DCF fails to take that into account.

First RO valuation model was based on the famous valuation formula for financial option valuation (Black and Scholes, 1973):

$$C(S,t) = N(d_1)S - N(d_2)Ke^{-r(T-t)} \quad (4)$$

$$d_1 = \frac{Ln\left(\frac{S}{K}\right)+(r-\frac{\sigma^2}{2})(T-t)}{\sigma\sqrt{T-t}} \text{ (5)}$$

$$d_2 = d_1 - \sigma\sqrt{T-t} \text{ (6)}$$

In this formula $N(d_1)$, $N(d_2)$ are the cumulative distribution functions of the standard normal distribution.

Where S – is the present value of the cash flows of the project, K –cost to stage the project, T – time available to stage the project, σ – volatility of the cash flows (underlying asset)

Analysing two papers (Black and Scholes, 1973) and (Bruner 2004a) we can do following conclusions about the applicability of the model:

Advantages:

- Gives some intuition behind the real option valuation logic.
- Simple to calculate if all parameters at present

Disadvantages:

- Inflexible. It is not possible to include several decision rules and exercised only at maturity.
- Hard to explain to client or external users
- Underlying asset should follow lognormal distribution

Binominal tree model

This method based on the assumption that the cash flows of the project (or underlying asset) follow the binominal process over discrete time periods (Cox, Ross, Rubinstein, 1979). This process can be presented in the form of tree (Figure 1.2)

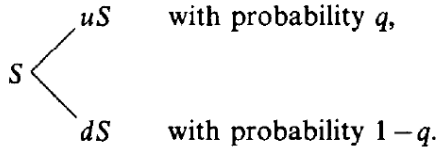


Figure 1.2 One time period binominal tree

Then from the underlying asset tree of option (or real option) payoffs is derived (Figure 1.3)

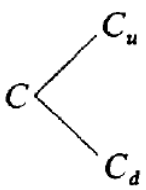


Figure 1.3 Option (Real option) payoff tree

Cu and Cd are payoffs of option (or real option) corresponding to the value of underlying asset (S). In the case of financial option the payoffs are defined by:

$$C_u = \max[0, uS - K] \text{ (7)}$$

$$C_d = \max[0, dS - K] \text{ (8)}$$

However in the case of real options rules behind the payoffs are unique depending on a particular case. Cox, Ross and Rubinstein (1979) used the non-arbitrage condition and derived risk-neutral probabilities for backwards:

$$p = \frac{r - d}{u - d} \text{(9)}$$

From the (real) option tree we calculate the option value by back solving along the branches of the tree. Where r – risk free rate, where u – 1 and d – 1 are possible returns of underlying asset in one period. Trees can be presented in the form of recombining binominal lattices and corresponding binominal trees (Figure 1.4)

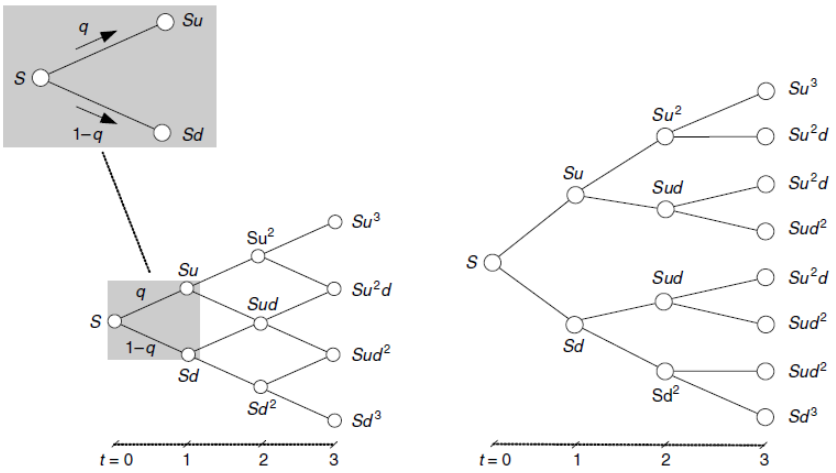


Figure 1.4 Combining and recombining binominal trees

For a given sigma the binominal recombining tree approximates the lognormal distribution und could be created by the following formulas:

$$u = e^{\sigma\sqrt{t/n}}, \quad d = e^{-\sigma\sqrt{t/n}}, \quad q = \frac{1}{2} + \frac{1}{2}(\mu/\sigma)\sqrt{t/n} \text{ (10)}$$

Where: t – time to maturity, n – number of, sigma - volatility per period.

The main advantage of binominal tree pricing method in comparison to Black&Scholes valuation is that, having built tree or lattice of underlying asset, we can program in different branches of the tree important decision making rules. For example we can program in which situation (which part of the tree) we will use abandonment option, flexible production ROs or other real options. Other relative advantage is that you can visually demonstrate when, under

which conditions (at which branch) the options are at present and could be executed. In the example below we show which real options binominal tree for a car manufacturing plant regarding currency level as one of the uncertainties. Colored areas shown the situation in which RO should be exercised (example provided from the GSOM Risk Management project, 2015):

- Option to postpone investment
- Option to invest and expand production
- Option to have flexible production using various shift schedules
- Option to sell assets and abandon the project

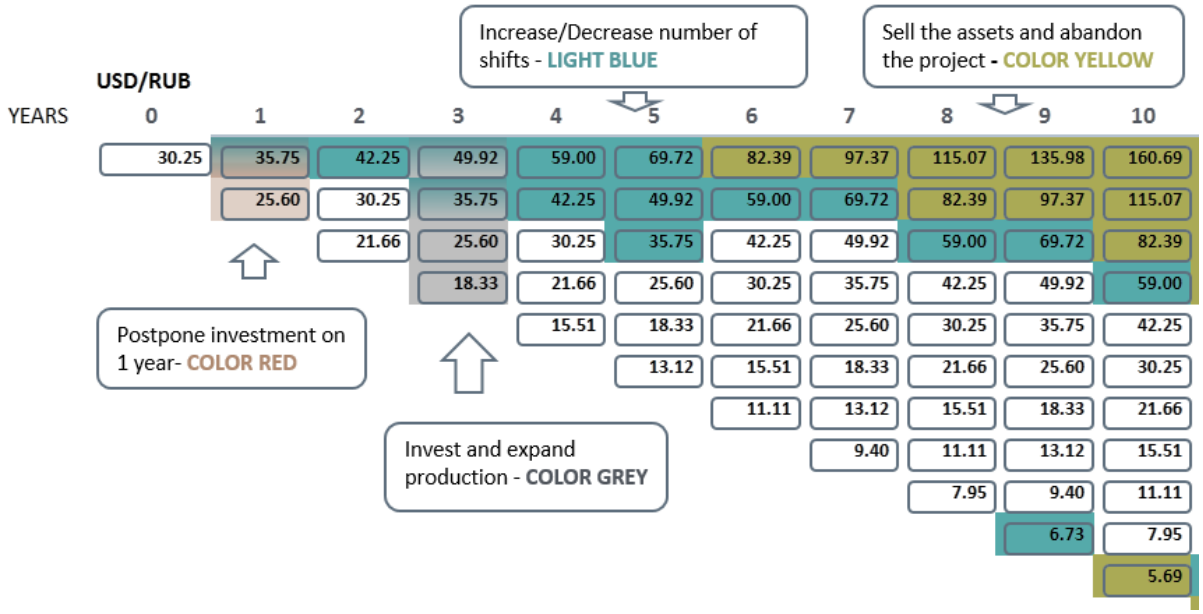


Figure 1.5 Example binominal tree

So, in the example above company should postpone investment in plant until year one, in the year 3 plant should exercise option to expand. If USD/RUB exchange rate is in the range 35.75 – 70, plant should use flexibility option (to decrease or increase the number of shifts). If USD/RUB exchange rate is higher than 70 or lower than 6, company should exercise options to abandon

As demonstrated above Binominal method also gives better intuition to decision makers to identify and value ROs. To disadvantages we can list that it is very cumbersome to build binominal trees and calculate the value of options with long time period and multiple sources of uncertainty.

Decision Trees

Decision tree framework is similar to binominal tree model but using this method analyst must himself/herself present full range of outcomes. The difference is that the decision tree integrates together underlying asset distribution, payoff rules and also decision nodes themselves

(Brandao, 2005). After valuation tree is formed, the option (project) value is backwards calculated along the branches with the help of special algorithms formally called dynamic programming Dixit and Pindyck (1994).

The method is suitable for not complex real options. In this case it could be quite flexible and intuitive for the user (Bruner 2004a). However, when project has long period with numerous options embedded the tree could be very cumbersome to calculate with potentially thousands or even millions ending points (Brandao, 2005). In addition decision trees method usually overvalues the project because it doesn't appropriately adjust the investment risk (Mathews, Datar, 2007)

1.4 Monte Carlo based methods

Initial Monte Carlo methods. Firstly, Boyle (1977) showed how to use Monte Carlo simulation to find the price of financial options. The method is implemented by constructing valuation model where certain variables are random with certain probability distribution. Then simulation is performed number of times and options value is derived as a present value of expected (positive) outcomes (Bruner 2004a).

This method is far more flexible than the previous we have reviewed. It is widely used in valuation of large capital investment programs, mining and drilling projects(Samis 2014). The method is the most adaptable to arrange of assumptions and allows to introduce wide range of payoff rules, the distribution of underlying asset is not required as it is automatically derived through the simulation process. (Boyle,1977).

Moreover, the method may provide result not only as a single value but also as histogram with visual representation of the range of uncertainty around result, thus giving good intuition to the clients and the users of the method.

As a disadvantage of the method we can consider that fact that it could be quite time consuming and skill demanding to use it, and it is complicated to program assumptions about the probability distribution of random variables. The resulting distribution can be unrelated to the market and produce so called "garbage in – garbage out" models (Mathews, Datar, 2007). In addition the method could be difficult to explain to practitioners of traditional methods and financial analysts because they operate with different data-inputs (Bruner 2004a). For practitioners the concepts probability distribution of costs or other parameters may sound awkward.

Datar–Mathews method

Taking into account the main disadvantages of Monte Carlo based methods an expert panel consisting of Scott Mathews of The Boeing Company, Vinay Datar from Seattle University and Blake Johnson from Stanford University have developed new method which is clearer for practitioners. The aim of the project was to create a new real options valuation method which is based on the language and frameworks of classic DCF valuation to make managers and financial analyst feel comfortable to work with this method. (Mathews, Datar, 2007)

The method includes several steps.

1. Scenario planning. During this stage main relevant factors are discussed for example: current technology, time schedule of product readiness and project launch, contingency plans, investments and other issues. The fundamental difference of DM method from previous Monte Carlo based methods is that uncertain inputs to the model are being provided in the form of scenarios being developed by experiences professionals in the field. For example, marketing department provides the valuation team potential scenarios for demand growth in the considered time schedules, production department provides the timeframes when the product will be ready for launch and probable postponements in the stages. The procurement department on the other hand can provide or material cost scenarios for the observable period and so on.

Thus after having obtained scenarios the team can "create" probability distribution from the scenarios. The simplest distribution for random variable is triangular distribution which uses only the minimum, maximum and most probably value of distribution and linear functional dependency between the value and its probability. (Figure 1.6)

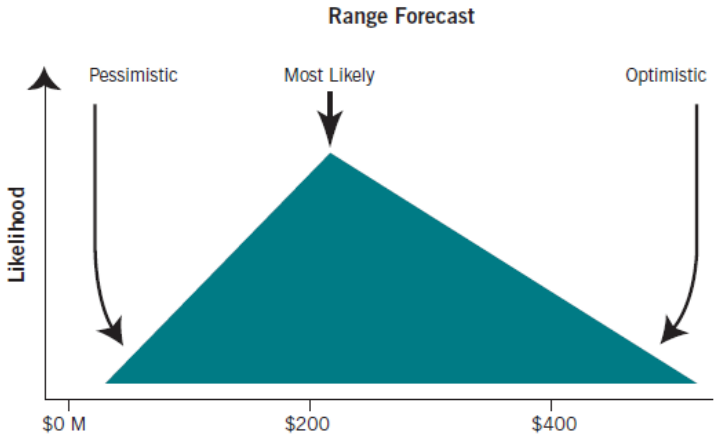


Figure 1.6 Triangular distribution of the forecast

However, Datar and Mathews pinpoint that in most cases such assumption is not accurate as some scenarios are more probable. In such cases skewed, trapezoid or other types of distribution could be suitable. The information about the form of the distribution is derived through the coordination of valuation team and the corresponding department. Again this method doesn't require from those specialists understanding of the methods and types of distributions. The team will use experience and knowledge in their field of focus to develop suitable distributions for random parameters. Moreover, probability distribution and its type can be extracted from the empirical data (Masson, 2006).

2. Simulation. After model configuration we should use Monte Carlo software (Crystal Ball, @Risk) or program ourselves the simulation model in VBA, R or other language. Datar&Mathew advise to use 500 trial for initial results and the number of subsequent trials depends on the particular model and could be 10000 and higher. It is also possible to introduce other conditions such as correlations between the value of variables in the first and subsequent years.

1. *Operating profits.* After obtaining operating profits (cash flows) for every period we find discount rates. For investments and costs company should use corporate bond rate (Mathews, Datar, 2007) or risk free rate (Collan, Fuller, Mezei, 2009) and for revenues risk adjusted discount rate (Collan, Fuller, Mezei, 2009). Then we find present value of the operating profits

2. *Strike.* To define strike we find present value of costs to launch the project (investments). And then we cut off the PV of operating profits which are less than strike considering them as 0.

3. We calculate the Real Option value as

Real option value = Average [MAX(operating profits – launch cost, 0)] (11)

General formula:

Real option value = Risk Adjusted Success Probability * (Benefits – Costs) (12)

The biggest advantage of the method that it connects NPV valuation and scenario analysis with Monte Carlo simulation technique thus greatly improving intuition in the usage of real options methods in managerial decision making. It is very flexible and many useful extensions could be applied: dynamic market curve, production variability, multi stage, compound, American options. DM Method can easily deal with non-lognormal cash flow distributions, multiple uncertainties, and random exercise price in comparison to Black&Scholes and binominal method.

Disadvantage of the method is that it requires good understanding of processes, experience or correct data to specify scenarios and distributions, however for company insiders it is available information and could be precisely specified.

1.5 Fuzzy numbers methods

Generally fuzzy numbers methods are based on the developments of fuzzy logic. This is another way to measure uncertainty along with probabilities (Ponsard, 1988). A fuzzy number refers not to a single number but to a set of possible interconnected values incorporating existing uncertainty of the parameters, properties, geometry, initial conditions, etc. (Zadeh, 1965). Fuzzy numbers can be triangular, trapezoidal or of other types and are operated according to fuzzy logic rules. Fuzzy logic is operating with various degrees of "true or false". Thus it allows to operate with both quantitative and qualitative categories which helps to improve the transparency and describe better the world.

For example triangular fuzzy number A can be represented in the form A= (a, α, β), where "a" – is the most probable value of this fuzzy number and "α" is the distance from the "a" towards the point in beginning of the axis and "β" is the distance to the point outwards from the beginning of the axis. Its structure can be presented by its membership function:

$$A(t)=\begin{cases} 1-\dfrac{a-t}{\alpha}, & if \quad \alpha-a\le t\le a \\ 1-\dfrac{t-1}{\beta}, & if \quad a\le t\le a+\beta \\ 0 & otherwise \end{cases} \tag{13}$$

Graphically it should be presented in the following way (Figure 1.7)

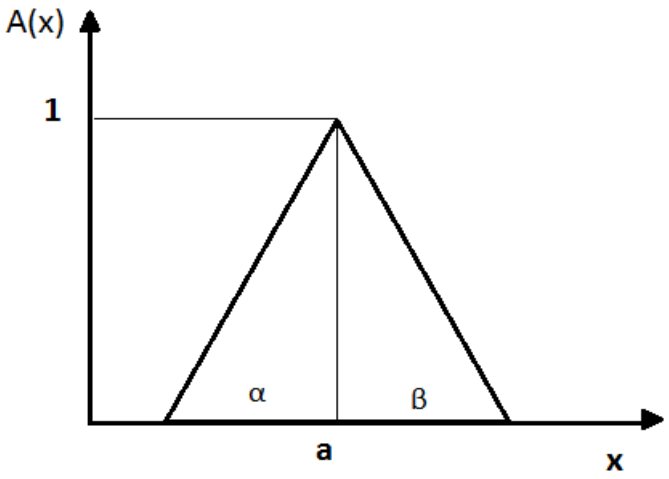


Figure 1.7 Fuzzy number A= (a, α, β).

There are three main methods of real options valuation based on fuzzy logic.

First two methods are based on Black Scholes (Collan, Carlsson, 2003) and binominal tree models (Muzioli, Torricelli, 2001). They use the same basic mechanism but operate with fuzzy numbers and their inputs are with certain degree of uncertainty determined by the membership function and the value of real option is calculated as a mean of resulting fuzzy number.

The first method has very limited application area and the second one doesn't have yet strong methodological basis (Muzioli, Torricelli, 2001). That is why we will concentrate on and explore more the third method due to its simplicity, novelty, and practical application.

Its name is Fuzzy Pay-off Method for Real Option Valuation developed by Mikael Collan, Robert Fuller, and Jozef Mezei (2009). Application of the Fuzzy Pay-off method to synergy valuation will have the following steps:

1) Managers should define 3 scenarios: good, most likely, and bad, for the investments to realize the synergies and the synergy benefits themselves. These scenarios can be achieved by any type financial analysis, modelling or using experience of the managers.

