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# Explanatory Power of Implied and Historical Betas in Comparison

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## Abstract

According to Markowitz's portfolio theory, the systematic risk of an investment cannot be eliminated from a portfolio through diversification. The systematic risk is determined, according to Sharpe, Lintner and Mossin, by the beta value. From a formal point of view, the beta value is determined by the covariance term, which describes the direction and strength of the correlation between the return of the security and the market return, and its weighting with the variance return. Beta values are fundamentally determined using the historical returns of the security and the market portfolio, which can lead to incorrect valuations. Use of implied beta values presents an alternative solution. In this working paper we consider the determination of implied beta values, with the focus lying on the question as to whether implied beta values can explain stock prices better than historical beta values. In so doing, the respective implied costs of capital $r_t^{CAPM}$ of the companies concerned are first determined on the basis of analysts' estimates using the three-stage RIM according to Gebhardt, Lee & Swaminathan (2001) as fundamental stock valuation model.

*Keywords: Beta, Portfolio Selection Theory, Residual Income Model*

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## 1. Introduction

Further developments of the portfolio theory have produced numerous models for determination of equilibrium prices on the capital markets. One of the best-known models is the Capital Asset Pricing Model ("CAPM") developed by Sharpe (1964, p. 425-442), Lintner

(1965, p. 13-37) and Mossin (1966, p. 768-783) in the sixties. The essence of the CAPM lies in determining the systematic investment risk, which is deemed the critical risk after diversification of the unsystematic part of the total investment risk (Sharpe 1964, p. 439; Bruns & Steiner 2007, p. 21). Here the positive or negative variance from an expected value, e.g. future expected financial surpluses, is understood as the business risk (Maier 2001, p. 298). The investment theory aims at appropriate determination of this inherent business risk by identifying an adequate target rate. One of the points of criticism concerning the identification of the adequate target rate and, specifically, the beta value used concerns the use of historical data (Spremann 2008, p. 286). This method is justifiable scientifically if it can be shown that past returns are representative of future returns. The literature, however, doubts this (Elton 1999) as new information received over time does not cancel out, resulting in a considerable distortion in the case of historical predictors. Further, the returns are not distributed uniformly and independently over time.

These findings have already led to studies on the determination of implied costs of capital (Siegel 1995; Stotz 2007). The questions still open are to be found in the field of use of stock valuation models to determine an implied beta factor on the German capital market and in the meaningfulness of these implied beta factors. This working paper considers these two questions.

## 2. Theoretical model principles

### *2.1 Portfolio theory and the CAPM*

Modern portfolio theory is based on the work of Markowitz (1952, p. 77-91) and Sharpe (1963, p. 277-293). Whereas the focus to the end of the fifties lay on the analysis of securities on the basis of the development in earnings and capitalised future surpluses, the question later arose as to a theoretical basis for the discount rate. This rate, also known as risk-related opportunity cost rate, reflects the return and thus the investor's risk (Bruns & Steiner 2007, p. 2).

The portfolio theory according to Markowitz not only has effects on the composition of the optimum portfolio, but also on the valuation of financial securities assuming equilibrium prices at risk (Maurer & Albrecht 2008, p. 257). Assuming equilibrium prices at risk means that the prices of securities on a capital market in equilibrium only consider that risk resulting from the security itself (Laux 2006, p. 29).

In addition to the premises of a perfect market, Markowitz makes further assumptions (Markowitz 1952, p. 77 in conjunction with Archer & Francis 1971, p. 7. With focus on the investor's utility function, cf. Maurer & Albrecht 2008, p. 257.):

- There are $n$ number of financial securities available for selection. They are characterised by their respective single-period cum dividend $R_i$ with $i = (1,...,n)$. It is defined as follows:

  $P_{i_t}$ : Uncertain selling price or market value of the security $i$ at the end of the period,

  $P_{i_{t-1}}$ : Certain buying price or market value of the security $i$ at the start of the period,

  $D_i$ : Dividend possibly paid during the investment period.

  Hence:

$$R_i = \frac{P_{i_t} + D_i - P_{i_{t-1}}}{P_{i_{t-1}}} \tag{1}$$

- Every investor assesses the incidental return of a portfolio or a single financial security exclusively by way of the expected return $E(R_i)$ and the variance of the return $VAR(R_i)$ or the standard variance of the return $\sigma(R_i)$;
- If two securities exist for which $VAR(R_1) = VAR(R_2)$ applies, the security that fulfils the condition $\max(E(R_1), E(R_2))$, i.e. has the higher expected return ("non-saturation" of the investor), is preferred;
- If two securities exist for which $E(R_1) = E(R_2)$ applies, the security that fulfils the condition $\min(VAR(R_1), VAR(R_2))$, i.e. has the lower variance ("risk aversion" of the investor), is preferred.

The following applies for the portfolio return (Maurer & Albrecht 2008, p. 269):

$$R = x_1 R_1 + \ldots + x_n R_n = \sum_{i=1}^{n} x_i R_i \tag{2}$$

Where
$x_1 \ldots x_n$: The proportionate investment in the security $i$.

The expected portfolio return can be derived from this:

$$\mu = E(R)_n = \sum_{i=1}^{n} x_i \mu_i \tag{3}$$

Hence for the variance of the portfolio return:

$$\sigma^2 = VAR(R) = \sum_{i=1}^{n} x_i^2 \sigma_i^2 + 2\sum_{i<j} x_i x_j \rho_{ij} \sigma_i \sigma_j \tag{4}$$

Where
$\mu_i = E(R_i)$,
$\sigma_i^2 = VAR(R_i)$,
$\rho_{ij} = \rho(R_i, R_j)$: Correlation coefficient of the investments $R_i$ and $R_j$.

Based on these fundamental assumptions, the effects of diversification and efficiency according to Markowitz are discussed below.

### *2.2 CAPM*

The Capital Asset Pricing Model ("CAPM") adopts the diversification according to Markowitz, so that only the systematic risk of a security is still considered (Sharpe 1964, p.

439; Bruns & Steiner 2007, p. 21). Further to the premises of the portfolio theory and the premises of a perfect market, the following assumptions must be added (Weston et al. 2005, p. 147ff.; Perridon et al. 2009, p. 261):

- The existence of a risk-free interest rate (risk-free rate of return) at which any amount of money can be borrowed and invested at any time.

- The expectations regarding the expected value, variance and covariance of the returns of the securities under disclosure of the normal distribution are homogenous.

- It follows from the premises of rational investor behaviour that every investor keeps a perfectly diversified portfolio.

