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Valuation beyond CAPM: How to calculate with earnings risk and insolvency[1]

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A cash flow's value depends on its (1) expected amount, (2) risk and (3) time of occurrence. This applies especially to uncertain payments that are generated by a company for its stakeholders. However, a cash flow's risk is not adequately considered when it comes to valuation by the traditional DCF method. This is owed to the fact that historical stock return fluctuations, rather than the risk of cash flows, are the subject of the beta factor in Capital Asset Pricing Models (CAPM).
To summarise the dark, likely-to-be-hidden secret of corporate valuation practice (see also Damodaran, 2018): a company's true opportunities and threats (risks) are currently ignored. The failure to explicitly consider, or 'typify', threats and opportunities (see Henselmann, 2006, pp. 144ff., Berger and Gleißner, 2018 and Gleißner 2019e) can lead to the undervaluation of a company which, in fact, has (1) good opportunities, (2) low cashflow volatility and (3) a very good rating.
This working paper clarifies the significance and effects of earnings risk, in general, and of insolvency risk, more precisely.

1 How risks influence a company's value

A company's value can be influenced by its risks in several distinct ways:

- Risks affect the expected value of cash flows.
- Risks affect the probability of insolvency (probability of default), which itself exerts an implicit influence on expected cash flow values and their development over time.
- Risks influence the cost of debt (see Baule, 2019) and may affect the cost of capital.

Consequently, companies must attend to the reality that risks can potentially influence (1) the expected value of cash flows *V(CF)* and, simultaneously, (2) risk discount (counter) or risk premium (in the nominator r_z) – risk surcharge r_z of the risk-free rate r_f, respectively the numerator and denominator.
This effect on Risk *R* is illustrated by Figure 1 (source: Gleißner, 2019b, pp. 692).

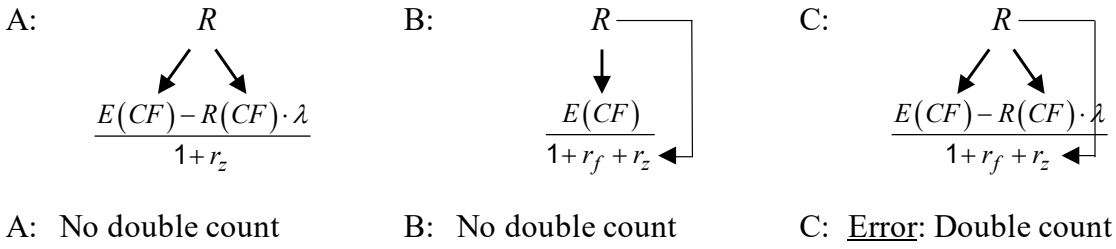

Figure 1: Double counting of asymmetric risk

Earnings and insolvency risks become a challenge for corporate valuation when the cash flows (earnings or profits) described by corporate planning, which are submitted to an evaluator, don't correspond to the expected return. Especially problematic are cases where the probability of insolvency is left entirely unaccounted for.
A major part of corporate planning is based on target values that result from corporate control, but corporate planning does not rely heavily on expected values. This is important when it comes to controlling a firm: in order to value a company and make 'entrepreneurial decisions', in the sense of the business judgement rule (§93 AktG; see RMA, 2019), expected values that can be achieved *on average*, when considering existing opportunities and threats, are required (in accordance with Gleißner, 2019b, p. 692).

2 Risk analysis, earnings risk, plan values true to expectations and a risk-adequate discount interest rate

When it comes to corporate valuation, it is chiefly risk analyses that deliver information helpful to considering earnings risk and insolvency risk (see Gleißner, 2019c, p. 891). It is crucial to take such analyses into account alongside corporate planning. In practice, many companies, despite being aware of the existence of opportunities and threats, do not consider them in their valuation; this leads to serious valuation errors.
For a risk-adequate – more precisely, simulation-based – rating (see Füser, Gleißner, and Leibbrand, 2010), systematic analysis and aggregation of a company's risks is required. This task should fall to the company itself, its evaluator, or both. When it comes to risk analysis, strategic risks (see Gleißner, 2017a) and uncertain assumptions of corporate planning should be considered at all times. Any uncertain planning assumption indicates that opportunities and threats exist in the relevant area and that as a consequence, plan deviations may occur.

