Multiples

10

10.1 Introduction

The intrinsic value of an equity security is determined on the basis of a cash flow model using the growth rate of the cash flows and the expected return. Relative valuation analysis, on the other hand, assesses the value of an equity security against a benchmark employing a multiple. This approach makes it possible to examine whether the security is valued correctly relative to the stocks of comparable companies. The fundamental economic principle of the comparables method is based on the law of one price, according to which two identical assets are traded at the same price.[1]

Essentially, a distinction is made between price multiples and value multiples. With a price multiple, the price of an equity security is set in relation to a financial variable that has a significant influence on the share price. The variable chosen for this purpose is, for example, the earnings or the book value per share. The intuition behind value multiples is similar. Investors evaluate the market value of an entire company relative to the amount of earnings before interest, taxes, depreciation and amortisation (EBITDA), sales, operating cash flow, or free cash flow to firm. Thus, the enterprise value is considered in relation to a financial variable that affects its value. The price and value multiples can be used to determine whether the stock is correctly valued in the market.

The use of multiples in equity valuation assumes that capital markets are informationally efficient. However, the efficient market hypothesis applies only to the peer group. By contrast, an inefficient capital market is assumed for the company to be valued. Only then it is possible to identify a mispriced stock with the assistance of peer companies that are correctly valued. Moreover, the inefficiency in this

[1] See Reilly and Brown 2003: *Investment Analysis and Portfolio Management*, p. 388.

© The Author(s), under exclusive license to Springer Fachmedien Wiesbaden GmbH, part of Springer Nature 2023

E. Mondello, *Applied Fundamentals in Finance*, Springer Texts in Business and Economics, https://doi.org/10.1007/978-3-658-41021-6_10

	P/E	PEG	P/BV	P/C	EV/EBITDA	EV/S
Automobile	•	•		•	•	•
Banks			•			
Construction	•			•	•	
Food	•			•	•	•
Health	•	•		•	•	
Insurance			•			
Mechanical engineering	•			•	•	
Media	•	•			•	
Real estate			•			
Retail	•			•	•	•
Technology	•	•		•	•	•
Telecommunication	•	•			•	•
Transport/logistic	•			•	•	
Utility	•			•	•	

Fig. 10.1 Common industry multiples (Source: Based on Hasler 2013: *Aktien richtig bewerten*, p. 286)

sub-sector of the capital market must gradually disappear so that an alpha can be achieved by detecting the mispriced stock by means of multiples.

A multiple reflects the price an investor has to pay to buy a certain valuation unit of the company such as earnings. At the beginning of equity valuation, the accepted multiples consisted only of the price-to-earnings ratio (P/E) and the price-to-book ratio (P/B).[2] In the meantime, the number of multiples has increased considerably. In addition to the P/E ratio and the P/B ratio, the price/earnings-to-growth ratio (PEG) and the price-to-cash-flow ratio (P/C), as well as enterprise value-based multiples such as the enterprise value EBITDA ratio (EV/EBITDA) and enterprise value sales ratio (EV/S), among others, are used today. Figure 10.1 presents an overview of the most common industry-specific multiples.

Multiples can also be calculated with non-financial variables if they affect the share price. For mobile telecommunications, for example, the number of subscribers is defined as the relevant performance indicator. For hospitals and hotels, the relevant performance indicator is the number of beds, while for social media companies, it is the number of registered users.

[2] Graham and Dodd described the P/E ratio and the P/B ratio in equity valuation as early as 1934. See Graham and Dodd 1934: *Security Analysis*, p. 351 ff.

The following section examines the price-to-earnings ratio, the price/earnings-to-growth ratio, and the price-to-book ratio as examples of price multiples. It goes on to discuss the enterprise value EBITDA ratio, which belongs to the value multiples.

10.2 Price-to-Earnings Ratio

10.2.1 Definition

The share price is arrived at by dividing the market value of equity by the number of outstanding shares. For example, a two-for-one stock split doubles the number of shares, which halves the share price. Since the price of an equity security is affected by the number of outstanding shares, the share prices of different companies are not easily comparable. Nevertheless, in order to be able to compare the share prices of similar companies, the prices must be standardised or brought to a comparable basis with the assistance of a multiple. For example, the P/E ratio can be calculated by considering the price of a share in relation to the earnings per share:

$$\frac{P}{E} = \frac{\text{Share price}}{\text{Annual EPS}}, \tag{10.1}$$

where

EPS = earnings per share.

The P/E ratio is the most widely used price multiple.[3] The numerator of the multiple contains the market value of the equity per share or the traded share price. The denominator, on the other hand, includes the earnings per share, which reflects the profitability of the equity as the earnings per share can be used together with the book value per share to calculate the return on equity. While the determination of the numerator, the traded share price, does not pose any problems—at least for listed companies—the setting of the denominator is a challenge. Various earnings measures can be used, such as the earnings of the past business year, the earnings of the past 12 months, or the expected future earnings. For valuation purposes, diluted recurring earnings are usually used. The following are the three main variants of the P/E ratio:

- The current P/E ratio, which is based on the earnings of the past financial year (or the most recently published annual result)
- The trailing P/E ratio, which is based on the earnings of the last 12 months (LTM or last 12 months)

[3] A survey conducted by Bank of America Merrill Lynch in 2012 indicates that 81% of institutional investors took the P/E ratio into account in their equity analysis. Thus, the P/E ratio is the most utilised valuation indicator. See Bank of America Merrill Lynch 2012: *Annual Institutional Factor Survey*, p. 18.

- The forward P/E ratio, which refers to the expected earnings of the next 12 months (NTM or next 12 months)

Share prices are not determined by past data, but by expectations. Therefore, whenever possible, the forward P/E ratio is preferable to the trailing P/E ratio.

The basic idea behind using multiples is that the price of an equity security should not be evaluated in isolation. Therefore, the share price must be considered in relation to another variable to determine how much one is willing to pay for a unit of, say, earnings or book value. For example, a P/E ratio of 15 means that 15 units of a currency (e.g. EUR 15) are needed to buy one currency unit of earnings (e.g. EUR 1).[4] This standardisation makes it possible to compare share prices with each other. If one stock has a P/E ratio of 20 and another stock has a ratio of 15, then one pays more for one unit of earnings (EUR 20 instead of EUR 15 for a profit of EUR 1). If the two securities are comparable—that is, they have similar growth, risk, and expected cash flows—the stock with the P/E ratio of 15 is relatively undervalued compared to the stock with the higher price multiple of 20.

Relative valuation analysis can be used to determine whether the equity security is correctly valued in relation to stocks of one or a group of similar companies. The assumption of this analysis is that the stocks of the peer companies in the market are correctly valued on average.

One of the advantages of the P/E ratio is that the company's profitability as the main driver of the share price is included in the multiple in the form of earnings per share. Moreover, the P/E ratio is an accepted valuation indicator among market participants when buying and selling stocks and is accordingly widely used. Empirical studies conclude that the relative level of the P/E ratio has an influence on the long-term average stock return.[5] The disadvantages of using the P/E ratio are due primarily to the characteristics of earnings. For example, earnings per share can be zero, negative, or very small compared to the share price, with the result that the P/E ratio is not meaningful or makes no economic sense. The amount of earnings reported is affected by the interpretation and application of the accounting standards used. Earnings per share can also be very volatile, which is regularly the case, especially with high-growth and high-risk companies. Furthermore, different levels of gearing are not explicitly taken into account in the P/E ratio, since in the price multiple the numerator consists of the share price and the denominator of earnings after taxes and interest on debt per share.

[4] Another interpretation of a P/E ratio of 15 is that it takes 15 years to pay back the price paid for the stock with the earnings. Accordingly, a lower P/E ratio is preferable to a higher P/E ratio because the share price paid for one unit of earnings is lower and the payback period is shorter.

[5] Equity securities with a value bias are characterised, among other things, by a below-average P/E ratio and have a consistently higher risk-adjusted return over longer periods of time than stocks with a high P/E ratio (stocks with a growth bias). See Fama and French 1998: 'Value versus growth: the international evidence', p. 1975 ff.

Example: Comparables Method

Delta stock trades at a price per share of EUR 50 and has had earnings per share of EUR 2.50 for the last 12 months. The comparable company Gamma, which has similar growth, risk, and expected cash flows, has a trailing P/E ratio of 23.

1. Is the Delta stock correctly valued relative to the Gamma stock?
2. What is the share price of Delta if it is assumed that the Gamma stock is correctly valued or that both equity securities are trading at the same trailing P/E ratio of 23?

Solution to 1

The trailing P/E ratio of the Delta stock is 20 and can be calculated as follows:

$$\text{Trailing P/E of Delta} = \frac{\text{EUR 50}}{\text{EUR 2.50}} = 20.$$

Compared to the Gamma stock's trailing P/E ratio of 23, the Delta stock's lower trailing P/E ratio of 20 leads to the conclusion that the Delta stock is undervalued compared to the stock of the benchmark company Gamma. Delta's share price should be higher so that both securities trade at the same P/E ratio of 23.

Solution to 2

Assuming that the trailing P/E ratio of Delta is equal to that of Gamma and that the Gamma stock is correctly valued, an intrinsic value of EUR 57.50 can be calculated for the Delta shares:

$$P_{\text{Delta}} = 23 \times \text{EUR } 2.50 = \text{EUR } 57.50.$$

If the calculated share price of EUR 57.50 is compared with the traded share price of EUR 50, the Delta stock is again undervalued. The example demonstrates that a comparison of the multiples, just like the calculation of the intrinsic value, leads to the same conclusion, namely that the Delta stock is undervalued.