Applying these premises, the expected return of a security ensues from the sum of the risk-free return and a risk premium. The risk premium here is the product of the company-specific beta factor and the market risk premium as subtraction of the expected return of the market portfolio and the risk-free return (Kleeberg & Rehkugler 2002, p. 55):

$$E(R_i) = r_j + \beta_i \lfloor E(R_m) - r_f \rfloor \quad (5)$$

Use of the risk-free rate of return $r_f$ can be ascribed to Tobin (1958, p. 65-86). The investor does not build his portfolio solely with risky investments, but with $n+1$ investments, i.e. a multitude of risky and risk-free investments. According to Tobin's separation theorem, the decision on the composition of the portfolio is separated from the risk appetite (level of risk aversion). The risk appetite itself is only taken into account in the distribution of the investment budget in the uncertain securities portfolio and the risk-free rate of return (Perridon et al. 2009, p. 268). The consequence of the market portfolio and the risk-free rate of return is thus that all investors have the same portfolio mix instead of an individual portfolio (Bruns & Steiner 2007, p. 23).

Security-specific risks ($\sigma_i$) and fundamental factors (e.g. price-earnings ratio, dividend yield) are not incorporated in the equally weighted valuation. As in the market model, the factor $\beta_i$ is determined on the basis of a market portfolio corresponding to a market-value weighted and $\mu - \sigma$-efficient portfolio of all assets (Kleeberg & Rehkugler 2002).

Due to homogenous expectations and a lack of transaction costs, it may be concluded that all investors hold the same market portfolio. Practically, however, it is assumed that investors do not hold the market portfolio (Pratt & Grabowski 2008, p. 162), and are also not willing to hold the market portfolio and hence invest primarily in non-diversified equity funds (Massa et al. 2004; Goetzmann & Kumar 2008). It must be borne in mind that holding a well-diversified portfolio over time presupposes, due to declining correlations, the inclusion of further stocks to diversify the unsystematic risk (Campbell 2001).

Various empirical tests have also been unable to confirm the validity of the CAPM (see Elton et al. 2007, p. 336-349 for a further description of the past test). The determination of the market portfolio, as fictitious and thus approximately derived quantity, is, in particular, a serious point of criticism (Roll 1977, p. 130), whereby the results of the CAPM are not very sensitive to the selection of the market portfolio (Stambaugh 1982, p. 266), which, however, could also be refuted (Roll 1978; Dybvig & Ross 1985; Green 1986).

The assumed stability of the beta factor has been disproved in investigations of various markets (Fabozzi & Francis 1978; Ohlson & Rosenberg 1982; Bos & Newbold 1984; Collins et al. 1987; Brooks et al. 1992; Opfer 2004). Further, Fama & French (1993) have shown that beta is not adequate as a sole measure of risk, that it explains stock returns to only a very limited extent and that there are other influencing factors (see Fama & French 2004, p. 36 ff. for an historical overview). For instance, anomalies that smaller companies offer a higher return than should be the case according to beta have been identified since 1985 (see Spremann 2008, p. 319 f. and the literature cited there. For example, weekend, January and fair weather effects.). In spite of the points of criticism and the models developed further as a consequence, the CAPM is the best-known model for explanation of the relationship between the expected return and the risk of a security (Myers et al. 2008, p. 189). It is also the most relevant model in practice for determination of a market-based risk mark-up in company valuation (see IDW 2008, p. 19 or Düsseldorf Higher Regional Court, ruling of 27.5.2009 I-26 W 5/07, final, with the principle: "The Capital Asset Pricing Model (CAPM) is currently the most important model for the determination of risk-adjusted capital costs in the valuation of companies"). The restrictive CAPM assumptions have led to various extensions and generalisations, with the Tax CAPM according to Brennan (Brennan 1970; Brennan 1971) being seen as the most important extension of the model (see Spremann 2008, p. 306 and the appendix containing supplementary information with further literature).

## 3. Residual Income Model

The Residual Income Model (RIM) according to Ohlson (1995) is based on accounting values. The intrinsic value of a stock can be ascribed to the sum of the book value of the equity per stock on the valuation date and the cash value of the income extending beyond a reasonable return on the equity ("residual income") (Jamin 2006, p. 35; Penman 2010, p. 153). The fundamental prerequisite for derivation of the RIM from the DDM is adoption of the "Clean Surplus Relation (CSR)". This is described formally as follows (Ohlson 1995, p. 666; Prokop 2003, p. 148 f.; Crasselt & Nölte 2007, p. 525 f.):[1]

$$BPS_t^E = BPS_{t-1}^E + EPS_t - DPS_t \Leftrightarrow DPS_t = EPS_t - BPS_t^E + BPS_{t-1}^E \qquad (6)$$

Where
$BPS_t^E$ : Book value of the equity per stock at the time $t$.

The book value of the equity per stock can therefore be derived in any period from the sum of the book value per stock of the previous period and the difference between the earnings per share and the dividend per share. It is assumed that any changes in the book value of the equity only occur due to retained earnings and not from transactions without effect on net income. All transactions not related to the shareholders are shown in the profit and loss statement (Jamin 2006, p. 37; Crasselt & Nölte 2007, p. 526).

[1] In the literature the CSR is also known as congruence principle and the term $\sum_{t=0}^{n} EPS_t = \sum_{t=0}^{n} DPS_t$ as sum theorem. The sum theorem is also known as congruence principle, cf. e.g. Ewert & Wagenhofer 2008, p. 67. It, however, represents only a necessary, but inadequate condition, cf. Krotter 2007, p. 694 f. Adherence to the sum theorem is not discussed further, cf. Lorenz 2009, p. 46.

With a certain $DPS_t$, the one-stage DDM leads to:

$$P_0 = \sum_{t=1}^{\infty} \frac{DPS_t}{(1+r)^t} = \sum_{t=1}^{\infty} \frac{EPS_t - BPS_t^E + BPS_{t-1}^E}{(1+r)^t} \tag{7}$$

The expression $(R-1)*BPS_{t-1}^E$ can then be used in the numerator both as addend and as subtrahend without changing the result, where $R=(1+r)$ (Jamin 2006, p. 38; Crasselt & Nölte 2007, p. 526. For derivation using the transversality condition, cf. Lorenz 2009, p. 46.):

$$\begin{aligned} P_0 &= \sum_{t=1}^{\infty} \frac{EPS_t - BPS_t^E + BPS_{t-1}^E + (R-1)BPS_{t-1}^E - (R-1)BPS_{t-1}^E}{R^t} \\ &= \sum_{t=1}^{\infty} \frac{EPS_t - (R-1)BPS_{t-1}^E}{R^t} + \sum_{t=0}^{\infty} \frac{BPS_t^E}{R^t} - \sum_{t=1}^{\infty} \frac{BPS_t^E}{R^t} \end{aligned} \tag{8}$$

This is possible because $\sum_{t=1}^{\infty} \frac{BPS_{t-1}^E}{R^t} = \sum_{t=0}^{\infty} \frac{BPS_t^E}{R^t}$. The difference leads to the RIM valuation equation and thus shows the equivalence to DDM:

$$\begin{aligned} P_0 &= BPS_t^E + \sum_{t=1}^{\infty} \frac{EPS_t - (R-1)BPS_{t-1}^E}{R^t} \\ &= BPS_t^E + \sum_{t=1}^{\infty} \frac{EPS_t - (1+r-1)BPS_{t-1}^E}{(1+r)^t} \\ &= BPS_t^E + \sum_{t=1}^{\infty} \frac{EPS_t - rBPS_{t-1}^E}{(1+r)^t} \end{aligned} \tag{9}$$