All risks, especially those comprised of uncertain assumptions during corporate planning, must be characterised using an appropriate probability distribution (e.g., by specifying minimum value, most likely value, and maximum value, or by normal distribution – see Gleißner, 2018). In order to derive total scope of risk from the overall risks, a so-called risk aggregation (see Gleißner, 2005) is necessary.

An aggregation of the various risks related to corporate planning can only be made by using a Monte Carlo simulation (see Gleißner, 2019e). In such a simulation, numerous representative, possible scenarios that result from risk are calculated and evaluated. This immediately yields the probability of insolvency due to excessive debt or illiquidity (the rating of insolvency risk).

From this 'bandwidth planning' that results from risk simulations, the expected value of cash flows can be derived. This value often differs from the plan value (due to an excess of risks, for instance). The extent of divergence from the expected value determines a risk-adequate cost of capital (see also Gleißner, 2019d and Gleißner and Ernst, 2019). This value is directly dependent on the variation coefficient of cash flows (flow to equity) – more precisely, the relationship between standard deviation and expected value. The figure similarly depends on the risk–return profile of available investment alternatives (e.g., risk-free government bonds or broad stock indexes).[3]

The underlying principle is simple: higher cash flow volatilities (earnings risks) result in greater deviations from plans, the consequence of which is higher demands for returns (increased discount rates).

The derivation of equations for a risk-adequate valuation technique is based on the so-called 'incomplete replication' method (with risk–value models; see Sarin and Weber, 1993, and Dorfleitner and Gleißner, 2018). Unlike the CAPM, for example, this method of valuation does not require assumptions of a perfect or complete capital market. Since historical fluctuations in stock returns are also not required, this method can also be used without issue to value unlisted companies or strategic action options (strategy valuation).
The derivation of the valuation equations is based on a fairly unrestrictive assumption: two (simultaneous) risky cash flows have exactly the same value if their expected value and the selected risk measure[4] match (cf. Gleißner, 2014, p. 151, Gleißner and Wolfrum, 2009 and Dorfleitner and Gleißner, 2018, p. 1). An evaluator must therefore decide on the risk measure and determine which alternative investment options should be considered.

[3] For a theoretical background, see Dorfleitner and Gleißner, 2018, p. 1.
[4] E.g. the standard deviation.

The discount rate (see Toll/Leonhardt, 2019, p. 195 for theoretical background) and the certainty equivalent are factors which bridge the gap between corporate value and the aggregated earnings risk. Unlike traditional 'capital market-orientated' valuation (e.g., using the CAPM), capital costs from bandwidth planning can be directly derived from the earnings risk as a result of risk analysis and risk aggregation. Consequently, consideration of a peer group or of historical stock return fluctuations, typical beta factors in the CAPM, is obviated (cf. Gleißner, 2014, p. 151 and Gleißner, 2017b, p. 4). Capital cost *c* is often considered as constant for the sake of convenience and can be derived, for example, from standard deviation of return $\sigma_{earnings}$ as a measure of risk.

Based on the risk-free interest rate r_f, Equation 1 can be developed for a risk-adequate discount rate (cost of capital) (cf. for deriving 'incomplete replication', see Gleißner, 2014, pp. 151ff. and also Dorfleitner and Gleißner, 2018, p. 1):

$$c = \frac{1 + r_f}{1 - \lambda \cdot V \cdot d} - 1 \approx r_f + \lambda \cdot V \cdot d$$

Equation 1: risk-adequate discount rate (cost of capital)

V represents the variation coefficient of cash flow – specifically, the relation of earnings risk $\sigma_{earnings}$ to expected return $E^r = E^{(\text{earnings})}$, where both are influenced by opportunities and threats.

