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The Simulation-Based Valuation of Companies and Their Strategies

– Classification, Methodology and Case Study –

Simulation-based business planning and business valuation are being increasingly used in business valuation practice. In contrast to CAPM-based DCF valuation, simulation-based DCF valuation derives the cost of capital from the risks that actually exist in the company. It can also consider market imperfections, insolvency risks and a varying degree of diversification of the valuation subject. When applying simulation-based business valuation, it is important for valuation practitioners to understand the basic ideas and valuation equations behind this approach. This article uses a simple example to convey all the essential aspects and steps of simulation-based business valuation.

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I. Introduction and overview

The value of a company is a ratio that expresses, in condensed form, the (1) expected amount, (2) risk and (3) timing of cash flows generated by the company. In real, imperfect markets, this company value usually does not coincide with the stock market price (as price).[1] Due to the unrealistic assumptions and empirically unconvincing results, it is now obvious that discount rates (cost of capital rates) cannot be reliably determined using the Capital Asset Pricing Model (CAPM). The so-called build-up models[2] with a surcharge on the CAPM cost of capital also cannot be applied in a consistent valuation approach, because the assumptions underlying the CAPM mean that all valuation-relevant risks must be included in the beta factor.[3] Such build-up models are suitable as "price estimation models", i.e., use in for explaining prices observable on the market. They are conceptually unsuitable for determining a fundamental company value, and specifically for evaluating various options for action by a company.

Indeed, to determine a fundamental company value as a measure of the risk–return profile, it is necessary to capture the risks of the company itself (volatility of cash flows). It is unsuited, as with the beta factor, to considering the risks of fluctuations in stock returns. For a long-term-oriented investor, temporary stock return fluctuations are effectively irrelevant (see, e.g., the investment approach of Warren Buffet).

Particularly when evaluating a company's strategic options (e.g., two strategy variants or major investments), it is necessary to determine the potential different risks by means of risk analysis. These must then be considered in the valuation calculus (what–if analysis). In recent years, new valuation concepts have been developed to meet the challenges outlined here of valuing companies and their strategic options for action in a real, imperfect capital market with (credit) rating and financing constraints. The by the authors so-called semi-investment-theoretical valuation theory builds on the investment-theoretical valuation theory[4] (see the glossary for the most important terms) developed years ago, particularly in the German literature, and can be practically used following some simplifications. Semi-investment-theoretical valuation theory, when used as a method for risk-adequate valuation, does not assume perfect capital market. It considers rating and financing constraints and allows the derivation of discount rates based on an analysis of the risks of a company (or investment project). Historical stock return fluctuations of the valuation object (or data of a peer group) are not required. The derivation of the valuation equation and discount rates is based on only one, less restrictive assumption: two cash flows at the same time have the same value if they match in expected value and a chosen risk measure (such as standard deviation or value at risk).[5] Since companies display a large number of risks that are recorded in risk analyses, a so-called risk aggregation is required as a bridge between the risk analysis and the assessment. Based on the corporate planning and the analysis of existing opportunities and threats (risks) that trigger deviations from the plan, a large number of representative possible risk-related future scenarios are calculated using Monte Carlo simulation. By doing so, a realistic range of future cash flows is derived. From this, the expected value of cash flows (or flow-to-equity) and their levels of risk can be derived. From the volume of risk, a suitable risk-adjusted discount rate can again be derived: more risk leads to higher expected return requirements and correspondingly higher discount rates. Since in practice such a risk-adequate valuation always requires the use of a Monte Carlo simulation, this variant is referred to as a "simulation-based company valuation". In the practical implementation of simulation-based valuation, the familiar equations of the discounted cash flow (**DCF**) method can be used. It should be noted that expected cash flows and risk-adjusted discount rates are derived together and consistently with each other, taking into account the identified risks.

In this paper, Section 2 first explains semi-investment theory valuation, and the simulation-based business valuation that is based on it. This theory is related to traditional capital market-oriented (financing theoretical) valuation concepts, such as the discounted cash flow method based on the capital asset pricing model. In Section 3, the practical application of the method is illustrated using a case study. The starting point is the "traditional" valuation of a company based on the cost of capital derived using the CAPM. It is shown how the valuation is changed if, instead of (often ambitious) plan values, unbiased plan values are set that consider opportunities and risks. It is also shown how the risk volume of the cash flows can be used to derive a risk-adjusted discount rate that differs from the discount rate derived according to CAPM. Finally, it is made clear how the insolvency risk, i.e., the probability of insolvency expressed by the rating, can also be considered in the company valuation. In addition to the valuation of the company in its current situation, the valuation of a strate-

1 Ernst/Gleißner, Paradigm Shift in Finance: The Transformation of the Theory from Perfect to Imperfect Capital Markets Using the Example of Company Valuation, JRFM, vol. 15, no 9 (2022): 399-411; Shleifer/Vishny, The Limits of Arbitrage, The Journal of Finance, vol. 52, no. 1 (1997): 35-55 and Gromb/Vayanos, Limits of Arbitrage, Annual Review of Financial Economics, vol. 2, no. 1 (2010): 251-275.

2 See e.g. Damodaran, The Little Book of Valuation: How to Value a Company, Pick a Stock and Profit, 2011 and Grabowski, The size effect continues to be relevant when estimating the cost of capital, Business Valuation Review, vol. 37, no. 3 (2018): 93-109.

3 Kruschwitz/Löffler/Mandl, Damodarans Country Risk Premium – und was davon zu halten ist, WPg, no. 4 (2011): 167-176 and Ernst/Gleißner, Damodarans Länderrisikoprämie, WPg, no. 23 (2012): 1252-1264.

4 Matschke, Funktionale Unternehmensbewertung, Band II, Der Arbitriumwert der Unternehmung, 1979; Hering, Unternehmensbewertung, 4th ed. 2021 and Matschke/Brösel, Business Valuation, 2021.

5 Dorfleitner/Gleißner, Valuing streams of risky cashflows with risk-value models, Journal of Risk, vol. 20, no. 3 (2018): 1-27.

Table 1: Comparison of valuation methods

	Risk-adequate valuation ("incomplete replication")		Capital market-oriented valuation	
	Risk coverage approach	Coefficient of variation approach	CAPM (return equation)	Multi-factor models*
Level of information	Individual level of information		Information processed on the capital market	
Risk reference	Earnings (EBIT or cash flow) - historical or - future-related (Monte Carlo simulation)		As a rule, stock returns (for derivation beta)	Stock returns
Risk effect on	Discount rate and at the same time expected earnings (cash flow)		Discount rate (expected earnings are not linked)	
Risk measures	Value at risk due to financing restrictions	Standard deviation	Standard deviation (by beta factor)	Several or not explicit
Alternative investment	- risk-free investment - risky stock index (Note: other investments possible)		- risk-free investment - (theoretical) market portfolio	Not explicit
Diversification (valuation subject)	Any / individual (often d = 1)	Any / individual (often d = 1, d = 0.5, d = *p*)	Perfectly diversified (d = *p*) *p* is the correlation to the market return required to determine the beta factor of the CAPM (see Chapter III)	Not explicit

*See e.g. Fama/French, A five-factor asset pricing modell, Journal of Financial Economics, vol. 116, no. 1 (2015): 1-22.

gic option for action, an efficiency enhancement program, is also carried out. In this way, the risk-return profile of alternative options for action can be evaluated in a well-founded manner, which is necessary to developing comprehensible and well-founded decision-making proposals for upcoming entrepreneurial decisions (Business Judgement Rule).[6] A concise conclusion ends the article.