The equation can be simplified by assuming an infinite period with identical residual income (Reichert 2007, p. 13-16):

$$P_0 = BPS_t^E + \frac{EPS_t - rBPS_{t-1}^E}{r} \tag{10}$$

If residual income grows constantly:

$$P_0 = BPS_t^E + \frac{EPS_t - rBPS_{t-1}^E}{r-g} \quad with \quad r > g \tag{11}$$

Here it should be borne in mind that a different growth rate to that according to the Gordon Growth Model must be used because an identical growth rate for dividends and residual income would have various implications for the future development of the company (Reichert 2007, p. 14). Both Ohlsen (1995), by introducing a stochastic process to describe the behaviour of the future residual income time series (Jamin 2006, p. 32ff. Using auto-regressive processes of the first order, AR (1) processes.), and Feltham & Ohlsen (1995), by separating operational and financial activities, have added to the RIM (Jamin 2006, p. 39ff.).

Analogously to the phase-based DDM, the RIM also enables representation of the refinement of the future development over various phases. The RIM passes through a subsequent second phase with infinite and stable residual income, which is known analogously as the infinite/stable phase (Penman & Sougiannis 1998, p. 352; Prokop & Zimmermann 2003, p. 273):

$$P_0 = BPS_0^E + \sum_{t=1}^{n} \frac{EPS_t - rBPS_{t-1}^E}{(1+r)^t} + \underbrace{\frac{EPS_{n+1} - rBPS_n^E}{r(1+r)^n}}_{\text{Infinite/Stable Phase}} \tag{12}$$

Assuming infinite residual income, which grows at a constant factor, the following ensues:

$$P_0 = BPS_0^E + \sum_{t=1}^{n} \frac{EPS_t - rBPS_{t-1}^E}{(1+r)^t} + \underbrace{\frac{EPS_{n+1} - rBPS_n^E}{(r-g)(1+r)^n}}_{\text{Infinite/Stable (Growth) Phase}} \tag{13}$$

The respective models can be applied analogously to the model company situations of the phase-based DDM.

Gebhardt, Lee & Swaminathan (2001) ("GLS" model) developed a three-phase RIM of the following form:

$$P_0 = BPS_0^E + \underbrace{\sum_{t=1}^{5} \frac{FEPS_t - r_{GLS} BPS_{t-1}^E}{(1+r_{GLS})^t}}_{\textit{Detail}\text{ Phase}} + \underbrace{\sum_{t=6}^{11} \frac{\left(\frac{FEPS_t}{BPS_{t-1}} - r_{GLS}\right) BPS_{t-1}^E}{(1+r_{GLS})^t}}_{\text{ITransition Phase}} + \underbrace{\frac{FEPS_n - r^{EK} * BPS_{t-1}}{r_{GLS}(1+r_{GLS})^n}}_{\text{Infinite/Stable (Growth) Phase}} \tag{14}$$

Where

$FEPS_t$ : Predicted earnings per share, of the respective period.

In the transition phase the development in earnings is no longer determined by a growth rate, but by the expected return on equity. The stable phase is influenced by the earnings forecasts, with which, using the congruence principle, all book values and thus also residual income on the valuation date can be calculated (Wiesenbach & Daske 2005, p. 411f).

Claus & Thomas (2001) use a detailed planning phase of five years ("CL" model), with a subsequent terminal value based on a constant growth factor:

$$P_0 = BPS_0^E + \underbrace{\sum_{t=1}^{5} \frac{EPS_t - rBPS_{t-1}^E}{(1+r)^t}}_{\textit{Detail}\text{ Phase}} + \underbrace{\frac{(EPS_5 - rBPS_4^E) * (1+g)}{(r-g) * (1+r)^5}}_{\text{Infinite/Stable Phase}} \tag{15}$$

The approach of Easton et al. (2002) ("ETSS" model) forgoes an assumed long-term growth rate. The calculation of the equity capital costs is, however, based on a portfolio in order to estimate the long-term earnings growth rates using a regression approach, whereby individual companies cannot be valuated readily. Further, this method delivers less plausible values for German companies (Daske 2005, p. 212), and is therefore not discussed further.

## 4. Empirical analysis

### *4.1 Implied beta*

From a present point of view, all events lying in the future are uncertain, partly with grave risks. The future therefore remains the investor's risk (Volkart 2003, p. 177). In practice the definition of risk has developed such that risk can assume both positive ("upward price fluctuations", profit opportunities) as well as negative ("downward price fluctuations", risks of losses) forms (Schlütz & Beike 2005, p. 155). Based on a financial investment in the form of a stock, the ex-ante uncertainty lies in the future returns, i.e. the development of the market value until sale and the dividends distributed by the company (Maurer & Albrecht 2008, p. 103).

The risk can be measured both quantitatively and qualitatively, although the majority of risk variables are of a quantitative nature. Qualitative variables are, for example, rating symbols in the assessment of creditworthiness, while quantitative risk variables, which predominate in the practice of portfolio management, include, for example, variance or volatility (Cf. Bruns & Meyer-Bullerdiek 2008, p. 8).

The systematic risk is, in comparison to the unsystematic risk, that part that cannot be excluded through diversification according to Markowitz. It results from the difference between total risk and unsystematic risk. Due to their fundamental causes, it is usually easier to forecast systematic risks. Examples of this are, in the field of tangible assets, tax incentives and laws on rent adjustments, which affect the complete residential property market. Bonds are subject to a systematic currency and interest change risk, which is reflected in the case of variable interest coupon bonds in the change in the reinvestment conditions for disbursed interest as well as in the price of the bond. For example, although an increase in the market interest rate ceteris paribus causes a drop in the prices of variable interest coupon bonds, it improves the reinvestment conditions. In the case of stocks there is a systematic overall market risk influenced by political events, economic changes and natural disasters (Schlütz & Beike 2005, p. 288 ff. in conjunction with Bruns & Steiner 2007, p. 54-55. Examples of political events: unrest, revolution, war, elections. Economic changes: tax reforms, changed currency parities, establishment of free trade zones. Natural disasters: crop failures, volcanic eruptions, earthquakes.). In the CAPM the beta factor is the central measure of risk for the systematic risk and thus also in practice, which is why it is discussed in more detail hereinafter.

The beta factor discussed here is part of the CAPM and reflects the risk entered into at a market risk premium. The CAPM is, however, an ex-ante model, which is why on the one hand a constant beta factor would be desirable, but not possible, and on the other it is estimated on the basis of ex-post data. As a further approach, it is possible to derive observable variables within the framework of an implied approach. The relationship between the costs of capital and the risk lies in the investor's perspective. Thus the costs of capital determine that return, $r$ or $E(R_i)$, which is asked for by investors in order to assume the risk of the investment (Terberger & Schmidt 1997, p. 198f.; Westerfield et al. 2005, p. 94-103).