A multiple can also be determined using forecast fundamentals of the company, such as the expected growth rate, risk, and projected cash flows, which significantly influence the firm value. They can be converted into a multiple by means of a cash flow model. Thus, one can determine the intrinsic equity value by applying a cash flow model and then convert it into a price multiple by dividing the intrinsic equity value by the expected earnings. If, for example, the intrinsic equity value is EUR 45 million and the expected earnings are EUR 3 million, the result is a forward P/E ratio of 15. Comparing the price multiple calculated in this way with the P/E ratio of

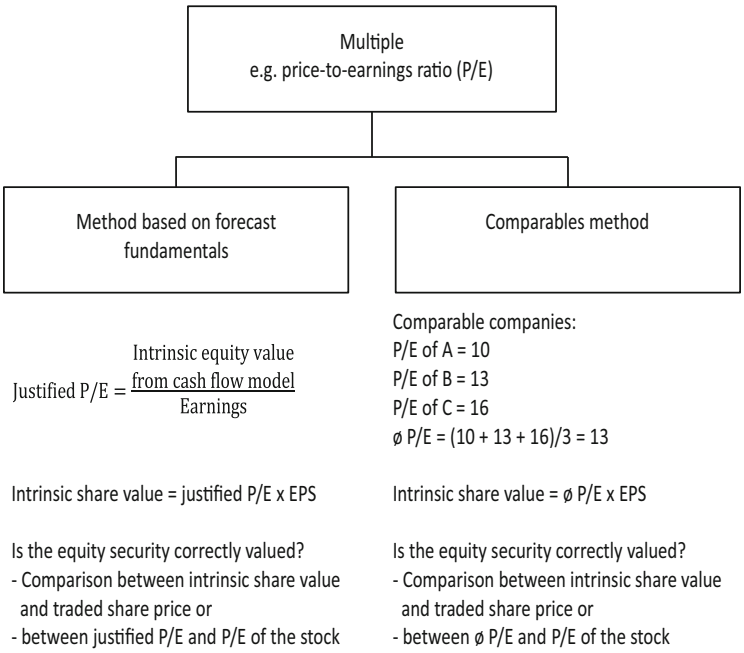

Fig. 10.2 Calculation of the price-to-earnings ratio and intrinsic share value with the method based on forecast fundamentals and the comparables method (Source: Own illustration)

the equity security (traded share price divided by the expected earnings per share), it is possible to determine whether the security is correctly valued in the market. If the forward P/E ratio calculated with the cash flow model is higher (lower) than the forward P/E ratio observable in the market, the stock is undervalued (overvalued). In addition, the intrinsic share value can also be estimated by multiplying the forward P/E ratio of 15 by the expected earnings per share of the company. A comparison with the traded share price makes it possible to assess whether the security is correctly valued. Figure 10.2 contrasts the two methods for determining multiples, that is, the method based on forecast fundamentals and comparables method, which are described in more detail below.

10.2.2 P/E Ratio Based on Forecast Fundamentals

By calculating the P/E ratio using a cash flow model, it is possible to determine the share price that must be paid for one unit of earnings. This incorporates the forecast fundamentals of the company, such as profitability, growth, and risk.[6] The one-stage

[6] See Barker 2001: *Determining Value: Valuation Models and Financial Statements*, p. 54 ff.

dividend discount model (Gordon–Growth model) is applied below to calculate the justified price multiple. A one-stage model is appropriate for mature companies in a saturated market. For growth stocks, multiples should be determined using a multi-stage dividend discount model.[7]

In a one-stage dividend discount model, the intrinsic share value can be calculated as follows $[E(r) > g]$:[8]

$$P_0 = \frac{D_0(1+g)}{E(r)-g} = \frac{D_1}{E(r)-g}, \tag{10.2}$$

where

D_1 = expected dividend per share in period 1,
$E(r)$ = expected return of shareholders, and
g = perpetual constant growth rate of dividends.

Dividing both sides of the equals sign by the expected earnings per share for the next year (E_1) yields the justified forward (or leading) P/E ratio $[E(r) > g]$:

$$\frac{P_0}{E_1} = \frac{D_1/E_1}{E(r)-g} = \frac{1-b}{E(r)-g}, \tag{10.3}$$

where

b = retention rate of earnings or $1 - b$ = payout ratio of earnings.

The valuation model can also be used to determine the justified trailing P/E ratio by dividing Eq. (10.2) on both sides of the equals sign by the last 12 months' earnings per share $[E(r) > g]$:

$$\frac{P_0}{E_0} = \frac{D_0(1+g)/E_0}{E(r)-g} = \frac{(1-b)(1+g)}{E(r)-g}. \tag{10.4}$$

The justified forward and trailing P/E ratios have a positive relationship with the earnings payout ratio and growth rate and a negative relationship with the expected return, which reflects the risk of the company. The influence of one of these three fundamental factors on the level of the multiple is examined by changing one factor while all other factors remain unchanged. A higher intrinsic share value and thus a higher P/E ratio, for example, is obtained either with a higher earnings payout ratio, a higher growth rate or a lower expected return.[9]

[7] For the application of the two-stage dividend discount model for growth stocks, see, for example, Mondello 2017: *Aktienbewertung: Theorie und Anwendungsbeispiele*, p. 453 ff.

[8] See Sect. 8.4.

[9] In this analysis, it should be noted that a higher earnings payout ratio results in a lower earnings retention rate, and thus a lower growth rate ($g = b$ ROE). Therefore, this statement is only valid if

For a given growth rate, the higher (lower) the earnings payout ratio, the higher (lower) the P/E ratio. This relationship can be explained by the fact that companies with low investment needs have a higher earnings payout ratio and hence a higher P/E ratio than firms with high capital expenditures. Furthermore, the lower the difference between the expected return and the growth rate, the higher the P/E ratio. If this difference is negative, the result is a negative P/E ratio, which does not make economic sense.

Example: Calculation of the Justified Trailing P/E Ratio and of the Intrinsic Share Value Using the Deutsche Telekom Stock

The following information is available for the listed Deutsche Telekom stock at the beginning of 2022 (Source: Refinitiv Eikon):

Dividend per share (for 2021)	EUR 0.64
Earnings per share (for 2021)	EUR 0.87
Share price	EUR 16.55
Historical beta	0.70

Based on the 2021 fundamentals, it is assumed the company will grow in perpetuity. The return on equity is 10.6%. The yield to maturity on 30-year bonds of the Federal Republic of Germany is 1.1%. The expected market risk premium for Germany is 7%. What is the justified trailing P/E ratio and the intrinsic share value of Deutsche Telekom?

Solution

In order to estimate the justified trailing P/E ratio, the adjusted beta of the stock must first be calculated, followed by the expected CAPM return:

$$\beta_{\text{Adjusted}} = 0.333 + 0.667 \times 0.70 = 0.80,$$

$$E(r) = 1.1\% + 7\% \times 0.80 = 6.70\%.$$

The earnings payout ratio is 0.7356 (= EUR 0.64/EUR 0.87). The fundamental growth rate is 2.80% and can be determined as follows:

$$g = (1 - 0.7356) \times 10.6\% = 2.80\%.$$

The justified trailing P/E ratio of 19.39 can be calculated as follows:

(continued)

one fundamental factor is changed and the other fundamental factors remain the same. For the fundamental earnings growth rate, see Sect. 8.3.

$$\frac{P_0}{E_0} = \frac{0.7356 \times 1.028}{0.067 - 0.028} = 19.39.$$

The intrinsic share value of EUR 16.87 is arrived at by multiplying the justified trailing P/E ratio of 19.39 by the earnings per share of EUR 0.87:

$$P_0 = 19.39 \times \text{EUR } 0.87 = \text{EUR } 16.87.$$

The intrinsic share value of EUR 16.87 is higher than the traded share price of EUR 16.55. The Deutsche Telekom stock, therefore, appears to be undervalued by approximately 2%. The same conclusion is reached when the trailing P/E ratio of Deutsche Telekom stock of 19.02 (= EUR 16.55/ EUR 0.87) is compared with the justified trailing P/E ratio of 19.39.

10.2.3 P/E Ratio Based on Comparable Companies

The current P/E ratio of the equity security can be compared with the P/E ratio of stocks from benchmark companies to determine whether the security is correctly valued. For this purpose, the benchmark (or peer) firms must be identified.[10] Common valuation practice defines a benchmark company as a company that operates in the same industry or sector. This is not the most appropriate approach for identifying peer companies as it does not take into account differences in fundamentals. A benchmark company must have expected cash flows, growth prospects, and risk that are similar to those of the firm being valued. A stock has the same price as the stock of an identical peer company if the forecast fundamentals such as cash flows, growth rate, and expected return are the same. This definition does not make reference to the affiliation of equity security to an industry or sector. Accordingly, a machinery industry stock can be compared to equity securities in other industries, such as health care, as long as the expected cash flows, growth prospect, and risk are the same. Nevertheless, analysts use comparable companies that operate in the same industry or sector as a benchmark. The implicit assumption here is that stocks in the same industry sector have the same risk, growth, and cash flow patterns and are therefore comparable to each other.[11] If there are a large number of peer companies, other criteria such as similar company size (market capitalisation) or similar revenues are usually used in order to reduce the number of comparable firms.

If a company is compared with the market leader in the industry, care should be taken that this security can be traded at a valuation premium due to its outstanding

[10] See Pinto et al. 2010: *Equity Asset Valuation*, p. 279.

[11] See Frykman and Tolleryd 2003: *Corporate Valuation: An Easy Guide to Measuring Value*, p. 51.

market position. In addition, the number of comparable companies in a specific country such as Germany or Switzerland may be relatively small or, in extreme cases, no corresponding company may be listed on the home stock exchange. In such a case, foreign companies are also included in the peer group. As a result of different accounting standards, such as IFRS, US-GAAP, and other national accounting standards, the valuation-related figures such as earnings have to be adjusted so that the multiples are comparable.