2) Then PV all both investments and benefits from synergies should be calculated for all scenarios. In the result we will have NPV for three scenarios: good, most likely, and bad in the form of fuzzy number. Example of fuzzy NPV distribution is presented in the figure below:

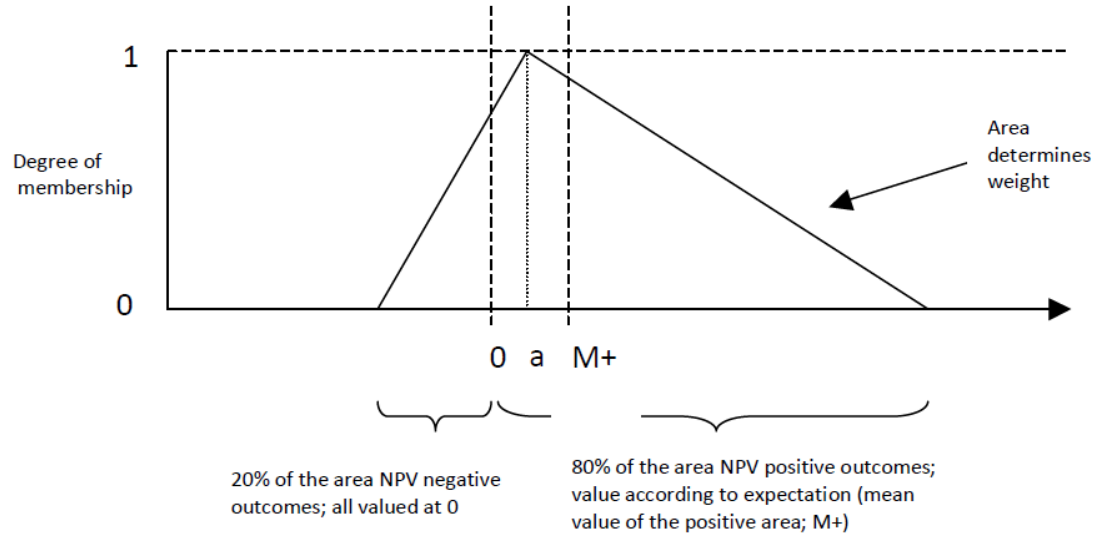


Figure 1.8 Fuzzy NPV example for triangular membership function

This fuzzy NPV has negative value in worst case and mean of "a" and mean of positive values (M+).

3) During the next step we cut off negative values and find the mean of positive values of the fuzzy number. For a triangular fuzzy number A= (a, α, β) the positive mean equals:

$$E(A_+) = \frac{(\alpha - a)^3}{6*\alpha^2} + a + \frac{\beta - \alpha}{6} \quad (14)$$

The derivation can be accessed at (Collan, Fuller, Mezei, 2009)

4) As traditionally real option value is the probability weighted average of the positive values of a project - the real option value in fuzzy calculation is the probability weighed fuzzy mean of positive values.

5) After finding both positive mean of the fuzzy number and the probability of positive outcomes the real option value can be found using the following formula:

$$ROV\ (Real\ Option\ value) = \frac{\int_0^\infty A(x)dx}{\int_{-\infty}^\infty A(x)dx} * E(A_+) \quad (15)$$

In the figure above $\int_{-\infty}^{\infty} A(x)dx$ refers to the total area below the fuzzy number and $\int_0^\infty A(x)dx$ refers to the positive area under the fuzzy number. And probability of positive outcome will be their division of these areas.

This method is similar in some way to Datar-Mathews method as it also works with scenarios and NPV outcomes. Its main advantage is its simplicity; it doesn't require any special software and can be even implemented on paper. The second big advantage is that it operates with scenarios and forecasts so well-known and intuitive for managers and practitioners.

The key issues lie in the accuracy of assumption and forms of fuzzy numbers. The membership function should be specified in the way correctly describing the process of variable. This could be very difficult to implement and requires close coordination of valuation team and experienced members of functional departments. Kinnunen (2009) claims that generally method can be used in pre deal stage screening process, when uncertainty is very high and that is why managers can resort to fuzzy numbers.

1.6 Comparison of methods

We will summarize our findings on RO valuation methods by creating table where we will evaluate each method by different criteria. This will help us to determine in the second chapter of the Thesis applicability of particular methods for synergies valuation.

Firstly, we will define the criteria and their significance.

Flexibility. Flexibility of the method allows to introduce various decision and exercise rules. For example option to abandon can be exercised almost at any time before maturity and thus requires the method to allow it.

Difficulty to calculate. This criteria means that the user should be able to operate with certain mathematical or statistical tools in order to implement the valuation process. And the scale of calculations and operations should be manageable for an analyst.

RO decision making intuition. Method must be intuitive in decision making. It should replicate managerial thinking and be transparent for the managers or analysts to transfer their thoughts in mathematical model.

Easy to explain to unrelated party. This criteria implies how easy it is to understand or operate the method for clients or colleagues from other departments. This criteria is also important because these parties also indirectly take part in the valuation process by providing feedback or experience and thus should be well aware of how the process works or how to interpret the results.

Underlying process/multiple uncertainties. This criteria measures how a particular method can deal with various types of distribution of underlying process (asset) and multiple uncertainties.

In the table 1.1 we analyzed and evaluated each method according to each criterion.

Table 1.1 Comparison of methods.

Methods/Criteria	Classic model				Modern models	
	Black& Scholes	Bin. tree	Decision tree	Monte Carlo	Datar–Mathews	Fuzzy payoff
Flexibility	- -	+ +	+	+	+ +	+
Easy to implement	+ +	-	- -	-	+	+ +
RO decision making intuition	-	+	+	-	+ +	+
Easy to explain to unrelated party	- -	+	-	-	+	+
Underlying process/multiple uncertainties	- -	-	- -	+	+	+

From the table above we can see that earlier classic methods are less successful in dealing with various types of underlying processes and multiple uncertainties. And also generally they are also less intuitive and more difficult to explain to unrelated party. The easiest methods to implement are modern methods and based on Black&Scholes formula. However, Black&Scholes due to its limitations is negatively evaluated according to other criteria and there are serious doubts that it can produce meaningful results for practitioners in synergy valuation as a real option.

Binominal and decision tree methods also allow a certain degree of flexibility and good decision making intuition. However they are more difficult to implement and especially decision tree method could be difficult to explain to unrelated parties of the project. Simple Monte Carlo presented by Boyle (1977) provided good flexibility in decision rules and is also effective with incorporating different underlying process and multiple uncertainties. However, otherwise the method is not easy to implement and it is problematic to build intuition around it. Datar-Mathews method although also based on Monte Carlo simulation has greatly improved intuition in decision making mechanism and is easier to operate and explain to third parties. Fuzzy pay-off method is a very well balanced approach but its flexibility is not proven to be perfect.

Although modern methods appear to be better for use in general scale we can see that each method is quite unique in characteristics and we will research further in Methodology chapter how they can be utilized for our synergy valuation models.

1.7 Chapter summary

In this chapter first we have tried to explain performance puzzle of M&A deals. We analyzed range of major studies on M&A performance for acquirers in short term and long term. In short term results appear to be very mix to present some unequivocal conclusion but in the long term most studies tend to confirm negative abnormal returns for acquires. As this work is concerned with strategic acquisitions negative abnormal returns in the long term for acquirer confirm topicality of the issue.

Scholars identified two main mistakes explaining negative returns for acquires:

1) Measurement and valuation mistakes
2) Integration and synergy extraction mistakes

Our work is dedicated to address the first problem.

Then we have looked at what practitioners and scholars say about the sources of synergies and their types. Identifying correctly sources of synergies will be one the most critical steps in our methodology. We agreed to use Bruner's classification of types of synergies resulting from M&A with the exception that we will consider $Value_{synergies}^{In\ place}$ (operating and financial synergies) also as Real Options regarding modern works of Collan and Kinnunen (2009) and the goal of this paper. So, we have presented a list of 8 synergies which will be treated in real options framework and could be valued by our method,

In the second part of the chapter we overviewed main real options valuation methods, their advantages, and disadvantages. Then we have built the criteria and compared the methods according to them. We have found that modern methods are generally more flexible, intuitive

and could be better suited for practical applications. Generally, we identified that Datar-Mathews method could be the most applicable to serve as a basis for our synergy valuation methodology.

In the next chapter we will create method for synergy valuation in strategic acquisitions using our conclusions from this chapter and other relevant information.

2. METHODOLOGY

2.1 Methodology plan

In the beginning of the chapter we will shortly outline the structure of the method and how it should be used. We will formalize the method in the form of software (VBA application) for easy use. The method will produce 2 resulting figures for the user: 1) total value of expected synergies 2) maximum premium company can pay to acquire the target.

As we have identified in the literature review practical method of real options valuation (Datar-Mathew method) has the best characteristics to serve as a basis for our synergy valuation method. We will explain the valuation model itself in detail in the part 2.4 Valuation model but before in parts 2.2 and 2.3 we cover shortly standalone valuation of the target and categorization of synergies for the purpose of valuation. If the case market value of the target is different from its intrinsic value the user of the method will have to account for the fact that target maybe overvalued or undervalued. That is why in this case stand-alone valuation would be necessary. We will categorize 8 main types of synergies which our method will be able to valuate. It is necessary in order to build mathematical model for each type of synergies later in valuation part.

2.2 Stand-alone valuation: A + B

Managers can come up to the figure for A + B valuation either by conducting independent valuation using a range of methods or using market value of stock as a proxy for intrinsic value of stock of the company.

First way: using market value of stock for public companies

If companies are public and operate in developed countries we can accept market efficiency concept and take market capitalization as a fair figure for stock value of the company and after finding market value of debt and deducting cash we can approximately arrive to the total enterprise value (Fama 1991, 1998). However, practitioners should be cautious and take into account general macroeconomic situation because value can be driven down by economic crisis, unexpected new from inside the company and other (Schleifer, 2011)

Second way valuing target (and acquirer) using range of methods

We will define stand-alone value of company using definition of Boer (2002) where total value of target consist of two parts. Firstly, it is value of assets of place (cash flow generating capital). Secondly, it is so called strategic capital which includes human, intellectual capital. This type of capital produces potential for growth and adjustment for changing environment Boer (2002). We present several variants of valuation of company in figure 2.1

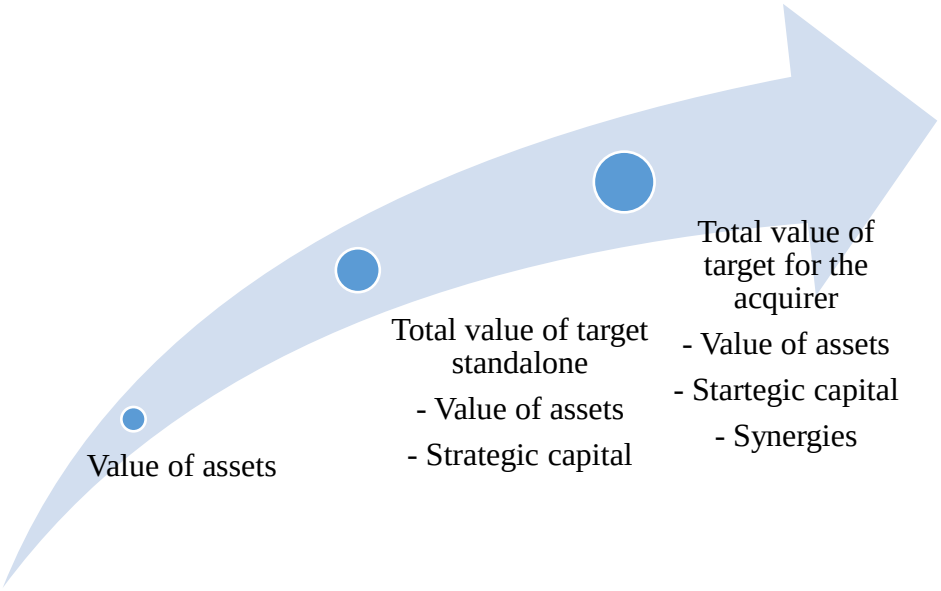


Figure 2.1. Several variants of target valuation (Collan, 2009)

Total value of target stand alone can be determined for the purpose of valuation by several methods for which we can refer to the well-known valuation scholar Aswath Damodaran (Damodaran, 2005). We will not go into detail but just give common vision about difference between them and their applicability. Applicability of certain methods depends on a range of factors (Damodaran, 2005) we list below.

Industry. In some industries business model could be very different from traditional way of business and it ensues the need to use special valuation techniques. For example in Financial Industry special status of debt and interest expense is a part of operations or for oil and gas companies value is derived from the amount of oil reserves in possession.

Private or public status of company. Generally, public companies are "more expensive" because of liquidity premium in comparison to private companies.

Debt-to-equity ratio. Certain methods and multiples are not applicable for otherwise comparable companies but with different debt ratios for example group of price/earnings multiples

Capital intensity. Companies with high CAPEX should be for instance valued using EBIT based multiples because Depreciation would make up significant share of expenses for such companies.

Growth (life cycle). Life cycle of the company is also critical choosing valuation method. For example major part of market value of fast growing companies could lie in present value of growth opportunities (PVGO) despite meager earnings in present.

Profitability status and dividend paying status. Companies with negative profit cannot be valued using certain multiples (P/E; EV/EBIT, and etc.); non-dividend-paying firms cannot be valued by dividend discount model.

Other factors arising from the specifics of the firm also could be defining the applicability of valuation method.

So first group is income based valuation methods:

- Free Cash Flow to the Firm
- Free Cash Flow to the Equity
- Dividend Discount model
- Residual Income Model

Second group is based on comparable deals and multiples:

1. Profit multiples
    1. P/E
    2. EV/EBIT
    3. EV/EBITDA
    4. PEG
2. Revenue based multiples
    1. P/Revenue
    2. EV/Revenue
3. Balance value based multiples
    1. P/BV
4. Industry specific multiples
    a. EV/number of items in stock
    b. EV/number of unique visitors
    c. EV/number of clients

Third group are industry specific methods:

1. Net asset value approach
2. Fund from operation method for Real Estate Investment Trusts

Concluding this part we can see that if managers use market value of stock to calculate the enterprise value it must be assumed that the companies, neither acquirer nor the target, are overvalued or undervalued as standalone and total figure A + B represent fair value of combination without synergetic effects. The premium for the target in this case will be considered all money paid above the current value of B (value of target).

However, using second way and applying valuation methods could lead to the results when intrinsic value is different from the market value of the target. If calculated value (IV) is lower than market value (MV) then in order for the deal to be successful for acquirer value of expected synergies (S) should be greater than the size of premium (P) required to pay to acquire the target plus the difference between MV and IV.

$$S > P + |MV - IV| \quad (16)$$

If intrinsic value (IV) is determined to be higher than MV than in order for the deal to be successful for acquirer value of expected synergies (S) should be higher than the size of premium (P) required to pay to acquire the target minus the difference between MV and IV.

$$S > P - |MV - IV| \quad (17)$$

Speaking about "successfulness of the deal" we imply positive long term abnormal returns for the shareholders of the acquirer (Tsay, 2009). By positive abnormal returns we imply positive residual income for the equity owners of acquirer (Lyon, 1999) and long term in our cases means extended time period after M&A excluding short term fluctuation of stock price of combined company (Campbel, 1993)

As a *general condition of successfulness of acquisition* for acquirer given intrinsic (IV) and market values (MV) of the target, expected size of synergies as real option values (S), and requested premium (P) we can describe by the following inequality:

$$IV + S > MV + P \quad (18)$$

In case we don't have intrinsic value and take a market value as a fair value of the company expected synergy size should be higher than the required premium

$$S > P \quad (19)$$

2.3 Categorization of synergies for valuation purpose

We need to understand which type of synergies we are going to value because specification of parameters depends on a type and characteristics of synergy. Using definitions of Bruner, 2004, Damodaran, 2005, and Collan, 2009 for our methodology we build the following categorization of types of synergies

8 types of synergies which <u>could be valued by our method</u>

1) Operational synergies
    - Revenue enhancing synergies through cross selling, cross branding and so on
    - Cost reduction synergies through greater purchasing power, capacity utilization, reducing overlapping management

- Growth synergies. Synergetic effect giving opportunities for higher growth in one of the segments

2) Financial synergies
   - Tax benefits
     - Loss carryforward
     - Asset write-up
     - Tax rate decrease
   - Increased borrowing capacity / Decreased borrowing rate
   - Decreased cost of capital

Other synergies (cannot be valued by our method)

1) Company and industry specific real options
2) Synergies depending on how effectively will be organized divestment
   Options to divest, split and sell in parts on favorable conditions for acquirer (KONE acquisition of Partek) (Collan 2009)

2.4 Valuation model

Our synergy valuation model will be loosely based on Datar-Mathews method. In the literature review we have identified that this method provides great flexibility and managerial decision making intuition. Most importantly, it clearly converts classical concepts of NPV valuation with latest developments in real options valuation.

This method has been developed in cooperation of practitioners (managers from Boeing) and academics. It smoothly transforms the scenarios, opinions or existing empirical data in the company in real options valuation parameters using intuitively clear definitions and mechanism.

Creating the valuation model we will have to implement several steps

1) Assignment of probability distribution to synergies and cost of integration
2) Building formulas for synergies and combined formula
3) Doing simulation modelling
4) Terminating negative values and calculating positive mean of resulting distribution

2.4.1 Assignment of probability distributions for each type of synergy

Firstly, we need to know probability distribution for values of each type of synergy as a representative of their uncertainty. The distribution should reflect the scenarios identified by the managers.

Triangular distribution

The simplest and most intuitive is triangular distribution which is widely used in Corporate Finance (Armstrong, 2004). It is easy to understand for users because it requires to specify minimum, maximum and most probable values for distribution.