If the ratio *V* represents the coefficient of variation of flow to equity (FTE), the cost of equity is calculated. Correspondingly, the variation coefficient of free cash flows (FCF) results in the weighted average cost of capital (WACC). One advantage of the method presented here is that it allows direct conclusions to be drawn regarding the total cost of capital. That is, it is not necessary to determine the costs of equity or debt and their weights at respective market values).

This coefficient expresses the *usual range of variation* – more specifically, the planning uncertainty – as a percentage. Excess cash flow per unit of risk is demonstrated by λ (λ is the Sharpe ratio of market risk premium to standard deviation of stock market return), which expresses the risk–return profile of investment alternatives. For illustration: if λ amounts to a market-typical 0.25, the implication is that per added unit of risk, a 0.25% increase in cash flow can be expected.

Due to the fact that stakeholders do not necessarily bear all of a company's risk $\sigma_{cashflow}$, a so-called risk diversification factor (*d*) must be considered. This factor, which corresponds to the market portfolio correlation found in the CAPM, expresses the proportion of an enterprise's risks that a stakeholder must carry according to Equation 1.

As smaller companies typically have a higher variation coefficient and, consequently, higher cash flows and costs of capital, the connections described here contribute to an explanation of the size effect (see Grabowski, 2018).
This implies that a 'simulation-based valuation' resulting from risk analysis can offer various benefits:

- A systematic analysis of existing opportunities and threats allows a straightforward extrapolation of common plan values to expected values relevant for valuation, that will, 'on average', be realised (as also required by the German valuation standard, IDW S1).

- By evaluating key financial figures and considering the combination effects of risks (via Monte Carlo simulation), the probability of insolvency, expressed by rating, can be derived (see Füser, Gleißner and Leibbrand, 2010).
- Risk analysis and risk simulation (aggregation) accomplish transparency in planning security, and aggregated earnings risk (cash flow volatility) allows a deviation of risk-adequate cost of capital. This way, expected values of profits or cash flows (*numerator*) and the discount interest rate (*denominator*) are consistently defined, and problems associated with the by low information value of the CAPM, such as cost of capital[5] are avoided.

3 Risk of insolvency (distress risk)

The existence of a company is finite, as is the expected value of its limited duration of existence.

In the event of insolvency, cash flows to the company's owners generally cease, even if the company persists and its ownership passes to creditors. The probability *p* with which cash flows cease within one year is relevant for rating (payments to the owners in the event of insolvency are usually zero in any case). The insolvency risk can be measured specifically by the expected level of insolvency costs and the probability of insolvency.

Various methods, some of which can be used in combination, exist for recording insolvency risk in company valuations (cf. Gleißner, 2019b, p. 692):

Method A
One is the deterministic 'surcharge method': the recording of the probability of insolvency *p,* estimated (for example) by a rating as a 'surcharge' on the cost of capital in the continuation phase (an 'infinite annuity' – cf. Gleißner, 2010a, p. 735) with either (a) supplementary consideration of survival and insolvency scenarios in the detailed planning phase or (b) simulation of the detailed planning (cf. method C).

Method B
Insolvency risk can be recorded with the probability of insolvency, which is based on an assumption of uncertain development of cash flows or earnings before interest and taxes (EBIT), as described by a binomial model (cf. Friedrich, 2015) or a stochastic EBIT process (cf. Lahmann et al. 2018, p. 73). The disadvantage of this method is that it lacks reference to corporate planning and risk analysis, and it fails to record scenarios with negative free cash flows.

Method C:
Finally, one can employ a stochastic simulation of free cash flows and earnings based on a quantitative risk analysis and risk aggregation in an integrated planning model (see Berger and Gleißner, 2018 and Gleißner, 2018), i.e., a P&L and balance sheet planning using a Monte Carlo simulation to derive expected values (see Section 2).