Standardised classification systems such as the Global Industry Classification System (GICS) from Standard & Poor's and MSCI Barra[12] or the Industrial Classification Benchmark (ICB) from the Dow Jones and FTSE[13] are used to determine the peer group. This has the advantage that there is no need for a subjective evaluation of the peer group to which stocks belong.

The price multiple is calculated both for the company being valued and for each comparable company. An average value or benchmark multiple is then determined. To evaluate an individual equity security, the P/E ratio of the stock is compared with the benchmark P/E ratio. In addition, it is assessed whether the forecast fundamentals such as growth, risk, and cash flows make it possible to explain the difference between the two price multiples. For example, if a stock has a P/E ratio of 12 and the P/E ratio of the peer companies is 18, the stock may still be correctly valued if the difference can be explained by the forecast fundamentals such as lower growth and/or higher risk than the benchmark companies. In the event that the differences between the two multiples cannot be explained by the fundamentals, the stock appears undervalued relative to the benchmark.[14] The following example demonstrates how the stock of Mercedes-Benz Group is evaluated using the comparables method with the P/E ratio.

Example: Relative Valuation Analysis of the Mercedes-Benz Group Stock Based on the Comparables Method Using the Price-to-Earnings Ratio

For the 'automobile manufacturers' (GICS) sub-sector, the following global peer companies are given in order of market capitalisation (excluding Tesla Inc. due to negative trailing P/E ratio) with the corresponding trailing P/E ratios, expected annual earnings growth rates for the next 4 years, and betas as at the end of October 2017 (Source: Refinitiv Eikon):

Company	Trailing P/E ratio	Earnings growth rate	Beta
Toyota Motor Corp	11.2	6.3%	1.16
Volkswagen	8.7	33.3%	1.57
Mercedes-Benz Group	7.4	3.8%	1.54
General Motors Co	7.2	−2.3%	1.59
BMW	7.4	2.3%	1.43

(continued)

[12] See http://www.msci.com/products/indices/sector/gics.

[13] See https://www.ftserussell.com/data/industry-classification-benchmark-icb.

[14] See Martin 2013: 'Traditional Equity Valuation Methods', p. 164 ff.

Company	Trailing P/E ratio	Earnings growth rate	Beta
SAIC Motor Corp	11.1	7.9%	0.70
Honda Motor Co	9.5	4.5%	1.29
Nissan Motor Co	6.4	1.3%	1.08
Audi	12.5	−29.3%	0.40
Hyundai	9.7	8.4%	1.03
Renault	5.3	7.7%	1.81
Fiat Chrysler Automobiles	7.9	23.1%	1.36
Suzuki Motor Corp	14.0	8.9%	1.08
Peugeot SA	11.1	2.7%	1.79
Arithmetic mean	9.2	5.6%	1.27
Median	9.1	5.4%	1.33

The following questions must be answered:

1. Is the arithmetic mean or the median the better method to calculate, for example, the benchmark value for the trailing P/E ratio?
2. Is the Mercedes-Benz Group stock correctly valued compared to the benchmark? (The median should be taken for the analysis.)

Solution to 1

The median represents the middle of all P/E values, with half of the values below and half above the median. Unlike the arithmetic mean, the median is not affected by outliers in the data, and therefore the median is more suitable for determining the benchmark value. However, there are no outliers in the present example. Therefore, the median and the arithmetic mean are close to each other and both can be used for the relative value analysis.

Solution to 2

Without taking differences in fundamentals into account, the Mercedes-Benz Group stock is undervalued, as the P/E ratio of 7.4 is lower than the benchmark P/E ratio of 9.1. If the differences in fundamentals are included in the analysis, the stock no longer appears undervalued, since the earnings growth rate of 3.8% is lower than the median of 5.4% and the beta of the automobile stock of 1.54 is higher than the median of 1.33. A lower earnings growth rate and higher risk imply a lower share price, and therefore the conclusion that the security is undervalued cannot be justified.

To assess the value of the stock, an average of the stock's past P/E ratios can also be used as a benchmark, as long as the company's fundamentals have not changed significantly over time. The relative valuation method applied in this way assumes

that the P/E ratio of the stock converges to its own historical average.[15] However, a company may have undergone such a transformation process that a comparison between the current and historical multiples does not make sense. For example, two decades ago, European telecommunications companies were local monopolies with a single business segment. Today, they offer a variety of products and services both domestically and abroad. Finally, the P/E ratio of the stock can be related to the P/E ratio of an equity index (e.g. DAX 40 for large-cap German stocks or SMI for large-cap Swiss stocks). The relative P/E ratio calculated in this way enables an assessment of whether the equity security is correctly valued compared to the market as a whole.[16]

10.3 Price/Earnings-to-Growth Ratio

A multiple can be adjusted by its most important fundamental factor. This factor can be determined by running a regression between the multiple as the dependent variable and all fundamental factors as the independent variables. The fundamental factor that statistically best explains the multiple (i.e. has the highest t-statistic) is the dominant variable. Studies conclude that the expected earnings growth rate has the highest impact on the P/E ratio.[17]

The price/earnings-to-growth ratio (PEG) is the P/E ratio divided by the expected earnings growth rate multiplied by 100:

$$\text{PEG} = \frac{\text{P/E}}{g \times 100}, \tag{10.5}$$

where

P/E = price-to-earnings ratio, and
g = expected earnings growth rate.

For example, if the P/E ratio is 15 and the expected earnings growth rate is 5%, the result is a PEG ratio of 3 [= 15/(0.05 × 100)]. The PEG ratio reflects the P/E ratio of the stock for one percentage point of expected earnings. The price multiple calculated in this way can be compared with multiples of companies in the same industry. Equity securities with a low PEG ratio are more attractive than securities with a high PEG ratio, all else being equal. Such stocks have a low P/E ratio and a high expected earnings growth rate. Accordingly, the PEG ratio can be used to combine an investment strategy that is based on a value bias (undervalued stock due to a low P/E ratio) with an investment strategy that is based on a growth bias. As an

[15] See Frykman and Tolleryd 2003: *Corporate Valuation: An Easy Guide to Measuring Value*, p. 48.
[16] See Mondello 2017: *Aktienbewertung: Theorie und Anwendungsbeispiele*, p. 474 ff.
[17] See, for example, Fairfield 1994: 'P/E, P/B and the present value of future dividends', p. 30.

indicator of an attractive equity security, a PEG ratio of 1 or less than 1 is often used in valuation practice because the P/E ratio is lower than the expected earnings growth rate multiplied by 100.[18] This equity strategy is known as growth at a reasonable price (GARP).

The PEG ratio should be calculated with the trailing P/E ratio (or with the current P/E ratio), which takes into account the earnings of the last 12 months, and not with the forward P/E ratio; otherwise, the earnings for the next period are counted twice, which leads to a PEG ratio that is too low.

The PEG ratio should be calculated consistently and in the same way for all peer companies and the company to be valued. For example, the same time period for the expected earnings growth rate (e.g. 3 or 5 years) should be applied for all stocks. The growth rates should also be obtained from the same data source. For example, analysts' consensus forecasts of future earnings can be found in databases such as Bloomberg. Alternatively, growth rates can be estimated using historical data or company's fundamentals.[19]

Example: Relative Valuation Analysis of the Mercedes-Benz Group Stock Based on the Comparables Method Using the Price/Earnings-to-Growth Ratio

For the 'automobile manufacturers' sub-sector (GICS), the following global peer companies are given in order of market capitalisation (excluding Tesla Inc. due to negative trailing P/E ratio) with the corresponding trailing P/E ratios, expected annual earnings growth rates for the next 4 years, PEG ratios, and betas as at the end of October 2017 (Source: Refinitiv Eikon):

Company	Trailing P/E ratio	Expected earnings growth rate	PEG ratio	Beta
Toyota Motor Corp	11.2	6.3%	1.8	1.16
Volkswagen	8.7	33.3%	0.3	1.57
Mercedes-Benz Group	7.4	3.8%	1.9	1.54
General Motors Co	7.2	−2.3%	n/a	1.59
BMW	7.4	2.3%	3.2	1.43
SAIC Motor Corp	11.1	7.9%	1.4	0.70
Honda Motor Co	9.5	4.5%	2.1	1.29
Nissan Motor Co	6.4	1.3%	4.9	1.08
Audi	12.5	−29.3%	n/a	0.40
Hyundai	9.7	8.4%	1.2	1.03
Renault	5.3	7.7%	0.7	1.81
Fiat Chrysler Automobiles	7.9	23.1%	0.3	1.36

(continued)

[18] See, for example, Glenn 2011: *How to Value Shares and Outperform the Market*, p. 35.

[19] See Sect. 8.3.

Company	Trailing P/E ratio	Expected earnings growth rate	PEG ratio	Beta
Suzuki Motor Corp	14.0	8.9%	1.6	1.08
Peugeot SA	11.1	2.7%	4.1	1.79
Arithmetic mean	9.2	5.6%	2.0	1.27
Median	9.1	5.4%	1.7	1.33

Is the Mercedes-Benz Group stock correctly valued based on the comparables method using the PEG ratio? (The median should be taken for the analysis.)

Solution

Compared to the benchmark P/E ratio of 9.1, the Mercedes-Benz Group stock is undervalued, with a P/E ratio of 7.4. This conclusion assumes that all stocks have the same expected earnings growth rate, cash flow pattern, and risk. The PEG ratio can be used to incorporate the expected earnings growth rate into the analysis. The P/E ratio of the Mercedes-Benz Group stock adjusted for the expected earnings growth rate can be calculated with the benchmark PEG ratio of 1.7 and the expected earnings growth rate of the automobile stock of 3.8% as follows:

Adjusted P/E ratio of the Mercedes-Benz Group stock $= 1.7 \times 3.8 = 6.5$.