II. Valuation methods in comparison

Capital market-oriented valuation approaches, such as the CAPM, derive risks from capital market data. The calculations are based on fluctuations in stock returns. The CAPM has the disadvantage that company-specific risks, which arise from the company's risk analysis, are not adequately considered. In the beta factor of the CAPM, historical stock return fluctuations are evaluated (and the risks of a company's future cash flows are not explicitly considered). Given the condition of imperfect capital markets, valuations based on historical capital market data are problematic.[7] As explained in the introduction, a foundation for "risk-adequate valuation" has been developed in recent years in the form of semi-investment-theoretical valuation theory. This valuation method directly uses the result of the analysis of the future risks of a company to determine the discount rate and thus the value of the company. As an alternative to DCF valuation based on CAPM, two variants of "risk-adequate valuation" have developed, whose valuation equations can each be derived using the "incomplete replication" method.[8]

1. The risk coverage approach, which uses the value at risk measure and considers financing restrictions. This approach is only classified here (see Table 1) and not explained in more detail.[9]
2. The risk-adequate valuation method, which derives the costs of capital via the coefficient of variation of earnings or cash flows.[10]

Table 1 compares the two approaches of risk-adequate (semi-investment theory) valuation with the approaches of capital market-oriented valuation.[11] In the case study in Chapter III, a risk-adequate valuation is carried out and compared with a valuation based on CAPM. In the risk-adequate valuation, the discount rate is derived from the coefficient of variation of the cash flows (flow-to-equity)

6 Gleißner, Entrepreneurial Decisions, Entrepreneurial Decisions – Avoiding liability risks (Section 93 AktG, Business Judgement Rule), Controller Magazin, vol. 45, no. 1 (2021): 16-21.

7 See for criticism Dempsey, The Capital Asset Pricing Model (CAPM): The History of a Failed Revolutionary Idea in Finance?, Abacus, vol. 49, no. S1 (2013): 7-23 and Dempsey, The CAPM: A Case of Elegance is for Tailors?, Abacus, vol. 49, no. S1 (2013): 82-87; Rossi, The Capital Asset Pricing Model: A Critical Literature Review, GBER, vol. 18, no. 5 (2016): 604-617; Schildbach, Modigliani/Miller-Thesen und CAPM: Irrlehren statt wegweisender Theorien, BFuP, no. 4 (2022): 375 et sqq. and Fernández, Is It Ethical to Teach That Beta and CAPM Explain Something?, working paper, 2019, SSRN-ID 2980847 (last access 05.05.2023).

8 Gleißner, Grundlagen des Risikomanagements. Handbuch für ein Management unter Unsicherheit, 4th ed. 2022: 490-493.

9 See for a more detailed explanation Ernst/Gleißner, Total Beta: A View from Outside, The Value Examiner (to appear 2023).

10 Gleißner, Cost of capital and probability of default in value-based risk management, Management Research Review, vol. 42, no. 11 (2019): 1243-1258.

11 See further Gleißner/Meckl, Methoden der Unternehmensbewertung und ihre Anwendung bei M&A, WiSt (to appear 2023).

(“coefficient of variation approach”). The coefficient of variation can be determined via risk analysis and risk aggregation and is formally defined as the standard deviation in relation to the expected value of the cash flows.

The method of risk-adequate valuation is always based on information about the risks of the company itself, which are determined by means of risk analysis. In principle, it is possible to derive the risk measures required for this purpose from historical fluctuations in earnings or cash flows. Statistical use is made of fluctuations in earnings and the results to determine, for example, the corresponding coefficient of variation of profits.[12] In principle, it is preferable to use a forward-looking valuation, which looks at the risks that are decisive for the value and viability of a company. In such cases, the basis yields an analysis of future risks and risk aggregation. If the valuation of a company or its strategic options for action is based on a risk analysis and a Monte Carlo simulation for risk aggregation, we arrive at a “simulation-based valuation”. The central characteristics of a simulation-based valuation are as follows:[13]

1. Considering the effect of corporate risks on integrated planning;
2. Using of Monte Carlo simulation for risk aggregation.

Initially, a simulation-based valuation does not imply commitment to a specific valuation theoretical framework. The use of that valuation method is possible in

1. An investment theoretical valuation;[14]
2. A semi-investment-theoretical valuation by means of “imperfect replication”;[15]
3. In a finance-theoretical valuation based on the CAPM.[16]

The frequency distributions of the cash flows from the simulation are each condensed to the expected value in the valuation. The risk of the cash flows is expressed by a risk measure, such as standard deviation or value at risk.[17] With a risk-value model and the imperfect replication method[18], the risk-adequate present value can be calculated, taking into account the (a) amount, (b) risk and (c) timing of cash flows. The value calculated in this way only represents a certain amount of money equivalent to an uncertain future cash flow with the same expected value and risk. Neither capital market data on the valuation object nor the hypothesis of perfect capital markets are required for the valuation. Besides assumptions about alternative investment options, e.g., government bonds with AAA-rating and a world equity portfolio, we only need one other assumption: two cash payments at the same time coincide exactly in value if they have the same expected value and the same values of the chosen risk measure. Thus, the risk-adequate cost of capital can be derived[19] without historical capital market data (beta factor of the company or peer group).

The defining characteristic of a simulation-based assessment is the explicit consideration of business risks (opportunities and threats) and the application of Monte Carlo simulation for the calculation of risk-related future scenarios. The resulting “multi-value” planning (bandwidth planning) structure allows expected values of cash flows or earnings to be derived directly, determines and captures insolvency risk, and allows discount rates to be derived directly from the uncertainty of cash flows (i.e., without evaluating stock return fluctuations). With a simulation-based assessment, the new legal requirements for risk management are also met (e.g., in Germany § 1 StaRUG).

The main characteristics and advantages of a “simulation-based business valuation” based on the analysis of business risks can thus be summarized as follows:[20]

1. Only with simulation-based planning can the expected values of cash flows or earnings be derived in a comprehensible manner.
2. A plausibility check of the planning and planning logic is carried out.
3. A simulation-based valuation can be used to consider the impact of insolvency risk on the value of the company.
4. A simulation-based business valuation allows the derivation of a risk-adjusted discount rate (cost of capital) directly from the simulation results.
5. Simulation-based valuation can represent a basis for preparing business decisions because planned future changes in planned values and risks can be considered.

12 Gleißner, Unternehmenswert, Ertragsrisiko, Kapitalkosten und fundamentales Beta – Studie zu DAX und MDAX, BewertungsPraktiker, no. 2 (2016): 60-70.

13 See Gleißner, Simulationsbasierte Unternehmensbewertung: Methode und Nutzen, BewertungsPraktiker, no. 3 (2021): 84-87.

