# Valuing M&A Synergies as (Fuzzy) Real Options

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## Abstract

This paper views operating synergies as real options that acquiring companies have in the post-acquisition M&A process. The paper builds on the synergistic restructuring theory, which states that both acquisitions and divestitures are wealth-creating activities. Acquisition synergies are broadly defined as arising both from resource redeployments between the acquirer and the acquisition target company and the executed divestitures of target's assets within the post-acquisition process. We present a procedure to ex-ante calculate the first approximate value of the synergies in the screening stage of the M&A process. We argue that synergies are highly uncertain and require significant management actions and, for that reason, an appropriate method for the valuation is the fuzzy real options pay-off method, which is presented as an integrated part of a decision support system built for the screening of potential acquisition targets. The paper also discusses the ordering of acquisition candidates according to their total value based on the presented fuzzy measure.

*Keywords: Synergy Real Options, Divestiture, Mergers and Acquisitions, Acquisition Screening, Decision Support System, Fuzzy Pay-Off Method*

# 1. Introduction

There are many ways to measure the success of mergers and acquisitions (hence M&As) from the acquirer's point of view. Aspects that can be measured range from creation of value, to improvements in financial stability, strategic position, organizational strength, brand, or the whole M&A process (Bruner, 2004b, 2005), and to capture of value (Capron and Shen, 2004), the last one referring to M&A deals closed under the fair-value of the target. We focus on the value creation opportunities and improvements in the M&A process. Also, the capture of value is included implicitly in our analysis, when we compare the total value of a target with the price of the target at the end of the paper.

We will show that the value creation opportunities and the total value of a target can be valued ex-ante, in the pre-deal stage, using a real options approach, and we will argue that the use of the structured screening and the fuzzy pay-off method for real options valuation can improve the M&A process, when they are integrated to a decision support system (hence DSS), which we have built for the screening of potential acquisition target companies together with senior managers from a large listed active acquirer through a strategy development project jointly financed by Tekes (Finnish Technology Agency) and the corporate partners. The DSS is presented in the paper with a focus on its synergy module. We focus on operating (sales increasing and cost reduction) synergies, while potential financial synergies taken into account in our DSS (related, e.g., to lower cost of capital, dept capacity, reductions in working capital and capital expenditures, or tax benefits) are not discussed in this paper, but we note that they can follow from an acquisition and also be reflected in integration and divestitures (of assets or business units), which are argued to support the creation of operating synergies. We include divestitures in the analysis of operating synergies. We argue that it is an inherent part of the restructuring process of creating such synergies, because preparing for divestitures can be seen as an inverse action to integration required for synergy gains. To the best of our knowledge this is a new approach. Further, divestitures can release resources and ease management's attention on synergy creation, and the approach is supported by the literature reviewed in the next chapter.

Chapter 2 discusses the concepts and the real options valuation framework applied in the paper. Section 2.1 discusses the importance of synergy for M&A rationales focusing on the key sources of synergies, i.e., restructuring including resource redeployments and divestitures, and, based on that, presents a decision process to create synergistic gains. Section 2.2 presents a total value concept as the valuation approach from the acquirer's perspective and discusses the synergy real options available in the post-acquisition process. Chapter 3 presents the synergy module of the DSS built for the screening of acquisition targets. The chapter presents the cost reducing and sales enhancing synergies including asset divestitures, as they are built in the DSS. Chapter 4 presents the fuzzy pay-off method integrated to the DSS with an example to illustrate its applicability to value operational synergies together with related divestitures. Chapter 5 concludes with a discussion of the presented approach to corporate acquisitions and synergy real options with possible benefits and limitations of our approach, and suggests further research opportunities.

# 2. Synergy Real Options in M&A Decision Sequence

## 2.1 Synergy Creation Process

Acquisition motives include at least the following wealth-increasing motivations for corporate takeovers (cf. Bradley et al., 1986; Bruner, 2004a, 2004b; DePhamphilis 2009; Healy et al, 1992; Krishnamurti and Vishwanath, 2008; Pablo and Javidan, 2004; Seth, 1990; Walker, 2000). Firstly, acquisitions can increase efficiency by creating economies of scale or scope. Secondly, takeovers can exploit asymmetric information between acquiring-firm managers and acquiring- or target-firm shareholders. Thirdly, acquisitions can mitigate agency problems associated with the firm's free cash flows. Fourthly, takeovers can enhance the acquirer's market power. Fifthly, acquisitions can lead to tax benefits.

DePhamphilis (2009) notes that the most common motive for M&As is synergy. While operating synergies arise primarily from economies of scale and scope (DePhamphilis, 2009; Houston, James, Ryngaert, 2001), we argue that synergistic gains can legitimize all the above-mentioned motivations for M&As. This follows from our broad definition of synergy according to which all the value of the combined firm that comes above the value of the acquirer and the target as stand-alone entities accounts for the value of synergy. The definition is in line, e.g., with Khrishnamurti and Vishwanath (2008) and Seth (1990).

The post-acquisition process has been pointed out as the most crucial phase of value creation (Agrawal and Jaffe 2000, Epstein, 2004; Harding, Rovit, and Corbett, 2004; Hitt, King, Krishnan, Makri, Schijven, Shimizu, and Zhu, 2009; Khrishnamurti and Vishwanath, 2008). Post-acquisition integration is where envisioned synergies and expectations are realized or broken. Failing in the ex-ante analysis of post-merger issues can lead to problems already at the bargaining table during the negotiation stage, as well as, in the post-merger implementation (Bruner, 2004b). Integration is a transformation process vital to the success of an M&A, e.g, Habeck, Kröger, and Träm (2000) report that post-merger integration is the primary reason for failure in 53% of all unsuccessful deals. A survey of KPMG (1999) shows that ex-ante/pre-M&A synergy evaluation is the most important factor behind a successful M&A; it increases the probability of success by 28% according to respondents.

Operating synergies are generally responsible for the major part of the value creation potential in M&As in addition to financial synergies (e.g., Anslinger and Copeland, 1996; Khrishnamurti and Vishwanath, 2008) and (other) growth options (e.g., Kester, 1984; Smit and Trigeorgis, 2006; Smith and Triantis, 1995; Vishwanath, 2009). An opportunity of creating revenue increasing synergy can be seen as a type of growth option. Growth can be sought, e.g., through increases in market share, expansions to new geographic or new product markets, or through R&D acquisitions (Bower 2001, 2004; Ficery, Herd, and Pursche, 2007; KPMG, 1999). Such growth opportunities are the most typical examples of growth options. We will discuss this further in section 2.2 and we will illustrate with an example in Chapter 4 that growth options (also ones, which are different from our operating synergy options) can be added in the analysis analogously to how we handle options to create synergies and to divest.