The formula for probability density function is:

$$f(x) = \begin{cases} 0, & x < a \\ \dfrac{2(x-a)}{(b-a)(c-a)}, & a \le x \le c \\ \dfrac{2(b-x)}{(b-a)(b-c)}, & c \le x \le b \\ 0, & x > b \end{cases} \quad (19)$$

Where "a" is the minimum value, "c" – most probable, and "b" – maximum values of distribution. Maximum value of probability density function is $\frac{2}{b-a}$

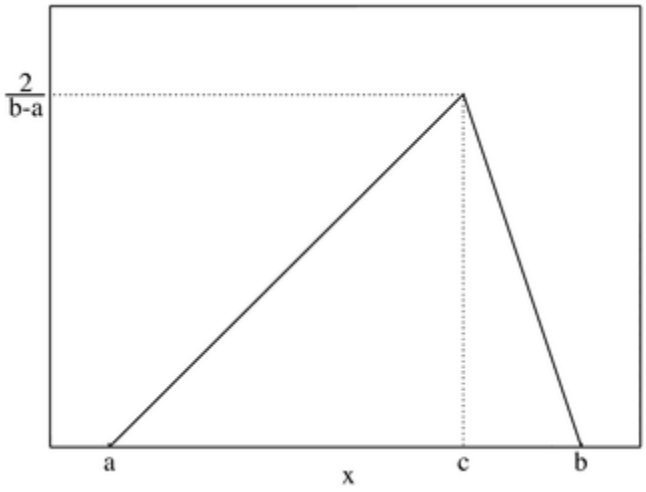


Figure 2.2 Triangular distribution

As mentioned above this distribution approximately imitates managerial scenario logic. For example analysts (DT Mathews) may give market growth figures for one of the segments following the acquisition: most probably we will have 2% points increase in growth; pessimistic scenario could be 0% and optimistic 3%. In case of triangular distribution we will have; a = 0%; b = 3%; c = 2%. The triangular distribution will have following look (Figure 2.3).

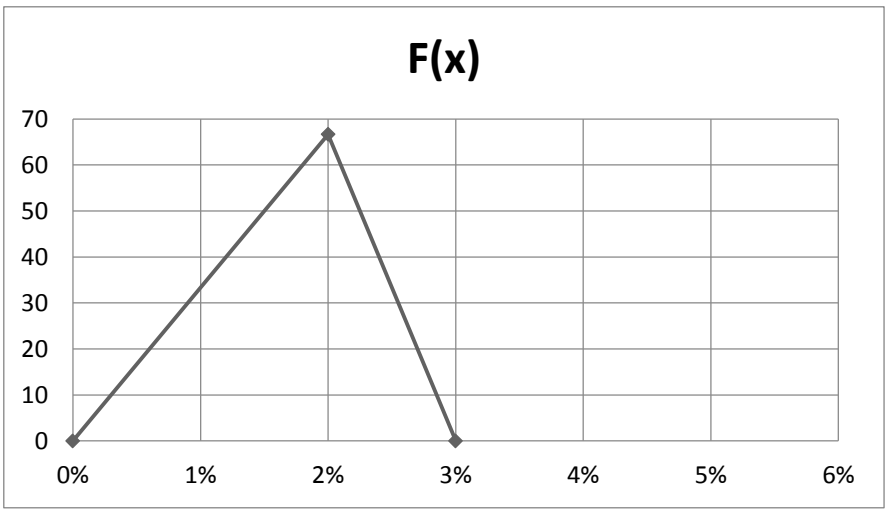


Figure 2.3 Triangular distribution (2)

Empirical probability distribution

Another types of distribution could be applied for synergy value ranges. For instance managers can use empirical probability distribution based on synergy extraction statistics from the similar deals or deals from the same industry or sector. The managers can look into the pool of previous M&As and gather information on which synergy value has been planned to be extracted and which value has been extracted in reality and during what time period. So we can calculate synergy extraction rates out of 100% and their probabilities from this pool.

This method reflects more accurately the process and would lead to more precise results. However, on the other hand it requires much more work to derive such distribution and, moreover, not for every industry there is enough data to build such pool and produce the distribution.

To demonstrate how it would work we will assume that we have a pool of 10 M&As in our industry: in 2 M&As only 20% have been extracted; in 3 M&As - 50%; in 4 M&As - 75%, and in 1 M&A 120%. If our analysts came up with the planned figure of 1Bln of PV synergies graphic interpretation of probability distribution will have the following view (Figure 2.4)

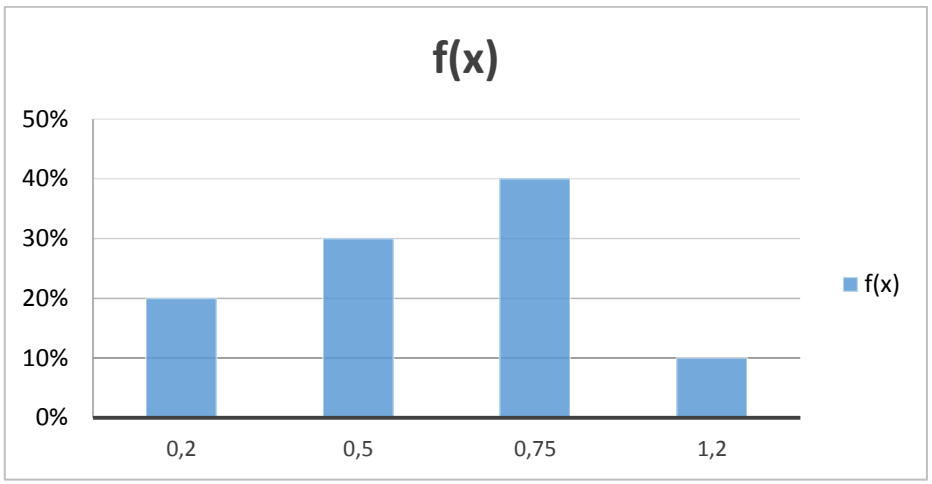


Figure 2.4 Empirical probability distribution

Other types of distribution

Depending on a type of synergy other distribution types could be also applicable for example trapezoidal or curved distribution with various degrees of skewedness (figures 2.5 and 2.6)

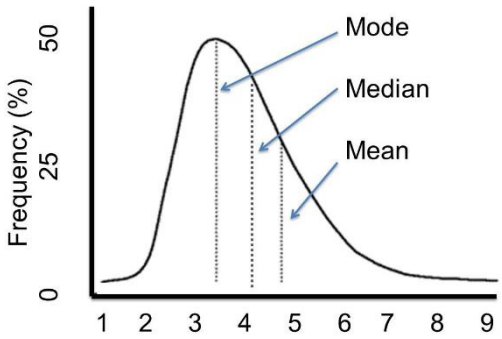


Figure 2.5 Curved skewed distribution

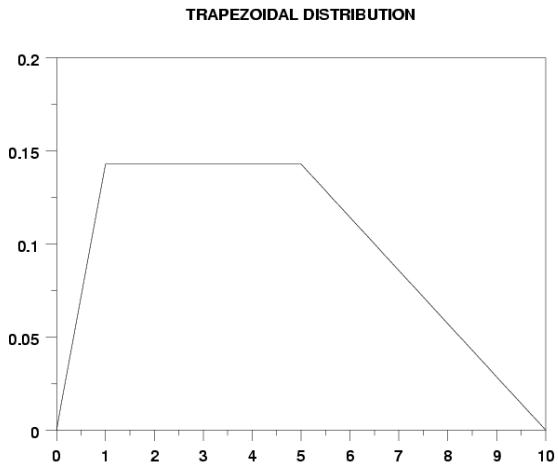


Figure 2.6 Trapezoidal distribution

For every category and company the form of distribution could be different. The most important criterion choosing the type of distribution is that it *should intuitively reflect the scenarios* and assumptions of the managers and experts. The range is not limited by the list of traditional types of distribution but can be customized if scenarios and assumptions behind them are credible for the purpose of valuation.

For instance if experts think that the most probable is not the single value but a range at the top trapezoidal type could be applied. If managers contend that function should not be linear, curved distribution can be used.

We can also specify time schedule for synergy extraction. This is time required to integrate the company, implement cost reductions, merger of operations and so on. It may look as a chain of several time steps. Before every subsequent time step acquirer should realize certain percentage of synergies as they declare in their M&A documents (Figure 2.7)

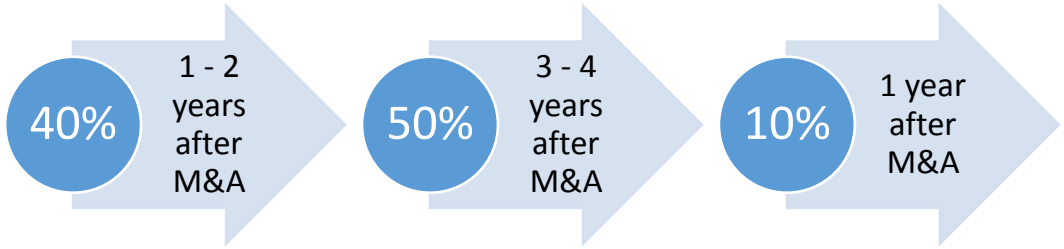


Figure 2.7 Synergy extraction plan

The realization plan can be accepted as certain or it could be also represented by probability distributions. For example the synergy extraction rate can be uncertain or even realization time schedule itself. Thus acquirer can again use empirical data, analysts' and experts' opinions to build probability distribution for realization time schedules for every type of synergy if it would significantly improve the precision of valuation.

2.4.2 Cost of integration

As we have discussed in Literature review integration is one of the two mail issues defining success of M&A deal. Shrivastava (1986) defines three different types of post-merger integration

Procedural integration. It includes combining working procedures, instructions and operational systems of the companies. It could typically range from legal and accounting integration to other functional integration such as inventory control, sales analysis and etc.

Physical integration. This type of integration includes redeployment and redistribution of assets of the companies: plants, production lines, warehouses and etc. Physical integration process is much more laborious and time consuming.

Managerial and sociocultural integration. This process involves a range of issues associated with transformation of organizational structure, management restructuring, redevelopment of common corporate culture, and motivation and leadership policy. This type of integration is more difficult to implement due to abstractive and less transparent nature of concepts involved. It is difficult for managers to grasp and measure this concepts. However, 51% of practitioners in EY integration report agree that cultural factors are overestimated in the deal success

EY integration report survey identifies that main functional areas in the acquisition were considered: 1) Sales and marketing; 2) Operations 3) Research and development. 46% and 45% of companies participated in the survey spend respectively most time and largest budget to operations in the integration process

Summarizing we will compare the types of integration according to several criteria (Table 2.1)

Table 2.1 Comparison of types of integration

Type	*Costs*	*Difficulty to implement*	*Importance*
Procedural	Medium	Medium	Medium
Physical	High	Easy	Medium
Managerial/Sociocultural	Low	High	High

In most cases managers will have to conduct all three types of processes after M&A to extract synergies. And the associated costs during the integration process combined with difficulty of each type of integration define successful extraction of synergies. As practitioners x

from Accenture and managers in EY's M&A survey write that the benefits from M&A deal arise directly in relation to the efforts company apply to extract them.

The costs associated with synergies in most cases will not represent a lump sum but will be distributed according to integration schedule defined by experts. EY integration report on average gives total integration cost on average of 14% of the deal value. However it can vary from deal to deal and usually managers come up with certain ranges for integration cost before initiating the bidding.

Thus for the purpose of model managers can come up with a single estimated number for integrated cost and distributed across the integration schedule. In the case integration cost is uncertain, a probability distribution can be constructed either using analysis results and scenarios from experts or using empirical data on previous deals.

Integration schedule could be also uncertain and defined by probability distribution. In the figure below (Figure 2.8) we give an example for integration cost presented by triangular probability distribution. We can assume that time schedule for cost of integration should match approximately the timeline of synergy extraction because synergy extraction is usually implemented together with integration of companies.

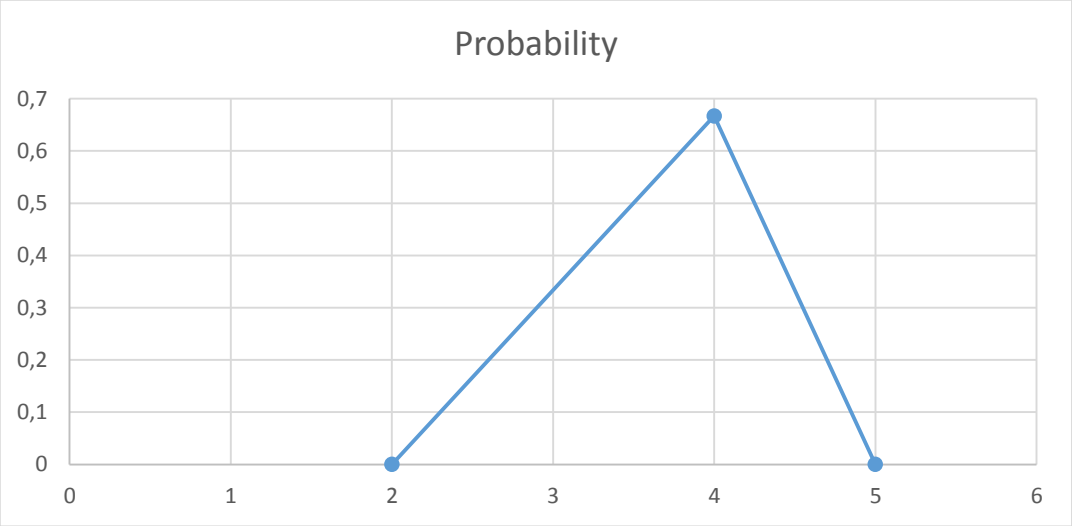


Figure 2.8 Triangular distribution for cost of integration

2.4.3 Building formulas for synergies

We include to simulation model formulas calculating incremental cash flows. These incremental cash flows are derived as benefits from particular type of synergy presented in probability distribution of pre-tax cost reductions, increased revenue growth and others.

Operational synergies formulas

Cost reduction synergy

Operational cost reduction will lead to increase of FCF of the company by size of reduction multiplied by (1 – tax rate). Assuming that effective corporate tax rate in 40% present value of incremental benefits from this type synergy will be determined by the following formula:

$$\text{PV} = \frac{CRrand*(1-t)}{r*(1+r)^n} \quad (20)$$

Where:

- t – effective tax rate
- r – discount rate for the combined company
- n – the number of years takes to realize the synergy
- CFrand a distribution of possible cost savings defined by the following probability density function for our example with minimum value minCR = 0 mln; the most probable value maxpCR = 500 mln; and maximum value maxCR = 600 mln.:

$$P(CFrand) = \begin{cases} 0, & CFrand < 0 \\ \frac{2*CFrand}{600*500}, & 0 \leq CFrand \leq 500 \\ \frac{2*CFrand}{500*100}, & 500 \leq CFrand \leq 600 \\ 0, & CFrand > 600 \end{cases}$$

Revenue synergy

Revenue synergy formula will be different in structure from formula above because revenue increase will not directly result in corresponding boost of FCF of the company. Revenue gain will be accompanied by proportionate increase in cost of goods sold. Thus formula will be based on FCF as a percentage of sales (FCFS)

$$PV = \frac{dRrand*FCFS}{r*(1+r)^n} \quad (21)$$

r – discount rate for the combined company

n – the number of year taken to realize the synergy

FCFS – FCF as a percentage of sales in the segment (or generally for the combined company)

$dRrand$ a distribution of possible revenue increases defined by the triangular probability density function with the following parameters (example) dRmin = 0 mln; dRmaxp = 300 mln; dRmax = 400 mln:

$$P(CFrand) = \begin{cases} 0, & CFrand < 0 \\ \frac{2*CFrand}{400*300}, & 0 \leq CFrand \leq 300 \\ \frac{2*CFrand}{300*100}, & 300 \leq CFrand \leq 400 \\ 0, & CFrand > 400 \end{cases}$$

Growth synergy

Present value of *synergetic effects resulting from revenue growth* increase in one of the segments will be defined by the following formula:

$$PV(dG) = \sum_{k}^{n=1}\left(\frac{(R*x*((G_2{}^k)-(G_1{}^k)))*FCFS}{(1+r)^k}\right) + \frac{(R*x*((G_2{}^k)-(G_1{}^k)))*FCFS}{r*(1+r)^k} \quad (22)$$

Where:

- R – revenue of combined company just before the merger
- x – % share of segment positively affected by acquisition
- FCFS – FCF as a percentage of sales in the segment (or generally for the combined company)

- r – discount rate for cash flows of combined company
- k – number of years company can sustain increased growth rate
- G1 – old growth of segment
- G2 – new growth of segment defined by probability density distribution with G2min = 2%; G2maxp = 5%; G2max = 6% (example):

$$P(G2) = \begin{cases} 0, & G2 < 2\% \\ \frac{2*G2}{4*3}, & 2\% \leq C2 \leq 5\% \\ \frac{2*G2}{3}, & 5\% \leq C2 \leq 6\% \\ 0, & C2 > 6\% \end{cases}$$

Financial synergies

Tax benefits

NOL carryforwards. Tax benefits arise in M&A when one of the merging parties has losses but retains very low probability to achieve profits in the observable future (US Code 26 § 382) and hereby will not be able realize loss carry forward tax reduction. Merging with profitable company will open such opportunities. US GAAP allow for the loss to be carried forward for up to seven years and in some cases even up to 15 - 20 years (US Code 26 § 382).