14 Hering/Schneider/Toll, Simulative Unternehmensbewertung, BFuP, vol. 65, no. 3 (2013): 256-280.

15 Gleißner, Risikoanalyse und Replikation für Unternehmensbewertung und wertorientierte Unternehmenssteuerung, WiSt, no. 7 (2011): 345-352; Gleißner, op. cit. (footnote No. 10): 1243-1258; Dorfleitner/Gleißner, op. cit. (footnote No. 5): 1-27; Dorfleitner, On the use of the terminal-value approach in risk-value models, Annals of Operations Research, vol. 313, no. 2 (2020): 877-897; Ernst, Simulation-Based Business Valuation: Methodical Implementation in the Valuation Practice, JRFM, vol. 15, no. 5 (2022): 1-17.

16 On the use of the less common certainty-equivalent variant of the CAPM, in which the risk of the cash flows is included in the valuation calculation, see Robichek/Myers, Conceptual problems in the use of risk-adjusted discount rates, The Journal of Finance, vol. 21, no. 4 (1966): 727-730 and Rubinstein, The Fundamental Theorem of Parameter Preference security valuation, JFQA, vol. 8, no. 1 (1973): 61-69.

17 Ernst, Risk Measures in Simulation-Based Business Valuation: Classification of Risk Measures in Risk Axiom Systems and Application in Valuation Practice, Risks, vol. 11, no. 1 (2023): 1-13.

18 Gleißner, op. cit. (footnote No. 15): 345-352; Gleißner, op. cit. (footnote No. 10): 1243-1258 and Dorfleitner/Gleißner, op. cit. (footnote No. 5): 1-27.

19 Gleißner, op. cit. (footnote No. 10): 1243-1258.

20 According to Gleißner, op. cit. (footnote No. 13): 84-87 and Ernst, op. cit. (footnote No. 15): 1-17.

6. Finally, there is an additional benefit for companies, namely, compliance with legal requirements for risk management.[21]

In the following case study, a company is first valued on the basis of the CAPM, with the exception of insolvency risks. Step by step, the valuation is then improved, considering the company's earnings and insolvency risks. This shows how a sound assessment of earnings and insolvency risks is possible based on risk analysis and risk aggregation.

III. Case study: Company valuation and strategy evaluation

1. Overview

An important field of application of risk analysis in conjunction with adequate risk valuation[22] is strategy evaluation.[23] This serves to prepare decisions to be made by the board of directors or management. In the following case study, a strategy evaluation is carried out for a listed company. This is based on the standard deviation or the coefficient of variation of cash flows, which captures the extent of possible deviations from the plan ("output-oriented valuation"). As in the CAPM, the shareholders' risk diversification options are also taken into account. The effect of an outsourcing strategy on the company value is to be examined.[24] In doing so, it will be determined whether this strategy makes sense under consideration of return and risk. The idea of outsourcing was derived from the consideration of the strategic positioning and the essential success potentials. The relevant section of the value chain does not show any viable potential for success in the company. Thus, an outsourcing strategy was developed in cooperation between the departments established for controlling, production and logistics, in order to:

- Reduce costs (and increase earnings) by lowering purchasing prices;
- At the same time, to reduce risks by replacing part of the fixed costs with variable costs.

Whether the corresponding concept is promising and thus leads to an increase in value is examined in the case study.

In preparation for the strategy evaluation, the aggregated total risk volume (earnings risk), the rating and the risk-adjusted company value (as a measure of success) are first determined to establish the status quo. Subsequently, an evaluation is performed of how a planned measure set out to optimize the supply chain (outsourcing of a key section of the value chain) will affect these parameters. The aim is to use the risk-return profile (and the enterprise value as a performance measure) to make a well-founded assessment of the economic added value of this idea, which initially appears strategically plausible.

2. The company valuation with CAPM

The initial situation of the company can be characterized by the following figures: With total assets representing the capital employed ($\mathbf{CE}$) of CE = € 100 million, the company has an equity ratio of 30%. The interest-bearing net financial liabilities (debt) amount to D = € 50 million, the non-interest-bearing debt to € 20 million. In the fiscal year in t(0), an operating profit ($\mathbf{EBIT}$) of € 11.5 million and a profit (taxes are neglected for the sake of simplicity) of € 10 million were generated on sales of € 200 million. Without growth, the entire profit can be distributed. The valuation is carried out using the flow-to-equity method (capitalized earnings method), but the entity variant, based on FCF, is shown for comparison[25]. The difference between EBIT and profit is the interest expense. The return on capital employed ($\mathbf{ROCE}$) is therefore as follows:

$$\mathrm{ROCE} = \frac{\mathrm{EBIT}}{\mathrm{CE}} = \frac{11.5}{100} = 11.5\% \qquad (1)$$

In corporate planning, for the financial year $\mathbf{t(1)}$ and all subsequent years, € 10 million profit is assumed with the highest probability (as planned value $\mathbf{Profit^{plan}}$). This profit is to be distributed to the owners (earnings = flow to equity = profit). Due to the difficult market conditions, management does not expect any growth in the future (growth rate $\mathbf{g = 0}$). The valuation-relevant free cash flow ($\mathbf{FCF}$) also allows the full distribution of profits. Using the Gordon-Shapiro model for an infinite annuity, the company value ($\mathbf{Value}$) is calculated here – based on assumptions considered to be credible and plausible – as follows (growth rate $\mathbf{g}$ would reduce $\mathbf{FCF}$ by $\mathbf{CE \cdot g}$ and earnings by $\mathbf{CE \cdot g \cdot equity\ ratio}$):

$$\mathrm{Value}_1 = \frac{\mathrm{FCF}^{\mathrm{plan}}}{\mathrm{WACC} - \mathrm{g}} - \mathrm{D} \approx \frac{\mathrm{Profit}^{\mathrm{plan}}}{\mathrm{c}} = \frac{\mathrm{Earning}^{\mathrm{plan}}}{\mathrm{c}} \qquad (2)$$

The discount rate (cost of equity, $\mathbf{c}$) is traditionally first derived based on historical stock return fluctuations using CAPM. Assuming, for comparison purposes, an expected return on the market portfolio (r_m^e) of 8%, a risk-free rate (r_f) of 3% and a standard deviation of the market return (σ_m) of 20%, the beta factor can first be determined if the following two pieces of information are also derived from the historical stock price fluctuations (capital market data):

21 In close accordance with Gleißner, op. cit. (footnote No. 8): 490-493 and 513-523.

22 Semi-investment theory valuation based on a risk-value model see Dorfleitner/Gleißner, op. cit. (footnote No. 5): 1-27 and Gleißner, op. cit. (footnote No. 10): 1243-1258.

23 See Gleißner/Ernst, Company valuation as result of risk analysis: replication approach as an alternative to the CAPM, Business Valuation OIV Journal, vol. 1, no. 1 (2019): 3-18 with an alternative case study.

24 According to Gleißner, Die risikogerechte Bewertung alternativer Unternehmensstrategien: ein Fallbeispiel jenseits CAPM, BewertungsPraktiker, no. 3 (2013): 82-89 and Gleißner, op. cit. (footnote No. 8): 433-434.