Drivers of operating synergies and the long-term performance of M&As is studied by

Capron (1999) and Capron, Mitchell, and Swaminathan (2001). Capron (1999) builds a theoretical model for long-term acquisition performance based on value-maximizing theory rooted in the cost efficiency theory (economies of scale and scope) and in the resource-based view (utilization of core competencies and resources). He shows empirically, based on a survey of acquiring firm managers of 253 horizontal acquisitions (i.e., acquisition of a business within the same industry) on European and American manufacturing companies, the causal links between the post-acquisition actions and cost savings and revenue enhancements. The earlier paper of Mulherin and Boone (2000) studies acquisitions and divestitures separately. However, the authors state that their paper is the first one studying both of them within one study. They report industry clustering for both acquisitions and divestitures, which suggests that both synergy and divestiture gains represent empirically important explanations for M&A activities. They state that both acquisitions and divestitures support the synergistic theory of restructuring activities as opposed to activities based on managerial hubris, empire building, or firm-size maximizing theory.

Capron (1999) shows that resource redeployment and asset divestiture drives the long-term acquisition success, noting also that there is a significant risk involved in divested assets of targets and they will not lead to cost-savings, in general. He finds, particularly, that divestitures including disposal of physical assets and cutoffs in personnel (in sales/ manufacturing/ logistics/ R&D/ administrative) of both the acquirer's and the targets assets drive the cost-based synergies, while the redeployments of both the acquirers' resources (R&D capabilities/ manufacturing know-how/ marketing resources/ supplier relationships/ distribution expertise) including physical transfers of resources to new locations or sharing resources without physical transfers, to targets and target's resources to acquirers drive revenue-based synergies through their effects on market coverage and innovation capability. Resource redeployment of acquirers' resources to targets can also lead to cost-saving synergies. Further, asset divestiture and resource redeployment are commonly interconnected. Capron et al (2001) is based on the same survey data with Capron (1999). They take a dynamic view to the post-acquisition process and find that post-acquisition resource redeployment leads to asset divestiture from the business that receives such resources. They argue that the asset divestiture is a logical consequence of reconfiguration of the structure of post-acquisition resources. They show that strategic similarity of the acquirer and the target is the major determinant of the post-acquisition resource redeployments between the two companies and that the strategic similarity together with resource redeployments from the acquirer to the target further drive possible divestitures of the target's assets.

Based on the above findings on the key drivers of operating synergies and the importance to evaluate the post-M&A restructuring activities for synergy creation already in the screening & due diligence phase (emphasized, e.g., by Habeck et al., 2000; and KPMG, 1999), we present a decision process for creating synergies in Figure 1. We will base the presentation of the DSS in Chapter 3 on this process framework and will show in Chapter 4 how the fuzzy pay-off method can be applied to valuing the alternative decision paths presented in Figure 1.

As shown in Figure 1, the ex-ante evaluation conducted during the screening & due diligence phase is followed by a decision to acquire the target (Acquisition of target in Figure 1) or stop the acquisition or postpone it for now (No acquisition (or deferral)).

The decision is done potentially after negotiations with the target or after the bidding process in the case, where there are also other acquirer(s) at the bidding table.

The negotiating, bidding, and the final closure of the deal is followed by the post-acquisition restructuring phase in which we consider two options: either to integrate (Integration) the two companies primarily through redeployments of resources without considering any divestitures, or to integrate the firms except the assets or (non-core) business units to be divested (Integration & splitting). With splitting we refer to the requirements not to integrate the to-be-divested parts to the acquirer, but instead to prepare the parts to be sold or liquidated, which may not need significant actions (in the case of a real asset), but which may require resource redeployments or investments to or from the business unit to make it operational as a stand-alone to ease a possible sell-off. The first option will lead to sales (Sales synergies) and cost synergies (Cost synergies) and required restructuring costs, and the latter option will lead to both the operating synergies and the net cash-flows from the divestiture (Divestiture revenues).

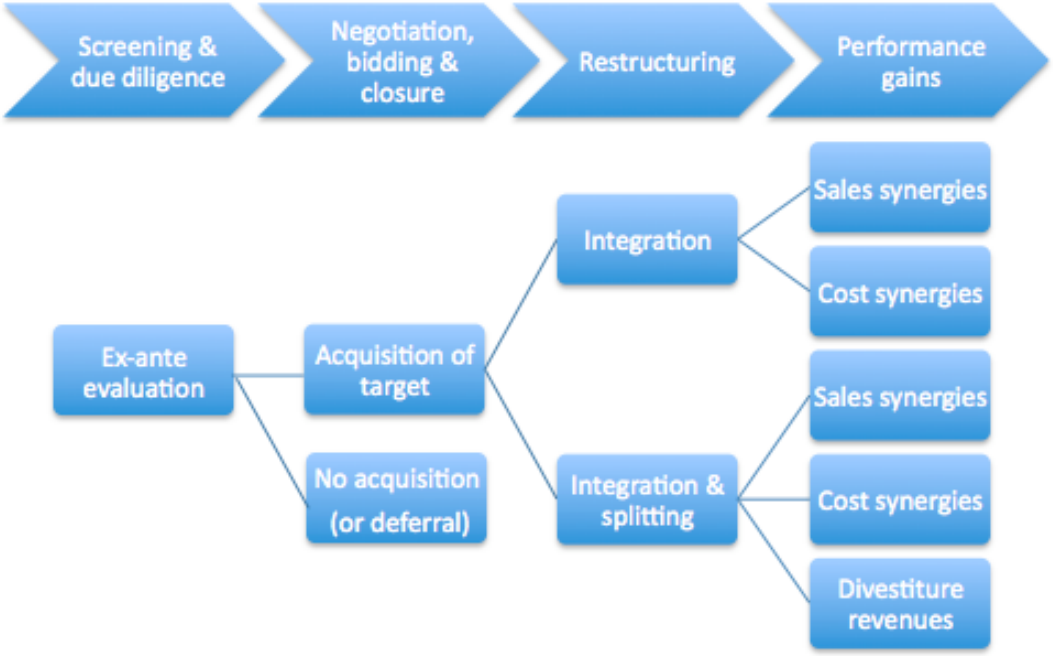


Figure 1: The M&A decision process of creating synergistic gains

Alvarez and Stenbacka (2006) have presented an M&A decision sequence close to ours. They have also included the divestiture as an opportunity in their compound real options model to determine the optimal timing of the acquisition, as well as, the total value of the target. They also include synergies in their model. However, they assume that the divestiture happens later in the post-acquisition process, after the synergy creation. They view the option to divest parts of the acquired company as related to not meeting the profitability expectations rather than as a part of the synergy creation process, as we see it.

In the next section the valuation framework for the total value of the target is presented together with the post-acquisition real options considered in this paper. In

Chapter 3 we return to the evaluation of the post-acquisition value creation opportunities in the screening stage by presenting the DSS built for that purpose.

## 2.2 Total Value and Synergy Real Options

We view M&A transaction to be followed by a mix of synergy creating real options from the acquiring company's perspective. By valuing the synergistic opportunities together with the stand-alone value of the target, the buyer gets the total value of the target, which helps it in the negotiations and in formulating the post-acquisition strategy.

To value acquisition targets, we start from the total value concept presented, e.g., in (Boer, 2002). The idea is that the total value of an acquisition target arises from target's cash flow generating economic capital (active assets in place) and also from the strategic capital, comprising of the target's intellectual and human capital including all the plans and the know-how to turn the plans into profitable operations. This view takes into account the real options that lie within the target company, such real options that are available, and possibly in-the-money, also to the target itself. Such total value represents the value of the company as a stand-alone, i.e., as an independently operating company.