If the adjusted P/E ratio of 6.5 is compared with the traded P/E ratio of the Mercedes-Benz Group stock of 7.4, the security no longer appears undervalued but overvalued. However, this conclusion applies only if all equity securities have the same risk. Moreover, this analysis assumes a linear relationship between the P/E ratio and the expected earnings growth rate.

A cash flow model can be used to identify the company's fundamentals that have an impact on the PEG ratio. The intrinsic share value can be estimated with a one-stage dividend discount model as follows [$E(r) > g$]:[20]

$$P_0 = \frac{D_0(1+g)}{E(r)-g}.$$

The dividend per share (D_0) is equal to the earnings per share (E_0) multiplied by the earnings payout ratio or by 1 minus the earnings retention rate ($1 - b$), which leads to the following price equation [$E(r) > g$]:

$$P_0 = \frac{E_0(1-b)(1+g)}{E(r)-g}.$$

[20] See Sect. 8.4.

If both sides of the equals sign are divided by the earnings per share (E_0) and then by the expected earnings growth rate (g) multiplied by 100, the following formula for the justified PEG ratio is obtained:

$$\text{PEG} = \frac{(1-b)\times(1+g)}{g\times 100\times[E(r)-g]}. \tag{10.6}$$

The net impact on the price multiple depends on the corresponding level of the growth rate. However, the expected growth rate cannot exceed the expected return, as a negative P/E ratio makes no economic sense.[21] Moreover, there is a positive relationship of the multiple with the earnings payout ratio, while the relationship with the expected return or risk (beta) is negative (if all other factors remain unchanged).

Example: Calculation of the Justified Price/Earnings-to-Growth Ratio Using the Deutsche Telekom AG Stock

The following information is available for the listed Deutsche Telekom stock at the beginning of 2022 (Source: Refinitiv Eikon):

Dividend per share (for 2021)	EUR 0.64
Earnings per share (for 2021)	EUR 0.87
Share price	EUR 16.55
Historical beta	0.70

The company is assumed to grow in perpetuity based on its 2021 fundamentals. The return on equity is 10.6%. The yield to maturity of 30-year bonds of the Federal Republic of Germany is 1.1%. The expected market risk premium for Germany is 7%. What is the justified PEG ratio of the Deutsche Telekom stock and is the stock correctly valued?

Solution

The adjusted beta of 0.80 and the expected CAPM return of 6.70% can be calculated as follows:

$$\beta_{\text{Adjusted}} = 0.333 + 0.667\times 0.70 = 0.80,$$

$$E(r) = 1.1\% + 7\%\times 0.80 = 6.70\%.$$

The earnings payout ratio is 0.7356 (= EUR 0.64/EUR 0.87), while the fundamental earnings growth rate is 2.8% [= (1 − 0.7356) × 10.6%]. The justified PEG ratio of 6.92 can be determined with the following equation:

(continued)

[21] See Sect. 10.2.1.

$$\text{PEG} = \frac{0.7356 \times 1.028}{0.028 \times 100 \times (0.067 - 0.028)} = 6.92.$$

If the stock's trailing P/E ratio of 19.02 (= EUR 16.55/EUR 0.87) is divided by the long-term expected earnings growth rate of 2.8% multiplied by 100, the result is a PEG ratio of 6.79. Accordingly, the Deutsche Telekom stock appears to be undervalued based on the PEG ratio.

10.4 Price-to-Book Ratio

10.4.1 Definition

The price-to-book (P/B) ratio is an important price multiple and is widely used in valuation practice.[22] To calculate the P/B ratio, the traded share price is divided by the book value per share:

$$\frac{P}{B} = \frac{\text{Share price}}{\text{Book value per share}}, \tag{10.7}$$

where

$$\text{Book value per share} = \frac{\text{Book value of equity}}{\text{Number of shares outstanding}}.$$

The P/B ratio is a price multiple because the share price is divided by the book value per share, which is an equity measure. The term 'book value' in accounting refers to the value of assets and liabilities in the balance sheet. The book value of equity can be obtained by deducting the book value of liabilities from the book value of assets. In order to calculate the price multiple, any non-controlling interests (minority interests) must be removed from the book value of the equity because the equity securities are held by the shareholders of the parent company. The book value of the equity can then be divided by the number of outstanding shares. For example, at the end of December 2021, Mercedes-Benz Group AG had an equity book value (excluding non-controlling interests) of EUR 71,951 million and outstanding shares of 1069.837 million, resulting in a book value of EUR 67.25 per share:[23]

[22] A survey by Bank of America Merrill Lynch in 2012 indicates that 53% of the institutional investors surveyed use the P/B ratio in equity analysis. See Bank of America Merrill Lynch 2012: Annual Institutional Factor Survey, p. 18.

[23] See Mercedes-Benz Group 2022: Annual Report 2021, p. 182 ff.

$$\text{Book value per share} = \frac{\text{EUR 71,951 million}}{\text{1069.837 million shares}} = \text{EUR 67.25}.$$

The Mercedes-Benz Group stock trades at a price per share of EUR 67.59 at the end of December 2021, leading to a P/B ratio of 1.01:

$$\frac{P}{B} = \frac{\text{EUR 67.59}}{\text{EUR 67.25}} = 1.01.$$

If the company has different classes of shares—for example, ordinary shares and preference shares—the price of each class of shares may be different and it is not clear how the book value of equity should be divided between the different classes of shares. Nevertheless, a P/B ratio can be determined for all share classes by dividing the total market value of equity—that is, the number of shares in the different categories multiplied by the corresponding share price—by the book value of equity:

$$\frac{P}{B} = \frac{\text{Market value of equity}}{\text{Book value of equity}}. \tag{10.8}$$

For example, if the profitability of the invested assets increases, the market value of the assets or equity increases (the corresponding book values, however, remain the same), which results in a higher P/B ratio. Thus, there is a positive relationship between earnings or profitability and the P/B ratio. The relationship between the P/B ratio and profitability can also be illustrated with the following equation by transforming the price multiple as follows:

$$\frac{P_0}{B_0} = \left(\frac{P_0}{E_1}\right)\left(\frac{E_1}{B_0}\right) = (P_0/E_1)\text{ROE}, \tag{10.9}$$

where

B_0 = book value per share at the beginning of the period,
E_1 = earnings per share in period 1, and
ROE = return on equity.

The equation indicates that the P/B ratio is positively related to the leading P/E ratio and the return on equity. Furthermore, the equation illustrates that the only difference in fundamental factors between the P/B ratio and the P/E ratio is the return on equity. In principle, companies with a higher return on equity can be expected to trade at a higher P/B ratio. If companies generate a return on equity above the cost of equity, they are likely to be valued at a P/B ratio well above 1. A non-profitable company with a return on equity below the cost of equity has a P/B ratio of less than 1. In particular, companies in economic difficulties or in the maturity phase of their life cycle are often no longer able to earn the cost of equity capital. In such cases, the share price falls below the book value per share, if no economic recovery is expected.

The book value of equity is positive under the going concern assumption, and therefore the P/B ratio, unlike the P/E ratio, can be used even if earnings per share are zero or negative. Furthermore, the book value per share is a more stable measure than the earnings per share. For example, if earnings are very volatile, the P/B ratio is more meaningful than the P/E ratio. For companies in the financial industry, such as banks and insurance companies, the book value and the market value of assets are approximately equal because the assets consist mainly of liquid assets. Accordingly, if the P/B ratio deviates significantly from 1, this is an indication of an incorrect valuation of the stock. Finally, empirical studies have concluded that the P/B ratio can be used to explain long-term average returns of equity securities.[24]

One argument against the use of the P/B ratio is that book values, as well as earnings, are affected by the estimates made when applying the accounting and valuation principles. If peer companies and the company to be valued use different accounting standards (e.g. IFRS and US GAAP), the P/B ratios of the stocks are no longer comparable. For example, depending on the accounting standards used, companies may capitalise development costs on the balance sheet or recognise them as an expense on the income statement. Capitalising these costs on the balance sheet results in a higher book value of equity and thus a lower P/B ratio. Accordingly, adjustments must be made to ensure the comparability of the P/B ratio. In addition, intangibles such as human capital, corporate reputation, comparative advantages, and customer relationships are not included in the book value of equity and are therefore not considered in the relative valuation analysis. Hence, the P/B ratio is not suitable for companies that depend primarily on human capital. These include, for example, software companies, investment banks, and real estate developers.

The highest P/B ratios are observed in industries in which the most valuable assets are not recognised on the balance sheet. In the software or biotechnology industry, if development and research costs are expensed (i.e. not capitalised), the book value tends to be too low or the P/B ratio too high. Similarly, the book value of equity is too low for branded companies since a significant portion of their earnings is due to the internally generated brand name, which is not listed on the balance sheet. These companies have high returns on equity due to the rather low book value of equity and are traded on the market with a P/B ratio that is well above average. Applying the P/B ratio for equity valuation in such cases results in a mispricing.[25]

[24] See, for example, Fama and French 1992: 'The cross-section of expected stock returns', p. 427 ff.
[25] See Martin 2013: 'Traditional Equity Valuation Methods', p. 157.