The implied determination of the equity capital costs of an enterprise, as aggregated and capital-market orientated expected return according to the CAPM, sets in before the individual parameters of the CAPM and focuses the implied determination of the parameter $r$ or $E(R_i)$, as it is used in the models discussed for fundamental stock valuation. The fundamental approach to estimate implied costs of capital is hence to invert the valuation models, whereby the market value is given in the form of the share price and the return required sought in the form of an internal rate of return (Gebhardt et al. 2001, p. 140). The following table lists and describes recent empirical studies that pursued this approach, mostly on the basis of modified RIM or AEGM models. Here it must be borne in mind that the studies often only determined the implied risk premium and a risk-free return must be added in order to obtain the implied equity capital cost rate.

**Table 1: Empirical studies of implied equity capital cost rates on the basis of different stock valuation models**

| Year | Author(s) | Data basis | Valuation models | Results |
|---|---|---|---|---|
| 2001 | *Gebhardt, Lee & Swaminathan (2001)* | USA; 1979-1995; 1,000 to 1,300 companies; I/B/E/S estimates | GLS[2] | Mean of implied risk premiums according to RIM: 2-3%, plus a 10-year US federal bond yield of 6.18% |
| 2001 | *Claus & Thomas (2001)* | USA; 1985-1998; 1,559 to 3,673 companies; I/B/E/S estimates | CL[3] | Mean of implied equity capital costs according to CL: 11.04% |
| 2002 | *Easton et al. (2002)* | USA; 1981-1998; 756 to 2,508 companies; I/B/E/S estimates | ETSS[4] | Mean of implied equity capital costs according to ETSS: 13.4% |
| 2003 | *Gode & Mohanram (2006)* | Worldwide; 1984-1998; 711 to 1,423 companies; I/B/E/S estimates | GM[5]; GLS | Mean of implied risk premiums: GM: 5.6%; GLS: 3.2%, plus a 10-year US federal bond yield of 10.6% (1984) to 2.5% (1998) |
| 2005 | *Botosa & Plumlee (2005)* | USA; 1983-1993; 1,013 to 1,226 companies; I/B/E/S estimates | DIV[6];GLS; GG[7]; GM; MPEG[8] | Mean of implied risk premiums: DIV: 6.4%; GLS: 1%; GG: 2.1%; GM: 6.6%; MPEG: 5.0%, plus a five-year monthly US federal bond yield of 12.77% (1983) to 5.5% (1993)[9] |
| 2005 | *Wiesenbach & Daske (2005)* | Germany; 190 companies as at 2.3.2004; I/B/E/S estimates; Bloomberg | DDM; GM; MPEG; GLS; ETSS | Mean of implied equity capital costs: DDM: 13.4%; GM: 11.4%; MPEG: 12%; GLS: 10.5; ETSS: 8.4% |
| 2006 | *Daske, Gebhardt & Klein (2003)* | Germany; 1989-2002; 100 to 350 companies; I/B/E/S estimates | GLS; ETSS | Mean of implied equity capital costs: GLS: 10%; ETSS: 11.2% |

[2] A three-stage RIM modified according to Gebhardt, Lee & Swaminathan (2001), i.e. a five-year detailed planning period is followed by a five-year transition period and a terminal value.
[3] A two-stage RIM modified according to Claus & Thomas (2001), with a five-year detailed planning phase and terminal value.
[4] A one-stage RIM modified according to Easton et al. (2002), in which the long-term earnings growth rate is estimated on the basis of the expectations on the market of the growth in earnings with the help of a regression approach.
[5] A one-stage AEGM modified according to Gode &Mohanram (2003) that assumes a uniform growth factor.
[6] Cf. Botosan & Plumlee (2002) as reference to previous study results.
[7] Cf. Gordon & Gordon (1997), DDM assuming full disbursement.
[8] A one-stage AEGM modified according to Easton (2004) that derives the growth factor from industry-based portfolios.
[9] The details were added from www.federalreserve.gov as they were not explicitly named in the study.

| Year | Author(s) | Data basis | Valuation models | Results |
|---|---|---|---|---|
| 2009 | *Lee, Ng & Swaminathan (2009)* | Worldwide; 1990-2000; 2,491 companies; I/B/E/S estimates | FCFE; MPEG; CL; AEGM | Mean of implied risk premiums: FCFE: 5.8%; MPEG: 4.83%; CL: 5.08%; AEGM: 7.57% plus a 10-year US federal bond yield, which was not specified. |

Source: Own

Due to the different assumptions of the respective models, some approaches deliver less plausible estimates. The DDM, in particular, must be challenged due to the strong influence of the growth rate. The most suitable for practical use are AEGM and RIM with their modifications. The implied determination of equity capital costs thus does by all means seem to be a suitable alternative to backward-looking models for capital-market orientated companies (Wiesenbach & Daske 2005, p. 419).

It would be correct to estimate the beta factor on the basis of ex-post data if past returns were representative for the future. However, Elton (1999) doubts the correlation between past and future returns. The fundamental arguments are firstly that new information received over time does not cancel out, resulting in a considerable distortion in the case of historical predictors. Further, returns are not distributed uniformly and independently over time (Bos & Newbold 1984). Generally returns vary with the economic cycle, whereby future and past returns can be related to each other negatively (Stotz 2007, p. 318). This means that both new information and time-variable returns have a strong influence on historical beta factors. Taking both problems into consideration, historical returns do not make it possible to explain future ones, which has led to the development of two approaches to determining implied beta factors. They are calculated either according to Siegel (1995) or Husmann & Stephan (2007), on the basis of options, or according to Stotz (2007), on the basis of implied equity capital costs. Both approaches must be seen as relatively new and have received little academic consideration to date.

Siegel's approach uses the implied volatility according to Latane & Rendleman (1976), who have determined that future returns can be forecast better on the basis of implied volatilities. The basis for determining implied volatilities is formed by a so-called "exchange option", which entails the right to exchange an asset or stock for another one (Hull 2009, p. 692). Margrabe (1978) presented this type of option and its valuation within the framework of option valuation according to Black & Scholes (1973). Apart from the exchange option, an option on the stock and an option on the market index are also needed for calculation (Husmann & Stephan 2007, p. 7). This gives rise to the first point of criticism, namely that a market index does not exist and an option on it definitely not. Further, the assumptions according to Black & Scholes are not realistic and exchange options are, with the exception of currency trading, not available on the market (Siegel 1995, p. 126; Husmann & Stephan 2007, p. 7).

Husmann & Stephan (2007) also use the findings of Latane & Rendleman (1976) and determine the implied beta on the basis of "Plain Vanilla Options" (Hull 2009, p. 235ff). Although they are traded on the market, the normal distribution of returns is presumed in their application. Empirical findings on the basis of EUREX show that the calculated beta factors are plausible, beta is variable over time and an estimate based on historical returns and an assumption of constant beta factors leads to wrong results (Husmann & Stephan 2007, p. 9f).