We are interested in the total value of the target from the acquiring company's perspective, i.e., including also the real options, which are not necessarily available to the target's management, but are exclusively available to the acquiring company. Specifically, we make a difference between out-of-the-money real options (for the acquisition target company) and the real options, which are turned into in-the-money real options (for the post-acquisition combined entity) using the resources of the acquirer. We need to add the economic and strategic capital of the acquiring company into the equation. The base for the total value of the target for the acquirer is presented in Figure 2. It is seen that the knowledge and resources brought by the acquiring company open up value adding real options. The value of such added real options comes in addition to the total stand-alone value.

The real options that lie in acquisition targets and may also be available to several acquirers and also to the target's management are sometimes discussed as growth options, which are priced at the market price (e.g., Kester, 1984; Smit and Trigeorgis, 2006; and Vishwanath, 2009). The distinction can sometimes be hard to make and Bruner (2004b) states that true synergies create value for shareholders by harvesting benefits from M&A that they would be unable to gain on their own. We also focus only on the value adding real synergies, which are not available to target's management (value added in Figure 2). Growth options can be seen falling into our category of value adding real options. Smit and Trigeorgis (2006) view long-term strategic planning as involving a portfolio of corporate growth options actively managed by a firm in a competitive environment. They argue that the total value of an executed acquisition strategy comprises of the value of assets in place and the value of future growth opportunities incorporated in the stock prices. Kester (1984) explicitly discusses synergies, which only enhance the growth option's value.

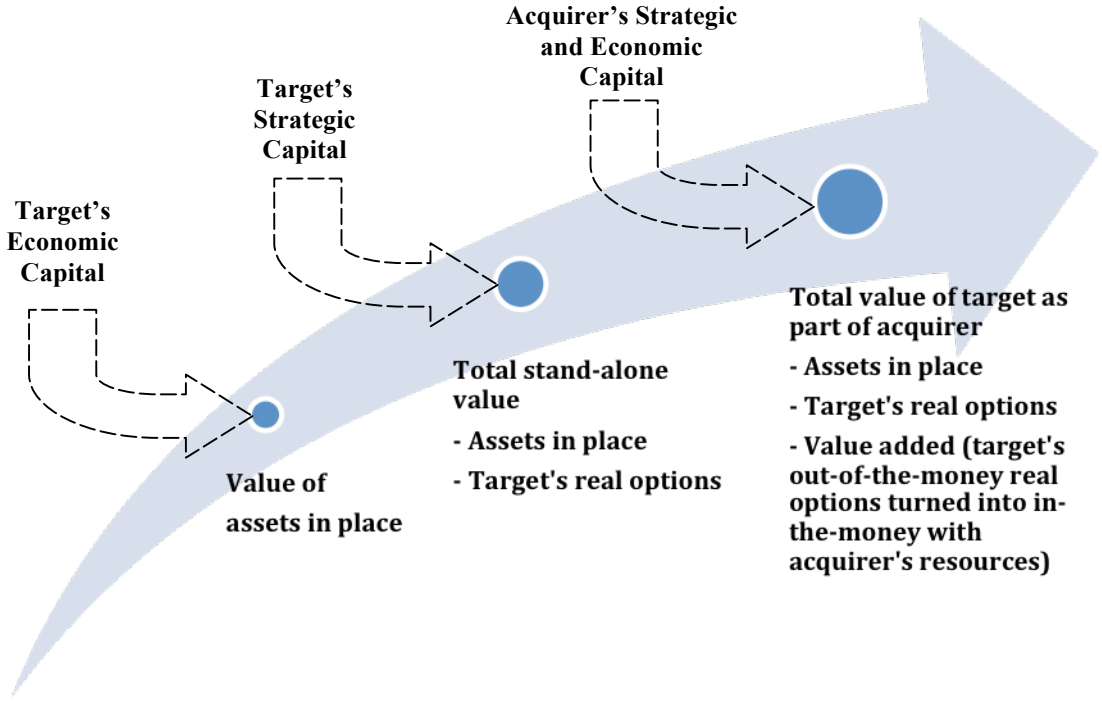


Figure 2: Acquisition target's total value comprises of the assets in place and the value of merging companies' combined real options.

Our view is that even though growth options, in general, could be valued by the market, this is not the case with synergy options. We argue that an acquirer, who views synergies as real options can profit from acquisitions even though it paid a premium over the market price. We handle post-acquisition strategic real options as the value adding real options (which we defined broadly as synergies) that are unlikely fully priced in the market, because they can be exclusively available only for a specific acquirer.

The relevant value adding real options for our purposes have been identified for the follow-up and valuation purposes by Collan and Kinnunen (2008, 2009). They present (among other strategic real options) the option to create synergies, the option to split, and the option to divest a part of a target.

*Option to create synergies* arise at the acquisition and can be exercised by initial investments or using other resources (cf. strategic capital). The major driver of synergies is resource redeployment, i.e., either utilizing acquirer's resources to develop the target or vice versa (cf. Capron, 1999; Capron et al, 2001). The synergies are dependent on management decisions on the redeployments and additional investments, and they take time to be developed to their full potential. This is why we argue that synergies should be valued as real options. The value of the synergies comes on top of the stand-alone value of the target.

*Option to split* existing business into parts can be relevant, when the target company is composed of parts, which include non-core businesses from the acquirer's perspective. The acquirer may want to divest them. The execution of the option to

split is typically required before divestments can be executed. In a specific case acquired businesses/assets are already split by the target company. The option to split also deals with corporate restructuring. Disintegration, or splitting, can be viewed as an inverse action to integration, which is typically the pre-requisite for exercising the option to create synergies. This implies that these post-acquisition strategic real options should be handled together in a timely manner. A business to be divested most likely needs to be operational as a stand-alone, before it can be sold, unless the business is stopped and/or only the assets are sold. Exercising the option to split, however, needs not be followed by a divestment. E.g., efficiency reasons can be behind establishing separately operational businesses. However, we consider the option to split as a cost part of the option to divest assuming that the first one is executed only when followed by the latter.

*Option to divest* non-core parts or assets is a right to sell (a put option) part of the target's businesses or assets, or to stop all the operations (fully exit) in the case of having executed an unprofitable acquisition. The latter can be seen as the option to exit, which is suggested being analyzed separately, because of its risk-limiting property. The option to divest or exit fully provides the acquirer with protection against unsuccessful acquisitions. Option to divest is acquired, when the acquisition deal is closed, however, its availability can be limited due to the acquirer's actions. If the acquired businesses are totally integrated with the acquirer's businesses, the option to divest can be, at least partly, destroyed. In this case, the option to split becomes a pre-requisite for the divestment. There are various ways to divest/abandon, each is an option on its own, including, e.g., IPO, MBO, LBO, asset liquidation, and shut-down. In this paper we focus on the option of partial divestiture, i.e., we do not account for the option to (fully) exit, which is used after unsuccessful acquisitions.