10.4.2 P/B Ratio Based on Forecast Fundamentals

The P/B ratio, like the P/E ratio, can be calculated using forecast fundamentals of the company. Following the one-stage dividend discount model (Gordon−Growth model), the intrinsic share value can be determined as follows [$E(r) > g$]:[26]

$$P_0 = \frac{D_1}{E(r) - g}. \tag{10.10}$$

Replacing the expected dividend per share (D_1) by the product of the expected earnings per share (E_1) and the payout ratio ($1 - b$) yields the following price equation for the one-stage dividend discount model [$E(r) > g$]:

$$P_0 = \frac{E_1(1-b)}{E(r) - g}, \tag{10.11}$$

where

b = earnings retention rate, and
$(1 - b)$ = earnings payout ratio.

The return on equity (ROE) is equal to the expected earnings per share (E_1) divided by the book value per share at the valuation date (B_0). If this equation, ROE $= E_1/B_0$, is solved for the expected earnings per share, the result is $E_1 =$ ROE B_0. Replacing the earnings per share in Eq. (10.11) by the product of the return on equity and the book value per share and dividing both sides of the equals sign by the book value per share leads to the justified trailing P/B ratio [$E(r) > g$]:

$$\frac{P_0}{B_0} = \frac{\text{ROE}\,(1-b)}{E(r) - g}. \tag{10.12}$$

Accordingly, the P/B ratio is positively related to the return on equity, the earnings payout ratio, and the expected earnings growth rate. Its relationship to the expected return or risk, on the other hand, is negative. If the payout ratio of $1 - b$ is replaced by $1 - g$/ROE in Eq. (10.12),[27] the justified trailing P/B ratio can be calculated as follows [$E(r) > g$ and ROE $> g$]:[28]

$$\frac{P_0}{B_0} = \frac{\text{ROE} - g}{E(r) - g}. \tag{10.13}$$

[26] See Sect. 8.4.

[27] The fundamental earnings growth rate can be determined as follows: $g = (1 - \delta)$ ROE. If this equation is solved for the earnings payout ratio (δ), $\delta = 1 - g$/ROE is obtained.

[28] $\frac{P_0}{B_0} = \frac{\text{ROE}\,(1-b)}{E(r)-g} = \frac{\text{ROE}\left(1-\frac{g}{\text{ROE}}\right)}{E(r)-g} = \frac{\text{ROE}-g}{E(r)-g}$

The equation indicates that the P/B ratio of a company with a perpetual constant earnings growth rate—in other words, a company in the maturity phase of its life cycle—increases when the return on equity rises or the expected return falls. If the return on equity is greater (less) than the expected return, the share price exceeds (falls below) the book value per share.[29] This relationship can be demonstrated more clearly if the earnings growth rate is set equal to zero ($g = 0$): $P_0/B_0 = \text{ROE}/E(r)$.

Example: Calculation of the Justified Price-to-Book Ratio Using the Deutsche Telekom AG Stock

The following information is available for the listed Deutsche Telekom stock at the beginning of 2022 (Source: Refinitiv Eikon):

Dividend per share (for 2021)	EUR 0.64
Earnings per share (for 2021)	EUR 0.87
Share price	EUR 16.55
Book value per share	EUR 8.56
Historical beta	0.70

The company is assumed to grow in perpetuity based on its 2021 fundamentals. The return on equity is 10.6%, and the yield to maturity of 30-year bonds of the Federal Republic of Germany is 1.1%. The expected market risk premium for Germany is 7%. What is the justified trailing P/B ratio of the Deutsche Telekom stock and is the equity security correctly valued?

Solution

The earnings payout ratio is 0.7356 and can be calculated as follows:

$$\delta = \frac{\text{EUR } 0.64}{\text{EUR } 0.87} = 0.7356.$$

The fundamental earnings growth rate is 2.8%:

$$g = (1 - 0.7356) \times 10.6\% = 2.8\%.$$

The adjusted beta of the stock of 0.80, and the expected CAPM return of 6.70% can be determined as follows:

$$\beta_{\text{Adjusted}} = 0.333 + 0.667 \times 0.70 = 0.80,$$

$$E(r) = 1.1\% + 7\% \times 0.80 = 6.70\%.$$

The justified trailing P/B ratio of the Deutsche Telekom stock is to 2 and can be calculated with one of the following two equations:

(continued)

[29] See Reilly and Brown 2003: *Investment Analysis and Portfolio Management*, p. 392.

$$\frac{P_0}{B_0} = \frac{\text{ROE}\,(1-b)}{E(r)-g} = \frac{0.106 \times 0.7356}{0.067-0.028} = 2.0$$

or

$$\frac{P_0}{B_0} = \frac{\text{ROE}-g}{E(r)-g} = \frac{0.106-0.028}{0.067-0.028} = 2.0.$$

Due to the calculated P/B ratio of 2, Deutsche Telekom shares must trade at a price that is significantly higher than the book value per share because the return on equity of 10.6% exceeds the expected return of 6.7%. For example, at the beginning of 2022, the Deutsche Telekom share price is EUR 16.55, while the book value per share is EUR 8.56.

The justified P/B ratio of 2 is higher than the traded P/B ratio of Deutsche Telekom shares of 1.9 (= EUR 16.55/EUR 8.56). Consequently, equity security appears undervalued.

If the return on equity and the expected return of the shareholders are the same [ROE = $E(r)$], the company achieves a return exactly equal to the expected return, and the P/B ratio of the stock is 1. If the return on equity exceeds the expected return [ROE > $E(r)$], the P/B ratio is above 1. In the opposite case [ROE < $E(r)$], the result is a P/B ratio of less than 1. Figure 10.3 presents the P/B ratio for the Deutsche Telekom stock for different levels of the difference between the return on equity and the expected return. The figure illustrates that a decrease in the difference between the return on equity and the expected return results in a lower P/B ratio. If the difference is zero, the P/B ratio is 1.

10.4.3 P/B Ratio Based on Comparable Companies

Using the comparables method in relative valuation analysis, the average P/B ratio is first calculated from a benchmark group. Then the P/B ratio of the stock to be valued is compared with the benchmark P/B ratio to determine whether the security is correctly priced. Any differences in fundamentals are assessed on subjective judgement. The return on equity is the most important fundamental factor because the share price is significantly affected by the profitability of the company. Other fundamental factors are the expected earnings growth rate, the earnings payout ratio, and the expected return or risk. The following example demonstrates the application of the P/B ratio based on the comparables method, using the Mercedes-Benz Group stock.

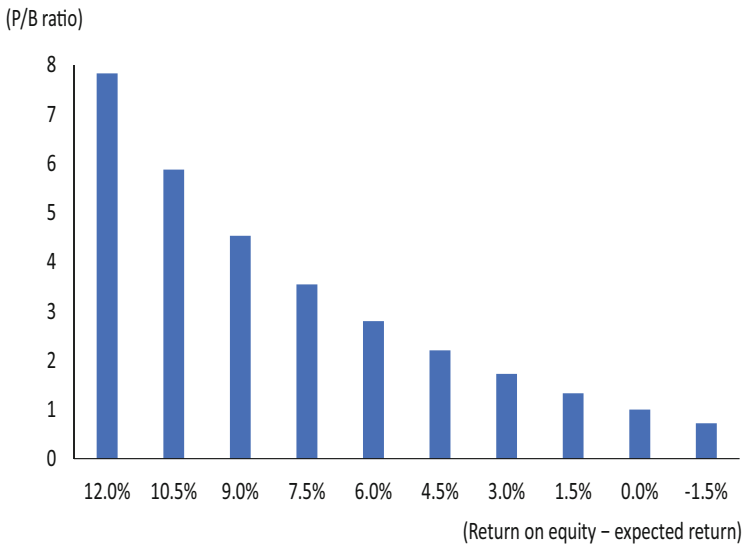

Fig. 10.3 Price-to-book ratio and difference between return on equity and expected return (Source: Own illustration)

Example: Relative Valuation Analysis of the Mercedes-Benz Group Stock Based on the Comparables Method Using the Price-to-Book Ratio

For the 'automobile manufacturers' sub-sector (GICS), the following global peer companies are given in order of market capitalisation with the corresponding P/B ratios, expected annual earnings growth rates for the next 4 years, returns on equity, and betas as at the end of October 2017 (Source: Refinitiv Eikon):

Company	P/B ratio	Expected earnings growth rate	Return on equity	Beta
Toyota Motor Corp	1.1	6.3%	11.1%	1.16
Volkswagen	0.7	33.3%	8.5%	1.57
Mercedes-Benz Group	1.2	3.8%	16.4%	1.54
General Motors Co	1.5	−2.3%	21.8%	1.59
BMW	1.1	2.3%	16.2%	1.43
Tesla Inc.	11.3	114.4%	−20.1%	0.98
SAIC Motor Corp	1.8	7.9%	17.2%	0.70
Honda Motor Co	0.8	4.5%	9.3%	1.29
Nissan Motor Co	0.9	1.3%	14.3%	1.08
Audi	1.1	−29.3%	9.5%	0.40
Hyundai	0.6	8.4%	6.3%	1.03
Renault	0.8	7.7%	14.1%	1.81

(continued)

Company	P/B ratio	Expected earnings growth rate	Return on equity	Beta
Fiat Chrysler Automobiles	1.4	23.1%	15.4%	1.36
Suzuki Motor Corp	2.2	8.9%	17.8%	1.08
Peugeot SA	1.3	2.7%	13.0%	1.79
Arithmetic mean	1.9	12.9%	11.4%	1.25
Median	1.1	6.3%	14.1%	1.29

Is the Mercedes-Benz Group stock correctly valued based on the comparables method using the P/B ratio? (The median should be taken for this analysis.)