If the acquirer is very confident to be profitable in the future it may consider to calculate tax benefits just using classic NPV methods. However, if there is substantial uncertainty managers can also specify expected tax benefits using triangular distribution and include in the real option valuation model.

$$PV = \sum_{n-k}^{m=1}\left(\frac{(NOL*Erand)/(n-k)}{(1+r)^m}\right) (23)$$

Where:

- k – Average "age" of losses
- n – Number of years carryforward is allowed
- NOL – Total size of accumulated losses
- r – discount rate (usually cost of debt or risk free to discount tax benefits)
- Erand – coefficient showing which percentage of NOL can be allowed carryforward, it's probability density function is specified using triangular distribution with probability density function in the form presented above

Asset write-up. In the case tax benefits are coming from potential asset write up synergetic effects are derived through higher depreciation deductions and resulted tax shield. Present value of synergy in this case will be calculated using the following formula(25). It should

be noted however that the formula would be different if company doesn't use straight line depreciation method:

$$PV = \sum_{n}^{1} \frac{\left(\frac{(K*A_1)}{n}\right)*t}{(1+r)^n} (24)$$

Where:

- n – useful life in number of years (in this case linear depreciation schedule)
- A_1 – asset value before merger
- t – effective tax rate for the combined company
- r – discount rate (usually used cost of debt to discount tax benefits)
- K – probable % of asset appreciation determined by triangular distribution

Effective tax rate decrease. Resulting combination of two companies may also achieve absolute tax benefits resulting from decrease of effective tax rate due to geographical distribution, headquarters relocation, assets combinations and other reasons. In this case formula for calculation synergy would be:

$$PV(dG) = \sum_{k}^{n=1}\left(\frac{(Tax1-TaxRand)*EBT*((1+g1)^k)}{(1+r)^k}\right) + \frac{(Tax1-TaxRand)*EBT*\left((1+g1)^k\right)*(1+g2)}{(r-g2)*(1+r)^k} (25)$$

Where: Tax1 – tax rate before acquisition

- TaxRand – triangular distribution of possible tax rates for merged company after acquisition
- EBT – earnings before taxes of merged companies
- K – number of years in horizon period
- g1 – high growth rate during horizon period
- g2 – growth rate beyond horizon period (long term)
- r –discount rate for combined company (WACC)

Increased borrowing capacity / Decreased borrowing rate

Decreased borrowing costs mean for the company less money spend on serving debt leading to proportional increase in pretax cash flow of the company. Formula for calculation of PV of the synergy will be:

$$PV = \frac{(I1-randI2)*D*(1+g)^{n+1}*(1-t)}{(r-g)*(1+r)^n} (26)$$

Where: D – market value of combined debt in the year of merger

- I1 – borrowing rate before acquisition

- g – long term growth rate for a combined company
- t – effective tax rate for a combined company
- r – discount rate for the combined company
- n – number of years required to realize the synergy
- randI2 – borrowing rate after acquisition defined by triangular distribution

Decreased discount rate for the company

Decrease in discount rate will increase the value of combined company and present value of the synergy will be presented by formula:

$$PV = \frac{FCF*(1+g)^{n+1}}{Rrand*(1+Rrand)^{n}} - \frac{FCF*(1+g)^{n+1}}{R*(1+r)^{n}} \quad (27)$$

Where: FCF – combined cash flow of the company in the year of acquisition

- g – long term growth of combined company
- R – discount rate for the combined company before acquisition
- Rrand – discount rate for the combined company after acquisition determined by triangular distribution with parameters Rrand – minimum; R most probable; R maximum.

Option to reorganize, split and divest assets of the company (<u>not covered by our method</u>)

As presented by Mikael Collan (Collan, 2009a) acquirer may have opportunity to reorganize the target and itself to compose separate combinations of assets and sell them separately on favorable conditions.

Although strictly speaking this option is not considered as a part of synergy it is proven by Collan based on acquisition of Partek by KONE and followed reorganization that this strategy can also bring great benefits to the acquirer.

Acquirer has opportunity to create unique combinations of assets and sell them as separate entities realizing capital gain profits and on the other side acquirer will have to also incur significant losses associated with post-merger integration. Thus this strategy can also be evaluated in using real options frameworks.

On the other hand real options associated with integration of companies (operational, financial) and real options associated with reorganization of the companies and subsequent divesture can be mutually exclusive because reorganization process is be highly disruptive and may prevent the acquirer from extracting operating synergies.

Concluding we would like to underscore the significance of these types of synergies and if option to split is clearly identifiable *and does not destroy the operating and financial synergies*

it can also be valued in the acquisition using real options approach. However our method values only operating synergies and cannot be applied to the options mentioned above if they are existent in the considered combination. Separate valuation model should be constructed as operating synergies and financial synergies have cost of integration as a "strike" and options to split and divest have *cost of reorganization* as a "strike".

2.4.4 Real options logic in M&A

In this paragraph we will explain in more detail the real options logic in the methodology and how the company extracts value from flexibility.

The whole process of acquisition and integration is presented in Figure 2.9. The main uncertainty lies in the period between decision on acquisition and decision on integration.

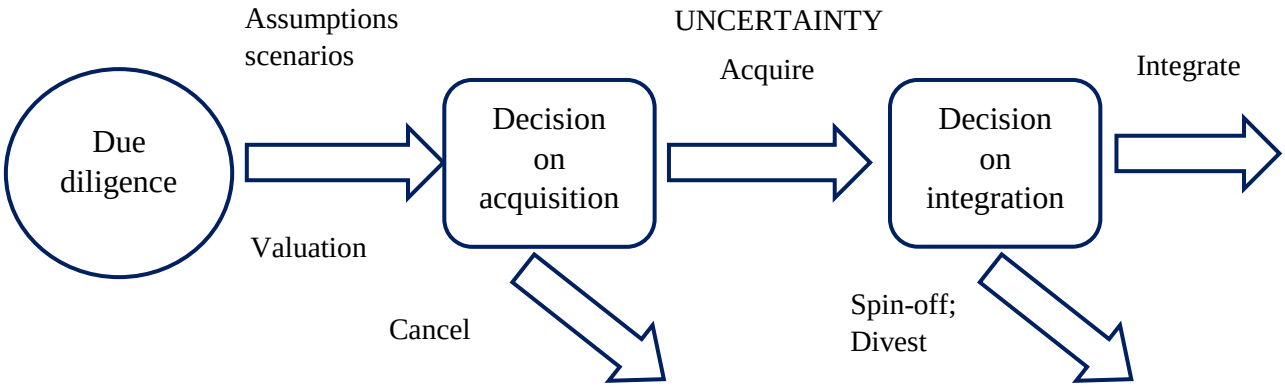


Figure 2.9 Acquisition process and uncertainty

After initial due diligence the total value of expected synergies is based on the assumptions about the compatibility of companies and other relevant factors. Thus both the expected value of synergies and the cost of integration are uncertain figures. This uncertainty is resolved only when the target is acquired and the acquirer can see exactly how much will the integration will costs and whether it is worth to proceed with that.

So if after acquisition expected value of synergies and integration costs are confirmed using insider information from the target and PV of synergies package is higher than integration cost company may proceed with integration, if not, acquirer may cancel the integration and leave the target as a separate entity or spin-off this way exercising option to abandon.

That is why total value of expected synergies should be:

$$\text{Value of synergies} = \text{Average}[\text{Max}(PV(\text{synergies}) - PV(\text{Integration costs}), 0)] \quad (28)$$

We should note that the acquirer will have to incur *transaction costs (fees to M&A intermediaries)* and will not be able to avoid these losses even if it will not proceed with

integration and leave the target as separate entity (or spin-off). Thus we should take into account that issue if transaction costs are significant.

Another issue is that integration may be more realistically represented as a *multistage process* where acquirer may have option to choose to integrate partially (integrate several overlapping departments and so on). These two issues are very important for further research to improve the model, however it goes beyond the goal and scope of this work.

2.4.5 Doing simulation modelling

After we identified and specified probability distributions and formulas for synergies and cost of integration we build general formula for simulation in the following form for k simulations:

For n ∈ {1:k}:

NPV_n(total synergies) = PV_n(costsyn) + PV_n(revenuesyn) + PV_n(growthsyn) + PV_n(taxsyn) + PV_n(bcsyn) + PV_n(drsyn) – PV_n(CI) (29)

Where:

- PV_n(revenuesyn) - formula for calculating revenue synergies
- PV_n(costsyn) – formula for calculating cost synergies
- PV_n(growthsyn) – formula for calculating growth synergies
- PV_n(taxsyn) – formula for calculating tax synergies
- PV_n(bcsyn) – formula for calculating borrowing capacity synergies
- PV_n(drsyn) – formula for calculating discount rate synergies
- PV_n(CI) –cost of integration defined by triangular distribution function

After k simulations we get k NPV values for total package of synergies in the following form (Figure 2.10):

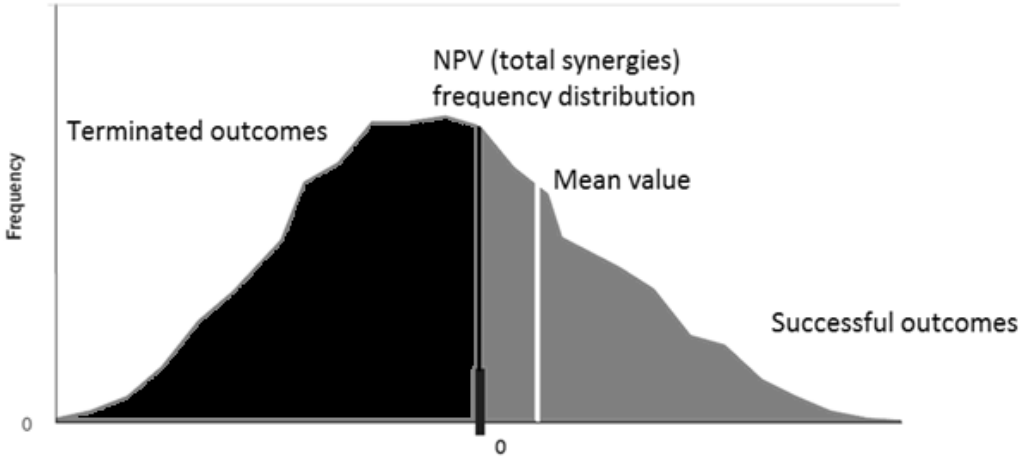


Figure 2.10 Distribution of outcomes

The value of synergies we derive as a positive mean of distribution of NPV outcomes:

Value of synergies = Average[Max(PV(synergies) – PV(Integration costs), 0)] (30)

For example the acquirer which expects cost synergy and growth synergy will calculate value of synergy in one simulation using the following formula:

After obtaining combined value of synergies we *build our bidding strategy* around the equality

$$\underline{IV + S > MV + P}$$

Where:

- IV – intrinsic value of the target
- S – expected value of synergies
- MV – market value of target
- P – required premium to acquire the target

From the formula above we can see that target should be acquired only if its intrinsic value plus acquired value of synergies is greater than the total amount of money the acquirer should pay for the target. In the next chapter we are going to demonstrate how this method works using several M&A deals.

As we have noted in the beginning of the chapter in order to implement this method the user should not implement all the steps manually. We have created software ("SynergyCalculator" VBA application) which includes all formula and rules for triangular distributions in its core.

It is very convenient and easy to use. The user of software should just enter the economic characteristics for the acquirer and the target (tax rate, EBIT, Revenue and others) and his or her scenarios for uncertain parameters of synergies for example cost reduction pessimistic, optimistic, and most probable scenarios.

3. DEMONSTRATION OF METHOD ON M&A CASES

Information for the cases below has been derived using public sources of data such as SEC filings, prospectuses, annual reports and data from Databases. The detailed list of sources is presented in reference list.

3.1 Pfizer – Hospira (2015)

On 5th February 2015 Pfizer announced friendly acquisition of entire share capital of Hospira, manufacturer and seller of pharmaceutical products. Pfizer offered 90 USD cash per with total value of 16,771 mln USD with around 39% premium. Following the acquisition Hospira shares has been delisted from New York Stock exchange.

Acquirer, Pfizer is global established Pharma company headquartered in New York (USA), it is listed on New York, London, Swiss and Euronext Stock Exchanges. The mission of the company to become a premier innovative biopharmaceutical corporation with the purpose to improves the lives of the patients. In 2014 alone Pfizer issued 131 patents in the US and 1730 patents outside the US. Company has huge scale of operations serving 175+ markets with 130 distribution network sites and 200+ supply partners.

Pfizer sells 600+ major product groups and operates in the following main segments:

- Global Innovative Pharmaceutical Business (GIP)
- Global Vaccines, Oncology and Commercial Healthcare (VOC)
- Global Established Pharmaceuticals (GEP)

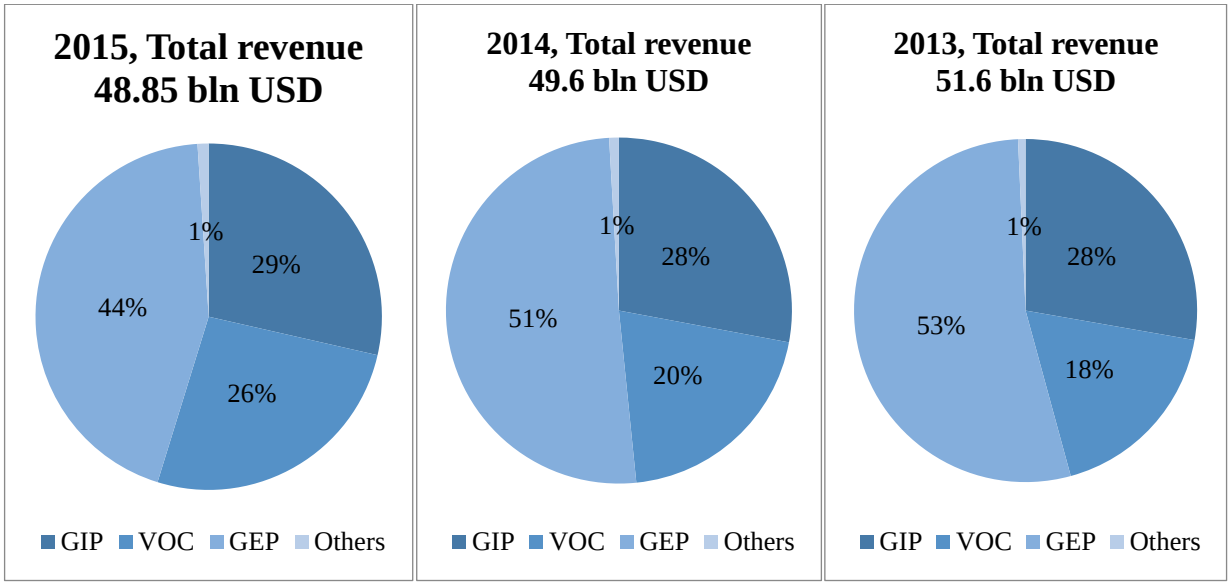


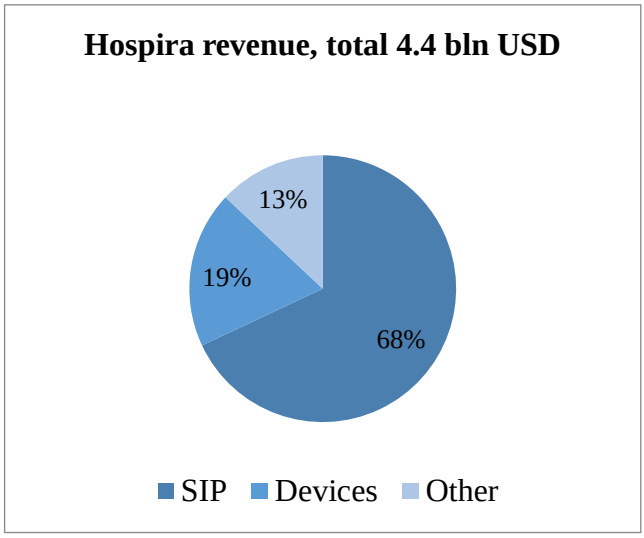
Figure 3.1 Pfizer revenue (2015, 2014, 2013)

In 2015 Pfizer decided to bid to acquire Hospira pursuing with the main goal to become a leader in a fast-growing sterile injectable and biosimilars segment.

Hospira is a leading provider of injectable drugs and infusion technologies with more than 80 years of experience, 19000 employees and 15 manufacturing plants. It operates in 3 segments:

- Specialty Injectable Pharmaceuticals (SIP)
    - Recognized leader in major markets but most sales are in the US
    - 200 products with differentiated specifications
- Biosimilars
    - Top global company in the segment with 3 main products: EPO, GCFS, Infliximab)
    - More than 5 years experience in Europe and Australia
- Devices (Leader in medication management systems). 3 platforms:
    - Infusion
    - Pain management
    - Ambulatory devices

Company has revenue of around 4.4 bln USD in 2014 and the product segmentation was as following, presented in Figures 3.2 and 3.3



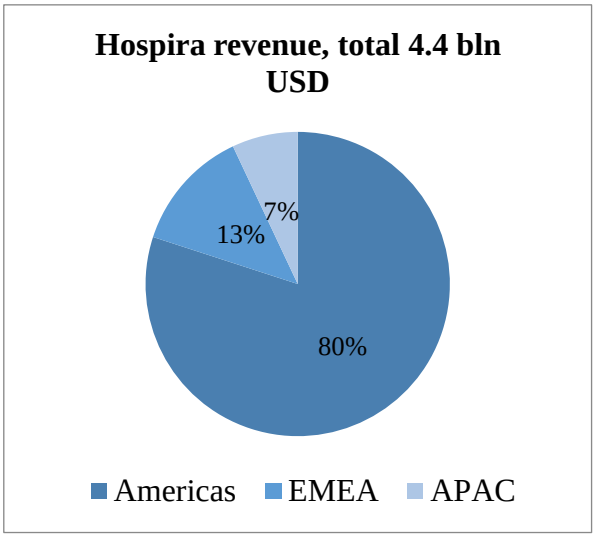


Figure 3.2 Hospira product segments

Figure 3.3 Hospira Markets

Most of revenues comes from SIP segment and overwhelmingly from domestic market.