25 Matschke/Brösel, op. cit. (footnote No. 4).

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- Correlation (ρ) of the stock return to the market return 0.5;
- Standard deviation of the stock return (σ_i) 25%.

The beta factor is calculated as follows:

$$\beta = \rho \cdot \frac{\sigma_i}{\sigma_m} = 0.5 \cdot \frac{0.25}{0.2} = 0.625 \qquad (3)$$

In accordance with the well-known CAPM return equation, the discount rate, assuming that the CAPM assumptions are valid, is as follows,

$$r_e = c^{CAPM} = r_f + \left(r_e^m - r_f\right) \cdot \beta = $$
$$= 0.03 + \left(0.08 - 0.03\right) \cdot 0.625 = 6.1\% \qquad (4)$$

and for the company value,

$$Value_1 = \frac{Earning^{plan}}{c^{CAPM}} = \frac{10}{6.1\%} = 163.9 \qquad (5)$$

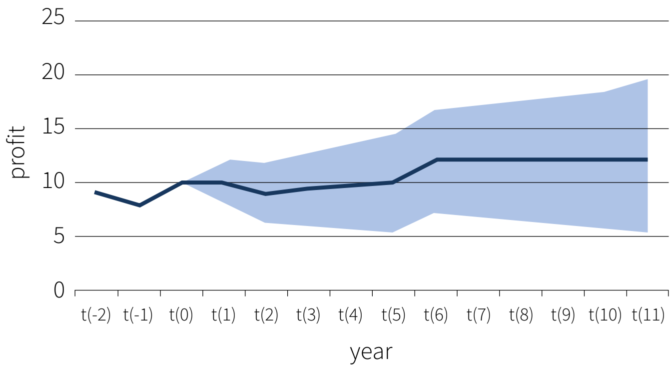
Value1 stands for the value of variant 1, which corresponds to the CAPM approach. In this "traditional" approach, information on the risks of future earnings is not considered, nor is the probability of insolvency (p) expressed by the rating. Furthermore, no consideration is given to the extent to which the "planned value", in this case the most probable value (modal value), is actually unbiased.

3. Risk-adequate company valuation in the initial situation

In the following, the valuation case is refined to determine the "risk-adequate value" in the initial situation. In doing so, it is assumed that a quantitative risk analysis has been carried out as part of risk management, and that the aggregated total risk volume has been calculated using Monte Carlo simulation, which is explained in more detail below.

In our case study, the risk aggregation for the status quo of the company (i.e., before implementation of the planned measure (outsourcing)) results in the following situation: The original planned value of the profit of € 10 million is not "unbiased". This value does not show what profit can be expected "on average" across all risk-related possible scenarios.[26] We can easily derive the expected value of the profit as an average of all simulated scenarios from the risk aggregation. It amounts to € 9 million (the individual risks are not presented here). This means that an average of € 9 million can be expected for all risk-related possible future scenarios (as mentioned, this value is considered representative of the future below). Of course, it is also possible to look at the

Figure 1: Range of profit from Monte Carlo simulation (risk aggregation)



earnings of the detailed planning period independently.[27] Due to an existing risk overhang compared to the opportunities, the expected value relevant to valuation is therefore lower than the planned value of € 10 million (see Figure 1).

The expected return on assets, which strongly influences the rating in addition to the equity ratio (30%), is calculated as follows, assuming the time-variant expected value of profit (€ 9 million)[28], but the case with consideration of the simulation result) and interest (€ 1.5 million) (EBIT as € 10.5 million).

$$ROCE = \frac{10.5}{100} = 10.5\% \qquad (6)$$

Adequate consideration of the probability of insolvency p (of the rating), and the impacts of opportunities and threats (risks) relevant to the expected value of earnings or cash flows, is necessary in any proper company valuation, especially in strategy valuation. The probability of insolvency acts like a "negative growth rate" in the long term, that means:

$$Value = \frac{Earning^e \left(1 - p\right)}{c + p} \qquad (7)$$

It is important to note that the insolvency probability is not a premium on the cost of capital (as in the build-up models). There is no double counting of a risk because p "only" captures the effect on expected earnings over time (just like a growth rate).

Given a growth rate g[29], the (conditional) expected values of the earnings $Earning^e$ (without insolvency – conditional ex-

26 Gleißner, op. cit. (footnote No. 10): 1243-1258 and Gleißner, op. cit. (footnote No. 8): 318-325, especially also for simulation-based risk aggregation.

27 Cf. Gleißner/Ernst, op. cit. (footnote No. 23): 3-18.

28 Still without considering failures; index 2 doesn't mark here period 2 (t=2).

29 For the relationship between w and k in the case of inflation-, retention- and tax-indexed (endogenous) growth, see Tschöpel/Wiese/Willershausen, Unternehmensbewertung und Wachstum bei Inflation, persönlicher Besteuerung und Verschuldung (Teil 1 und 2), WPg, no 7 (2010): 349-357 and WPg, no 8 (2010): 405-412.

pected value – as well as period-invariant insolvency probability, here for **T**, i.e. after detailed planning phase) and a discount rate **c**, the following equation results for the **Value** in the going concern phase (terminal value) as a function of the insolvency probability **p** (i.e. after detailed planning phase) and a discount rate **c** results in Equation (8) for the enterprise value in the going concern phase (terminal value) depending on the insolvency probability **p**[30]:

$$\text{Value} = \sum_{t=1}^{\infty} \frac{\text{earning}^e \cdot (1-p)^t \cdot (1+g)^t}{(1+c)^t} = \frac{\text{earning}^e \cdot (1-p) \cdot (1+g)}{c - g + p \cdot (1+g)} \qquad (8)$$

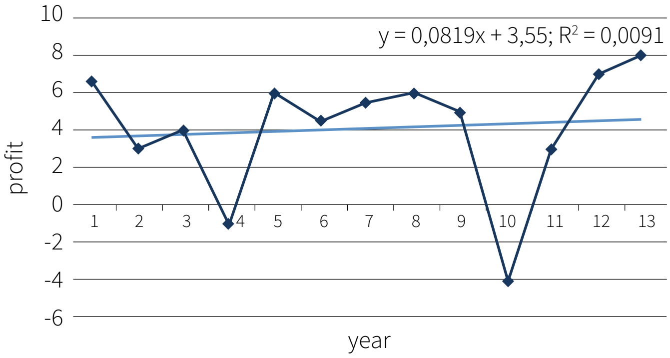
This also applies if one wishes to derive the cost of capital (discount rates) on the basis of the CAPM.