The next chapter presents the DSS, which values synergies based on the stand-alone valuation of the target. This will give us the first approximate value of revenue enhancing and cost reducing synergies together with divestitures of simple assets or small business units.

# 3. Decision Support Tool for Pre-Deal Valuation of Targets

## 3.1 Constructing Stand-alone Cash Flows

We suppose that there are two ways to proceed in the post-acquisition process as explained in section 2.1. The acquirer either integrates the target as a whole to pursue revenues enhancing and cost reducing synergies, or the acquirer chooses to integrate the core-business part of a target and, simultaneously, prepare a part or parts of the target for divestment.

The synergy valuation builds on the stand-alone valuation of the target company in our decision support system developed with our corporate partners and presented by Kinnunen and Collan (2009). The DSS incorporates a set of qualitative pre-specified factors connected to each quantitative (financial) input, adapts the required discount rate according to target characteristics, and includes also an analysis of financial synergies and an acquisition timing analysis, among other functions. However, the discussion to follow is only about the quantitative factors required for a simple, but

still comprehensive, way to value the acquisition target as a part of the acquirer by calculating its stand-alone value based on its forecasted cash flow scenarios, which are thereafter used as a basis for the operating synergy valuation together with net benefits from divestitures, and which together lead to the total value of the target. The approach is also to demonstrate how a spreadsheet application can be used to create the cash flow scenarios, which are required inputs for the fuzzy pay-off method for real options valuation discussed in Chapter 4. The DSS calculates the stand-alone value of the target by depreciating free cash flows for which the following inputs are required:

*Eq. 1*

\+ Total sales of the market (total demand)
x Market share of the target company
= Stand-alone sales of the target company
x EBIT margin (i.e. less operative costs)
= Earnings before interest and taxes
\- Taxes
+/- Cash flow adjustments
= Free cash flows

We first take a short look at how the above inputs are collected before going to the synergy evaluation.

*Total demand, i.e., market size,* in our DSS is modelled through model parameters for the demand cycle. Figure 3 shows how the DSS creates scenarios (for good, base, and bad cases) using the following inputs: The monetary value of *current total demand* (not seen in the figure), *current stage of the demand cycle* (8 possibilities ranging from the top of the cycle decreasing to the bottom and increasing to the peak as seen on the left side of the figure), *the length of the cycle* (in months), the *trend growth rate* over the next whole cycle, and the *amplitude of the cycle*, i.e., the difference from the top of the cycle to the bottom of the cycle (as a percentage of the current total demand). The future growth rates are required for the three scenarios. Together with the *past observed growth rate* (from year -3 to year 0, i.e., the current year) and the *growth rate following the next whole cycle* (pre- & post-cycle growth in Figure 3) the market size scenarios are constructed from today to ten years from now as seen on the right side of Figure 3.

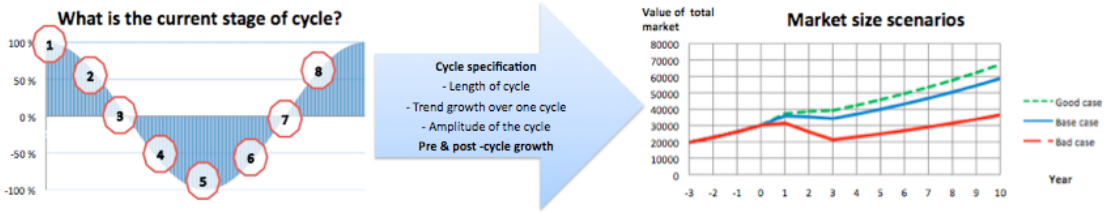


Figure 3: Modelling the demand cycle

*Market share (%) of the target* as stand-alone is forecasted for one year in the future (in addition to the current market share) as seen in Figure 4. The year, when the expected market share is achieved is used in the calculation in such a way that it is reached linearly from today's market share after which it is expected to be fixed. The expected market share may include costs, which are not accounted for through the costs related to the sales increasing synergies. If that is the case, they should be entered below the expected market share percentage. All of the inputs (market share, related costs, and the time to reach the market share) are required for the three scenarios. These inputs allow the DSS to construct three scenarios for stand-alone sales of the target (similarly as for the market size on the right side of Figure 3).

Inputs for the *operating margin, or EBIT margin (%)* forecast (also seen in Figure 4) and the current operating margin (not seen in the figure) are required analogously to the inputs for market share: inputs for the three scenarios for the expected future margin, the year when it is achieved, and the possible costs, which are not related to cost synergy creation. The calculation again uses linearly changing margin until the year when it is expected to be achieved and keeps it constant afterwards. The margin forecast together with tax-rate inputs and possible cash flow adjustments (not seen in the figure) lead to free cash flow scenarios from now to year ten, which is enough for calculating the stand-alone value of the target for the bad, base, and good cases.

| CATEGORY | CRITERIA | Bad case | Base case | Good case |
|---|---|---|---|---|
| Market share forecast | **Future market share (%)** | 20.0 % | 25.0 % | 30.0 % |
| | Stand-alone cost to achieve market share target (Euros) | 1 | 1 | 1 |
| | Time to achieve market share target (Years) | 2 | 1 | 1 |
| Margin forecast | **Margin forecast (%)** | 5.0 % | 6.0 % | 7.0 % |
| | Stand-alone cost to achieve forecasted margin (Euros) | 0 | 0 | 0 |
| | Time to achieve forecasted margin | 1 | 0 | 0 |

Figure 4: Inputs to determine the sales and the EBIT of the target

## 3.2 Constructing Synergistic Cash Flows

Next, we need forecasts for operating synergy benefits. Figure 5 shows how the required inputs for synergy benefits are collected in the DSS for the revenue enhancing, cost reduction, and divestitures. The logic for revenue and cost synergies is analogous to the stand-alone inputs presented in Figure 4, i.e., percentage inputs are required for all the synergy (sub)classes together with the estimated year when the full potential is achieved and how much that requires resources valued in monetary units, and all the inputs are needed for the bad, base, and good scenarios. Again, the percentage benefits are rising from zero (of today) to the full potential achieved in the given year linearly and stay fixed afterwards. The required costs, instead, are simply divided between the years from today to the year of achieving full potential, and they are non-existent from that year on.