Solution

Compared to the median of 1.1, the Mercedes-Benz Group stock appears slightly overvalued, with a P/B ratio of 1.2. The return on equity of 16.4%, which is higher than the median of 14.1%, justifies the higher share valuation. However, the lower expected earnings growth rate of 3.8% versus the median of 6.3% and the higher beta of 1.54 versus the median of 1.29 suggest a lower valuation, with the result that the equity security appears overvalued. A clear judgement as to whether the Mercedes-Benz Group stock is overvalued cannot be made on the basis of the differences in fundamentals between the stock and the benchmark. If, on the other hand, only the most important fundamental factor, namely the return on equity, is taken into account, the Mercedes-Benz Group stock appears to be correctly valued.

Given the positive relationship between the P/B ratio and the return on equity, it is not surprising that stocks with a high (low) return on equity trade at a high (low) P/B ratio.[30] Accordingly, equity securities with a comparatively high (low) P/B ratio and low (high) return on equity should attract investors' attention. For this purpose, stocks can be classified in a two-dimensional matrix consisting of the two criteria of P/B ratio and the difference between the return on equity and the expected return. This makes it possible to identify stocks that are mispriced in the market because the level of the P/B ratio does not correspond to the fundamental factors or the difference between the return on equity and the expected return. Figure 10.4 presents the two-dimensional matrix that makes it possible to identify mispriced stocks. The four quadrants of the matrix can each be defined by the median of the P/B ratio and the difference between the return on equity and the expected return.[31]

[30] Empirical studies demonstrate the positive correlation between P/B ratio and return on equity. See, for example, Fairfield 1994: 'P/E, P/B and the present value of future dividends', p. 30.

[31] For an example with companies from the car manufacturers sub-sector, see Mondello 2017: *Aktienbewertung: Theorie und Anwendungsbeispiele*, p. 491 ff.

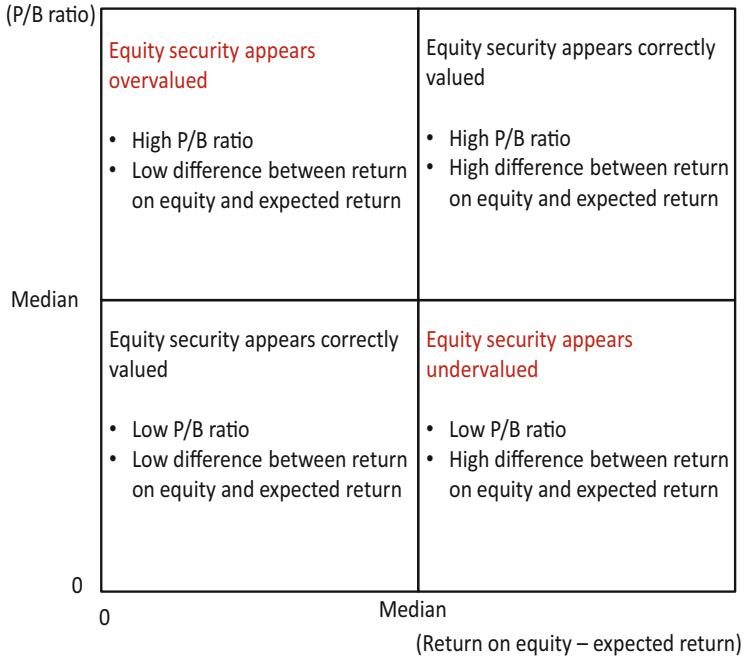

Fig. 10.4 Matrix for identifying mispriced equity securities using the price-to-book ratio and the difference between the return on equity and the expected return (Source: Based on Damodaran 2012: *Investment Valuation: Tools and Techniques for Determining the Value of Any Asset*, p. 524)

10.5 Enterprise Value EBITDA Ratio

Enterprise value-based multiples place the value of the operating company in relation to a quantity such as EBITDA and EBIT, which is attributable to all providers of capital. Price multiples, on the other hand, divide the share price by, for example, the earnings per share or the book value per share, all of which are quantities allocable to the equity providers.[32] The equity-based price multiples are influenced by the company's debt level. Thus, the P/E ratio may increase with a higher debt-to-equity ratio as a result of a higher return on equity and a consequent higher earnings growth rate. By contrast, the value multiples have the advantage that their level is not affected by the debt-to-equity ratio, with the result that companies with different gearing ratios can be compared with each other. Therefore, value multiples are suitable for assessing the value of a business model.[33]

[32] See Frykman and Tolleryd 2003: *Corporate Valuation: An Easy Guide to Measuring Value*, p. 47.

[33] See Koller et al. 2010: *Valuation: Measuring and Managing the Value of Companies*, p. 314.

The enterprise value EBITDA multiple (EV/EBITDA) measures the relationship between the total market value of the company, adjusted for cash and cash equivalents, and the operating result (EBIT) before deduction of depreciation and amortisation. The consistency between the numerator and the denominator is given in the multiple, as the total enterprise value consisting of the market value of debt and equity is divided by an earnings figure before interest on debt. For example, the value multiple can be calculated on a forward basis as follows:

$$\text{Forward EV/EBITDA ratio} = \frac{\text{EV}_0}{\text{EBITDA}_1}, \tag{10.14}$$

where

EV_0 = enterprise value = market value of equity + market value of debt + non-controlling interests − cash and cash equivalents.

Cash and cash equivalents (e.g. marketable securities with maturities of less than 1 year) are deducted from the enterprise value because the interest income from cash and cash equivalents is not included in EBITDA. If this adjustment is not made, the multiple will be too high. Alternatively, it can be argued that in the case of an acquisition only the net price paid for the company should be taken into account. After the acquisition, the acquirer gains access to cash and cash equivalents that can be used to repay part of the purchase price (for example, part of the debt capital that was needed to finance the acquisition can be repaid). Analogous to this consideration, market values are taken for the debt and equity in the numerator of the value multiple, since the acquirer pays the market value and not the book value when repaying the debt. For example, if bonds are outstanding, they must be purchased at market price upon repayment. If the debt capital is not traded on the market (such as a loan from a bank), the book values from the balance sheet can be used for the valuation. Only the interest-bearing debt capital is considered. Non-interest-bearing liabilities such as trade payables or guarantee provisions are not included in the calculation of the enterprise value. The market value of equity corresponds to the market capitalisation of all share categories (e.g. ordinary and preference shares) on the valuation date. Non-controlling interests are included in equity in the consolidated balance sheet under IFRS. They arise in the case of majority shareholdings of less than 100%. Since non-controlling interests are not included in the share price, they must be added separately to the market value of the equity in order to determine the enterprise value.

EBITDA is the corporate result before interest, income taxes, depreciation, and amortisation. This figure eliminates distortions caused by different capital intensities and different income tax rates. EBITDA (as well as EBIT) reflect the earnings power from the company's business activities. For the calculation of the value multiple, the

EBITDA reported in the income statement is adjusted for extraordinary and non-recurring income and expense items.[34]

Example: Calculation of the Enterprise Value EBITDA Ratio

The following information from the annual financial statements as of the end of December 2022 is available for Vega AG, a fictitious company operating in the steel industry (in EUR million):

Balance sheet	2022
Cash and cash equivalents	2108
Accounts receivable	3630
Inventories	1112
Other assets	7
Current assets	*6857*
Property, plant and equipment	11,173
Financial assets (no shareholdings)	9788
Intangible assets	5000
Fixed assets	*25,961*
Total assets	**32,818**
Accounts payable	2806
Short-term interest-bearing financial liabilities	1370
Guarantee provisions	2768
Long-term interest-bearing financial liabilities	13,216
Total liabilities	*20,160*
Share capital	1200
Additional paid-in capital	2658
Retained earnings	8340
Non-controlling interests	460
Total equity	*12,658*
Total liabilities and equity	**32,818**

Vega's share capital of EUR 1200 million consists of 800 million ordinary shares with a par value of EUR 1 and 400 million non-voting preference shares with a par value of EUR 1. The preference shares carry an interim dividend per share of EUR 0.05. As of the end of December 2022, the ordinary shares are traded at a price of EUR 20, while the preference shares have a price of EUR 15. For the year 2022, EBITDA amount to EUR 5962 million.

(continued)

[34] See Koller et al. 2010: *Valuation: Measuring and Managing the Value of Companies*, p. 317.

1. What is Vega's trailing EV/EBITDA multiple?
2. Is the Vega stock correctly valued if the trailing EV/EBITDA ratio of the peer companies is 6.5?

Solution to 1

The enterprise value of EUR 34,938 million can be calculated as follows:

Market value of ordinary shares (800 million shares × EUR 20)	EUR 16,000 million
+ Market value of preference shares (400 million shares × EUR 15)	+ EUR 6000 million
+ Book value of current financial liabilities	+ EUR 1370 million
+ Book value of non-current financial liabilities	+ EUR 13,216 million
+ Non-controlling interests	+ EUR 460 million
− Cash and cash equivalents	− EUR 2108 million
= Enterprise value	= EUR 34,938 million

The trailing EV/EBITDA ratio is 5.86:

$$\frac{EV_0}{EBITDA_0} = \frac{\text{EUR 34,938 million}}{\text{EUR 5962 million}} = 5.86.$$

Solution to 2

The Vega stock appears undervalued due to the lower EV/EBITDA ratio of 5.86 (versus 6.5).

The EV/EBITDA ratio is more suitable than the P/E ratio for comparing companies with different debt ratios because EBITDA, in contrast to net income, is a measure of earnings before deducting interest on borrowed capital and is therefore not influenced by the capital structure. Furthermore, EBITDA is often positive when the company's net income is negative. The use of the EBITDA in a multiple is carried out, in particular, in those valuation cases in which the lower earnings levels such as EBIT and net income are negative. Furthermore, the application of different depreciation methods across different companies does not affect EBITDA, while the comparability of EBIT and net income is affected. Since depreciation and amortisation are added to operating income (EBIT), the EV/EBITDA ratio is suitable for capital-intensive industries such as steel, utilities, and telecommunications, where major infrastructure investments are required. Companies in such industries have high depreciation charges. For example, mobile communications providers require significant capital expenditures in the expansion and maintenance of network infrastructure. The use of the EV/EBITDA ratio is more appropriate for such companies than the P/E ratio due to the capital-intensive investments and the long-term orientation of the business model.