Following Stotz, his approach to determining an implied beta factor is the one that should also be followed partly in the empirical study. Current prices and market expectations form the basis here. From these, the respective implied costs of capital $r_t^{(e)}$ of the companies concerned are determined on the basis of analysts' estimates in a first step, using the three-stage RIM according to Gebhardt, Lee & Swaminathan as fundamental stock valuation model. An individual risk premium for every company is obtained by subtracting the risk-free rate of return. Stotz moreover determines the average implied risk premium of the market from the average value-weighted implied costs of capital of all companies less the risk-free rate of return (Stotz 2007, p. 320). Since the market portfolio has an assumed beta factor of one, the implied beta of every company can be calculated by division of both terms (Stotz 2007, p. 321).

A comparison of the calculated implied beta with a regression beta[10] shows the superiority of the implied beta on the basis of the approach described. The advantages lie in the possibility of also estimating beta factors for shares or companies traded only briefly. Furthermore, it is also possible to determine implied beta factors for companies that are facing a change in their future risk character, for example pharmaceutical companies due to expiring patents. In addition to this, the implied beta factors determined in this way are true to the CAPM, which uses expected returns (Stotz 2007, p. 333). Should there not be any estimates by analysts available for the respective company, it is possible to proceed according to Gebhardt, Lee & Swaminathan, who derive implied risk premiums on the basis of a cross-section regression against company-specific KPI's (Gebhardt et al. 2001).

### *4.2 Methodology*

The following study is based on the theoretical principles discussed above. It investigates how the implied costs of capital and implied beta factors have developed and whether historically derived beta factors can be used to explain implied beta factors. As far as the historical beta factors are concerned, various sets with different assessment period lengths, return intervals and proxies are used.

H1: The explanatory power of historical beta factors is not substantially better than implied beta factors.

H2: Implied beta factors explain the spot price significantly better than historical beta factors.

Before these questions are answered, the approach and data basis are described in detail.

The RIM following the approach of Nölte (2008, p. 201) is used to calculate the implied costs of capital and implied beta factors. The phase-based RIM is shortened to a period of three detailed planning phases and a subsequent terminal value.

Following Claus & Thomas (2001), the following results for the RIM, hereinafter RIM:

$$P_0 = BPS_0 + \sum_{t=1}^{3} \frac{FEPS_t - r_{RIMCL} \times FBPS_{t-1}}{(1 + r_{RIMCL})^t} + \frac{(FEPS_3 - r_{RIMCL} \times FBPS_2) \times (1 + g)}{(r_{RIMCL} - g) \times (1 + r_{RIMCL})^3} \tag{16}$$

Parameters:

$P_t$**:** Share price at time $t$,

$FEPS_t$: Earnings per share at time $t$,

$FBPS_t$: Forecast book price per share at time $t$,

[10] At a return interval of one month and an assessment period of five years. It was moreover tested against six different unbiased and variance-effective representative market portfolios.

$BPS_t$ : Book price per share at time $t$ ,
$g$ : Assumed long-term growth rate (0%, 1% and 2%),
$r_{RIMCL}$: Calculated implied costs of capital on the basis of formula 5.3.

In the first step, the equation is solved iteratively using the "Solver" function provided by MS Excel using the share price (closing price) on 03.01., 03.03., 03,06. and 03.09.;[11] where the 3rd day of the month is a Saturday or Sunday, the closing price on the following work day (Monday) is used. Due to this variation, the respective date is no longer given hereinafter, but only the month as substitute for the spot date. This results overall in three values for the implied costs of capital on the selected spot date for each company examined:

$r^0_{i,RIMCL}$ , $r^1_{i,RIMCL}$ , $r^2_{i,RIMCL}$ **: Implied costs of capital according to RIM.**

The risk-free rate of return $r_f$ is then subtracted from every factor calculated. The risk-free rate of return is calculated implicitly according to the Svensson method in dependence on the respective spot date for a period of 10 years. The result is, based on the CAPM, the respective implied risk premium of the company at different growth rates. Using the implied costs of capital according to the RIM without growth as example, the equation is as follows:

$$\pi^0_{i,RIM} = r^0_{i,RIM} - r_f = \beta\left(E(r_M) - r_f\right) \qquad (17)$$

Where
$\pi^0_{i,RIM}$ : Implied risk premium of the company according to RIM, without growth.

Following the approach of Stotz, the implied expected risk premium of the market is calculated using a mean, weighted according to market capitalisation, of the calculated implied company-specific costs of capital. The risk-free rate of return is then subtracted from this (Stotz 2007, p. 320). This approach corresponds to the theory of the CAPM, according to which the aggregated expected market return is represented by the factor $E(r_M)$ . The weighting is effected from the market capitalisation of the company on the spot date in relationship to the market capitalisation of all companies for which the implied costs of capital were determined. Using the implied costs of capital according to RIM without assuming growth, this results in:

$$\pi^0_{m,RIM} = \left(\sum_{i=1}^{T} w_{it} \cdot r^0_{i,RIM}\right) - r_f = E(r_M) - r_f \qquad (18)$$

Where
$w_{it}$ : Weight of the company at the time with $\sum_{i=1}^{T} w_{it} = 1$ ,
$\pi^0_{m,RIM}$ : Implied risk premium of the market according to RIM, without growth.

According to the theory of the CAPM, the beta factor of the market equals one. The implied beta factor for every company is thus obtained from:

[11] The 3rd day at the start of every quarter was selected as spot date for the price in order to keep distortion of the prices by the "turn-of-month effect" low, cf. McConnell (2006)

$$\hat{\beta}_{i,RIM}^{0,IMP} = \frac{\pi_{i,RIM}^{0}}{\pi_{m,RIM}^{0}} \tag{19}$$

With three different explicit growth factors and three different implied beta factors, the following then results for every company:

$\hat{\beta}_{i,RIMCL}^{0,IMP}$, $\hat{\beta}_{i,RIMCL}^{1,IMP}$, $\hat{\beta}_{i,RIMCL}^{2,IMP}$ : Implied beta factor according to RIM.

The historical beta factors are estimated for every company on the respective spot date on the basis of four different sets using a simple linear regression. The CDAX and DAX are used as proxies. The length of the assessment period is 250 and 60 weeks in each case, with a weekly return interval and discrete calculation of return. The 250-week interval is used to follow a certain best-practice, the 60-week interval to observe statistical requirements and the 30-week interval to take the latest price developments and information into account.

$\hat{\beta}_{i,CDAX}^{250,HIST}$ : Historical beta predictors for CDAX at 250 weekly returns,
$\hat{\beta}_{i,CDAX}^{60,HIST}$ : Historical beta predictors for CDAX at 60 weekly returns,
$\hat{\beta}_{i,CDAX}^{30,HIST}$ : Historical beta predictors for CDAX at 60 weekly returns.

To test the explanatory power of the historical and implied beta factors, they are applied to the RIM at a growth factor of zero and compared with the closing price on the spot date.