So additionally, the rating is also considered (risk of insolvency/bankruptcy). This indicates the insolvency risk, which is expressed by the probability of insolvency. Rating and insolvency probability **p** can be estimated using the Monte Carlo simulation.[31] In a simplified form, the probability of insolvency **p** can be estimated using financial ratios for the planned year equity ratio and **ROCE**, by means of the following "mini-rating"[32]:

$$p = \frac{0.265}{1 + e^{-0.41 + 7.42 \cdot \text{equity ratio} + 11.2 \cdot \text{ROCE}}} = \frac{0.265}{1 + e^{-0.41 + 7.42 \cdot 0.30 + 11.2 \cdot 0.105}} = 1.3\% \qquad (9)$$

The insolvency probability derived from a simple financial ratio system can be estimated even more soundly using somewhat more complex ratio systems. For a supplementary plausibility check of the insolvency probability, considering the aggregated earnings risks neglected in financial ratios, risk aggregation can again be used. In this process, each simulation runs checks of whether illiquidity or (less relevant) over-indebtedness occurs. Often, the company can already be assumed to be illiquid if either (a) covenants are breached in a simulation run, and/or (b) a financial ratio rating of "B" is no longer guaranteed due to losses. In our case study, the risk simulation results in a fairly similar probability of insolvency. In the following, we will continue to calculate with using insolvency probability of **p** = 1.3% given in Equation (9).

Figure 2: Profit development in recent years (in € million)*



*Gleißner, op. cit. (footnote No. 4), pp. 82–89.

If the company is to be assessed from the perspective of a long-term committed investor (owner) and it is assumed that the valuation-relevant risks of future earnings are not reflected in historical stock returns, the following derivation of the cost of capital rates based on earnings risks is recommended.

It is important to emphasize here that the risk-adequate valuation method can always be applied if the risk content of the cash flows or earnings (flow-to-equity) is captured by a risk measure, such as σ_{Earning} here. In the simplest case, the determination of the risk measure can simply be performed as an estimate or be based on a statistical evaluation of historical profit fluctuations.[33]

However, it is recommended to use the best available information about the future risks of a company, which ultimately determines the level of the risk measure, i.e., the standard deviation. This is made possible using the simulation-based variant of the risk-adequate valuation of the company outlined here. The starting point here, as explained in section 2, is a risk analysis plus risk aggregation using Monte Carlo simulation. In this procedure, the main risks of a company are first systematically identified.[34] For example, all of a com-

30 Franken/Gleißner/Schulte, Insolvenzrisiko und Berücksichtigung des Verschuldungsgrads bei der Bewertung von Unternehmen – Stand der Diskussion nach Veröffentlichung des IDW Praxishinweises 2/2018, Corporate Finance, no. 3-4 (2020): 84-96; Gleißner, op. cit. (footnote No. 10): 1243-1258; Knabe, Die Berücksichtigung von Insolvenzrisiken in der Unternehmensbewertung, 2012 and Saha/Malkiel, DCF Valuation with Cash Flow Cessation Risk, JAF, vol. 22, no. 1 (2012): 175-185.

31 See Gleißner, op. cit. (footnote No. 10): 1243-1258 on simulation-based rating and evaluation procedures; for example using the "strategy navigator" software used here.

32 See Gleißner, op. cit. (footnote No. 8): 433-434 and alternative Altman, Predicting financial distress of companies: revisiting the Z-score and ZETA models, working paper of New York University, 2000, http://pages.stern.nyu.edu/~ealtman/Zscores.pdf (last access 05.05.2023) or Drobetz/Heller, What Factors Drive Corporate Credit Ratings? Evidence from German SMEs and Large Corporates, Working Paper Series, 2014, SSRN-ID 2392377 (last access 05.05.2023) and Krotter/Schüler, Empirische Ermittlung von Eigen-, Fremd- und Gesamtkapitalkosten: eine Untersuchung deutscher börsennotierter Aktiengesellschaften, zfbf, vol. 65 (2013): 390-433, which approximate S&P ratings using a simple financial ratio system.

33 See Figure 2 and Gleißner/Günther/Walkshäusl, Financial sustainability: measurement and empirical evidence, JBE, vol. 92, no. 3 (2022): 467-516.

34 Gleißner, op. cit. (footnote No. 10): 1243-1258 and Hunziker, Enterprise Risk Management: Modern Approaches to Balancing Risk and Reward, 2019.

Cost of capital in real time

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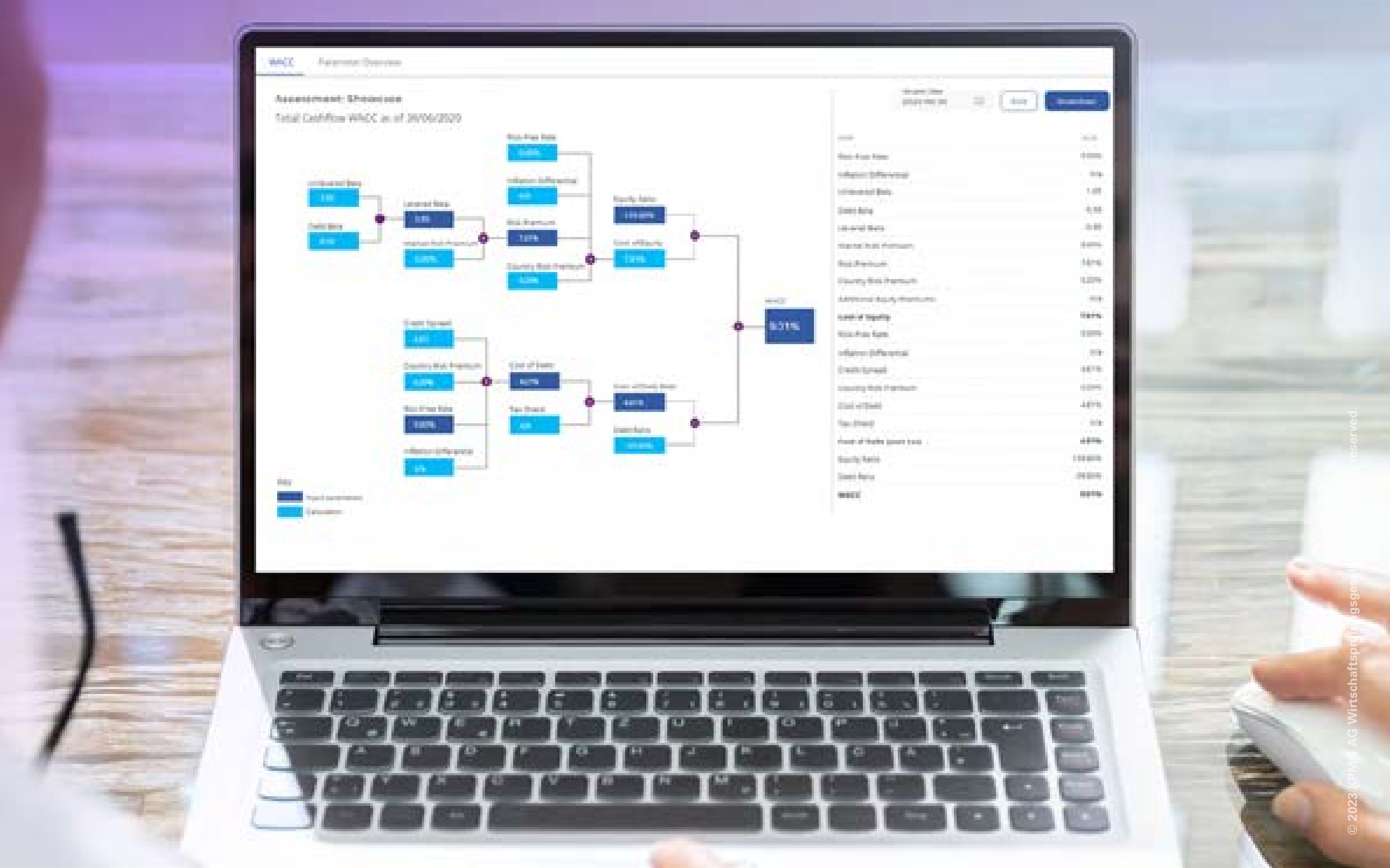