In the detailed planning phase of a company's first years (t=1 to T), the probability of insolvency must be taken into account when determining the expected values of earnings; a scenario with often-zero returns to the owners often results from insolvency. Indirect insolvency costs, e.g., as a result of problems in acquiring employees and customers encountered by companies with low credit ratings, are directly and often implicitly included in detailed planning.

[5] Due to market flaws, cf. Gleißner, 2014, p. 151; Dempsey 2013a, b and c; Fama and French, 2015; Shleifer and Vishny, 1997 and Fernández, 2017.

With simulation-based planning, the insolvency risk can automatically be recorded in expected values in the detailed planning phase (method C). When risks are aggregated with reference to corporate planning, a Monte Carlo simulation is used to calculate a large number of representative, risk-related potential scenarios. From these, the expected value (mean value of the scenarios) and the frequency of insolvency scenarios can be derived directly.

In the continuation phase,[6] following detailed planning (t>T), the initially expected cash flows are usually updated with a growth rate *g*. Insolvency can also occur in any year of the continuation phase, which can be recorded using method A. If it is assumed for the continuation phase, when determining the terminal value, that the probability of insolvency – corresponding to the steady state of the bond model – remains constant, this c.p. leads to continuously decreasing expected values of cash flows, as shown in Figure 2 (cf. Gleißner, 2010a, pp. 735ff.; EACVA, 2011, p. 12; Knabe, 2012; Saha and Malkiel, 2012, p. 175).

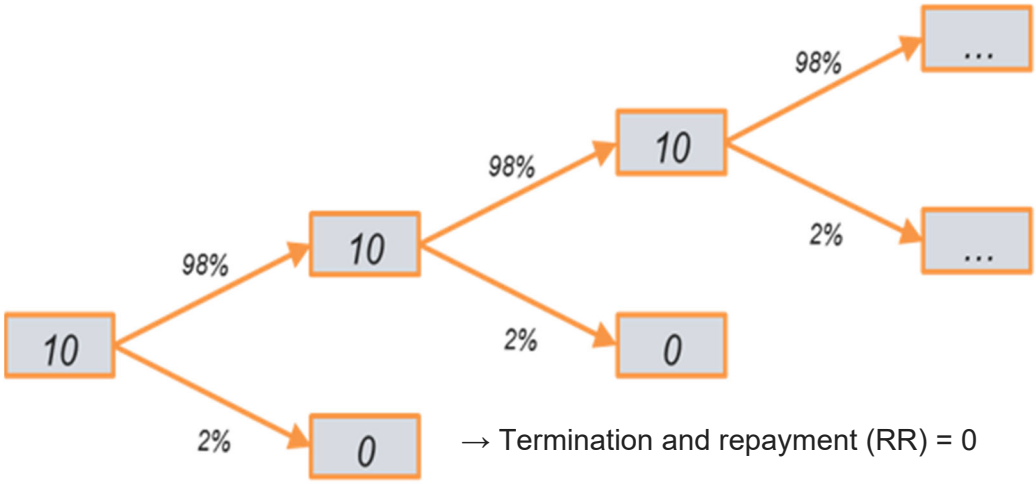

Figure 2: Effect of probability of insolvency (*p* = 2%) on expected cash flow.

With a constant probability of insolvency *p*, a discount rate *k* and a growth rate *g* of the expected values of the cash flow (flow to equity) CF^e (without insolvency, the 'conditional expected value'), the following terminal value, value *V* of payments during continuation phase (here already starting at t=1), results:

$$Value = \sum_{t=1}^{\infty} \frac{CF^e \cdot (1-p)^t \cdot (1+g)^t}{(1+c)^t} = \frac{CF^e \cdot (1-p) \cdot (1+g)}{c-g+p \cdot (1+g)} \approx \frac{CF^e}{c-g+p}$$

Equation 2: Terminal value

When determining an infinite series (Gordon–Shapiro model), the probability of insolvency (as well as the growth rate) appears in the numerator in each period. However, dissolving the series leads to the appearance of the probability of insolvency (like the growth rate) as a 'surcharge' in the denominator. In the continuation phase, the probability of insolvency thus has the effect of a 'negative growth rate' (Füser, Gleißner and Leibbrand, 2010).