Transaction overview

Price:

- $90.00 per share; 100% cash consideration (financed with mix of cash and debt)
- 39% premium to closing price (4 Febr, 2015)

- Transaction value of approximately $16.77 bln USD

Financial impact:

Cost reduction synergies. Combining production, procurement and other operations, cutting management expenses. Analysts came up with number of 800mln USD annual cost reductions achieved in 3 years.

Incremental increased growth in sterile injectables segment which is projected to be 6% - 10% per year until 2020. Sterile injectables (SI) products are part of Pfizer's Global Established Pharmaceuticals segment which revenues has been consistently falling over the last years and this acquisition should help to revert this trend

On the other hand Hospira despite being very strong in Sterile Injectibles (SI) segment most of its sales are coming from domestic market and combination with Pfizer will help to participate in global growth in this segment leveraging on Pfizer's brand, customer relations and built worldwide distribution see figure (3.4, 3.5).

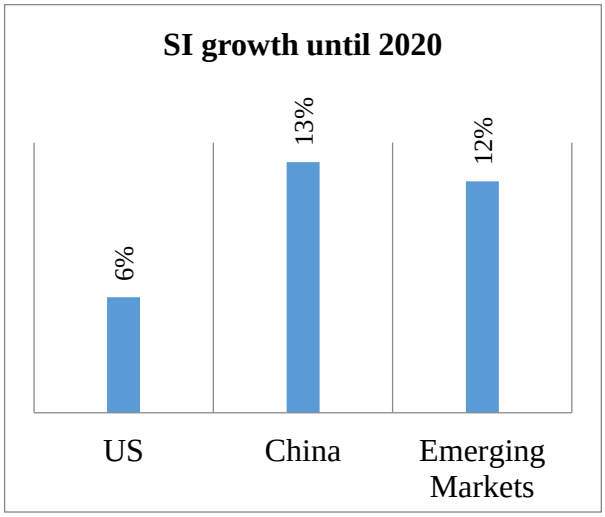


Figure 3.4 SI growth by regions

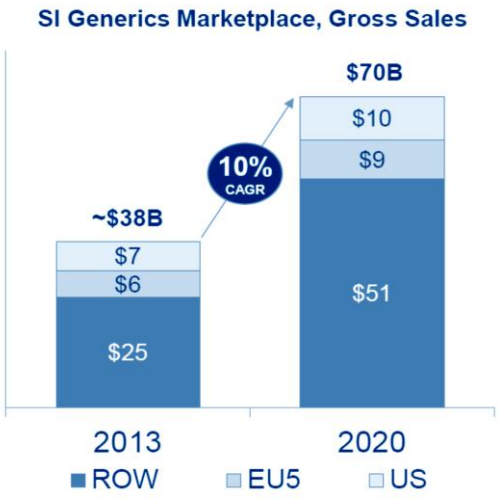


Figure 3.5 SI size growth

So we have identified 2 types of synergies Pfizer expects to extract from the deal

1) Cost reduction synergy
2) Growth reduction synergy

According to our methodology we calculate <u>our bidding strategy around the formula:</u>

$$IV + S > MV + P$$

$$P < IV + S - MV$$

Where: IV – intrinsic value of Hospira, MV – market value of Hospira, S – expected value of synergies, P – required premium to acquire Hospira.

We will take accept market efficiency concept and consider market value of Hospira as a fair value of the company thus MV(Hospira) = IV(Hospira) and inequality turns into:

P < S

Expected value of synergies should be higher that required premium to acquire the target.

Cost synergy parameters

1) Tax. Effective tax rate Pfizer (2014) = Provision for taxes/Earnings before taxes = 3120/12240 = 0.255 = = 25.5%

Effective tax rate Hospira = Provision for taxes / Earnings before taxes = 27 / 388 = 0.186 = 18.6%

We will weigh tax rates using revenues to effective tax rate for the combined company

Revenue (Pfizer) (2014) = 49605 mln USD; Revenue (Hospira) (2014) = 4464 mln USD

T = 25.5%*(49605/(49605 + 4464) + 18.6%*(4464/(49605 + 4464)) = 0.25 = 25%

2) Discount rate. We will calculate WACC first for Pfizer and then for Hospira und will weigh them according to size of the companies.

WACC(Pfizer) = Re*(E/(D + E)) + Rd*(1 – t)*(D/(D + E))

Where re – cost of equity of Pfizer

E – market value of equity of Pfizer

D – market value of debt of Pfizer

Rd - before tax cost of debt

t – effective tax rate

Re = rf + B*(rm – rf)

Rf = 2.29% (Average yield on treasury securities with different maturities)

B = 0.89 (Beta of stock of Pfizer)

Rm = 11% (S&P500 (Annualized Return))

Re = 2.29 + 0.89*(11 - 2.29) = 10%

Rd = Interest expense / (Short term Debt + Long term Debt) = 1360 / (31500 + 5140) = 0.037 = 3.7%

E = 197 bln USD (Jan 2015); D = 36.64 (Dec 2014)

WACC(Pfizer) = 10%*(197/(36.64 +197)) + 3.7%*(36.64/(36.64 + 197))*(1-0.255) = 8.86%

Cost of capital Hospira;

Beta (Hospira) = 1.04; Re(Hospira) = 2.29 + 1.04*(11 - 2.29) = 11.35%

E(Hospira) = 12 bln USD; D(Hospira) = 1.756 bln USD; Rd(Hospira) = IntExp/D = 86 / 1756 = 0.049 = 4.9%

WACC(Hospira) = 11.35%*(12/(12 +1.756)) + 4.9%*(1.756/(12 + 1.756))*(1 – 0.186) = 10.41%

We find WACC for combined company weighing by sizes of the compaies.

WACC(Combined) = 8.86%*(233.64/(233.64 + 13.8)) + 10.41%*(13.8/(233.64 + 13.8)) = 8.95%

3) Number of years to realize the synergy (n) – 3 years (declared by Pfizer analysts)

4*) Cost reduction scenarios.* Although we couldn't obtain data on all three scenarios we are provided with most probable cost reduction by Pfizer analysts. CR(mb) = $800 mln. There is a very low probability that company will not be able to extract synergies CR(pess) = 0 mln. Optimistic scenario we will derive using historical volatility of costs of acquirer as a proxy for probable cost reduction fluctuations. Costs of Pfizer had low volatility over the last three years and maximum deviation from average has been around 10%. Thus for optimistic scenario we will assume CR(opt) = 800*(1.1) = 880.

We have identified all parameters for calculation of cost synergy component:

- t = 25%;
- r(WACC) = 8.95%;
- n = 3 years;
- CR(mb) = $800 mln; CR(pess) = 0 mln; CR(opt) = 880

Parameters for Growth Synergy

1) *Revenue of combined company* R = R(Pfizer, 2014) + R(Hospira, 2014) = 49,650 bln + 4464 bln = 54,114 bln

2) *% of revenue represented by sterile injectables segment* = Revenue from SI / Total revenue

Revenue from SI (Pfizer) = 3277

Revenue from SI (Hospira) = 68%*4464 = 3036

%Revenue from SI = (3277 + 3036) / 54114 = 11.7%

3*) FCFS (FCF as a percentage of sales, Pfizer, 2014)* = FCF/Revenue

FCF(2014, Pfizer) = EBIT*(1 – T) + D&A – dNWC – CAPEX

dNWC = NWC2014 – NWC2013 = (57.7 bln – 18.6 bln) – (56 bln – 21.31 bln) = 3.5 bln

CAPEX = Change in net PPE + Depr = -0.5 bln

FCF(2014, Pfizer) = 12240*(1- 0.255) + 5537 – 3500 +500 = 11656 mln USD

FCFS = 11656/54114 = 23.5%

4) *r(WACC for combined company)* = 8.95% (calculated in previous section)

5) *k – number of years company can sustain increased growth rate*. Analysts from Pfizer claim that combined company will grow at high growth rate from 2015 – 2020, 5 years

6) *Old growth.* Growth in Pfizer in this segment has been actually close to zero. Growth in Hospira has been very unstable and last year 12% with no growth in previous years. For the purpose of valuation we will take average of growth in last two years with average 6%.

Growth of SI segment without merger for both companies would be:

GrowthOld(weighed) = 0*(3277/(3277 + 3036)) + 6%*(3036//(3277 + 3036)) ≈ 3%

7) *New growth defined by 3 scenarios.* Pfizer defined 3 scenarios of growth in SI segment if merged with Hospira;

G(opt) = 12%; High growth equal to project SI growth in developing countries (2015 – 2020)

G(most probable) = 9% - average growth of SI between emerging markets and US (12% and 6%)

G(pess) = 3%; There is small possibility that synergy extraction will be unsuccessful and company will grow to growth current combined long term growth of 3%

Now we have all parameters required to calculate growth synergy:

- R (Combined revenue) = 54,114 bln
- %Revenue from SI segment = 11.7%
- FCFS = 23.5%
- r (WACC) = 8.95%
- k (growth years) = 5
- GrowthOld(weight) = 2.9%
- New growth scenarious: G(opt) = 12%; G(most probable) = 9%; G(pess) = 3%

Cost of integration. Pfizer did not elaborate how much will be spent on integration and that is why we will base our assumptions on EY integration survey where they presented how much on average has been spent to integrate the target after acquisition (EY, 2003).

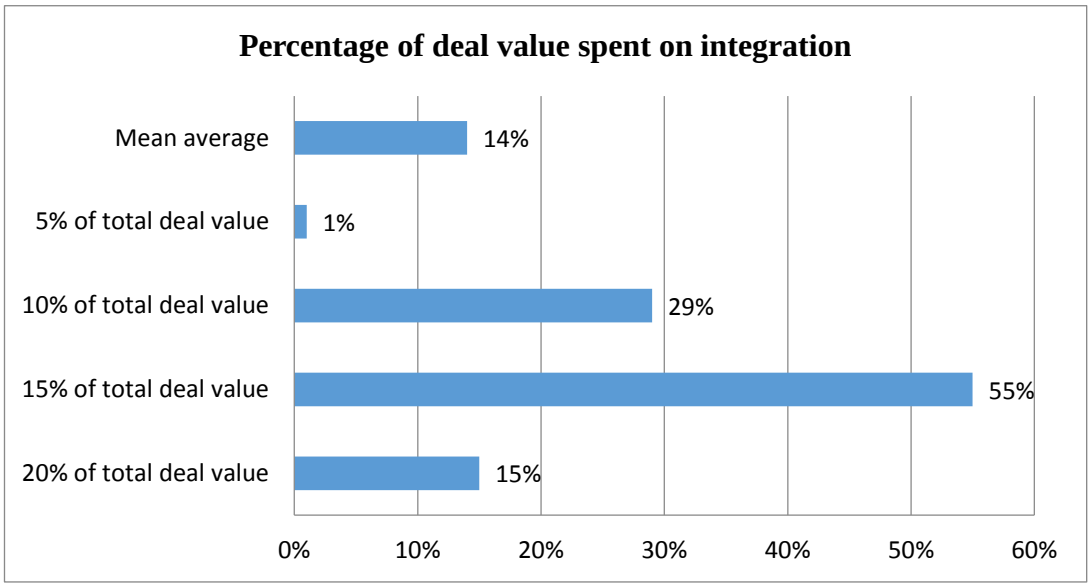


Figure 3.6 Percentage of deal spent on integration (EY, 2013)

Using results of EY analysis we will built our external assumptions for pessimistic, optimistic, and most probable scenarios. So we well have the following scenarios for cost of integration(Coi):

- Coi(opt, 5%) = 0.05*17bln = 850 mln
- Coi(most prob.) = 0.1*17bln = 1.7 bln
- Coi(pess) = 0.2*17bln = 3.4 bln

Then we submit these parameters to our VBA software, set the number of simulations 10000 and after running we get the number in the separate window representing expected value

of synergies. For different numbers of simulations results produce synergies valued at around 5.9 bln USD, in reality Pfizer paid around 5 bln premium. According to our valuation the acquisition should have increased value of shareholders because calculated synergy is almost 20% greater than premium they paid.

We have back checked the share price of Pfizer and how it has been affected in short and medium term by the deal. On announcement day Pfizer's share price initially jumped from $32 to $35 over the next several weeks, however, in year it dipped below $30 and now it is around $33 (April 2016). We can conclude that the deal hadn't had some decisive effect on Pfizer so the deal maybe fairly priced.

3.2 AT&T – DirectTV (May 2014)

AT&T overview. Alexander Graham Bell inventor of phone set up a company in 1876 that would later become AT&T. Over the years it has gone through series of acquisitions and divestures to become world's largest communications company in the world with more than 280 mln people subscribers covered by AT&T LTE services and 4G.

In the Figure 3.7 are presented main revenue drivers for AT&T (2013).

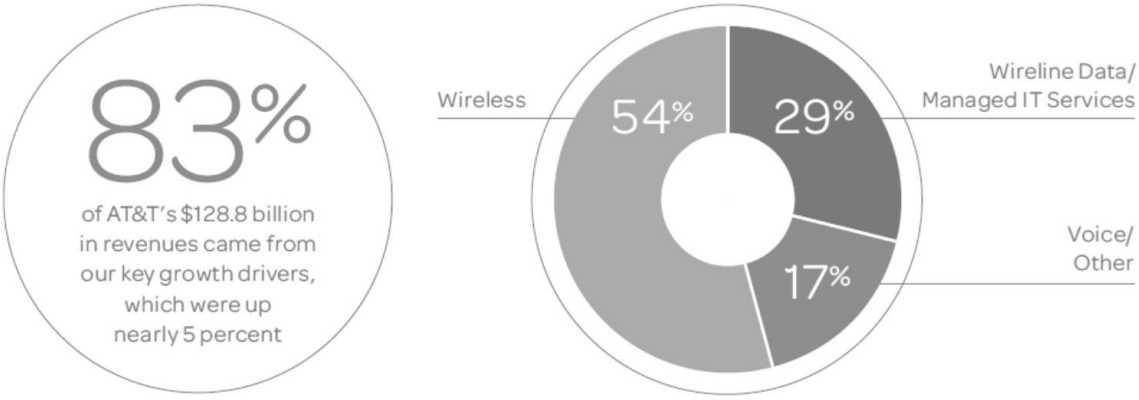


Figure 3.7 AT&T revenue drivers

DirecTV overview. DirecTV is a leader TV pay provider in the world and promotes direct broadcasting television and audio services using satellite channels. DirecTV has 20.3 mln clients in the US and 18.1 mln clients in Latin America. DirecTV has growth about 4% growth in the US and impressive +20% growth in Latin America. The deal was announced on 18th of May 2014, AT&T paid 67186 mln USD for DirecTV with about 22.42% premium.

AT&T hoped to get revenue synergies from a combination of two complimentary businesses projecting 15 million new customer locations through cross selling. In addition significant cost synergies were expected at size at least $1.6 bln by year 3.

Cost synergy parameters

1) Tax. Effective tax rate (AT&T), Average tax rate for 2013, 2012, 2011 = 32.9%

Effective tax rate (DirecTV) = Average tax rate for 2013, 2012, 2011= 34.18%

We will weigh tax rates using revenues to effective tax rate for the combined company

Revenue (AT&T) (2013) = 128,752 mln USD; Revenue (DirecTV) (2013) = 31,754 mln USD

T = 32,9%*(128,752/(128,752 + 31,754) + 34,18%*(31754/(128,752 + 31,754)) = 0.25 = 33.15%

2) Discount rate. We will calculate WACC first for AT&T and then for DirecTV und will weigh them according to size of the companies.

WACC(AT&T) = Re*(E/(D + E)) + Rd*(1 – t)*(D/(D + E))

Where re – cost of equity of AT&T

E – market value of equity of AT&T

D – market value of debt of AT&T

Rd - before tax cost of debt

t – effective tax rate

Re = rf + B*(rm – rf)

Rf = 2.29% (Average yield on treasury securities with different maturities)

B = 0.33 (Beta of stock of AT&T)

Rm = 11% (S&P500 (Annualized Return))

Re = 2.29 + 0.33*(11 - 2.29) = 5.16%

Rd = Interest expense / (Short term Debt + Long term Debt) = 3940 / (5498 + 66358) = 5.48%

E = 184.6 bln USD (Nov 2014); D = 74,788 mln (End 2013)

WACC(AT&T) = 5.16%*(184.6/(184.6 +74.788)) + 5.48%*(74.788/(74.788 + 184.6))*(1 – 0.329) = 4.73%

Cost of capital DirecTV;

Beta (DirecTV) = 1.04; Re(DirecTV) = 2.29 + 1.04*(11 - 2.29) = 11.35%

Rd(DirecTV) = IntExp/D(2012) = 840 / 17528 = 0.049 = 4.8%

E(DirecTV) = 55,618 mln USD; D(DirecTV, 2013) = 19,540 mln USD;

WACC(DirecTV) = 11.35%*(55,618 6/(55,618 +19,540)) + 4.8%*(19,540 /(19,540 + 55,618))*(1-0.3418) = *9.22%*

We find WACC for combined company weighing by sizes of the companies (E+D).

WACC(Combined) = 4.73%*(259.4/(75.158 + 259.4)) + 9.22%*(75.158/(75.158 + 259.4)) = 5.74%

3) Number of years to realize the synergy – 3 years (declared by Actavis analysts)

4) Actavis analysts claim that that cost reductions should be at least 1600 mln USD So in most probable scenario CR(mb) = $1600 mln and in optimistic scenario $1700 mln. There is a very low probability that company will not be able to extract synergies CR(pess) = 0 mln.