The forecasts available are used for the numerators of the models and the respective beta factors examined for the denominators. Since the denominator is determined by the CAPM, it is necessary to determine risk-free rates of return and expected market returns. The yield of the 10-year Government bond index for Germany according to Bloomberg $r_t^{GDBR10}$ is supposed for the risk-free return (Bloomberg Ticker: GDBR10 Index.). The expected market return is calculated for the CDAX on the basis of the Compound Annual Growth Rate (“CAGR”) using the historical yield of a 20-year period:

$$CAGR_t = \left( \frac{r_t}{r_{t-20Jahre}} \right)^{\frac{1}{20}} - 1 = E(r_t^{CDAX20}) \tag{20}$$

It is assumed that this approach reflects the real expectations of the market.

In dependence on the three different historical beta predictors, the following base equations result on the basis of CAPM:

$$r_i^{250} = r_t^{GDBR10} + \hat{\beta}_{i,CDAX}^{250,HIST} \cdot \left( E(r_t^{CDAX20}) - r_t^{GDBR10} \right) \tag{21}$$

$$r_i^{60} = r_t^{GDBR10} + \hat{\beta}_{i,CDAX}^{60,HIST} \cdot \left( E(r_t^{CDAX20}) - r_t^{GDBR10} \right) \tag{22}$$

$$r_i^{30} = r_t^{GDBR10} + \hat{\beta}_{i,CDAX}^{30,HIST} \cdot \left( E(r_t^{CDAX20}) - r_t^{GDBR10} \right) \tag{23}$$

Reduction to the models with a growth factor of zero results in a base equation on the basis of CAPM in the form of:

$$r_{i,RIMCL}^{IMP} = r_t^{GDBR10} + \hat{\beta}_{i,RIMCL}^{0,IMP} \cdot \left( E(r_t^{CDAX20}) - r_t^{GDBR10} \right) \tag{24}$$

From the results it is possible to make a statement on the implied costs of capital, and the positive variances of the theoretical share prices from the spot-date closing price are used to make a statement about the quality of historical and implied beta factors.

### 4.3 Data

The data basis is formed by all companies listed in the CDAX in the time from 2005 to 2010. Due to the changes in the listed companies that the CDAX underwent in this time, the data basis is also subject to a change over time. Apart from this, I/B/E/S data is not available from Bloomberg in the necessary scope for all companies.

**Table 2: Data basis I**

| Data basis I | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Period | N | Forecast year (t = 1) | | | | | |
| | | | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 |
| Modell | Q1 | CDAX | 689 | 678 | 684 | 684 | 664 | 621 |
| | Q2 | | 689 | 674 | 680 | 683 | 660 | 617 |
| | Q3 | | 682 | 674 | 690 | 681 | 654 | 619 |
| | Q4 | | 676 | 673 | 682 | 676 | 643 | 612 |
| RIM | Q1 | F | 19 | 23 | 28 | 31 | 28 | 26 |
| | | V | 19/19/18 | 22/22/21 | 27/27/25 | 31/29/26 | 27/27/27 | 26/25/25 |
| | Q2 | F | 83 | 99 | 139 | 160 | 159 | 157 |
| | | V | 81/81/80 | 93/92/79 | 132/125/109 | 157/146/127 | 155/149/135 | 152/144/124 |
| | Q3 | F | 86 | 132 | 149 | 159 | 160 | 159 |
| | | V | 84/84/83 | 122/110/92 | 144/130/115 | 155/148/129 | 157/149/141 | 153/145/127 |
| | Q4 | F | 80 | 130 | 143 | 154 | 154 | 24 |
| | | V | 78/78/75 | 120/113/98 | 137/126/105 | 151/145/129 | 150/144/127 | 23/22/18 |

Q (Quarter): The 3rd day of each quarter was used. If this day fell on a Saturday or Sunday, the closing price on the following Monday
F (Forecasts): All companies with forecasts for the model.
V (Valid): All companies with implied costs of capital, applying the model, of 0% to 100%. This takes "outliers" due to negative or lacking income forecasts into account. n is given with explicit 0%/1%/2% growth rates.

Source: Own

**Table 3: Data basis II**

| Data basis II | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Period | N | Forcast year (t=1) | | | | | |
| | | | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 |
| Modell | Q1 | CDAX | 689 | 678 | 684 | 684 | 664 | 621 |
| | Q2 | | 689 | 674 | 680 | 683 | 660 | 617 |
| | Q3 | | 682 | 674 | 690 | 681 | 654 | 619 |
| | Q4 | | 676 | 673 | 682 | 676 | 643 | 612 |
| RIM | Q1 | V | 19 | 22 | 27 | 31 | 27 | 26 |
| | | H | 15 | 21 | 22 | 23 | 22 | 16 |
| | Q2 | V | 81 | 93 | 132 | 157 | 155 | 152 |
| | | H | 67 | 85 | 115 | 130 | 128 | 111 |
| | Q3 | V | 84 | 122 | 144 | 155 | 157 | 153 |
| | | H | 72 | 114 | 127 | 130 | 127 | 111 |
| | Q4 | V | 78 | 120 | 137 | 151 | 150 | 23 |
| | | H | 71 | 112 | 118 | 126 | 105 | 20 |

Q (Quarter): The 3rd day of each quarter was used. If this day fell on a Saturday or Sunday, the closing price on the following
V (Valid): All companies with implied costs of capital, applying the model, of 0% to 100%. This takes "outliers" due to negative or lacking income forecasts into account. n is given with explicit 0% growth rate.
H (Historical): All companies that are V and have a historical price range of 250 or 60 weekly returns.

Source: Own

### *4.4 Results*

The implied costs of capital calculated were averaged over all three explicit growth rates for the purposes of a descriptive representation. The RIM, with annual averages of 12.42% (2005) to 7.89% (2010), indicates a predominately similar trend. The explanatory power of historical and implied beta factors is described below. For this, the absolute valuation errors for implied ("IMPL") and historical ("HIST") beta factors resulting from the difference between estimated price and spot-date closing price were averaged on every spot date and juxtaposed.