pany's uncertain planning premises are taken as a risk (e.g., assumptions about exchange rates, raw material prices or the sales growth rate). The risks are described by suitable probability distributions; for example, an exchange rate fluctuation with a normal distribution, or the uncertain growth rate specifying (a) minimum value, (b) most probable value and (c) maximum value (triangular distribution or beta-percent distribution).[35] All risks are assigned to the corporate planning items (integrated) in which they can trigger deviations from the plan. Risk aggregation (Monte Carlo simulation) based on this risk analysis is then used to calculate a sufficiently large representative number of future scenarios. In this way, the expected value and, consistently, the risk measure of cash flows or flow-to-equity can be derived.[36]

In the simple case study here, all the ways outlined, including risk analysis and risk aggregation, lead to similar results in the standard deviation of return (flow-to-equity) as the risk measure to be used to determine the cost of capital (c).

The risk aggregation (risk simulation) allows quantification of the earnings risk, expressed by the standard deviation of earnings. This corresponds to the standard deviation of profit $\sigma_{Earning}$ = € 3.1 million (the standard deviation of the past is € 3,47 million and thus similar, see Figure 2). The standard deviation of profit can be interpreted as a measure of planning certainty. This corresponds to the value at risk (e.g., at the 99% level), and in the case study is around € 13 million.

The correlation of the earnings (or changes in earnings) of companies to the market index is 0.5, which thus corresponds to the degree of risk diversification d (see Section III. 5. for derivation).

Equation (10) can be used to calculate the following risk-adjusted discount rate.[37] The equation converts the coefficient of variation (V) derived from risk analysis and risk aggregation into an expected return corresponding to this risk, i.e., a risk-adequate discount rate (c). The derivation is based on the method of "imperfect replication" briefly outlined above). In the case study, it is assumed that the correlation of earnings to the return (or earnings) of the market portfolio is as high as the correlation between the company's shares and the market portfolio, i.e., $d = \rho = 0.5$ (see Equation (3)). It is possible that some medium-sized entrepreneurs, who essentially own their company, will set $d = 1$ when determining subjective decision values, i.e., neglect risk diversification effects.[38]

35 Wehrspohn/Ernst, When Do I Take Which Distribution? A Statistical Basis for Entrepreneurial Applications, 1st ed. 2022.

36 See the relevant risk management methods in Gleißner, op. cit. (footnote No. 10); Ernst, op. cit. (footnote: 17): 1-13.

37 Derivation e.g. in Gleißner, op. cit. (footnote: 10): 1243-1258.

38 See Kerins/Smith/Smith, Opportunity Cost of Capital for Venture Capital Investors and Entrepreneurs, JFQA, no. 6 (2004): 385-405 and the total beta approach that assumes d = 1.

$$c = \frac{1+r_f}{1-\lambda \cdot V \cdot d} - 1 = \frac{1+r_f}{1-\lambda \cdot \frac{\sigma_{Earning}}{Earning_2^e} \cdot d} - 1 =$$

$$= \frac{1+3\%}{1-0.25 \cdot \frac{3.1}{9} \cdot 0.5} - 1 = 7.6\% \qquad (10)$$

with

$$\lambda = \frac{r_m^e - r_f}{\sigma_{r_m}} = \frac{8\% - 3\%}{20\%} = 0.25$$

and

$$V = \frac{\sigma_{Earning}}{Earning^e}$$

as coefficient of variation.

As can easily be seen, the ratio λ (Sharpe ratio) is exclusively derived from information that is also used in the CAPM (specifically beta factor, see Equations (2) and (3)). λ is a measure of the risk-return profile of alternative investment opportunities. Accordingly, a λ of 0.25 expresses that an additional return of 0.25% can be expected on the capital market per unit of increased risk. When evaluating the company, its risk-return profile is compared with that of the selected alternative investment options; in this case, government bonds and a broad stock market index (e.g. MCSI World).

In our case study, the risk-adjusted cost of capital deviates significantly from that determined using the CAPM. The "implied beta factor" β', which can be calculated for comparison purposes, is:

$$\beta' = (c - r_f) / (r_m^e - r_f) = 0.92$$

The reason for this is that the risk-adequate cost of capital precisely considers the risks (which are in themselves relevant to valuation) of a company's future earnings and cash flows, and not, as in the CAPM, the risks from (historical) stock price fluctuations, which are mainly significant for a shareholder investing in the short term.

For the value in the initial situation, considering the unbiased earnings of € 8.88 million, the probability of insolvency (1.3%) and the cost of capital (7.6%), the following result is obtained. $Value_2$ stands for the value of variant 2, which corresponds to the risk-adequate approach (simulation-based valuation).

$$Value_2\left(Earning_2^e\right) = \frac{earning_2^e \cdot (1-p)}{c+p} = \frac{9 \cdot (1-1.3\%)}{7.6\% + 1.3\%} = 99.8 \qquad (11)$$

4. Strategy evaluation: risk-adequate evaluation of an option for action

So far, the status quo of the company has been considered. The calculated (risk-adequate) company value of € 99.8 million is to be interpreted as a "benchmark" (or hurdle rate) for the strategy assessment, i.e., the strategic action to now be evaluated. Such a course of action makes sense precisely if it increases the sustainable success of the company, i.e., leads to an improvement in the risk-return profile. The basis of the evaluation is now an alternative business plan, in which the effects of the planned measures on sales, costs and capital commitment are taken into account ("what-if analysis"). In the case study, it is assumed that the "internal" measure in the value chain will have no impact on sales. The capital commitment is also considered to be essentially unchanged.

From discussions and negotiations with the potential outsourcing partners, a significant improvement in profitability of one million euros is forecast.

A structured risk analysis, which is not presented in detail here, shows that outsourcing has advantages and disadvantages in terms of the risk position. The advantage is that production-related risks (e.g., due to machine failure) are eliminated within the company because the corresponding activities are no longer carried out. Another advantage is that previously largely fixed costs are substituted by variable costs based on sales. However, a quantitative risk analysis also shows the downsides of outsourcing: an on-site visit to the production facility of the potential outsourcing partner by a team of experts with specialists from production, quality assurance and logistics showed that, due to a largely lack of redundancy, the technical insolvency probabilities at the partner company are higher than those previously seen at the company itself. In addition, a rating analysis of this company's key financial figures reveals a non-negligible insolvency risk, which could lead to the loss of a key supplier that is virtually impossible to replace in the short term. From publicly available data on equity ratio and profitability, a "B" rating is estimated, which implies an insolvency probability of no less than 5% per year.