We have identified all parameters for calculation of cost synergy component:

- t = 33.15%;
- r(WACC) = 5.74%;
- n = 3 years;
- CR(mp) = $1600 mln; CR(pess) = 0 mln; CR(opt) = 1700 mln

Revenue synergy parameters

1) *Revenue increase scenarios.* We will first calculate most probable scenario for revenue increase through cross selling. We know that AT&T expects 15 million new customer locations. As for 2013 AT&T had 280 mln total customer locations and 128,752 mln operating revenues. Thus per customer location AT&T had on average the following amount of Revenue:

Yearly revenue per customer location = Revenue AT&T(2013)/Number of customer locations = $\frac{\$128{,}752\ mln}{280\ \text{mln}} \approx \$460$

So revenue in year should be around = 15 mln * $460 = $6.9 Bln. R(most probable) = 6.9 Bln. There is low probability that the synergy will be realized: R(pess) = 0; Optimistic scenario R(opt) is 10% more: R(opt) = $7.6 Bln

2) FCFS (FCF as a percentage of sales) = FCF/Revenue

FCF(2013, AT&T) = EBIT*(1 – T) + D&A – dNWC – CAPEX

dNWC = NWC2013 – NWC2012 = (23196 – 34995) – (22709 – 31787) = -2721 bln

Effective tax rate (AT&T, 2013) =

CAPEX = Change in net PPE + Depr = 1207 + 2690 = 3897 mln

FCF(2014, Actavis) = 30,479*(1- 0.329) + 2690 – 3897 + 2721 = 21,965.41 mln USD

FCF was negative for that moment for Actavis, that is why we will take cash flows from operations as proxy for calculation of FCFS.

FCFS = CFO/Revenue 21,965/128,752 = 17%

3) r (WACC for combined company) = 5.74% (calculated in previous section)

4) Number of years to realize the synergy – 3 years (declared by Actavis analysts)

We have identified all parameters for calculation of revenue synergy component:

- FCFS = 17%;
- r(WACC) = 5.74%;
- n = 3 years;
- R(mp) = $6,900 mln; R(pess) = 0 mln; R(opt) = 7,600 mln

Cost of Integration. Actavis hasn't given any figures for cost of integration and we will use again results of EY cost of integration survey to calculate cost of integration scenarios for the deal.

- Coi(opt, 5% of deal) = 0.05*37.6bln = 3320 mln
- Coi(most prob. 10% of deal) = 0.1*37.6bln = 6640 mln
- Coi(pess, 20% of deal) = 0.2*37.6bln = 13281 mln

In the end we submit these parameters to our VBA software, set the number of simulations 10000 and after running we get the number in the separate window representing expected value of synergies. Accepting market efficiency will consider market value of DirecTV as its fair value and will try to independently valuate and find intrinsic value of the company. Our software gives the result of 15.317 Bln USD for the total pack of synergies. In fact AT&T paid around 11.57 Bln USD 1 months premium. According to our valuation the deal should have been profitable for shareholders of AT&T and increased its share price.

We have again checked the share price of AT&T and how it has been affected in short and medium term by the deal. At the time of acquisition acquirer's share price was around $36. During the first months after announcement day AT&T's share price has gone through some

volatility falling down to 33. However in 1.5 year share price started to grow at a very fast pace reaching almost $39 by April 2016 to 8 year high. Summarizing, we can say that it is not yet clear which impact the deal had on AT&T. However, eventual stock rise can give ground to contend that it has certainly not been a failure confirming the soundness of results of valuation.

3.3 Actavis – Allergan (Nov, 2014)

Friendly merger of two pharmaceutical companies created new top 10 global company. The deal has been announced on 17th of November 2014, Actavis paid 66Bln USD paying $219 per share with massive 64% 1 day premium and 77% 1 week premium. Later in 2015 Actavis adopted Allergan name for the whole merged combination. The main rationale for shareholders of acquirer behind the deal was to create high growing country resulted from combination, gain from expected vast cost and financial synergies and probable revenue synergies. High growth was expected to result from combined vast commercial reach, cross selling and participation in high growth in BioPharma segments.

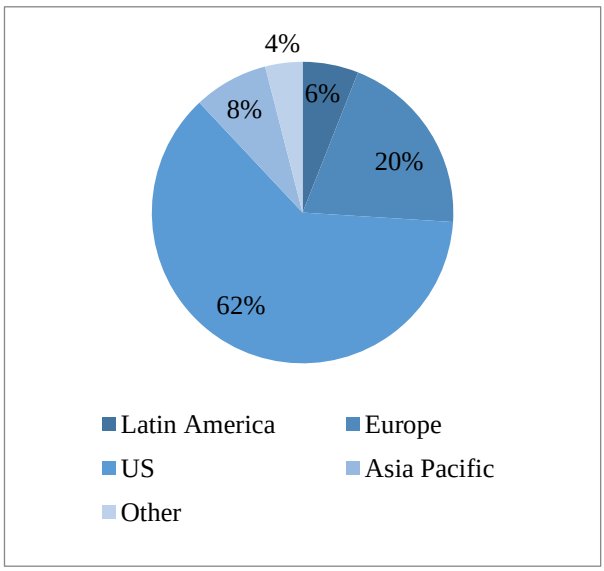
Actavis is one of the leading integrated global pharmaceutical companies which does the development, manufacturing, sale and distribution of generic, biosimilar and over-the-counter ("OTC") pharmaceutical products. Company operates in 60 countries across the world and sells 250 generic product families and 45 branded products it has own global distribution called "Anda Distribution"

Allergan is multi-specialty health care corporation. It focuses on developing manufacturing and selling pharmaceutical products, biological products, medical services and over-the-counter products. It had a presence in around 100 countries and employed around 11500 employees.

Key segment products include:

- Ophthalmic
- Neurological
- Aesthetics
- Dermatology/Plastic Surgery

In the figures 3.8 and 3.9 you can see Allergan's sales segmentation



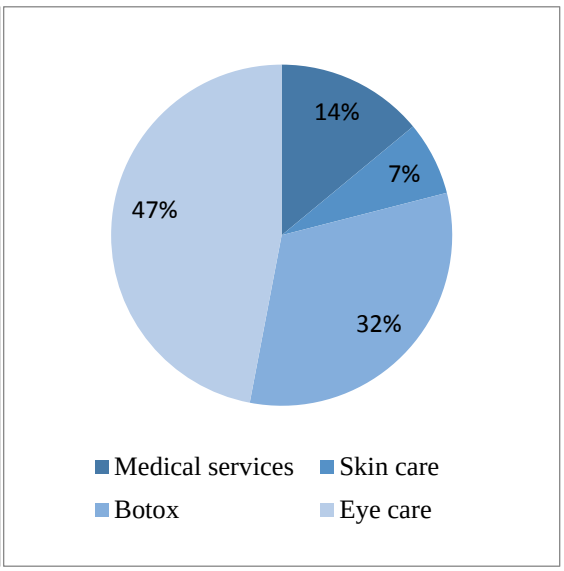


Figure 3.8 Sales by regions Figure 3.9 Sales by products

Allergan is a high growing company with projected growth presented in figure 3.10.

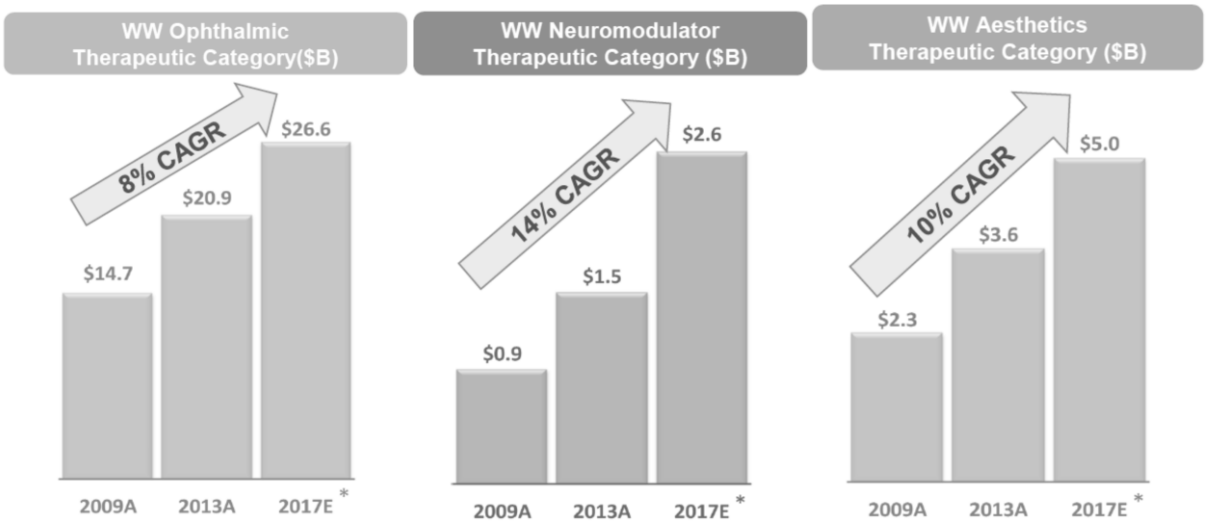


Figure 3.10 Allergan growth by segments

Actavis claims that financial benefits from expected synergies are highly probable citing successful track of record in previous acquisitions of Actavis, Allergan and their subsidiaries (Figure 3.11)

		Timing	Synergies/Costs
Watson Pharmaceuticals	actavis	Faster	Overachieved
Actavis	Warner Chilcott	Faster	Overachieved
Forest Laboratories, Inc.	Aptalis	Faster	Overachieved
Forest Laboratories, Inc.	Rejuvenate	Faster	Overachieved
Actavis	Forest Laboratories, Inc.	Faster	Overachieved
Allergan	Endurance	Faster	Overachieved

Figure 3.11 Previous acquisitions' results of Allergan and Actavis

For the purpose of demonstration of method we will accept market efficiency concept and consider market value of the target as its fair value. Thus in bidding process Actavis should pay a premium to acquire the Allergan no more than value of expected synergies. Expected financial benefits to shareholders of Actavis declared by analysts are presented below.

Cost savings: More than 1.35 Bln USD

New growth: more than 10% growth rate for the combined company in observable future

Effective tax rate for the combined company expected to decrease to ≈15%

Cost synergy parameters

1) Tax. Effective tax rate (Actavis) (2014) = Average tax rate for 2012, 2011, 2010, 2009 = 35.35% (in 2013 Actavis wasn't profitable)

Effective tax rate Allergan = Provision for taxes / Earnings before taxes = 458/1731 = = 26.46%

We will weigh tax rates using revenues to effective tax rate for the combined company

Revenue (Actavis) (2014) = 8678 mln USD; Revenue (Allergan) (2014) = 5339 mln USD

T = 35.35%*(8678/(8678 + 5339) + 26.46%*(5339/(8678 + 5339)) = 0.25 = 25.45%

2) Discount rate. We will calculate WACC first for Actavis and then for Allergan und will weigh them according to size of the companies.

WACC(Actavis) = Re*(E/(D + E)) + Rd*(1 – t)*(D/(D + E))

Where re – cost of equity of Actavis

E – market value of equity of Actavis

D – market value of debt of Actavis

Rd - before tax cost of debt

t – effective tax rate

Re = rf + B*(rm – rf)

Rf = 2.29% (Average yield on treasury securities with different maturities)

B = 0.74 (Beta of stock of Actavis)

Rm = 11% (S&P500 (Annualized Return))

Re = 2.29 + 0.74*(11 - 2.29) = 8.74%

Rd = Interest expense / (Short term Debt + Long term Debt) = 240 / (8517 + 535) = 0.0265 = 2.65%

E = 66.37 bln USD (Nov 2014); D = 9.052 (End 2013)

WACC(Actavis) = 8.74%*(66.37/(66.37 +9.052)) + 2.65%*(9.052/(66.37 + 9.052))*(1 – 0.3535) = 7.9%

Cost of capital Allergan;

Beta (Allergan) = 0.78; Re(Allergan) = 2.29 + 0.78*(11 - 2.29) = 9.1%

E(Allergan) = 37.6 bln USD; D(Allergan) = 1.527 bln USD; Rd(Allergan) = IntExp/D = 75 / 1527 = 0.049 = 4.9%

WACC(Allergan) = 9.1%*(37.6/(37.6 +1.527)) + 4.9%*(1.527/(37.6 + 1.527))*(1-0.2646) = *8.89%*

We find WACC for combined company weighing by sizes of the companies (E+D).

WACC(Combined) = 7.9%*(75.4/(75.4 + 39.13)) + 8.89%*(39.13/(75.4 + 39.13)) = 8.24%

3) Number of years to realize the synergy – 3 years (declared by Actavis analysts)

4) Actavis analysts claim that that cost reductions should be not lower than 1350 mln USD. So in most probable scenario CR(mb) = $1350 mln and in optimistic scenario $1500 mln. There is a very low probability that company will not be able to extract synergies CR(pess) = 0 mln.

We have identified all parameters for calculation of cost synergy component:

- t = 25.45%;
- r(WACC) = 8.24%;
- n = 3 years;
- CR(mb) = $1350 mln; CR(pess) = 0 mln; CR(opt) = 1500 mln

Parameters for Growth Synergy

1) Revenue of combined company

R = R(Actavis, 2013) + R(Allergan, 2013) = 8678 mln + 6197.5 mln = 14876 mln

2) % of revenue with new growth ≈ 100%

3) FCFS (FCF as a percentage of sales, Actavis, 2011, 2013 is unprofitable year) = FCF/Revenue

FCF(2014, Actavis) = EBIT*(1 – T) + D&A – dNWC – CAPEX

dNWC = NWC2012 – NWC2011 = (4105 – 1808) – (3518 – 2292) = 1071 bln

CAPEX = Change in net PPE + Depr = 1616 – 1485 +202 = 333 mln

FCF(2014, Actavis) = 523.4*(1- 0.43) + 448 – 1071 - 333 = -656 mln USD

FCF was negative for that moment for Actavis, that is why we will take cash flows from operations as proxy for calculation of FCFS.

FCFS = CFO/Revenue 1214/8678 = 14%

4) r (WACC for combined company) = 8.32% (calculated in previous section)

5) k – number of years company can sustain increased growth rate. Analysts from Actavis claim the period "observable future" for the purpose of valuation we assume that it is 2015 – 2025, 10 years

6) Old growth. Analysts from Actavis claimed that company would grow as standalone only at 8% over the same period

7) New growth defined by 3 scenarios. Actavis claims 10% to minimum growth rate combined and we will assume that its most probable so G(most probable) = 12%; There is very low probability that in case of wrong integration or other shocks synergy will not be realized and growth would stay the same G(pess) = 8%. And in optimal scenario combined company will grow with rate of Allergan's main segments G(opt) = 14%;

Parameters for growth synergy:

- R (Combined revenue) = 14876 mln

- %Revenue affected = 100%
- FCFS = 14%
- r (WACC) = 8.24%
- k (growth years) = 10
- GrowthOld(weight) = 6%
- New growth scenarious: G(opt) = 14%; G(most probable) = 10%; G(pess) = 6%

Tax synergy.

1. Calculating earnings before taxes (EBT) we will use average of EBT(2011) and EBT(2012) of Actavis because EBT(2013) has been negative due to very high investments in working capital and CAPEX.

EBT(Actavis) = (EBT(2011) + EBT(2012))/2 = 351 mln

EBT(2013) = EBT(Actavis) + EBT(Allergan, 2013) = 351 + 1731 = 2082 mln

2. Horizon period (K) – number of years in horizon period – 10, 2015 – 2025

3. High growth during horizon period (g1) – 10%

4. Growth rate beyond horizon period, long term (g2) – 3%

5. WACC(calculated in previous section) – 8.32%

6. Tax rate before merger (t) – 25.45%

7. New tax rate scenarios. T2(most probable) = 15%; T2(pess) = 25%(will not change); T2(opt) = 14% (exceeding expectations)

Parameters for tax synergy:

- EBT = 2082 mln;
- k = 5 years
- g1 = 10%
- g2 = 3%
- WACC = 8.24%
- T = 25.45%
- T2(most probable) = 15%; T2(pess) = 25%(will not change); T2(opt) = 14% (exceeding expectations)

Cost of Integration. Actavis hasn't given any figures for cost of integration and we will use again results of EY cost of integration survey to calculate cost of integration scenarios for the deal.

- Coi(opt, 5%) = 0.05*37.6bln = 1880 mln
- Coi(most prob. 10%) = 0.1*37.6bln = 3760 bln
- Coi(pess, 15%) = 0.15*37.6bln= 5640 bln

Next we submit these parameters to our VBA software, set the number of simulations 10000 and after running we get the number in the separate window representing expected value of synergies. For 1000 simulations model produces valuation of total pack of synergies around 22.4 bln USD. In fact Actavis paid around 28.7 bln USD premium. If Allergan's intrinsic value at the time was not significantly higher that it market value (undervalued) then Actavis overpaid around 6.3 bln USD. The most important synergy in this deal according to our valuation model is growth synergy. Thus in order the deal to be profitable Actavis must have justified higher growth assumptions scenarios in their valuation model to compensate huge 77% premium.

We have back checked the share price of Actavis and how it has been affected in short and medium term by the deal. During the first months after announcement day Actavis's share price initially increased from around 260 to over 310 USD per share. However in 1 year share price started to decline and has been devalued recently down to 216 (April 2016). Summarizing, we can contend that the deal eventually failed to increase the shareholders' value in middle term and one of the mistakes may be attributed to overpayment for Allergan.