**Table 4: Explanatory power of implied and historical beta factors on the basis of RIM (250-week interval)**

| RIM | | 250 weeks | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Valuation error | | | t-Test | Standard deviation | | | F-Test |
| t | n | Impl | His | Difference | | Impl | His | Difference | |
| Jan-05 | 3 | 64.15 | 7.69 | 56.45 | | 96.42 | 6.74 | 89.68 | * |
| Mar-05 | 57 | 12.78 | 24.93 | -12.16 | | 24.96 | 62.20 | -37.24 | * |
| Jun-05 | 42 | 18.00 | 11.45 | 6.55 | | 27.77 | 13.00 | 14.76 | * |
| Sep-05 | 42 | 31.95 | 15.65 | 16.30 | | 67.42 | 21.26 | 46.16 | * |
| Jan-06 | 21 | 40.68 | 116.58 | -75.90 | | 81.23 | 269.84 | -188.60 | * |
| Mar-06 | 37 | 142.45 | 17.46 | 124.99 | | 607.97 | 19.44 | 588.54 | * |
| Jun-06 | 65 | 68.06 | 17.39 | 50.67 | | 267.68 | 16.08 | 251.60 | * |
| Sep-06 | 64 | 42.17 | 19.02 | 23.15 | ** | 71.62 | 17.71 | 53.90 | * |
| Jan-07 | 11 | 69.77 | 31.03 | 38.74 | | 145.67 | 67.25 | 78.42 | ** |
| Mar-07 | 50 | 128.85 | 16.87 | 111.99 | | 646.01 | 18.34 | 627.67 | * |
| Jun-07 | 85 | 69.51 | 45.64 | 45.64 | | 281.74 | 28.49 | 253.25 | * |
| Sep-07 | 74 | 37.50 | 23.87 | 17.52 | ** | 62.95 | 19.30 | 43.65 | * |
| Jan-08 | 11 | 18.09 | 16.56 | 1.53 | | 29.19 | 29.10 | 0.09 | |
| Mar-08 | 65 | 28.65 | 24.34 | 4.31 | | 27.64 | 24.95 | 2.68 | |
| Jun-08 | 88 | 75.59 | 21.30 | 54.29 | ** | 247.99 | 26.05 | 221.94 | * |
| Sep-08 | 66 | 32.30 | 20.91 | 11.39 | | 50.47 | 25.75 | 24.73 | * |
| Jan-09 | 19 | 62.10 | 77.52 | -15.42 | | 118.76 | 157.67 | -38.91 | |
| Mar-09 | 116 | 20.90 | 33.78 | -12.88 | | 64.37 | 110.83 | -46.46 | * |
| Jun-09 | 56 | 24.25 | 17.45 | 6.80 | | 32.88 | 30.76 | 2.12 | |
| Sep-09 | 65 | 17.63 | 14.09 | 3.54 | | 19.92 | 14.45 | 5.47 | ** |
| Jan-10 | 6 | 12.44 | 11.09 | 1.35 | | 11.90 | 11.99 | -0.09 | |
| Mar-10 | 54 | 30.01 | 19.43 | 10.58 | ** | 31.33 | 15.81 | 15.52 | * |
| Jun-10 | 58 | 20.82 | 17.92 | 2.91 | | 25.55 | 22.88 | 2.67 | |
| Sep-10 | 15 | 8.61 | 6.57 | 2.04 | | 10.41 | 10.12 | 0.29 | |
| *1% Significance level **5% Significance level ***10% Significance level | | | | | | | | | |

Source: Own

An analysis of the valuation errors shows that with RIM use of the historical beta involves fewer average valuation errors (83.33% (250-week interval), 79.17% (60-week interval) and 66.67 % (30-week interval). A significance at a level of 5% was established for 16.67% of the observations for the 250-week interval. The level of significance rises as the week interval is reduced. At a 60-week interval, only 8.33% of the observations with a level of 5% are significant and 8.33% at a level of 10%.

**Table 5: Explanatory power of implied and historical beta factors on the basis of RIM (60-week interval)**

| RIM | | 60 weeks | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Valuation error | | | t-Test | Standard deviation | | | F-Test |
| t | n | Impl | His | Differenz | | Impl | His | Differenz | |
| Jan-05 | 2 | 89.06 | 4.62 | 84.44 | | 121.94 | 2.72 | 119.22 | |
| Mar-05 | 57 | 12.78 | 25.07 | -12.29 | | 24.96 | 63.90 | -38.94 | * |
| Jun-05 | 42 | 18.00 | 17.48 | 0.52 | | 27,7679981 | 32.76 | -4.99 | |
| Sep-05 | 42 | 31.95 | 15.40 | 16.55 | | 67,4209144 | 22.66 | 44.76 | * |
| Jan-06 | 21 | 40.68 | 110.14 | -69.46 | | 81,232341 | 223.30 | -142.07 | * |
| Mar-06 | 38 | 138.95 | 15.60 | 123.34 | | 600,090354 | 16.46 | 583.63 | * |
| Jun-06 | 64 | 69.07 | 19.24 | 49.83 | | 269,676235 | 18.81 | 250.86 | * |
| Sep-06 | 63 | 42.78 | 22.49 | 20.29 | ** | 72,0258437 | 24.70 | 47.32 | * |
| Jan-07 | 11 | 69.77 | 19.48 | 50.28 | | 145,665943 | 39.84 | 105.83 | * |
| Mar-07 | 50 | 128.85 | 17.70 | 111.16 | | 646,014749 | 18.58 | 627.43 | * |
| Jun-07 | 84 | 70.33 | 24.43 | 45.90 | | 283,333253 | 22.51 | 260.82 | * |
| Sep-07 | 74 | 37.50 | 20.88 | 16.61 | *** | 62,950017 | 20.11 | 42.84 | * |
| Jan-08 | 11 | 18.09 | 14.83 | 3.26 | | 29,1866633 | 29.81 | -0.63 | |
| Mar-08 | 65 | 28.65 | 24.59 | 4.06 | | 27,6377885 | 25.15 | 2.48 | |
| Jun-08 | 88 | 75.59 | 21.07 | 54.52 | ** | 247,992126 | 25.86 | 222.13 | * |
| Sep-08 | 66 | 32.30 | 20.95 | 11.36 | | 50,4703231 | 24.85 | 25.62 | * |
| Jan-09 | 256 | 23.86 | 27.50 | -3.64 | | 57.62 | 83.60 | -25.98 | |
| Mar-09 | 116 | 20.90 | 32.92 | -12.02 | | 64.37 | 106.11 | -41.74 | * |
| Jun-09 | 56 | 24.25 | 17.50 | 6.75 | | 32.88 | 30.75 | 2.13 | |
| Sep-09 | 65 | 17.63 | 14.31 | 3.32 | | 19.92 | 14.67 | 5.25 | ** |
| Jan-10 | 6 | 12.44 | 12.00 | 0.44 | | 11.90 | 13.11 | -1.21 | |
| Mar-10 | 54 | 30.01 | 19.41 | 10.61 | *** | 31.33 | 15.62 | 15.71 | * |
| Jun-10 | 58 | 20.82 | 20.32 | 0.50 | | 25.56 | 24.95 | 0.60 | |
| Sep-10 | 15 | 8.61 | 8.87 | -0.26 | | 10.41 | 12.71 | -2.30 | |
| *1% Significance level **5% Significance level ***10% Significance level | | | | | | | | | |

Source: Own

At a 30-week interval, 4.17% (level: 5%) of the observations are significant and already 16.67% at a level of 10%. In those observations in which the implied beta in RIM has fewer valuation errors, the standard deviation is lower compared to the historical beta, which applies to 17.39% (250-week interval), 20.83% (60-week interval) and 29.17% (30-week interval) of the observations. The F-test indicates that in RIM a lower valuation error also goes hand in hand with a statistically significantly lower standard deviation, and vice versa. Overall, statistical significance was observed in 70.83% (250-week interval), 65.22% (60-week interval) and 66.67 % (30-week interval) of the observations.