This and other information on the changes in opportunities and threats (risks) in the event of outsourcing are now taken into account in the above-mentioned alternative planning. Then, by means of Monte Carlo simulation and risk aggregation, the change in the realistic range of the company's earnings and cash flows is shown. This occurs if the measure being assessed is implemented. In the case study, the expected increase in earnings to € 10 million earning_3^e is initially confirmed because, in addition to risks, some opportunities (further cost-saving opportunities) are also identified in the risk analysis. In addition, however, the risk aggregation shows a significant increase in the standard deviation of earnings (the risk measure) from € 3.1 million to € 4.2 million. This increase is caused by possible additional costs and lost sales in the event of a technical production stoppage (interruption of operations), or even insolvency of the future key supplier. However, the effects will not be so extreme as to have a significant impact on the company's own insolvency probability and rating. This means that an insolvency probability of p = 1.3% is still assumed.

Based on the increased predicted profitability and the simultaneously increased level of risk, we can now calculate the risk-adjusted cost of capital ($\mathrm{c'}$) that would result in the case of an outsourcing decision (also d, i.e., the share of risks to be borne is assumed to be constant, which can be examined as part of a detailed analysis):

$$c' = \frac{1+r_f}{1-\lambda \cdot \frac{\sigma_{\text{Earning}_3}}{\text{Earning}_3^e} \cdot d} - 1 = \frac{1+3\%}{1-0.25 \cdot \frac{4.2}{10} \cdot 0.5} - 1 = 8.7\% \quad (12)$$

and

$$\text{Value}_3\left(\text{Earning}_3^e\right) = \frac{\text{Earning}_3^e}{c'+p} = \frac{10 \cdot \left(1-1.3\%\right)}{8.7\%+1.3\%} = 98.7 \quad (13)$$

Value_3 stands for the value of variant 3, which corresponds to the risk-adequate approach taking into account the strategic option. Here, the effect of outsourcing on the company value as a measure of success can be seen directly. As we can see, the company value falls from € 99.8 million to € 98.7 million. The reason for this is that the risk-return profile deteriorates slightly. The increase in aggregate total risk and thus in the cost of capital more than compensates for the expected increase in profitability as a result of outsourcing. As mentioned above, this measure would not unduly affect the company's security of tenure (credit rating). However, it does not make economic sense when weighing up return and risk (cf. the following summary in Table 2).

5. The derivation of the diversification factor d

Up to now, it has been assumed for simplicity that the risk diversification factor d remains approximately unchanged. This assumption is uncontroversial if the valuation subject considers all risks to be relevant for valuation, i.e., sets $\mathrm{d} = 1$. If, however, in line with the CAPM assumption system, only the risks that cannot in principle be diversified are considered in the valuation calculation, changes in the degree of risk diversification are possible.[39] They are to be expected if the ratio between systematic and unsystematic risks changes.

39 For risk diversification see Gleißner/Wolfrum, Cost of capital and valuation with imperfect diversification and unsystematic risks, working paper, 2009, SSRN-ID 1437629 (last access 05.05.2023).

Table 2: Evaluation of a strategic option for action

	Status quo	Strategic option
Earning	€ 9 million	€ 10 million
Risk (coefficient of variation earning)	34%	42%
Cost of capital	7.6%	8.7%
Rating forecast (probability of default)	1.3%	1.3%
Rating (stress scenario)	BB	BB
Value (in € million)	99.8	98.7
Strategic fitting		Yes, but worse risk-return profile

Table 3: Profit development of the company and all companies in the market index (in billions of €)*

	t(-13)	t(-12)	t(-11)	t(-10)	t(-9)	t(-8)	t(-7)	t(-6)	t(-5)	t(-4)	t(-3)	t(-2)	t(-1)	t(0)
Profit Company	6.6	4	4	-1	6	4.5	5.5	6	5	-4	3	7	8	9
Profit Market index	47	12	-13	14	45	69	86	99	33	4	87	80	87	

*Source: Gleißner, op. cit. (footnote: 8).

In the simplest case, we can assume exactly one systematic risk factor of the exogenous environment for the calculation of d, such as, for example, the earnings fluctuations of all companies (e.g., of an economy), which are essentially caused by the business cycle (the CAPM also assumes exactly one risk factor, in contrast to the arbitrage pricing theory[40] (APT). There, the uncertain return of the market portfolio ($\mathbf{r}_m$) is usually used as a risk factor due to a "capital market-oriented" view.[41] It is possible to consider several exogenous risk factors – e.g. complementary inflation, exchange rate, commodity price – in an extended "risk factor model". In the case study, we now consider a "corporate earnings index" as the only systematic risk factor whose risk effects cannot be eliminated even for a diversified valuation subject (owner).

We can verify the estimate of risk measure and risk diversification degree $\mathbf{d}$ with historical profit fluctuations (see Figure 2). The standard deviation of the (trend-adjusted) past profit fluctuations of the company itself (see Table 3 and Figure 2) is 3.47, which is quite similar to the result of the risk aggregation. The correlation of the company's profits (or profit changes) to the profits of all companies in the market index (in € billions, source: Boerse Online database), which can also be derived from 2, is about 0.5 for the profit change rate (or 0.6 for the profits themselves), which roughly corresponds to the assumed risk diversification degree $\mathbf{d}$.

40 See also Fama/French, A five-factor asset pricing modell, Journal of Financial Economics, vol. 116, no. 1 (2015): 1-22.

41 See e.g. Rubinstein, op. cit. (footnote: 16): 61-69 and McConaughy/Covrig, Owners' Lack of Diversification and Cost of Equity Capital for Closely Held Firm, Business Valuation Review, vol. 26, no. 4 (2007): 115-120.

In a continuation of the case study, we now examine whether the strategic action option under consideration would lead to a change in the risk diversification factor $\mathbf{d}$.

From the quantitative risk analysis of the company, in particular the consideration of the uncertain assumptions in the planning model, it is determined that, essentially (and statistically significantly), sales only fluctuate as a function of overall economic demand (GDP), and that profit depends on all companies. The direct dependence of other planning items, such as material and personnel expenses, on this general exogenous risk factor is not statistically significant and is neglected. From the simulation-based risk aggregation, it thus follows that the valuation-relevant earnings considered here are also dependent on this risk factor. The various event-oriented risks in the value chain and the support processes (operational performance risks) are independent of the overall economic development expressed by the general risk factor. However, it is clear from empirical studies that the probability of insolvency of companies – in this case, of a key supplier – depends on the general earnings development of companies (as theoretically expected). This fact is captured in the risk aggregation model by linking the insolvency probability $\mathbf{p}^{\text{Supplier}}$ with the earnings index (or with GDP).

The measures explained above would change the company's risk profile. In order to be able to use this additional information to determine the change in the risk diversification factor from $\mathbf{d}$ to $\mathbf{d'}$, two risk aggregations are carried out in each of the two strategy assessment cases considered – (1) status quo and (2) status quo plus the

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Table 4: Risk diversification factor d

	Overall risk		Risk diversification factor
	All risks including exogenous risk factor (a)	Only exogenous risk factor (b)	Proportion of systematic risks (d or d') (b/a)
Status quo	3.1	1.55	d = 1.55/3.1 = 0.50
Status quo plus measure	4.2	2.2	d' = 2.2/4.2 = 0.52

strategic action option – namely, once (a) with and once (b) without considering the dependency of sales, and thus of the company's earnings, on the general risk factor "company earnings" (or GDP). The results are shown in Table 4.