The revenue synergies are calculated as a percentage of the stand-alone sales of the target. The DSS allows them to arise from two sources of which the first is cross-selling potential and the other is some other additional sales enhancing potential. The

cost synergies can arise from reductions in manufacturing, sourcing, research and development (R&D), or sales, general, and administrative (S,G&A) costs. The related costs to achieve the expected/targeted synergies may include, e.g., integration costs, new investments, higher salaries to keep key personnel in-house, higher marketing efforts, or any other cash-outflows, which take place in order to achieve revenue increases and efficiency benefits. Note that the *cursive figures* on the second rows of the input tables in Figure 5 are not inputs, instead, they show (in monetary units) what the synergy percentage entered in the above cell would mean as if the full synergy was instantly realized; they are only to support the user of the DSS.

| CATEGORY | CRITERIA | Bad case | Base case | Good case |
|---|---|---|---|---|
| Revenue synergy potential | **Cross-selling potential (% of target's sales)** | 0.0 % | 2.5 % | 5.0 % |
| | Cross-selling potential (Euros) in year 0 | *0* | *250* | *500* |
| | Costs to achieve the cross-selling synergies (Euros) | 0.5 | 0.5 | 0.5 |
| | Time to achieve full potential of synergies | 4 | 3 | 1 |
| | **Other additional selling potential (% of target's sales)** | 0.0 % | 1.0 % | 1.0 % |
| | Other additional selling potential (Euros) in year 0 | *0* | *100* | *100* |
| | Costs to achieve the synergies (Euros) | 0.5 | 0.5 | 0.5 |
| | Time to achieve full potential of synergies | 2 | 2 | 2 |
| Cost synergy potential | **Manufacturing cost synergies (% of manufacturing cost)** | 0.0 % | 1.0 % | 1.0 % |
| | Manufacturing cost synergies (Euros) in year 0 | *0.0* | *5.0* | *5.0* |
| | Costs to achieve the synergies | 1 | 1 | 1 |
| | Time to achieve synergies | 3 | 2 | 1 |
| | **Sourcing synergies (% of target's sourcing cost)** | 0.0 % | 4.0 % | 6.0 % |
| | Sourcing synergies (Euros) in year 0 | *0* | *320* | *480* |
| | Costs to achieve the synergies | 10 | 10 | 10 |
| | Time to achieve synergies | 1 | 1 | 1 |
| | **R&D synergies (% of target's R&D cost)** | 0.0 % | 1.0 % | 1.0 % |
| | R&D synergies (Euros) in year 0 | *0.0* | *2.0* | *2.0* |
| | Costs to achieve the synergies | 0 | 0 | 0 |
| | Time to achieve synergies | 3 | 2 | 1 |
| | **S,G&A synergies (% of target's S,G&A cost)** | 0.0 % | 5.0 % | 7.5 % |
| | S,G&A synergies (Euros) in year 0 | *0* | *30* | *45* |
| | Costs to achieve the synergies | 0.1 | 0.1 | 0.5 |
| | Time to achieve synergies | 3 | 2 | 1 |
| Divestitures | **Considerable assets (net cash flows in Euros/Year)** | | | |

| Year | Euros | Year | Euros |
|---|---|---|---|
| 0 | -100 | 5 | |
| 1 | 350 | 6 | |
| 2 | | 7 | |
| 3 | | 8 | |
| 4 | | 9 | |

Figure 5: Inputs for operating synergies and divestitures

We also consider revenues and costs from divestitures, because they can release resources, increase efficiency, and allow managers to focus on creating operating synergies from their core business, and because the preparation for divestitures is directly linked to the integration efforts (through an inverse relation) required for realizing operating synergies (as argued in section 2.1). The divestitures are handled in a most simple way in our DSS. Inputs are required on net basis for the years when cash flows are expected to be realized, and there is only one scenario allowed as seen in Figure 5. This is enough, e.g., for a simple real asset such as a warehouse or a

manufacturing machine, which are typically one-time transactions, and particularly the cash-inflow from a divestment can be attributed to a certain year. We find this appropriate also for a small business unit as the first approximation for the screening purposes for which the DSS has been built. However, we note that larger non-core businesses to-be-divested are likely to require more detailed analysis of cash flows as both the cost side (to organize the unit possibly to be able to operate on its own to make it more attractive to potential buyers) and the revenue side (possibly based on negotiations or bidding processes) can be complicated. They can also be interconnected with the sales and cost sides of the core business part of the target.

The presented inputs allow now the calculation of cash-flow scenarios also for operating synergies and divestitures, which come above the stand-alone cash flows of the acquisition target candidate. This already gives us the total net present value, NPV, of the target (excluding synergies related to, e.g., working capital, capital expenditures/CAPEX, or taxation, which are taken into account in our DSS, but which are out of the scope of this study).

In the next chapter we will show how the constructed scenario outputs are used as a basis for valuing synergies and the total value of acquisition candidates using the fuzzy pay-off method for real option valuation, and how the fuzzy measure and the price of the target can be used in selecting and ordering potential acquisition candidates.

# 4. Valuing Targets Using Possibilistic Pay-Off Distributions

## 4.1 The Pay-Off Method for Real Option Valuation

The fuzzy pay-off method for real option valuation developed by Collan, Fullér, and Mézei, (2009a) is applied here. It is based on fuzzy sets and possibility theory initiated by Zadeh (1965, 1978). The method builds the real option valuation on possibilistic expected value, i.e., the fuzzy mean of the possibilistic distribution developed by Carlsson and Fullér (2001).

The idea of the method of Collan et al (2009a) is similar to the idea of the practical real options valuation method presented by Datar and Mathews (Datar and Mathews, 2004; Mathews and Datar, 2007), which has been developed and initially applied at Boeing Corporation.

To calculate a real options value, ROV, a process is firstly needed to create the expected pay-off distribution, e.g., the Black-Scholes model (Black and Scholes, 1973) uses stochastic processes, the binomial method (Cox, Ross and Rubinstein, 1979) uses binomial processes, and so on. The process to create the expected pay-off distribution can be chosen by an analyst. We argue that a stochastic process, however, is not in line with the reality of real investments, because managerial actions can affect the value – the value is not random.

The ROV can be calculated by weighing the positive values (NPV > 0) by their expected probability/possibility and also weighing the negative side values (NPV < 0), *set to 0 (NPV = 0)*, by their expected probability/possibility. The Datar-Mathews

method uses three cash flow scenarios, i.e., the pessimistic, most likely, and optimistic scenarios as the basis for real options valuation. The method creates the expected full distribution of expected NPVs by Monte Carlo simulation (Boyle, 1977) and then weighs the NPVs according to the distribution (and setting negative expected NPVs to zeros), i.e., *the ROV is the mean of the positive side times the probability of NPV positive outcomes*.

Collan et al (2009a, 2009b) use a possibility distribution, i.e. a fuzzy number, instead of a probability distribution, and no simulation is required. The expected NPV of a project, its real options value is calculated by weighing the positive NPV (fuzzy) mean by the positive side area of the (fuzzy) distribution. The possible expected NPV of a project can be calculated from the fuzzy distributions of any shape[1]. Collan et al (2009a) presents the model and explains how it is calculated for triangular and trapezoidal fuzzy numbers. Collan et al (2009b) do the same for staged investments, i.e., compound real options.

In this paper we will use a triangular fuzzy number, A, which is defined by three points, a, α, and β, i.e., A= (a, α, β). Figure 6 present a triangular fuzzy number. Its peak, or center, is represented by a, which can be seen as a fuzzy quantity "x is approximately equal to a" or "x is close to a". The left width is represented by α, and its right width by β, i.e., α and β are the distance (a real positive number) from a, a - α representing the smallest, and a + β the largest possible number belonging to (a member of) the fuzzy distribution (cf. the normal probability distribution's tails with the smallest probability to occur). A fuzzy distribution is defined by the membership function, which determines the degree of membership ranging from 0 (not a member) to 1. The peak, a, has membership of degree 1. A fuzzy set is called triangular fuzzy number with peak a, left width $\alpha > 0$, and right width $\beta > 0$, if its membership function is of the following form:

*Eq. 2*

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

The support of A is a crisp (single number) subset of real numbers ranging from a - α to a + β. In Figure 6, the triangular fuzzy number has negative values (from a - α to 0) and positive value (from 0 to a + β), which represent negative NPV and positive NPV of pay-offs from a project, respectively.