A disadvantage of the EV/EBITDA ratio is that the free cash flows to firm have a stronger link to equity valuation than EBITDA. Only when depreciation and investments in fixed assets and net working capital cancel each other out are EBITDA and free cash flows to firm approximately equal.

The justified forward EV/EBITDA ratio can be calculated as follows [WACC > g].[35]

$$\frac{\mathrm{EV}_0}{\mathrm{EBITDA}_1} = \frac{(1-t) - \frac{\mathrm{Depr}_1(1-t)}{\mathrm{EBITDA}_1} - \frac{\mathrm{EI}_1}{\mathrm{EBITDA}_1}}{\mathrm{WACC} - g}, \tag{10.15}$$

where

t = income tax rate,
Depr = depreciation and amortisation of fixed assets, and
EI = expansion investments including investments in net working capital (EI = Capex − Depr + I NWC).

The formula demonstrates that the EV/EBITDA multiple is influenced by the following fundamental factors:[36]

- Income tax rate: With an increase (decrease) in the tax rate, the value multiple falls (rises), all else being equal.
- Depreciation and amortisation: The higher (lower) the level of depreciation and amortisation in EBITDA, the lower (higher) the EV-based multiple, all else being equal.
- Expansion investments: A larger (smaller) share of investments in net working capital and fixed assets less depreciation relative to EBITDA leads to a lower (higher) EV/EBITDA ratio, all else being equal.
- Weighted average cost of capital: A higher (lower) cost of capital results in a lower (higher) value multiple, all else being equal.
- Growth rate: If the expected growth rate increases (decreases) due to, say, a higher (lower) return on assets, the EV/EBITDA ratio increases (decreases), all else being equal.

Companies with a higher level of depreciation and amortisation in EBITDA trade at a lower EV/EBITDA ratio than companies whose depreciation and amortisation are of lesser importance. The same applies to companies with high capital expenditures compared to EBITDA. Accordingly, equity securities of capital- and depreciation-intensive industries, such as telecommunications, trade at a lower EV/EBITDA multiple than the stocks of less capital- and depreciation-intensive

[35] For the derivation of the formula, see Mondello 2017: *Aktienbewertung: Theorie und Anwendungsbeispiele*, p. 528 ff.

[36] See Frykman and Tolleryd 2003: *Corporate Valuation: An Easy Guide to Measuring Value*, p. 58.

industries (e.g. technology). Since individual industries have different value multiples, EV-based multiples of the same industry (and not of different industries) should be compared.

10.6 Summary

- Multiples can be categorised into price and value multiples. In the case of price multiples, both the numerator and the denominator have equity-related variables. The share price is set in relation to the earnings per share, the book value per share, or the free cash flows to equity per share. By contrast, value multiples consist of total capital-related variables. The enterprise value is divided by the EBIT, the EBITDA, the free cash flows to firm or by the sales.
- Company's fundamentals such as growth, expected cash flows, and risk influence the value of an equity security. Based on a one- or multi-stage cash flow model, the corresponding multiple for a mature or high-growth company can be derived. The intrinsic share value can be calculated if the multiple (e.g. P/E ratio) is multiplied by a company-specific variable that corresponds to the denominator of the multiple (e.g. earnings per share). A comparison with the traded share price makes it possible to assess whether the security is correctly valued. The multiple derived from a cash flow model can also be compared with the traded multiple of the stock in order to identify any mispricing.
- Multiples are usually applied with the comparables method. The analysis begins with two basic decisions, which relate to selecting the multiple and determining the comparable companies. The multiple is calculated for the company being valued and for the peer companies, subsequent to which an average (or median) value is calculated. In order to assess the share price, the multiples of the stock and the benchmark are compared. If the two multiples are apart, a subjective judgement can be made as to whether differences in fundamentals such as growth, expected cash flows, and risk can explain this discrepancy. If it is concluded that the differences in fundamentals do not justify the difference between the two multiples, the equity security is mispriced. In the event that the multiple of the security is higher (lower) than the corresponding benchmark multiple, the stock appears overvalued (undervalued).
- The P/E ratio can be calculated both with the earnings per share of the last 12 months (trailing P/E ratio) and with the expected next year's earnings per share (forward P/E ratio). The earnings per share are adjusted for non-recurring expenses and revenues. The P/E ratio is the most widely used multiple since earnings reflect the profitability of the company and thus represent the most important value driver of an equity security. However, reported after-tax earnings are distorted by the application and interpretation of the accounting standards used. Moreover, the earnings can be very volatile as well as negative.
- The P/B ratio is widely used in equity valuation. Unlike earnings, the book value of equity is less volatile and positive under the going-concern assumption. With very volatile and possibly negative after-tax earnings, the P/B ratio is more

meaningful than the P/E ratio. The P/B ratio is positively related to return on equity, earnings growth, and payout ratio. By contrast, the ratio is negatively affected by the expected return.

- Enterprise value-based multiples place the enterprise value in relation to a total capital-related variable such as EBIT, EBITDA, and sales. The enterprise value consists of the market value of equity and interest-bearing debt capital less cash and cash equivalents (including marketable securities with a term of less than 1 year).
- The EV/EBITDA multiple measures the ratio between the operating enterprise value and the operating income (EBIT) before deduction of depreciation and amortisation. Unlike the P/E ratio or the P/B ratio, this value multiple can be used to compare companies with different levels of debt-to-equity ratios.
- The expected growth rate, which depends on the return on total capital, among other things, has a positive effect on the EV/EBITDA ratio. On the other hand, the income tax rate, the share of depreciation and amortisation in EBITDA, expansion investments measured against EBITDA, and the WACC have a negative impact on the level of the multiple.

10.7 Problems

1. The following statements can be made on the use of multiples:
   1. Assuming falling after-tax earnings in next year, the forward P/E ratio is greater than the trailing P/E ratio if the share price remains unchanged.
   2. A value multiple consists of the ratio between the enterprise value and the operating income after interest and taxes.
   3. High positive P/E ratios or outliers (negative P/E ratios are not included in the analysis) lead to a right-skewed distribution of the multiples. Therefore, the median and not the arithmetic mean should be used for averaging the multiples.
   4. A permanent decrease in the return on equity leads to a decrease in the P/B ratio.
   5. An equity security trading at a price below book value per share is undervalued.
   6. The relationship between the enterprise value EBITDA multiple and investments in expansion projects and growth rate is positive.

Indicate whether each of the above statements is true or false (with justification).

2. An analyst examines the valuation of equity securities in the beverage industry. The benchmark companies have a forward P/E ratio of 20, which corresponds to the median of all positive P/E ratios of the peer companies. Earnings per share of CHF 4 are expected for the stock of Spring Water AG in the next year. The analyst calculates an intrinsic share value of CHF 80 (= 20 × CHF 4). A comparison with the traded share price of CHF 105 indicates that the share price is too high. Therefore, the security appears overvalued.
   a) Why can the conclusion that equity security is overvalued be wrong?
   b) What additional information about the equity security being valued and the benchmark is needed to support the conclusion that the security is overvalued?

3. The following information is available for the listed HeidelbergCement AG stock as of the end of December 2016 (Source: Refinitiv Eikon):

Dividend per share (for 2016)	EUR 1.60
Earnings per share (for 2016)	EUR 3.66
Share price	EUR 88.63
Book value per share	EUR 81.11
Historical beta	1.09

It is assumed that the company will grow in perpetuity based on 2016 fundamentals. The company's return on equity is 4.6%, while the earnings retention rate is 56%. The yield to maturity of 30-year bonds of the Federal Republic of Germany is 1.1%. The expected market risk premium for Germany is 7%.

a) What is the justified trailing P/E ratio of the HeidelbergCement stock and is the security correctly valued?
b) What is the justified trailing P/B ratio of the HeidelbergCement stock and is the security correctly valued?

4. The following information is available for the listed Linde stock at the beginning of 2017 (Source: Refinitiv Eikon):

Dividend per share (for 2016)	EUR 3.70
Earnings per share (for 2016)	EUR 6.50
Share price	EUR 165.74
Book value per share	EUR 78.52
Historical beta	0.89

The company is assumed to grow in perpetuity based on its 2016 fundamentals. The return on equity is 8.9%. The yield to maturity of 30-year bonds of the Federal Republic of Germany is 1.1%. The expected market risk premium for Germany is 7%.

a) What is the justified P/E ratio of the Linde stock and is the security correctly valued?

b) What is the justified PEG ratio of the Linde stock and is the security correctly valued?
c) What is the justified P/B ratio of the Linde stock and is the security correctly valued?

5. For the 'airlines' sub-sector (GICS), the following global peer companies are given in order of market capitalisation with the corresponding trailing P/E ratios, expected annual earnings growth rates for the next 4 years, and betas as at the end of October 2017 (Source: Refinitiv Eikon):

Company	Trailing P/E ratio	Earnings growth rate	Beta
Delta Air Lines	10.1	7.4%	1.28
Southwest Airlines.	15.7	15.9%	1.32
American Airlines Group	12.0	5.6%	0.98
Ryanair Holdings	13.5	8.0%	1.01
Air China	17.5	9.8%	1.44
United Continental Holdings	8.5	8.2%	1.01
International Consolidated Airlines	8.1	16.2%	0.85
Deutsche Lufthansa	7.2	1.1%	0.82
ANA Holdings	10.6	11.2%	0.63
China Eastern Airlines	17.8	14.4%	1.06
Japan Airlines	8.2	−5.9%	0.54
China Southern Airlines	18.3	11.9%	1.40
Arithmetic mean	12.3	8.7%	1.03
Median	11.3	9.0%	1.01

Is the Deutsche Lufthansa correctly valued based on the comparables method? (The median should be taken for this analysis.)