3.4 Summary

Summary of valuations you can see in table 3.1

Table 3.1

	Pfizer - Hospira	AT&T - DirecTV	Actavis - Allergan
Valuation of synergies	$5.9 Bln	$11.57 Bln	$22.4 Bln
Result	Underpaid 0.9 Bln	Underpaid 3.75 Bln	Overpaid $6.3 Bln
Stock price change	$32 (Febr 2015) – $33 (Apr 2016)	$36 (May 2014) – $39 (Apr 2016)	$260 (Nov 2014) – $214 (Apr 2016)
Predictive power	Confirmed	Confirmed	Confirmed

We have found that in Pfizer – Hospira and AT&T – DirecTV deal the value of expected synergies was higher than premium paid by 18% and 48% respectively. We should have expected positive impact on stock value of the acquirers if other factors had not erased these positive gains. For these two deals stock of acquiring increased slightly or moderately in 1 – 1.5 years. We cannot say unequivocally that the deals produced brilliantly positive effect however it is clear these deals were not failures thus the deals were either fairly priced eventually or may realize in medium term its value increasing potential as integration process goes on.

In Actavis – Allergan deal our valuation showed that the value of expected synergies is about 22% lower than the premium offered thus it should have had negative influence on stock price of Actavis. In fact after abound 1.5 years since announcement of merger share price of Actavis decreased from $260 to $214 which may confirm results of our valuation if other factors hasn't caused such a strong negative impact.

Generally we can conclude that our method produced sound results explaining well ex-poste movement of stock price of acquirers. It confirms its validity and importance for managers and practitioners as another tool to do valuations in M&As. It could be most useful after initial due diligence stage when acquirer possesses main information about the target and its analysts can build scenarios for each type of synergies expected to be extracted after acquisition and integration.

Once again we will repeat shortly how it should be used. The users should launch the program ("SynergyCalculator" VBA application). Initially all synergies are inactive and practitioner should turn on those types of synergies expected in the deal by clicking on checkbox "TICK THE CHECKBOX TO ENABLE THE SYNERGY". Depending on a type of synergy practitioner fills the parameters which represent internal information about the company (FCF, REVENUE, WACC and so on). On the right side of window should be submitted results of analysts about the optimistic, pessimistic and most probable scenarios of uncertain parameters and later cost of integration on the last tab of the program.

If the intrinsic value of target is expected to be different from its market value the practitioners should do independent valuation of target as standalone and submit it in a separate window on the last tab. In the case target is not public company we submit calculated intrinsic value both in window with market and intrinsic values. After entering the number of simulations and pushing button "CALCULATE" in windows "SYNERGY TOTAL VALUE" and "PAY PREMIUM LESS THAN" are presented figures of bidding strategy explaining which maximum premium over target's market value company should pay.

3.5 Limitations and areas of improvement

1. Assumptions. As mentioned in previous chapters our method is based of analysts' optimistic, pessimistic and most probable scenarios for values of uncertain synergy parameters. It means that accuracy of valuation will still be strongly dependent on quality of analysis and on how much we know about the target.

2. Triangular distribution. In our method we use simple triangular probability density function to quantify the uncertainty which is widely used in Corporate Finance. It has serious limitations because it is based on three points and linear functional dependence between

uncertain parameter's value and its probability. Thus it doesn't accurately represents the reality and in future researches scholars may try to use other distributions (trapezoidal, skewed and so on) to obtain more accurate results.

3. Multistage integration. In our method integration is considered to be one stage process of a certain length (for example 3 years), in reality integration may consist of several relatively independent processes which we have described in our methodology. Thus company may integrate in several steps and partially (Shrivastava, 1986).

4. Transaction costs. In our method premium is added to market value of the target thus representing total consideration acquirer must pay to initiate the integration. In reality we should also add transaction costs to financial and legal intermediaries. It is also regarding the spin-off or divesture of the target in the case acquirer cancels the integration and wants to get rid of the company. It will also incur similar costs. Generally, both these types of costs could be considerable and affect decision making in M&A resulting from our method.

The limitations presented above represent several exciting dimensions to scholars for future research.

CONCLUSION

In conclusion we will shortly summarize what we have done and which results we have achieved. Firstly, in literature review we have confirmed the actuality of the problem. We have reviewed works of many scholars and found that most of them confirm negative abnormal returns for acquirers in the long term. Other scholars identified two main types of mistakes leading to negative results:

- Valuation mistakes when existing methods fail to adequately measure the scope of benefits from the deal
- Integration mistakes when acquirer can't help to follow the integration plan and extract synergies

The goal and practical significance of the research has been determined to reduce first types of mistakes bringing new toolbox in M&A valuation.

Then we have analyzed synergy categorizations by several prominent authors and set up our own categorization with 8 types of financial and operational synergies for the purpose of valuation. We have confirmed using definition of Bruner(2004) that these synergies can be considered in real options frameworks.

We continued our work by analyzing real options valuations method. We compared 6 groups of methods and have found that modern practical method for synergy valuation (Datar-Mathew method) based on simulation modelling would serve best as basis for our synergy valuation method. It combines intuitive nature of NPV valuation with real options logic.

Then we described bidding strategy combining synergy value, premium, market and intrinsic values of the target. We have explained in the methodology in which way we will measure uncertainty and in our case we chose triangular distribution as the most simple and intuitive approach allowing to operate with scenarios. After that we described in detail mathematical model behind the valuation method. We presented formulas for each of 8 types of synergies, explaining all parameters which should be calculated by practitioners using public and insider information.

In the end of methodology we have explained in detail real options logic behind the method and technical process of calculation. In order to make the process of valuation easy and simple for users we have created software ("SynergyCalculator" VBA application) where all required parameters for synergies are requested in organized and comprehensible manner.

In the third chapter of our work we tested the method valuing synergies in 3 recent M&A cases and confirmed that our method gives sound and adequate results and can serve as one of

the tools in M&A bidding process or due diligence. In conclusion we pinpoint again the advantages of the method, its limitations and areas for improvement and future research. In the attachment to the digital copy of this work you can find the code for software or request the VBA application directly from GSOM St Petersburg State University or the creator.

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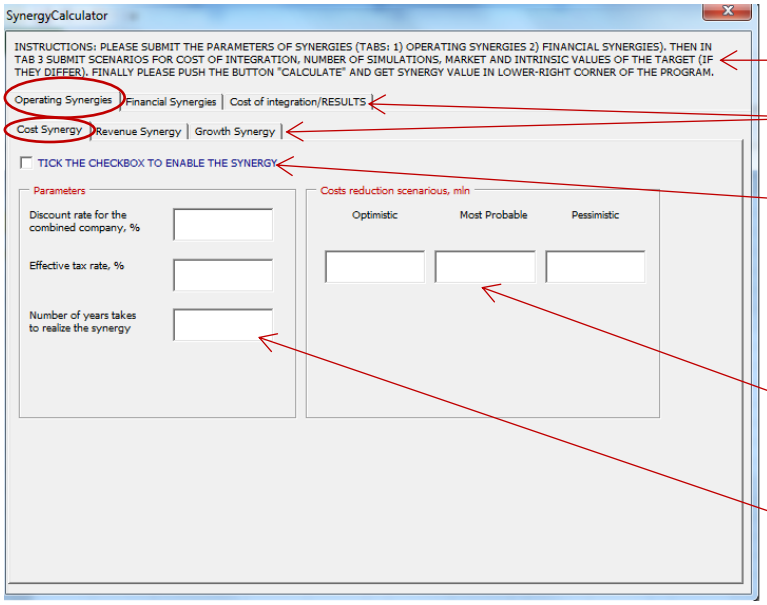
APPENDIX