[1] For mathematical presentation and definitions of fuzzy sets and numbers, see, e.g., Zadeh (1965, 1978).

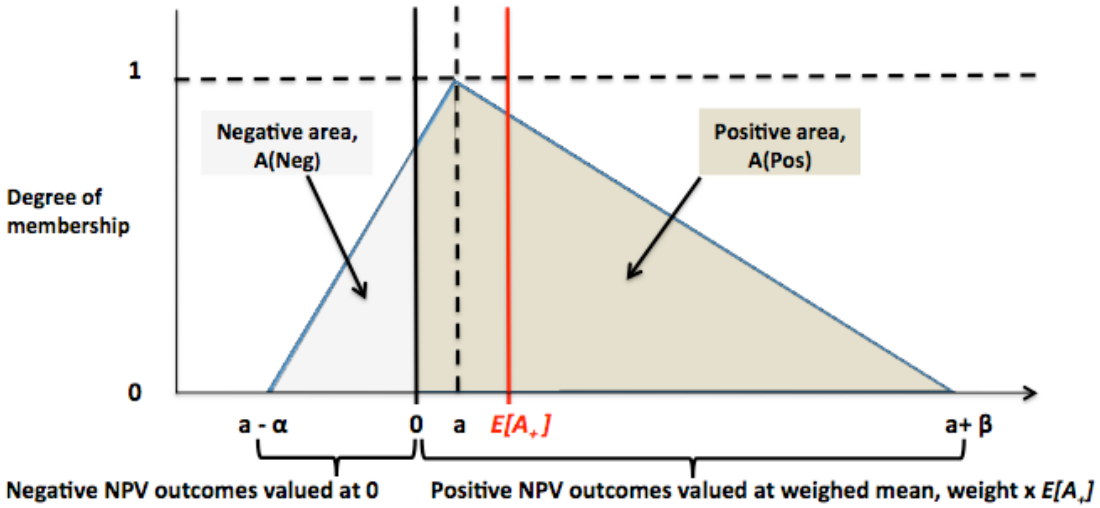


Figure 6: A triangular fuzzy number A is defined by three points, α, a, and β, and describes the NPV of a prospective project (adopted from Collan et al, 2009a)

Carlsson and Fullér (2001) derive the mean of the triangular fuzzy number. In Figure 6 $E[A_+]$ describes the mean of the positive side of the fuzzy distribution as follows:

*Eq. 3*

$$E[A_+]=\begin{cases} a+\dfrac{\beta-\alpha}{6}, & if\ \ 0<a-\alpha \quad \text{'all NPV positive'} \\ \dfrac{(\alpha-a)^3}{6\alpha^2}+a+\dfrac{\beta-\alpha}{6}, & if\ \ a-\alpha<0<a \quad \text{'some negative NPV; positive peak'} \\ \dfrac{(\alpha-\beta)^3}{6\beta^2}, & if\ \ a<0<a+\beta \quad \text{'some positive NPV; negative peak'} \\ 0 & if\ \ a+\beta<0 \quad \text{'all NPV negative'} \end{cases}$$

The mean of the positive side is what (Collan et al, 2009a, 2009b) use in calculating the real option value, ROV, from the (fuzzy) NPV distribution. The real option value is calculated by weighing the fuzzy mean of the positive side of the distribution by proportion of the positive area of the total area. Using the conceptss presented in Figure 6, the real option value is calculated as follows[2]:

[2] Collan et al (2009a, 2009b) formulates a single number expected real option value in the following form: $ROV=\dfrac{\int_0^{\infty}A(x)dx}{\int_{-\infty}^{\infty}A(x)dx}\times E(A_+)$

where A stands for the fuzzy NPV, and the integrals compute the areas, the numerator computes the area below the positive part of the fuzzy number A, and denominator computes the area below the whole fuzzy number.

*Eq. 4*

$$ROV = \frac{A(Pos)}{A(Neg) + A(Pos)} \times E(A_+)$$

It can be noted that when the whole fuzzy number is larger than zero then the ROV simplifies to the fuzzy mean E[$A_+$] (the weight is 1), and when the whole fuzzy number is smaller than zero the ROV is 0 (because the fuzzy mean of the positive side is 0).

In the next section we will show how the NPV of cumulative pay-offs can be interpreted as a fuzzy number (i.e., a possibilistic distribution) in the case of three scenarios, the pessimistic, base, and optimistic scenarios. However, as noted by Collan et al (2009a), cash flows could have been asked in the form of triangular (or trapezoidal) fuzzy numbers from the beginning, e.g., as inputs in the DSS presented in section 3; then such ”interpretation” would not be needed. However, the construction of the DSS itself would probably not need any modifications, only new guidelines and names of the current scenarios ought to be changed to represent those established notions of the theory and practice of fuzzy sets.

## 4.2 Valuing Synergy Real Options with the Pay-Off Method

The real option value of synergies and the total acquisition using the pay-off method can be calculated from the cash flow scenarios constructed in the previous section. Table 1 shows the forecasted cumulative net cash flows for the three scenarios, which are a direct output from our DSS. The upper part of table 1 shows the cumulative cash flows to ten years from now, or the year of the ex-ante evaluation (here we exclude the terminal value, i.e., the value of cash flows after the ten years forecast horizon). These figures include the operations of a stand-alone target company, the sales increasing and the cost decreasing synergies, as well as, the costs and revenues from a divestiture. The lower part of the table shows the combined cumulated cash flows from the operating synergies and the divestiture for the same period. All the cash flow figures are discounted to year 0, i.e., they represent the net present value, NPV, of the cash flows. It is seen in the table that the optimistic (good case) scenario produces the NPV of cumulative cash flows of 9057 (thousands) in monetary units, while the base case leads to 4719, and the pessimistic (bad case) scenario only to 1801 (highlighted in the rightmost column).

The variance is large between the scenarios. Here, the major part of the variability arises from synergistic gains/loss. In the example, the optimistic scenario produces over half of the total NPV, i.e., 5839 (thousands) of the total 9075. In the base case synergistic gains produce an NPV of 1846. The pessimistic synergy scenario leads to a negative NPV of -151 (thousands), which is due to assumptions that no operating synergy gains are achieved and the negative amount is due to restructuring costs of a planned divestment, which will not happen, e.g., because of a realized global financial distress, or the asset is shut down or liquidated without revenues. This may be a special case, but it is assumed now for illustrative purposes: such a scenario may occur, the uncertainty in the pre-deal and pre- due diligence phase can be very large, and this also demonstrates the ability of the applied fuzzy pay-off method for valuing real options to account for possible negative value scenarios.