10.8 Solutions

1.

1. The first statement is true. The relationship between the P/E ratio and earnings per share is negative. Since lower after-tax earnings are expected in the future, the forward P/E ratio is greater than the trailing P/E ratio.
2. The second statement is false. In a value multiple, the numerator comprises the enterprise value (market value of equity and interest bearing-debt less cash and cash equivalents), while the denominator includes a total capital-related variable, not an equity-related variable. After-tax earnings represent a quantity that is related to equity. By contrast, EBIT and EBITDA are total capital-related variables that can be allocated to all capital providers (and not just equity providers).

3. The third statement is true. Since only positive P/E ratios are included in the relative valuation analysis, a right-skewed distribution results due to outliers. To solve the problem of outliers in the data, the median can be used as an average value instead of the arithmetic mean.
4. The fourth statement is true. A decline in the return on equity has a negative impact on the level of the P/B ratio.
5. The fifth statement is false. If the return on equity is above the expected return of the shareholders, then a stock with a price-to-book ratio of less than 1 appears undervalued. If, on the other hand, the return on equity is below the expected shareholders' return, the security is correctly valued.
6. The sixth statement is false. The relationship between the EV/EBITDA multiple and investments in expansion projects is negative. Only the relationship with the growth rate is positive.

2.

a)

The conclusion that the stock is overvalued may be wrong for the following reasons:

The benchmark stocks of the beverage industry sector are undervalued. The average value of the forward P/E ratio of 20 is therefore too low, and as a result, the calculated intrinsic share value of Spring Water of CHF 80 is too low.

The fundamental factors consisting of earnings growth rate, earnings payout ratio, and risk are different for the stock and the benchmark. For example, the Spring Water stock may be correctly valued if the expected earnings growth rate is higher and the risk is lower than the corresponding average values of the benchmark companies. Accordingly, in order to calculate the intrinsic share value, the average forward P/E ratio of 20 must be adjusted upwards.

b)

The conclusion that the Spring Water stock is overvalued can be maintained if:

- The peer companies are correctly valued on average.
- There are no significant differences in fundamentals between the stock being valued and the benchmark.

3.

a)

The fundamental earnings growth rate is 2.58%:

$$g = 0.56 \times 4.6\% = 2.58\%.$$

The adjusted beta of the stock of 1.06, and the expected CAPM return of 8.52% can be calculated as follows:

$$\beta_{\text{Adjusted}} = 0.333 + 0.667 \times 1.09 = 1.06,$$

$$E(r) = 1.1\% + 7\% \times 1.06 = 8.52\%.$$

The justified trailing P/E ratio of the HeidelbergCement stock is 7.6 and can be determined with the following equation:

$$\frac{P_0}{E_0} = \frac{0.44 \times 1.0258}{0.0852 - 0.0258} = 7.6.$$

The trailing P/E ratio is 24.2 (= EUR 88.63/EUR 3.66). Therefore, the HeidelbergCement stock appears overvalued.

b)

The justified trailing P/B ratio of the HeidelbergCement stock is 0.34 and can be calculated with one of the two equations below:

$$\frac{P_0}{B_0} = \frac{\text{ROE}(1-b)}{E(r)-g} = \frac{0.046 \times (1-0.56)}{0.0852 - 0.0258} = 0.34$$

or

$$\frac{P_0}{B_0} = \frac{\text{ROE} - g}{E(r)-g} = \frac{0.046 - 0.0258}{0.0852 - 0.0258} = 0.34.$$

The justified P/B ratio of 0.34 is below the traded P/B ratio of the HeidelbergCement stock of 1.09 (= EUR 88.63/EUR 81.11), with the result that the equity security appears overvalued.

4.
a)

The adjusted beta of 0.93 and the expected CAPM return of 5.84% can be calculated as follows:

$$\beta_{\text{Adjusted}} = 0.333 + 0.667 \times 0.89 = 0.93,$$

$$E(r) = 1.1\% + 7\% \times 0.93 = 7.61\%.$$

The earnings payout ratio is 0.5692 (= EUR 3.70/EUR 6.50), while the fundamental earnings growth rate is 3.83% [= (1 − 0.5692) × 8.9%].

The justified trailing P/E ratio of 15.63 can be calculated as follows:

$$\frac{P_0}{E_0} = \frac{0.5692 \times 1.0383}{0.0761 - 0.0383} = 15.63.$$

The intrinsic share value of EUR 101.60 is arrived at by multiplying the justified trailing P/E ratio of 15.63 by the earnings per share of EUR 6.50:

$$P_0 = 15.63 \times \text{EUR } 6.50 = \text{EUR } 101.60.$$

The intrinsic share value of EUR 101.60 is lower than the traded share price of EUR 165.74. The Linde stock, therefore, appears to be overvalued. The same conclusion is reached when the trailing P/E ratio of Linde stock of 25.5 (= EUR 165.74/EUR 6.50) is compared with the justified trailing P/E ratio of 15.63.

b)

The justified PEG ratio of 4.08 can be determined with the following equation:

$$\text{PEG} = \frac{0.5692 \times 1.0383}{0.0383 \times 100 \times (0.0761 - 0.0383)} = 4.08.$$

If the stock's trailing P/E ratio of 25.5 (= EUR 165.74/EUR 6.50) is divided by the long-term expected earnings growth rate of 3.83% multiplied by 100, the result is a PEG ratio of 6.66. Accordingly, Linde stock appears to be overvalued based on the PEG ratio.

c)

The justified trailing P/B ratio of the Linde stock is to 1.34:

$$\frac{P_0}{B_0} = \frac{\text{ROE}\,(1-b)}{E(r)-g} = \frac{0.089 \times 0.5692}{0.0761-0.0383} = 1.34$$

or

$$\frac{P_0}{B_0} = \frac{\text{ROE}-g}{E(r)-g} = \frac{0.089-0.0383}{0.0761-0.0383} = 1.34.$$

Due to the calculated P/B ratio of 1.34, Linde shares must trade at a price that is higher than the book value per share because the return on equity of 8.9% exceeds the expected return of 7.61%. For example, at the beginning of 2017, the Linde share price is EUR 165.74, while the book value per share is EUR 78.52.

The justified P/B ratio of 1.34 is lower than the traded P/B ratio of Linde shares of 2.1 (= EUR 165.74/EUR 78.52), and therefore the equity security appears overvalued.

5.

As at the end of October 2017, the equity security of Deutsche Lufthansa has a trailing P/E ratio of 7.2, which is lower than the benchmark median of 11.3. Therefore, the security appears undervalued. However, an earnings growth rate of 1.1% which is lower than the benchmark growth rate of 9% suggests that the lower valuation is justified. When the stock's beta of 0.82 is included in the analysis, which is below the median of 1.01, a higher valuation appears appropriate, supporting the conclusion from the P/E comparison that the airline stock is undervalued.

As the inclusion of the differences in fundamentals in the relative valuation analysis leads to different results, the conclusion from the comparison of the P/E ratios cannot be confirmed that the Deutsche Lufthansa stock is undervalued. Therefore, a further analysis using additional multiples and valuation models is necessary.

References

Bank of America Merrill Lynch: Annual Institutional Factor Survey, United States, pp. 1−27 (2012)

Barker, R.: Determining value: valuation models and financial statements, Harlow (2001)

Damodaran, A.: Investment valuation: tools and techniques for determining the value of any asset, 3rd edn, Hoboken (2012)

Fairfield, P.M.: P/E, P/B and the present value of future dividends. Financial Anal. J. **50**(4), 23–31 (1994)
Fama, E.F., French, K.R.: The cross-section of expected stock returns. J. Finance. **47**(2), 427–465 (1992)
Fama, E.F., French, K.R.: Value versus growth: the international evidence. J. Finance. **53**(6), 1975–1999 (1998)
Frykman, D., Tolleryd, J.: Corporate valuation: an easy guide to measuring value, Harlow (2003)
Glenn, M.: How to value shares and outperform the market. Petersfield Hampshire (2011)
Graham, B., Dodd, D.L.: Security analysis, New York (1934)
Hasler, P.T.: Aktien richtig bewerten, Berlin (2013)
Koller, T., Goedhart, M., Wessels, D.: Valuation: measuring and managing the value of companies, 5th edn, Hoboken (2010)
Martin, T.A.: Traditional equity valuation methods. In: Larrabee, D.T., Voss, J.A. (eds.) Valuation techniques, pp. 155–176, Hoboken (2013)
Mercedes-Benz Group: Annual Report 2021, Stuttgart (2022)
Mondello, E.: Aktienbewertung: Theorie und Anwendungsbeispiele, 2nd edn, Wiesbaden (2017)
Pinto, J.E., Henry, E., Robinson, T.R., Stowe, J.D.: Equity asset valuation, 2nd edn, Hoboken (2010)
Reilly, F.K., Brown, K.C.: Investment analysis and portfolio management, 7th edn, Mason (2003)

Online Sources

FTSE Russell: Industry Classification Benchmark (ICB). https://www.ftserussell.com/data/industry-classification-benchmark-icb. Accessed 30 June 2022
MSCI: The Global Industry Classification Standard (GICS®). http://www.msci.com/products/indices/sector/gics (2022). Accessed 30 June 2022