Appendix 1. VBA program interface



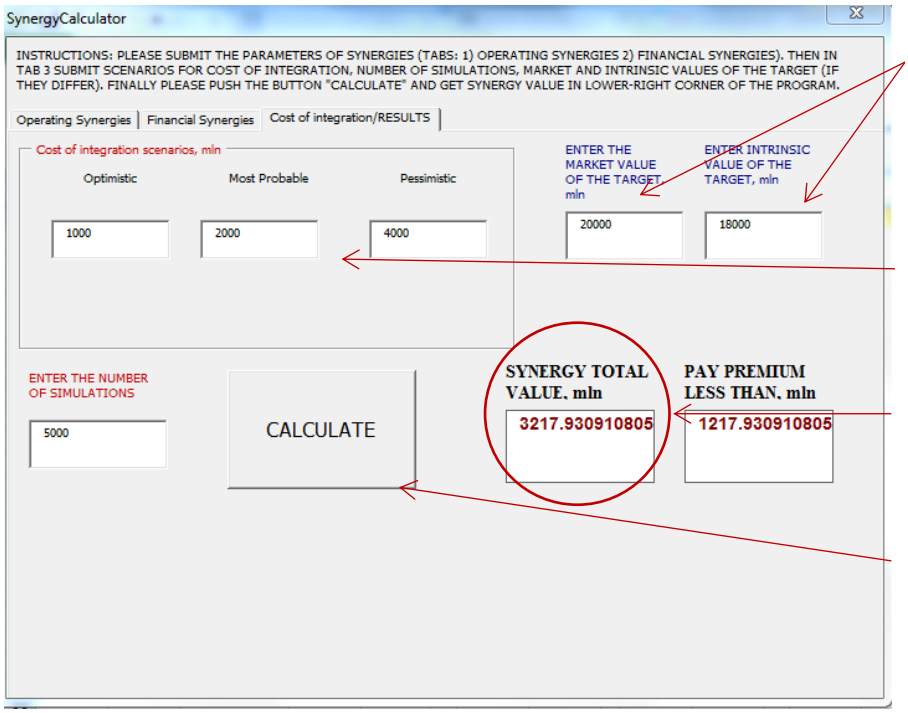
Instructions

Synergy choice tabs

Turn on the synergy

Submit scenarios

Submit company data

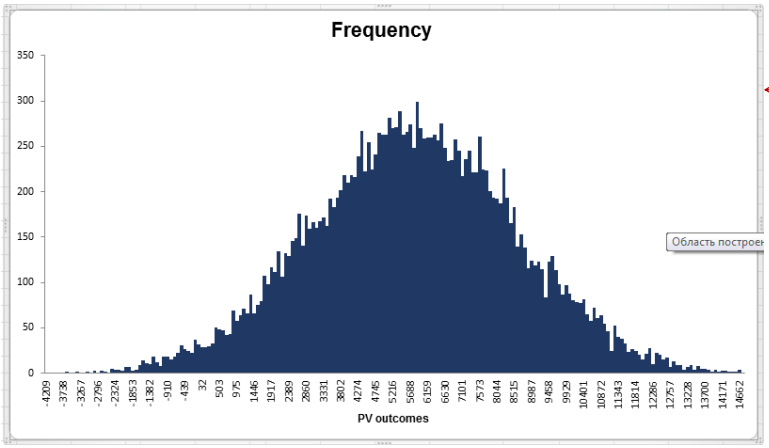


Market and intrinsic values for the target

Cost of integration scenarios

Result is here

Push the button



In addition application builds distribution of outcomes in the following form

Appendix 2. VBA code 1. Main code of the program (2 columns)

```
Sub user()

UserForm1.Show

End Sub

Public Function RandVal(range)
Dim B
B = range.CurrentRegion.Resize(, 2)
Randomize
c = 0: b = Rnd
For j = 1 To UBound(A)
   c = c + B(a, 2)
   If x <= c Then
      RandVal = B(a, 1)
      Exit For
   End If
Next a
End Function


'Probability distributions'

Sub Cost()

If UserForm1.CheckBox1.Value = False Then
range("A6:A1005").ClearContents
range("B6:B1005").ClearContents
GoTo A5
End If

range("A6:A1005").ClearContents
range("B6:B1005").ClearContents

'transfer values from user form to sheet cells'

Cells(2, 2).Value = UserForm1.TextBox2.Value
Cells(3, 2).Value = UserForm1.TextBox1.Value
Cells(4, 2).Value = UserForm1.TextBox3.Value

A = Cells(2, 2).Value
B = Cells(3, 2).Value + 1
c = Cells(4, 2).Value

'Probability density function for triangular distribution'

If B - A < 20 Then
A = 10 * A
B = 10 * B
c = 10 * c
ElseIf B - A > 1000 Then
A = A / 10
B = B / 10
c = c / 10
End If
For i = 1 To (B - A - 1)
Cells(5 + i, 1) = A + i
If Cells(5 + i, 1) >= A And Cells(5 + i, 1) <= c Then
Cells(5 + i, 2) = 2 * (Cells(5 + i, 1) - A) / ((B - A) * (c - A))
ElseIf Cells(5 + i, 1) >= c And Cells(5 + i, 1) <= B Then
Cells(5 + i, 2) = 2 * (B - Cells(5 + i, 1)) / ((B - A) * (B - c))
End If
Next i
range("A1:B5").ClearContents
A5:
End Sub

Sub Revenue()
If UserForm1.CheckBox2.Value = False Then
range("D6:D1005").ClearContents
range("E6:E1005").ClearContents
GoTo B5
End If
range("D6:D1005").ClearContents
range("E6:E1005").ClearContents


'transfer values from user form to sheet cells'

Cells(2, 5).Value = UserForm1.TextBox8.Value
Cells(3, 5).Value = UserForm1.TextBox7.Value
Cells(4, 5).Value = UserForm1.TextBox9.Value

A = Cells(2, 5).Value
B = Cells(3, 5).Value + 1
c = Cells(4, 5).Value

'Probability density function for triangular distribution'

If B - A < 20 Then
A = 10 * A
B = 10 * B
c = 10 * c
ElseIf B - A > 1000 Then
A = A / 10
B = B / 10
c = c / 10
End If
For i = 1 To (B - A - 1)
Cells(5 + i, 4) = A + i
If Cells(5 + i, 4) >= A And Cells(5 + i, 4) <= c Then
Cells(5 + i, 5) = 2 * (Cells(5 + i, 4) - A) / ((B - A) * (c - A))
ElseIf Cells(5 + i, 4) >= c And Cells(5 + i, 5) <= B Then
Cells(5 + i, 5) = 2 * (B - Cells(5 + i, 4)) / ((B - A) * (B - c))
End If
Next i
range("d1:e5").ClearContents
B5:
End Sub


Sub Growth()
If UserForm1.CheckBox3.Value = False Then
```

```
range("G6:G1005").ClearContents
range("H6:H1005").ClearContents
GoTo C5
End If
range("G6:G1005").ClearContents
range("H6:H1005").ClearContents

'transfer values from user form to sheet cells'

Cells(2, 8).Value = UserForm1.TextBox17.Value
Cells(3, 8).Value = UserForm1.TextBox16.Value
Cells(4, 8).Value = UserForm1.TextBox18.Value

A = Cells(2, 8).Value
B = Cells(3, 8).Value
c = Cells(4, 8).Value

'Probability density function for triangular distribution'

If B - A < 20 Then
A = 10 * A
B = 10 * B
c = 10 * c
ElseIf B - A > 1000 Then
A = A / 10
B = B / 10
c = c / 10
End If
For i = 1 To (B - A - 1)
Cells(5 + i, 7) = A + i
If Cells(5 + i, 7) >= A And Cells(5 + i, 7) <= c Then
Cells(5 + i, 8) = 2 * (Cells(5 + i, 7) - A) / ((B - A) * (c - A))
ElseIf Cells(5 + i, 7) >= c And Cells(5 + i, 8) <= B Then
Cells(5 + i, 8) = 2 * (B - Cells(5 + i, 7)) / ((B - A) * (B - c))
End If
Next i
range("g1:h5").ClearContents
C5:
End Sub

Sub LossCarryforward()
If UserForm1.CheckBox4.Value = False Then
range("J6:J1005").ClearContents
range("K6:K1005").ClearContents
GoTo D5
End If
range("J6:J1005").ClearContents
range("K6:K1005").ClearContents

'transfer values from user form to sheet cells'

Cells(2, 11).Value = UserForm1.TextBox25.Value
Cells(3, 11).Value = UserForm1.TextBox24.Value
Cells(4, 11).Value = UserForm1.TextBox26.Value

A = Cells(2, 11).Value
B = Cells(3, 11).Value
c = Cells(4, 11).Value

'Probability density function for triangular distribution'

If B - A < 20 Then
A = 10 * A
B = 10 * B
c = 10 * c
ElseIf B - A > 1000 Then
A = A / 10
B = B / 10
c = c / 10
End If
For i = 1 To (B - A - 1)

Cells(5 + i, 10) = A + i
If Cells(5 + i, 10) >= A And Cells(5 + i, 10) <= c Then
Cells(5 + i, 11) = 2 * (Cells(5 + i, 10) - A) / ((B - A) * (c - A))
ElseIf Cells(5 + i, 10) >= c And Cells(5 + i, 11) <= B Then
Cells(5 + i, 11) = 2 * (B - Cells(5 + i, 10)) / ((B - A) * (B - c))


End If
Next i
range("j1:k5").ClearContents
D5:
End Sub

Sub AssetWriteup()
If UserForm1.CheckBox5.Value = False Then
range("M6:M1005").ClearContents
range("N6:N1005").ClearContents
GoTo E5
End If
range("M6:M1005").ClearContents
range("N6:N1005").ClearContents

'transfer values from user form to sheet cells'

Cells(2, 14).Value = UserForm1.TextBox31.Value
Cells(3, 14).Value = UserForm1.TextBox30.Value
Cells(4, 14).Value = UserForm1.TextBox32.Value

A = Cells(2, 14).Value
B = Cells(3, 14).Value + 1
c = Cells(4, 14).Value


'Probability density function for triangular distribution'

If B - A < 20 Then
A = 10 * A
B = 10 * B
c = 10 * c
ElseIf B - A > 1000 Then
A = A / 10
B = B / 10
c = c / 10
End If
For i = 1 To (B - A - 1)
Cells(5 + i, 13) = A + i
If Cells(5 + i, 13) >= A And Cells(5 + i, 13) <= c Then
```

```
Cells(5 + i, 14) = 2 * (Cells(5 + i, 13) - A) / ((B - A) * (c
- A))
ElseIf Cells(5 + i, 13) >= c And Cells(5 + i, 14) <= B
Then
Cells(5 + i, 14) = 2 * (B - Cells(5 + i, 13)) / ((B - A) *
(B - c))

End If
Next i
range("M1:N5").ClearContents
E5:
End Sub

Sub Borrowing()
If UserForm1.CheckBox6.Value = False Then
range("P6:P1005").ClearContents
range("Q6:Q1005").ClearContents
GoTo F5
End If
range("P6:P1005").ClearContents
range("Q6:Q1005").ClearContents

'transfer values from user form to sheet cells'

Cells(2, 17).Value = UserForm1.TextBox37.Value
Cells(3, 17).Value = UserForm1.TextBox38.Value
Cells(4, 17).Value = UserForm1.TextBox39.Value

A = Cells(2, 17).Value
B = Cells(3, 17).Value
c = Cells(4, 17).Value


'Probability density function for triangular distribution'

If B - A < 20 Then
A = 10 * A
B = 10 * B
c = 10 * c
ElseIf B - A > 1000 Then
A = A / 10
B = B / 10
c = c / 10
End If
For i = 1 To (B - A - 1)
Cells(5 + i, 16) = A + i
If Cells(5 + i, 16) >= A And Cells(5 + i, 16) <= c Then
Cells(5 + i, 17) = 2 * (Cells(5 + i, 16) - A) / ((B - A) * (c
- A))
ElseIf Cells(5 + i, 16) >= c And Cells(5 + i, 17) <= B
Then
Cells(5 + i, 17) = 2 * (B - Cells(5 + i, 16)) / ((B - A) *
(B - c))
End If
Next i
range("P1:Q5").ClearContents
F5:
End Sub

Sub Discount()
If UserForm1.CheckBox7.Value = False Then
range("S6:S1005").ClearContents
range("T6:T1005").ClearContents
GoTo G5
End If
range("S6:S1005").ClearContents
range("T6:T1005").ClearContents

'transfer values from user form to sheet cells'

Cells(2, 20).Value = UserForm1.TextBox46.Value
Cells(3, 20).Value = UserForm1.TextBox47.Value
Cells(4, 20).Value = UserForm1.TextBox48.Value

A = Cells(2, 20).Value
B = Cells(3, 20).Value
c = Cells(4, 20).Value

'Probability density function for triangular distribution'

If B - A < 20 Then
A = 10 * A
B = 10 * B
c = 10 * c
ElseIf B - A > 1000 Then
A = A / 10
B = B / 10
c = c / 10
End If
For i = 1 To (B - A - 1)
Cells(5 + i, 19) = A + i
If Cells(5 + i, 19) >= A And Cells(5 + i, 19) <= c Then
Cells(5 + i, 20) = 2 * (Cells(5 + i, 19) - A) / ((B - A) * (c
- A))
ElseIf Cells(5 + i, 19) >= c And Cells(5 + i, 20) <= B
Then
Cells(5 + i, 20) = 2 * (B - Cells(5 + i, 19)) / ((B - A) *
(B - c))
End If
Next i
range("S1:T5").ClearContents
G5:
End Sub
Sub Tax()
If UserForm1.CheckBox8.Value = False Then
range("AB6:AB1005").ClearContents
range("AC6:AC1005").ClearContents
GoTo H5
End If
range("AB6:AB1005").ClearContents
range("AC6:AC1005").ClearContents

'transfer values from user form to sheet cells'

Cells(2, 29).Value = UserForm1.TextBox69.Value
Cells(3, 29).Value = UserForm1.TextBox70.Value
Cells(4, 29).Value = UserForm1.TextBox71.Value

A = Cells(2, 29).Value
B = Cells(3, 29).Value
c = Cells(4, 29).Value

'Probability density function for triangular distribution'
```

```
If B - A < 20 Then
A = 10 * A
B = 10 * B
c = 10 * c
ElseIf B - A > 1000 Then
A = A / 10
B = B / 10
c = c / 10
End If
For i = 1 To (B - A - 1)
Cells(5 + i, 28) = A + i
If Cells(5 + i, 28) >= A And Cells(5 + i, 28) <= c Then
Cells(5 + i, 29) = 2 * (Cells(5 + i, 28) - A) / ((B - A) * (c
- A))
ElseIf Cells(5 + i, 28) >= c And Cells(5 + i, 29) <= B
Then
Cells(5 + i, 29) = 2 * (B - Cells(5 + i, 28)) / ((B - A) *
(B - c))
End If
Next i
range("AB1:AC5").ClearContents
H5:
End Sub

Sub Integration()

range("V6:V1005").ClearContents
range("W6:W1005").ClearContents

Cells(2, 23).Value = UserForm1.TextBox59.Value
Cells(3, 23).Value = UserForm1.TextBox60.Value
Cells(4, 23).Value = UserForm1.TextBox61.Value

'transfer values from user form to sheet cells'

A = Cells(2, 23).Value
B = Cells(3, 23).Value
c = Cells(4, 23).Value

'Probability density function for triangular distribution'

If B - A < 20 Then
A = 10 * A
B = 10 * B
c = 10 * c
ElseIf B - A > 1000 Then
A = A / 10
B = B / 10
c = c / 10
End If
For i = 1 To (B - A - 1)
Cells(5 + i, 22) = A + i
If Cells(5 + i, 22) >= A And Cells(5 + i, 22) <= c Then
Cells(5 + i, 23) = 2 * (Cells(5 + i, 22) - A) / ((B - A) * (c
- A))
ElseIf Cells(5 + i, 22) >= c And Cells(5 + i, 23) <= B
Then
Cells(5 + i, 23) = 2 * (B - Cells(5 + i, 22)) / ((B - A) *
(B - c))
End If
Next i
range("V1:W5").ClearContents

End Sub

Sub simulation()

Columns(25).ClearContents
Columns(26).ClearContents
i = ActiveSheet.ChartObjects.Count
If i >= 1 Then ActiveSheet.ChartObjects.Delete

'cost reduction synergy'

For i = 1 To UserForm1.TextBox66.Value

If UserForm1.CheckBox1.Value = False Then
GoTo F1
pv1 = 0
End If

pv1 = (RandVal(Cells(6, 1)) * ((1 -
(UserForm1.TextBox5.Value) / 100))) /
((((UserForm1.TextBox4 / 100)) * ((1 +
(UserForm1.TextBox4 / 100)) ^
(UserForm1.TextBox6))))

If UserForm1.TextBox1.Value + 1 -
UserForm1.TextBox2.Value > 1000 Then pv1 = 10 *
pv1

F1:
If UserForm1.CheckBox2.Value = False Then
GoTo F2
pv2 = 0
End If

'revenue synergy'
pv2 = (RandVal(Cells(6, 4)) * (UserForm1.TextBox14 /
100)) / ((UserForm1.TextBox13 / 100) * ((1 +
(UserForm1.TextBox13 / 100)) ^
(UserForm1.TextBox15)))

If UserForm1.TextBox7.Value + 1 -
UserForm1.TextBox8.Value > 1000 Then pv2 = 10 *
pv2

F2:
If UserForm1.CheckBox3.Value = False Then
GoTo F3
pv3 = 0
End If

'growth synergy'

Valueinter = 0
For t = 1 To UserForm1.TextBox22
Valueinter = Valueinter + ((((1 + RandVal(Cells(6, 7)) /
1000) ^ t - (1 + UserForm1.TextBox23 / 100) ^ t) *
UserForm1.TextBox19 * (UserForm1.TextBox67 / 100)
* (UserForm1.TextBox20 / 100)) / ((1 +
(UserForm1.TextBox21) / 100) ^
UserForm1.TextBox22))
Next t
```

```
pv3 = Valueinter + (((1 + RandVal(Cells(6, 7)) / 1000) ^
UserForm1.TextBox22 - (1 + UserForm1.TextBox23 /
100) ^ UserForm1.TextBox22) *
UserForm1.TextBox19 * (UserForm1.TextBox67 / 100)
* (UserForm1.TextBox20 / 100)) / (((1 +
(UserForm1.TextBox21) / 100) ^
UserForm1.TextBox22) * (((UserForm1.TextBox21) /
100)))

F3:
If UserForm1.CheckBox4.Value = False Then
GoTo F4
pv4 = 0
End If

'Loss carryforward'

ValueInter1 = 0
For u = 1 To (UserForm1.TextBox28 -
UserForm1.TextBox27)
ValueInter1 = ValueInter1 + ((UserForm1.TextBox29 *
(RandVal(Cells(6, 10)) / 100)) / (UserForm1.TextBox28
- UserForm1.TextBox27)) / ((1 +
(UserForm1.TextBox68 / 100)) ^ u)
Next u

pv4 = ValueInter1

F4:
If UserForm1.CheckBox5.Value = False Then
GoTo F5
pv5 = 0
End If
'Asset write-up

ValueInter2 = 0
For u2 = 1 To UserForm1.TextBox33
ValueInter2 = ValueInter2 + ((((RandVal(Cells(6, 13)) /
100) * UserForm1.TextBox34) /
UserForm1.TextBox33) * (UserForm1.TextBox35 /
100)) / ((1 + (UserForm1.TextBox36 / 100)) ^ u2)
Next u2

pv5 = ValueInter2

If UserForm1.TextBox30.Value + 1 -
UserForm1.TextBox31.Value > 1000 Then pv5 = 10 *
pv5

F5:
If UserForm1.CheckBox6.Value = False Then
GoTo F6
pv6 = 0
End If
'Decreased borrowing rate

pv6 = ((((UserForm1.TextBox40 / 100 -
(RandVal(Cells(6, 16)) / 1000)) *
UserForm1.TextBox45 * ((1 + UserForm1.TextBox41 /
100) ^ (UserForm1.TextBox44 + 1)) * (1 -
(UserForm1.TextBox42) / 100))) /
((((UserForm1.TextBox43 / 100) -
(UserForm1.TextBox41 / 100)) * ((1 +
(UserForm1.TextBox43 / 100)) ^
UserForm1.TextBox44))))


F6:
If UserForm1.CheckBox7.Value = False Then
GoTo F7
pv7 = 0
End If
'Decreased discount rate
pv7 = (UserForm1.TextBox54 * ((1 +
UserForm1.TextBox49 / 100) ^ (UserForm1.TextBox51
+ 1))) / (((RandVal(Cells(6, 19)) / 1000) * ((1 +
RandVal(Cells(6, 19)) / 1000) ^
UserForm1.TextBox51))) _
- (UserForm1.TextBox54 * ((1 +
UserForm1.TextBox49 / 100) ^ (UserForm1.TextBox51
+ 1))) / (((UserForm1.TextBox50 / 100) * ((1 +
UserForm1.TextBox50 / 100) ^
UserForm1.TextBox51)))

F7:

If UserForm1.CheckBox8.Value = False Then
GoTo F8
pv8 = 0
End If

'tax synergy'

ValueInter3 = 0
For t5 = 1 To UserForm1.TextBox73
ValueInter3 = ValueInter3 + ((UserForm1.TextBox74 /
100 - RandVal(Cells(6, 28)) / 1000) *
UserForm1.TextBox77.Value * ((1 +
UserForm1.TextBox75 / 100) ^ t5)) / ((1 +
UserForm1.TextBox72 / 100) ^ t5)

Next t5

pv8 = ValueInter3 + (((UserForm1.TextBox74 / 100 -
RandVal(Cells(6, 28)) / 1000) *
UserForm1.TextBox77.Value * ((1 +
UserForm1.TextBox75 / 100) ^ t5)) * (1 +
UserForm1.TextBox76 / 100)) / (((1 +
UserForm1.TextBox72 / 100) ^ t5) *
(UserForm1.TextBox72 / 100 - UserForm1.TextBox76 /
100))

F8:

If UserForm1.TextBox60.Value + 1 -
UserForm1.TextBox59.Value > 1000 Then
Coi = 10 * RandVal(Cells(6, 22))
Else:
Coi = RandVal(Cells(6, 22))
End If
```

```
Cells(5 + i, 25) = pv1 + pv2 + pv3 + pv4 + pv5 + pv6 + pv7 + pv8 - Coi


Next i

Dim range1 As range
If WorksheetFunction.CountIf(range(Cells(6, 25), Cells(6, 25).End(xlDown)), ">=0") > 1 Then

Cells(6, 26) = WorksheetFunction.AverageIf(range(Cells(6, 25), Cells(6, 25).End(xlDown)), ">=0")

Else: Cells(6, 26) = 0
End If

UserForm1.TextBox80.Value = Cells(6, 26).Value
UserForm1.TextBox81.Value = UserForm1.TextBox79.Value - UserForm1.TextBox78.Value + Cells(6, 26).Value
If UserForm1.TextBox79.Value - UserForm1.TextBox78.Value + Cells(6, 26).Value <= 0 Then UserForm1.TextBox81.Value = "Do not bid"
Cells(5, 26).Value = "SYNERGY"
Cells(5, 25).Value = "OUTCOMES"
range("AT1:AT1000").Clear
range("AU1:AU1000").Clear
range("AP5").ClearContents
range("AP6").ClearContents
range("AP5") = WorksheetFunction.Min(range(Cells(6, 25), Cells(6, 25).End(xlDown)))
range("AP6") = WorksheetFunction.Max(range(Cells(6, 25), Cells(6, 25).End(xlDown)))

Histo
range("AT5:AT205").NumberFormat = "0"
Histo2
range("O2").Select
UserForm1.Show
UserForm1.TextBox81.SetFocus
range("A:AD").Clear
End Sub
Sub sdfggdf()
For i = 1 To 100
range("J6") = RandVal(Cells(6, 7))
Cells(6 + i, 10) = range("J6")
Next i
End Sub
```

Appendix 3. VBA code 1. Code for histogram

```
Sub Histo()
'
' Histo Macro
'
'Code to create histogram'

    Application.Run "ATPVBAEN.XLAM!Histogram", ActiveSheet.range(Cells(6, 25), Cells(6, 25).End(xlDown))
_
      , ActiveSheet.range("$AT$4"), ActiveSheet.range("$AR$5:$AR$205"), False, _
      False, False, False
End Sub

Sub Histo2()
'
' Histo2 Macro
'
'Code to draw and format histogram
'
   range("AT4:AU206").Select
   ActiveSheet.Shapes.AddChart.Select
   ActiveChart.ChartType = xlColumnClustered
   ActiveChart.SetSourceData Source:=range("Simulation!$AT$4:$AU$206")
   ActiveChart.ApplyLayout (8)
   ActiveChart.Axes(xlValue).AxisTitle.Select
   Selection.Delete
   ActiveChart.Axes(xlCategory).AxisTitle.Select
   ActiveChart.Axes(xlCategory, xlPrimary).AxisTitle.Text = "PV outcomes"
   Selection.Format.TextFrame2.TextRange.Characters.Text = "PV outcomes"
   With Selection.Format.TextFrame2.TextRange.Characters(1, 11).ParagraphFormat
      .TextDirection = msoTextDirectionLeftToRight
      .Alignment = msoAlignCenter
   End With
   With Selection.Format.TextFrame2.TextRange.Characters(1, 2).Font
      .BaselineOffset = 0
      .Bold = msoTrue
      .NameComplexScript = "+mn-cs"
      .NameFarEast = "+mn-ea"
      .Fill.Visible = msoTrue
      .Fill.ForeColor.RGB = RGB(0, 0, 0)
      .Fill.Transparency = 0
      .Fill.Solid
      .Size = 10
      .Italic = msoFalse
      .Kerning = 12
      .Name = "+mn-lt"
      .UnderlineStyle = msoNoUnderline
      .Strike = msoNoStrike
   End With
   With Selection.Format.TextFrame2.TextRange.Characters(3, 9).Font
      .BaselineOffset = 0
      .Bold = msoTrue
      .NameComplexScript = "+mn-cs"
      .NameFarEast = "+mn-ea"
      .Fill.Visible = msoTrue
      .Fill.ForeColor.RGB = RGB(0, 0, 0)
      .Fill.Transparency = 0
      .Fill.Solid
      .Size = 10
      .Italic = msoFalse
      .Kerning = 12
      .Name = "+mn-lt"
```

```
    .UnderlineStyle = msoNoUnderline
    .Strike = msoNoStrike
  End With
  ActiveChart.ChartTitle.Select
  ActiveChart.ChartArea.Select
  ActiveChart.ChartArea.Select
  ActiveChart.Axes(xlCategory).AxisTitle.Select
  ActiveChart.ChartArea.Select
  ActiveChart.ChartArea.Select
  ActiveChart.ChartTitle.Select
  With Selection.Format.TextFrame2.TextRange.Font
    .NameComplexScript = "Arial"
    .NameFarEast = "Arial"
    .Name = "Arial"
  End With
  ActiveChart.Axes(xlCategory).Select
  ActiveChart.Axes(xlCategory).AxisTitle.Select
  With Selection.Format.TextFrame2.TextRange.Font
    .NameComplexScript = "Arial"
    .NameFarEast = "Arial"
    .Name = "Arial"
  End With
  ActiveChart.SeriesCollection(1).Select
  With Selection.Format.Fill
    .Visible = msoTrue
    .ForeColor.ObjectThemeColor = msoThemeColorAccent5
    .ForeColor.TintAndShade = 0
    .ForeColor.Brightness = -0.5
    .Solid
  End With
  With ActiveChart.Parent
    .Top = range("O1").Top
    .Left = range("O1").Left

End With
End Sub
```

Code presented in the appendices is not complete but only represents the main mechanisms building probability distributions, formulas, and simulations. There are more code lines for errors, data consistency check, and other reasons.