**Cumulative total cash flows (NPV)**

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| Optimistic | 673 | 1964 | 2938 | 3879 | 4793 | 5697 | 6575 | 7427 | 8254 | 9057 |
| Base | 388 | 1173 | 1663 | 2133 | 2589 | 3041 | 3479 | 3905 | 4318 | 4719 |
| Pessimistic | 262 | 456 | 649 | 826 | 998 | 1168 | 1334 | 1494 | 1650 | 1801 |

**Cumulative synergistic cash flows (NPV)**

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| Optimistic | 288 | 1203 | 1840 | 2455 | 3052 | 3643 | 4216 | 4773 | 5314 | 5839 |
| Base | 13 | 450 | 641 | 827 | 1007 | 1185 | 1357 | 1525 | 1688 | 1846 |
| Pessimistic | -76 | -151 | -152 | -152 | -152 | -152 | -152 | -152 | -152 | -151 |

Table 1: Cumulative NPV cash flow scenarios from total acquisition and synergies

The inclusion of the divestiture option and the related restructuring/splitting costs in the above example could have been left out from the analysis based on an assumption that it was a simple non-operating asset or a small unit, and its interactions with the operating synergies could have been non-existent. This implies that non-sequential, separate real options can easily not only been left out of the analysis, but also easily included through a construction of cash flows scenarios, if they are additive with the cash flows from other available real options.

Figure 7 shows, on the left side, the charts for the figures in Table 1 together with the NPV of cash flows for the ten-year period (highlighted on yellow). On the right side of the figure, these scenario outputs are interpreted as a fuzzy triangular number separately for the total NPV of the acquisition (in the upper part of the figure) and the synergistic gains (in the lower part of the figure).

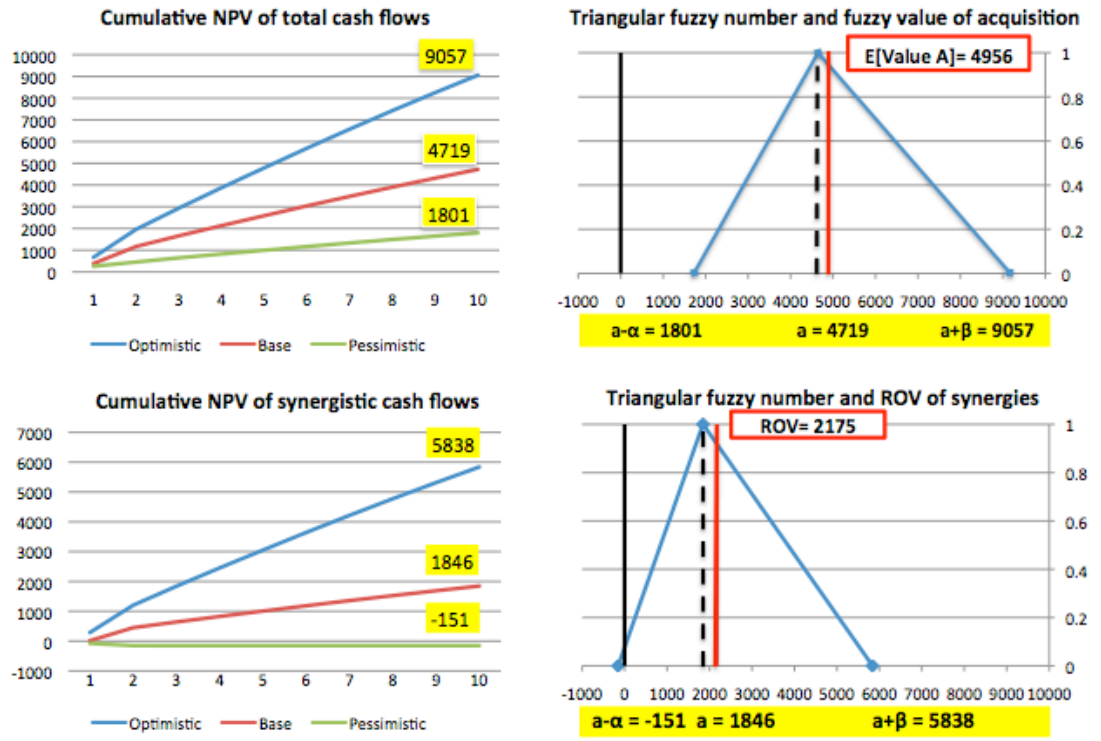


Figure 7: From cumulative NPV cash-flow scenarios to triangular fuzzy number, fuzzy expected value, E[Value A], and the real options value, ROV, for Company A.

Figure 7 shows that the fuzzy distribution of the total NPV of the acquisition is defined as $A_{TOTAL}$ = (a, α, β) = (4719, 2918, 4338), i.e., the peak a = 4719, α = 4719-1801 = 2918, and β = 9057-4719 = 4338. The right side of Figure 7 further shows (in the red box) the fuzzy mean, i.e., the expected NPV of the total acquisition, E[Value A], of 4956 (the target firm under discussion is called company A hence), and the real options value, ROV, of 2175 for the synergy real options.

The fuzzy pay-offs can be used in ordering acquisition candidates as seen in Figure 8. There are another potential target in addition to our company A, i.e., company B. They are compared with respect to their expected deal prices. Company A has the expected NPV, E[Value A], of 4956 as presented above. The other candidate, company B has the expected NPV, E[Value B], of 3258 from the acquirer's point of view. The expected value of company B is received (similarly as company A above) from the forecasted cumulated cash flows over the ten year period for the three scenarios: the pessimistic NPV of 1250 (a – α), the base case NPV of 2450 (a), and the optimistic NPV of 8500 (a + β). We have fixed the prices for simplification; also they could be presented as fuzzy numbers (in fact, they are presented now as fuzzy triangular numbers with α and β equal to zero; real numbers are a subset of fuzzy numbers) in the same way the NPV of the candidates is handled. The fixed price can be defended here also because an acquirer can have exact, or close to exact, knowledge of the prices through negotiations with the target, e.g., an owner of a small family business may be determined to stick to his or her decision on what would be the correct deal price.