**Table 6: Explanatory power of implied and historical beta factors on the basis of RIM (30-week interval)**

| RIM | | 30 weeks | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Valuation error | | | t-Test | Standard deviation | | | F-Test |
| t | n | Impl | His | Differenz | | Impl | His | Differenz | |
| Jan-05 | 3 | 64.15 | 7.83 | 56.32 | | 96.42 | 6.95 | 89.47 | |
| Mar-05 | 54 | 13.40 | 26.65 | -13.25 | | 25.51 | 56.30 | -30.79 | * |
| Jun-05 | 41 | 18.35 | 24.91 | -6.56 | | 28.02 | 44.65 | -16.63 | * |
| Sep-05 | 42 | 31.95 | 33.67 | -1.71 | | 67.42 | 63.55 | 3.87 | ** |
| Jan-06 | 20 | 42.22 | 320.30 | -278.08 | | 83.03 | 946.56 | -863.53 | * |
| Mar-06 | 38 | 138.95 | 17.16 | 121.79 | | 600.09 | 20.07 | 580.02 | * |
| Jun-06 | 64 | 69.7 | 19.90 | 49.18 | | 269.68 | 19.25 | 250.42 | * |
| Sep-06 | 63 | 42.78 | 23.65 | 19.13 | *** | 72.03 | 26.39 | 45.64 | * |
| Jan-07 | 11 | 69.77 | 19.98 | 49.79 | | 145.67 | 30.39 | 115.27 | * |
| Mar-07 | 49 | 131.35 | 20.00 | 111.35 | | 652.47 | 21.63 | 630.84 | * |
| Jun-07 | 85 | 69.51 | 23.65 | 45.86 | | 281.74 | 25.80 | 255.94 | * |
| Sep-07 | 74 | 37.50 | 20.58 | 16.91 | *** | 62.95 | 19.92 | 43.03 | * |
| Jan-08 | 11 | 18.09 | 13.67 | 4.42 | | 29.19 | 30.41 | -1.22 | |
| Mar-08 | 65 | 28.65 | 24.79 | 3.86 | | 27.64 | 25.78 | 1.86 | |
| Jun-08 | 88 | 75.59 | 21.38 | 54.21 | ** | 247.99 | 25.55 | 222.45 | * |
| Sep-08 | 66 | 32.30 | 20.61 | 11.70 | *** | 50.47 | 25.19 | 25.28 | * |
| Jan-09 | 18 | 65.32 | 72.22 | -6.91 | | 121.34 | 153.33 | -31.98 | |
| Mar-09 | 116 | 20.90 | 33.94 | -13.05 | | 64.37 | 110.20 | -45.83 | * |
| Jun-09 | 56 | 24.25 | 17.36 | 6.88 | | 32.88 | 30.80 | 2.08 | |
| Sep-09 | 65 | 17.63 | 14.66 | 2.97 | | 19.92 | 15.65 | 4.27 | *** |
| Jan-10 | 6 | 12.44 | 10.67 | 1.78 | | 11.90 | 12.36 | -0.46 | |
| Mar-10 | 54 | 30.01 | 19.51 | 10.50 | *** | 31.32 | 15.60 | 15.72 | * |
| Jun-10 | 58 | 20.82 | 22.18 | -1.36 | | 25.55 | 28.84 | -3.29 | |
| Sep-10 | 15 | 8.61 | 10.13 | -1.53 | | 10.41 | 14.47 | -4.06 | |
| *1% Significance level **5% Significance level ***10% Significance level | | | | | | | | | |

Source: Own

These results show that the hypotheses H1 and H2 stated in the introduction can be neither clearly confirmed nor rejected.

It must be borne in mind firstly that the complete study is based on the assumption that the prices on the selected spot dates are not distorted by capital market anomalies, i.e. the intrinsic value of the share is given. It is noticeable in the results shown above that RIM with historical beta factors has a generally higher explanatory power, as evidenced by a significance level of 5% in 16.67% of the observations for a 250-week interval. This further speaks for the estimation of a historical beta factor for the specified return interval if RIM is used as stock valuation model. When the assessment period is shortened to 30 weeks, this significance level can only be supported by 4.17% of the observations and 16.67% of the observations fall in a 10% significance level. Nevertheless, it remains conspicuous that no matter which historical beta is applied, September 2006 and 2007 always stand out significantly. This could indicate a largely balanced capital market at this point in time, as also supposed by Sharpe. Furthermore, the assumed advantageousness of the historical beta factor in RIM could lie therein that the model is not only based on forecasted quantities, but that with the factor $BPS_0$, it also includes realised quantities of the individual companies and hence the future uncertainty is reduced from the investor's point of view.

## 5. Summary

The portfolio theory according to Markowitz shows that the risk of a portfolio does not correspond to the sum of the individual risks and takes the covariances of the individual investments into consideration (Maurer & Albrecht 2008, p. 258). This diversification enables reduction of the unsystematic risk (Maurer & Albrecht 2008, p. 259), but the systematic risk, the beta factor, remains (Elton et al. 2007, p. 139). This plays a central role in the CAPM, which builds on the portfolio theory, as it is the risk that cannot be eliminated through diversification (Sharpe 1964, p. 439; Bruns & Steiner 2007, p. 21).

Due to the continued significant role of the CAPM in spite of the unavoidable criticism of it, the derivation and application of the beta factor has repeatedly been discussed, challenged, rejected and accepted over the years (Grinold 1993; Clare & Priestley 1997; Chi-Cheng Hsia et al. 2000; Evensky 2009). Nevertheless, the beta factor remains of central importance in the valuation of stocks and companies if the expected return is derived on a capital-market basis using the CAPM and applied to the RIM.

The beta factor can be derived implicitly on the basis of the estimates of analysts of dividends, earnings and equity book values and juxtaposed with the historical beta factors calculated by linear regression. This makes it possible to compare the quality of implied and historical beta factors. The empirical study cited showed that the use of historical returns and beta factors derived from them should be preferred in RIM for an assessment period length of 250 weeks and a weekly return interval.

It should be noted by way of criticism that only a part of the possible parameters and parameter combinations were applied and examined. For example, assessment periods and return intervals can be scaled at will and the choice of the CDAX as market portfolio can be substituted with an efficient $\mu - \sigma$ portfolio.

Regarding further empirical analyses of the use of the beta factor in the valuation of companies, it should be examined how both implicit and historical beta factors behave over time and what their relationship to economic and macroeconomic events is, whereby there is a need for an industry-specific study.

Generally, the goal should not be to see the systematic risk as a constantly changing risk, but as a risk that is stable over certain intervals and that only changes in the view of the investor due to macroeconomic developments. This also directs attention to an examination in a portfolio context. To this effect, implied beta factors, e.g. using the three-factor model according to Fama & French (2004), could be determined.

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