We can see the (slight) change in the risk diversification factor from **d** = 0.5 to **d'** = 0.52 by the measures (strategies) to be evaluated.

In the case study, therefore, there is a slight change in the degree of risk diversification **d** if a company is valued from the perspective of a (perfectly) diversified economic entity – as mentioned, this is of course irrelevant when considering all company risks (**d** = 1), as happens with the total beta model.[42] In the case under consideration, the change is also relatively small, and also tends to be "unfavorable", so that the above assessment of negligibility can at least be justified in principle. However, a review of the facts is of course useful if additional safeguarding is desired. In the case study, this relatively small effect results from the fact that, although the overall scope of risk has increased due to additional "unsystematic" risks, at the same time, a significant systematic risk – the probability and thus the expected impact of the key supplier defaulting – has increased.

The approach explained here is a simple introduction to the use of risk factor models, and also shows how changes in the degree of risk diversification (forward-looking) can be mapped. Here, too, it is important to present assumptions made (simplifications) in a transparent manner (in the example, only a cursory explanation of the change in the risk aggregation model was given). It should be emphasized that in this way, changes in risk diversification effects due to measures are addressed. In the traditional derivation of the CAPM beta factor for a capital market-oriented valuation, only historical information is used, i.e., it is implicitly assumed that the risk diversification factor remains unchanged. Changes in risk diversification effects (in this case, the correlation of the company's earnings or returns to the market portfolio return) are thus ignored in traditional capital market-oriented valuation methods in valuation practice, especially in strategy valuation.

42 Cf. Ernst/Gleißner, op. cit. (footnote: 9).

IV. Conclusion and implications for practice

In this paper, the method of simulation-based business valuation, based on the so-called semi-investment valuation theory, was explained and illustrated in possible applications by means of a case study. As shown, the presented method is an alternative to a DCF valuation based on the CAPM, which uses essential known building blocks derived from the method box of business valuation (like the DCF). The great advantage of the method is that the perfection of the capital market or the availability of capital market data on the valuation object (company) is not assumed, and rating and financing restrictions are also included in the valuation calculation (insolvency risks). A consistent derivation of the expected values of cash flows (or flow-to-equity) and the cost of capital to be used as a basis for the DCF method considers the opportunities and threats (risks) of a company. Based on the stringent identification and quantification of the risks, as well as their aggregation, by means of Monte Carlo simulation, it is possible to derive risk-adjusted discount rates. It is also possible to evaluate and compare different strategic courses of action or investment options of a company, whereby their different risk contents are taken into account in the evaluation calculation.

Glossary

Input-oriented valuation variant

The "input-oriented" valuation considers the rating and financing restrictions of the company. The risk is understood as a "possible loss" (e.g. measured by VaR). This valuation concept is called the "risk coverage approach" and can also be derived using the "incomplete replication" method.

Insolvency risk

The concept of insolvency risk is derived from risk theory and the conceptual understanding of risk in general. Accordingly, insolvency risk describes the possibility that insolvency may occur as a result of the uncertain future development of the company (with a probability > 0 over the entire future). To measure the level of insolvency risk, risk measures are needed, as for other risks.

The simplest insolvency risk measure is the insolvency probability. This is formally a lower partial moment of degree 0. Such LPM0 risk measures only indicate the probability of a certain event occurring, namely falling below a threshold.

Output-oriented valuation variant

The "output-oriented"/semi-investment-theoretical valuation methods (as well as the traditional methods of a finance-theoretical (capital market-oriented) valuation (e.g. with the CAPM)) are based on an understanding of risk, whose risk measures express the extent of possible deviations from the expected value of the payments (especially often the standard deviation). In the case of principally "tradable" (e.g. listed) investments, the standard deviation (or the DVaR or relative VaR) is used as a risk measure (measure of plan deviations) because any deviation from the expected value of cash flows or earnings triggers a reduction in the value of equity (rather than losses). This is referred to as an "output-oriented" valuation, in which only the uncertain outcome of the future – and not the initial situation/assets (in t=0) – is included in the valuation.

Rating

Rating is understood as credit rating, more precisely as issuer rating (which is to be distinguished from issue rating). A rating grade (AAA, A, BBB, BB, B) corresponds to a probability of insolvency (or default). This can be estimated simply based on financial ratios of the company (e.g. equity ratio and return on capital employed, ROCE). A more precise assessment is possible if the findings from risk analysis and risk aggregation are also taken into account (simulation-based rating forecasts). Accordingly, the rating provides information on the level of insolvency risk.

Risk-adequate valuation

Risk-adequate valuation allows the value of an uncertain cash flow to be determined based on the risk content of the cash flow expressed by a risk measure (such as standard deviation, coefficient of variation, or value-at-risk). A risk-adequate valuation of a company thus requires information from an analysis and aggregation of the company's risks (opportunities and threats); but not information about the risk of the company's shares (as expressed in the beta factor of the CAPM).

Risk coverage approach

The risk coverage approach is a special input-oriented valuation method that is used when capital market "imperfections" are particularly severe. The risk coverage approach is applied when the valuation object is hardly tradable (saleable) and the valuation subject is not well diversified. Risk is understood as a possible loss (equity requirement, thus formally a value at risk). The method illustrates the importance of risk analysis and the link between valuation and risk-based financing in an imperfect capital market with financing restrictions. Constraints on risk coverage potential, specifically equity, imply that potential losses, i.e., equity requirements, are used as a measure of risk.

Semi-investment theory valuation theory

Semi-investment theory valuation is based on the ideas of investment theory valuation and accepts simplifications that allow, for example, a company valuation based on the discounted cash flow calculation. Valuation equations are derived using the "incomplete replication" method, which does not require any capital market information about the valuation object and does not assume perfect capital market. In contrast to investment theory valuations, only two alternative investment options (a risk-free investment and an available stock market index) are considered for the valuation (similar to the CAPM). This simplifies the valuation (in particular, no optimization procedures are required). The derivation of the valuation equation (and discount rates based on it) is based on one assumption: two payments at the same point in time have the same value if they match in expected value and selected risk measure. Valuation equations are derived using "imperfect replication".

Simulation-based valuation

The central characteristics of a simulation-based valuation – (1) the consideration of business risks and (2) the use of Monte Carlo simulation – do not initially imply a commitment to a specific valuation theoretical framework. The use of the methods is possible in (1) an investment-theoretical valuation, (2) a semi-investment-theoretical valuation using "imperfect replication" and (3) also in a capital market-oriented valuation based on the CAPM.

Unbiased plan value

The basis of the company valuation in the DCF calculation are "unbiased" plan values, i.e. plan values that can be realized "on average" of the risk-related possible future scenarios. The calculation of plan values that are unbiased presupposes knowledge of existing opportunities and threats (risks) through a risk analysis. Unbiased plan values (expected values of cash flows) are lower than the ambitious target values usually set by companies for the purpose of corporate management. Unbiased plan values are also called simulation-based plan values. ◆