The probability of insolvency also has an impact on interest rates, debt capital and cost of debt; these should not be conflated (see Cooper and Davydenko, 2001 and Baule, 2019). A higher probability of insolvency leads c.p. to higher contractual interest rates or higher credit spreads of bonds. However, borrowing costs, i.e., the expected return on debt, do not rise

[6] Terminal value phase.

just as sharply. In addition to the effect of insolvency risk on the expected value and development over time of cash flows, insolvency risk can also influence tax shields and the cost of equity.
The best measure for determining the level of insolvency risk is the probability of insolvency (alternatively, the probability of the termination of owners' cash flows, which includes scenarios in which the company is liquidated for lack of significant revenues). The probability of a company becoming insolvent depends on its (1) profitability, (2) earnings risk and cash flow volatility and (3) risk coverage potential (equity and liquidity). The rating and insolvency forecast methods used by banks and rating agencies can be used for estimation purposes (see Gleißner and Ernst, 2019). The risk aggregation described above (Monte Carlo simulation, cf. Gleißner 2017a, p. 251) enables the recording of future opportunities and threats to the company that are not reflected in financial ratios.

4 Conclusion

A proper evaluation of a company is impossible without an analysis of its risks (opportunities and threats). The value of the company is dependent on earnings risks (or cash flow volatility), which influence the expected value of cash flows and also have effects on the risk-adequate cost of capital (discount rate). Negative fluctuations in earnings can lead to insolvency. Insolvency leads to the interruption of cash flows to the owners and thus influences the expected earnings value and its development over time (in the terminal value phase).

As a result, the following recommendations can be derived for the practice of company valuation (in accordance with Gleißner, 2019c, p. 909):

- A proper valuation of a company requires an analysis of the risks to which it is exposed. This risk analysis complements the plausibility check of corporate planning and creates the prerequisite for the derivation of expectation-loyal plan values (for free cash flows and earnings).
- In risk analysis, risks are first systematically identified, then quantitatively described (by probability distribution) and finally aggregated with reference to corporate planning using a Monte Carlo simulation. This results in multi-value bandwidth planning.
- With risk analysis and risk simulation, the expected values of cashflows and earnings can be directly derived. Thereby, a transition from a target planning that’s often prepared for the purposes of corporate management to the expected values that are required for the application of the DCF method (or capitalised earnings value) is achieved.
- In addition, risk analysis and risk simulation enable the direct derivation of risk-adjusted discount rates and the recording of insolvency risk (see Section 3).
- In a company valuation, at minimum, those risks that the company to be valued identifies itself (e.g., in the risk reporting of risk management) and those that can be derived directly from corporate planning (essentially including all uncertain planning assumptions) must be considered.
- In the case of risk analysis and risk simulation, cooperation between the company and the valuator is usually necessary. The information provided by the company (quantitative risk analyses and, if possible, risk simulation), as well as corporate planning, must be checked for plausibility by the valuator and considered in the valuation. Existing gaps (e.g., with regard to risks) or implausible quantifications must be closed or otherwise addressed by the valuator (in coordination with the company to be valuated) if they appear

The analysis of a company’s risks is clearly necessary; the consideration of the risks a company’s shares – e.g., expressed by the beta factor – is not sufficient. Only under the unrealistic assumption of a perfect capital market do cash flow and share yield fluctuations coincide; see Gleißner (2014, p. 151). It is the company's risks that determine the uncertainty of future

earnings and cash flows, as well as the probability of insolvency and discount rate (see Gleißner and Ernst, 2019 for more explanations and a case study).

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About the author

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