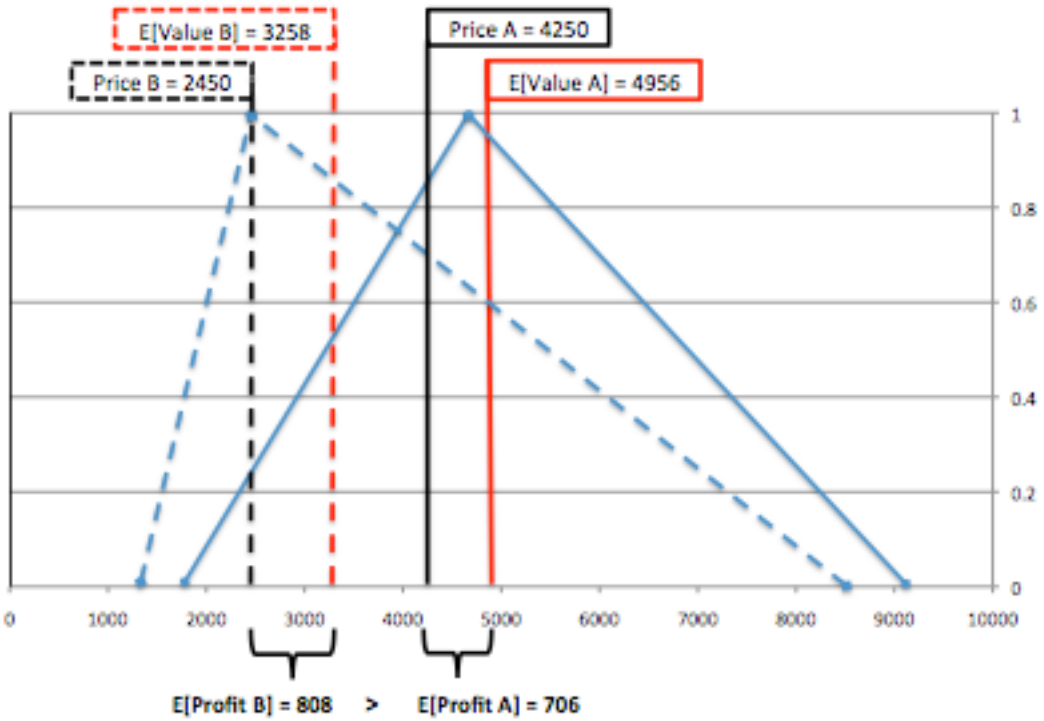


Figure 8: Comparing potential acquisition candidates with respect to their price and expected value

Figure 8 shows that the price of the company A, 4250, is clearly lower than the base-case scenario induced value of 4719, while the company B is on sale at the base-case value of 2450. Company A also seems to have a larger value in both the pessimistic and optimistic scenarios. However, Company B's expected profit, E[Profit B], for the acquirer is over 800, while company A is offering the expected profit, E[Profit A], of about 700, i.e., there is a difference of more than 15 percent due to the relatively larger upside potential to create value by acquiring and developing company B than company A. The real options value arising from company B is, say, 2500. Assuming that the two companies operate in the same industry, and that the total market size is the same (same potential customer base) and the demand cycle is modelled using the same parameters. The difference could arise from any kind of (or a combination of) synergy real option(s), e.g., the cross-selling potential, S,G&A cost reductions, and/or divestment opportunities.

In general, when there are a complex combination of several real options, which may be sequential and/or interrelated, which an acquirer foresees opening through an acquisition, the valuation is likely to become complicated even with the pay-off method applied in this paper. In that case, to reach the ROV, it is suggested (cf. Krishnamurti and Vishwanath, 2008; Seth, 1990) to, firstly, value the target with an assumption of total control over the target and value it as if optimal resource redeployments, divestitures of non-core assets, and possibly required new investments were done, and, secondly, value it as a stand-alone. The difference between the two values can be attached to the portfolio of real options available to an acquirer. We can further argue, as discussed in section 2.2, that the value-adding real options exclusively available to an acquirer, due to its specific strategic and economic capital, are not likely to be priced in the market. This implies that the focus on the analysis of such real options already in the target screening stage can prove to be a highly profitable approach.

The reason for the upside potential would require more in-depth analysis of the available synergistic real options, which could be done using the fuzzy pay-off method for real options valuation. We have focused on the first approximate valuation of the operational synergies and the related divestitures of non-core assets with a decision support tool built for the screening stage. The analysis can be deepened already in the due diligence stage, which potentially reduces uncertainty and makes it possible to adjust the forecasted cash flows.

The presented acquisition process can also be seen as a staged investment, where the synergy real options are sequential to the option to acquire the target. Companies can be evaluated and compared, e.g., within the real options growth, ROG, matrix initiated by Luehrman (1998) and developed further by Smit and Trigeorgis (2006). According to the ROG approach investment projects, e.g., corporate acquisitions can be positioned based on their Expanded (strategic) NPV = base NPV + PV of growth options (Smit and Trigeorgis, 2006). This is analogical to our model where the total NPV of acquisition = stand-alone NPV + ROV.

Our purpose in this section has been to suggest that the ex-ante analysis of acquisition targets with a real options approach based on the possibilistic pay-off distribution (Collan et al, 2009a, 2009b) can be utilized in target company valuations as a new measure in the field of M&A valuations, to help ordering potential candidates, to give

guidance for deal negotiations, and to help pre-formulate valuable post-acquisition processes. The next section is to conclude and discuss possible future research opportunities

## 5. Discussion and Conclusions

This paper has presented an M&A process framework for operational synergy creation, which is based on the notion that restructuring activities including divestitures of non-core assets drive synergistic gains. The synergy was defined broadly, but the focus of the paper has been on revenue enhancing and cost reducing synergies.

The real options approach was discussed using the total value concept, where we made a separation of real options that are available potentially for the target's management and also to other potential acquirers, and those real options that are exclusively available to the acquiring company. For instance, cross-selling potential may arise from complementary products and services, R&D cost reductions and sales increases may prove to be very large if a missing patent for a killer product can be acquired etc. The separation can be argued to apply to operational synergies, as well as, to more strategic growth opportunities arising from the acquirer's unique strategic and economic capital. It was argued that market prices will unlikely account for real options, which are exclusively available to a specific acquirer. That may open up profitable value capturing opportunities at the negotiation table or in the bidding process.

A decision support tool built for the ex-ante, pre-deal, screening stage was presented to support the calculation of the first approximate values of the operating synergy potential and the total target. It was argued that the uncertainty is very large at that phase, which supports the use of the fuzzy pay-off method for this purpose. The method was presented as an integrated part of the built spreadsheet DSS.

We discussed the valuation of corporate acquisition targets and their operational synergies through an example of two imaginary companies, which were compared under assumed differences in synergy potential and with respect to their assumed transaction prices at which the acquirer expects to be able to close the deal.

We also discussed the applicability of the pay-off method to valuing other than operational synergy options and argued that it can be used also to value other real options, particularly, other growth options, which are the key real options studied in the M&A literature. More traditional real options methods easily become complex and difficult to use, particularly, when there are several possibly sequential and interconnected options under analysis. For its simplicity the pay-off method can be applied and it is suggested that it should be applied whenever forward looking cash flow estimates are needed, uncertainty is large, past statistics are non-existent, or they are simply of no value, which is typical of large and unique investments, such as mergers and acquisitions. The presented literature suggested that a simple way to get the total value of the combination or a portfolio of real options is to value the target as if an acquirer was already in total control and made the restructuring activities and the

new required investments to create value, and to compare the result to the valuations of the target as a stand-alone.

There are several potential paths for further research arising from the discussed pay-off method, which could be applied in various ways in the field of M&As, e.g., alternative strategies comprising different post-acquisition real options could be valued, the total value of acquisition targets could be calculated including deferrals, large abandonments, different growth options etc. An optimal timing analysis can be studied using the method. Decision support tools could be developed around the method including the compound pay-off method of Collan et al (2009b). This could include the first stage (screening analysis), due diligence, and post-merger stages, which could be further divided according to flexible staged investment opportunities.

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